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MANAGER'S REPORT NO.	87
COUNCIL MEETING	1978 12 11

RE: LOCAL IMPROVEMENT PROGRAM
CONSTRUCTION ON STILL CREEK STREET

Following is a report from the Municipal Engineer regarding the construction of Still Creek Street.

RECOMMENDATION:

1. THAT the report of the Municipal Engineer be received for information purposes.

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TO: MUNICIPAL MANAGER 78 12 06

FROM: MUNICIPAL ENGINEER

SUBJECT: L.I.P. CONSTRUCTION ON STILL CREEK STREET

RECOMMENDATION:

1. THAT this report be received for information purposes.

REPORT

This report is submitted in response to an enquiry from Council at its Meeting of 78 11 06, regarding the uneven pavement on Still Creek Street west of Douglas Road.

As Council is aware, Still Creek Street is situated in the area of Burnaby known as the "Central Valley". The geology of this valley is characterized by glacial and glacio-marine deposits which were laid down over bedrock during and following the last period of glaciation. Subsequently, soft and compressible recent sediments were laid down through infilling and peat growth along the margins of Still Creek which drains the Central Valley to Burnaby Lake. It is the soil characteristics of this area which give rise to the special considerations necessary for all construction in the "peat terrain". Several public works projects are presently in progress in this area and, in order that Council may be fully informed, we would take this opportunity to incorporate this report to cover some of the more general aspects of "poor" ground construction.

While the ground conditions do vary throughout the valley, they can be summarized in the following manner. Soft black fibrous peat is underlain by brown to green amorphous peat which in turn is followed by very soft to soft silts and clays. The soft silty stratum is underlain by compact to dense post-glacial and glacial sandy soils. The variation in the soil conditions throughout the valley is principally the variation in the thicknesses and depths at which each of the above stratum occur; however, typical sections in the region of Still Creek Street would be as follows:

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Fibrous Peat	- 8 - 10 feet thick
Amorphous Peat	- 5 - 7 feet thick
Soft Clayey Silt	- 12 - 18 feet thick

The upper fibrous peat deposit is soft and highly compressible, the amorphous peat layer is likewise highly compressible but contains few fibrous partings and, therefore, behaves more as granular material than does the fibrous peat. The soft grey clayey silt which underlies the peat is sensitive to disturbance and is also soft and compresssible. Because the organic peat stratum and the clayey silt are highly compressible, they have limited supporting capacity and large settlements will result from loading.

The physical characteristics of the soil conditions in the area have been recognized for some time and are taken into consideration prior to construction of any public works project in the area. Projects presently either in progress or at the design stage in the Central Valley are Local Improvement Paving of Still Creek Street from Douglas to dead end west, Local Improvement Project construction of Norland Avenue from Douglas to Laurel, grade preparation of Norland (unopened section) from Laurel to Sprott, development of new Service Centre site and Still Creek Street extension from the present dead end west of Douglas through to the connection from the Eastbrook Industrial Site east of Willingdon, and the connection of Westminster Avenue between Regent Street and Still Creek Street. For the Still Creek Street Local Improvement Project and the two Norland Avenue projects we have retained R.F. Binnie Ltd. to provide road design and construction supervision services. Soils advice has been obtained from Golder Associates who have been retained on a subconsultant basis. Golder Associates are one of the recognized soils specialist firms in the area and their personnel have worked closely with R.F. Binnie Ltd. and Burnaby's Engineering Department staff on all of these and other projects. In addition to consideration of the ground conditions, each project must be examined and reviewed with consideration being given to all other existing circumstances. These circumstances include existing abutting development, current useage, underground services, etc. If no limiting circumstances exist other than the ground conditions, then the most practical construction treatment is utilization of a preconsolidation procedure. Treatment by preloading or pre-consolidation, the terms being practically interchangeable in this instance, is the method which is being successfully utilized on the unopened section of Norland Avenue. This section of Norland Avenue has no abutting development and no installed services to rule out acceptance of the preferred preconsolidation procedure.

The technique of preloading for construction on peat and associated soft soils consists of loading slowly during construction until the soft soils are surcharged and compressed under a load greater than they will receive in service. The excess load is left in place until the ultimate settlement that would occur under the final load condition has been reached. The process of consolidation is then well advanced and the soil may be termed "preconsolidated". Finally, the excess load is removed and construction completed. The end result of preloading is increased shear strength and reduced settlement in the soft soils after construction. The initial low shear strengths of the organic and silty soils limit the amount of surcharge which may be placed without causing failure. The long term loading is reduced by the use of lightweight fills such as hog fuel and lightweight fills also have the advantage of becoming buoyant as they settle below the groundwater level. It is precisely this technique which is being utilized on the unopened section of Norland Avenue. On average, we placed 4 feet of hog fuel, 4 feet of subgrade mineral fill and 3 feet of sur-charge material which will ultimately be removed. This gave an initial combined fill height of approximately 11 feet and the settlement in turn has been in the order of 5 to 6 feet with some minor

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local variations. This preloading operation has been in place for approximately one year and has exhibited classical conformation to the theoretical settlement curve. It is now at a point on the settlement curve where a decision has been made to remove the surcharge and proceed with completed road construction next spring.

We have provided the above example to illustrate how peat conditions can be treated when there are no or only a few limiting factors; however, turning our attention to Still Creek Street west of Douglas (the original point of enquiry) and also to Norland Avenue from Douglas to Laurel it can be readily appreciated that placement of eleven feet of fill on an existing industrial street is not a viable alternative. We could not reasonably hope to maintain traffic and critical access under such construction procedures, we cannot shut down the industries, and 6 feet of settlement could not be tolerated on existing services such as gas lines and watermains without severe incidences of rupture. Settlements, due to consolidation of the peat stratum, could be eliminated by complete subexcavation of the peat and replacement with granular fill; however, the bearing capacity of the underlying silty deposit is insufficient to support the additional weight of the granular fill required while the magnitude of immediate and long term settlements due to the consolidation of the clayey silt deposit would be increased due to the additional fill loads. Further, severe construction problems are usually experienced in maintaining excavations in peaty soils prior to backfilling. An alternative road construction method could have been the utilization of precast concrete slabs or truss sections structurally supported on piles. The advantage of this sytem is that no preloading is required to provide a satisfactory pavement with negligible settlements; however, any fill placed adjacent to the piled structure following its installation would settle differentially with respect to the pavement in addition to increasing the load on the piles due to negative skin friction actions. Because of this access ramps to adjacent properties would probably have had to be pile-supported also. The major drawback to this type of pavement would be the extremely high initial capital cost. The concept of pile-supported structures is one utilizied, by necessity, for buildings in this area and on Still Creek Street is the method of installation which we adopted for the construction of the storm and sanitary sewers with are, of course, grade-dependent. Pile-supported structures permit surrounding ground settlement while they maintain their original elevations. For this reason and the one of extremely high cost, the use of the "structural" road was ruled out.

Having given consideration to all influencing factors, it was felt that the best compromise solution for road construction on Still Creek Street was to limit the amount of road make-up material placed and to enter into a staged operation with a "planned maintenance" program. Settlements in peat conditions can be considered in two parts - primary consolidation and secondary or residual consolidation. The preloading technique described above for the previously unopened Norland Avenue will eliminate the adverse effects from primary settlement over a relatively short period of time; however, some long term secondary settlements will occur which will result in differential grade changes. These secondary settlements are virtually unavoidable but occur over a period of many years and are relatively minor in proportion to the intial primary settlement. The staged operation adopted for Still Creek Street was to place a minimum amount of base materials (both gravel and asphalt) and delay further construction to permit primary consolidation to take place.

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As previously mentioned, the sewers on Still Creek Street are pile-supported to maintain grade and it is the sewer connections' rigidity relative to the adjacent settlement which creates the differential settlement which in turn accentuates the "up and down" effect. It was fully recognized that a maintenance program would be required during the primary settlement period and additional temporary catch basins have been installed at the settled low points to facilitate drainage. The time rate and magnitude of settlement is very difficult to forecast because, in peat soils, the coefficient of consolidation is not constant and, also, uncertainty exists regarding the field permeability, both horizontally and vertically.

The average settlement which has occured on Still Creek Street is in the order of 6 to 9 inches which, although fairly minor compared to the 6 feet realized on the previously unopened section of Norland Avenue, is more visible on an opened and heavy trafficked street. Also, the settlements are of such a magnitude that simply to fill in and level out the differential settlements would only increase the loading and perpetuate the problem; it is therefore necessary that we consider using a modified preconsolidation procedure, the use of some surcharge fill and possibly the adjustment of high points. After expected settlements have been reached through the modified preconsolidation procedure, all excess surcharge will be removed and the final asphaltic pavement placed. Asphalt presently in place will remain as an integral part of the road base structure. There will be secondary settlements (residual) but it is anticipated that these will be contained within manageable limits.

With respect to Norland Avenue between Douglas Road and Laurel Street, it is our intention to place a minimum additional loading on the roadway as soon as practicable and to continue to monitor settlements in order to establish the most appropriate manner in which to complete the project. It had been our intention until very recently to utilize a modified preconsolidation procedure for Norland Avenue but there appears to be a reasonably good chance of avoiding the very costly and traffic-disruptive procedures inherent in the preconsolidation method. The minimum additional loading referred to above will likely be a nominal 1½ inch thickness of asphaltic concrete. It should be noted that the Engineering Department and, more directly, our Consultant Mr. Binnie, have kept the Norland Avenue property owners apprised of happenings on their street as plans have been developed and amendments made to those plans.

SUMMARY

1. Road construction in highly unstable ground as is prevalent in the Central Valley is not an exact science. However, engineering soil consultants generally recommend using a preconsolidation process, e.g. 11 feet of hog fuel and fill, such as was utilized on Norland Avenue from Laurel to Sprott (previously unopened section).

2. The process as mentioned in #1 is not feasible on a developed and very traffic-active street such as Still Creek Street or Norland Avenue from Douglas to Laurel, so a "compromise" process must be adopted; this is what was done on Still Creek Street.

3. The "compromise" process mentioned in #2 is a staged process and Still Creek Street at present is at the end of Stage I and in a condition not unexpected under the circumstances. However, the differential settlements were of a greater magnitude than anticipated.

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4. Norland Avenue from Douglas Road to Laurel Street will be treated with a minimum additional loading which will permit settlements to be monitored before making the decision on the best method of completing the project. It may thus be possible to save a great deal of money over the use of preconsolidation procedures.

This report is for the information of Council.

E E Olsen
MUNICIPAL ENGINEER

EEO/WCS/ch