GEOTECHNICAL EVALUATION
PROPOSED CANMORE RESIDENTIAL
SUBDIVISION AND HIGHWAY
COMMERICAL AREA

Submitted to:

Engineering Canada Associates

by

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10-038

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Assignment

Findings of a geotechnical evaluation conducted at a proposed residential and highway commercial development in Canmore, Alberta are presented in this report. The report was prepared to meet requirements outlined in a verbal request from Mr. Bryan Scott, P. Eng., of Engineering Canada Associates acting on behalf of the Alberta Housing Corporation. The work has been carried out in accordance with the approach and level of effort outlined in M. J. O'Connor & Associates Ltd. Proposal No. 20-027.

1.2 Scope

A decision has been made to develop residential and industrial subdivisions and highway commercial areas within the Town of Canmore on the east side of the Trans-Canada Highway. The varied terrain types and topographic features in the project area have made necessary the establishment of development guidelines.

M. J. O'Connor & Associates Ltd. was commissioned to carry out a geotechnical evaluation of the proposed residential subdivision and highway commerical areas and a hydrogeological investigation of the Cougar Creek alluvial fan. The purposes of the studies were to map and describe topographical, geological and hydrogeological features, to make preliminary recommendations pertaining to site development including site grading and site drainage and to present preliminary recommendations regarding foundation design, roadway and subsurface utility installation and design.

Weekly groundwater monitoring is currently being carried out and will continue until the end of June 1980, at which time the monitoring schedule will be reviewed.

1.3 Project Methodology

M. J. O'Connor & Associates Ltd. initiated the investigation by compiling and evaluating available geologic data and by analyzing aerial photographs of the project area. Literature reviewed included Geological Survey of Canada Bulletin 206 "Geomorphology and Multiple Glaciation in the Area of Banff, Alberta" and a report on the industrial subdivision area prepared by EBA Engineering Consultants Ltd. in September 1979. This preparatory work was followed by an intensive field program which included the installation of piezometers, and the excavation of backhoe test pits and hand auger holes. Concurrent with these activities, a detailed site reconnaissance was carried out by an engineering geologist. The following report documents the results of the entire investigation and makes recommendations regarding future development of the study area.

1.4 Report Format

The report consists of seven sections and four appendices. Following the introduction, Section 2.0 describes the field exploration and laboratory testing programs. Section 3.0 summarizes the physical setting of the study area with respect to geomorphology, geology and hydrogeology. Site features, summary and conclusions and development considerations are presented in Sections 4.0, 5.0 and 6.0 respectively.

Appendix A contains site plans including those illustrating the geo-morphological and cultural features. Borehole, test pit and hand auger hole logs are enclosed in Appendix B. Appendix C contains a photographic record of the study area and Appendix D presents the laboratory test results.

2.0 FIELD EXPLORATION AND LABORATORY TESTING PROGRAMS

The piezometer installation program involved the drilling of seven (7) boreholes to depths ranging from 9.1 to 11.9 metres. A Becker percussion hammer rig was used to advance the boreholes. The Becker system involves the driving of a double walled casing into the ground using a single acting diesel hammer. Compressed air is circulated in order to bring cuttings to the surface. Piezometers consisted of perforated 3.8 centimetre diameter PVC pipes wrapped in filter cloth to prevent plugging. The piezometer tips were sand packed and the upper ends protected with 7.6 centimetre diameter casings and caps. The piezometers are designated P1 to P7. An existing piezometer, presumably installed for an earlier investigation, was discovered during the site reconnaissance. This installation, which is in excess of thirty (30) metres deep, will be monitored during the current program and has been designated P8.

A Case 580C backhoe was utilized to excavate a total of twenty (20) test pits. The pits, designated TP 1 to TP 20, average 3.0 metres in depth. A standpipe piezometer was installed in TP 20 to facilitate groundwater monitoring. Representative samples were taken at various depths in each pit before they were backfilled. In areas which were inaccessible

to the backhoe, hand auger holes, designated HA 1 to HA 19, were drilled and sampled. Depths of the hand auger holes ranged from 0.5 to 1.0 metre. Coarse gravel materials precluded the drilling of deeper holes. With the exception of TP's 1, 2 and 20, all test pits and hand auger holes were dry upon completion.

Approximate locations of all piezometers and sampling points are shown on Drawing No. A-1, Appendix A. Borehole and test pit logs and hand auger hole descriptions are contained in Appendix B.

The mapping of surface features in the study area was accomplished during the field reconnaissance. Particular attention was given to sloping terrain and natural soil exposures. Survey methods appropriate for reconnaissance level studies were employed. Angles of inclination were measured with a Brunton compass equipped with an inclinometer. All data points were located on aerial photographs and a photographic record of the field reconnaissance was maintained. Selected photographs of significant site features are included in Appendix C.

Laboratory tests were performed on a representative samples to determine natural moisture contents, grain size distributions and water soluble sulphate concentrations. Test results are tabulated in Appendix D.

3.0 PHYSICAL SETTING

3.1 General

The study area is located in the Bow River Valley at the base of Fairholme Range. It occupies parts of Sections 28, 33 and 34, Township 24, Range 10, West of the 5th Meridian within the Town of Canmore Boundary and part of Section 4, Township 25, Range 10, north

of the town boundary. The proposed residential and highway commercial areas occupy approximately 300 hectares and have a highly irregular shape. The site is bordered on the west by the Trans-Canada Highway and on the southeast by Cougar Creek. The remaining site boundaries trend either along or parallel to section lines or on random alignments. The maximum elevation difference within the site is approximately 185 metres, with the lowest point (elevation 1310 metres) adjacent to the Trans-Canada Highway near the southwest corner of the site, and the highest point (elevation 1495 metres) along the northwest boundary line. Figure 1 shows the site boundaries and the proximity of the site to the Town of Canmore.

3.2 Geology

3.2.1 Bedrock Geology

The project area is situated in the Front Ranges of the Southern Rocky Mountains. Mississippian and Devonian rocks consisting principally of resistant limestone and dolomite are dominant in this area, but bedrock structure is not a factor in the physical character of the site.

3.2.2 Surficial Geology

The topographic features of the project area are the result of glacial deposition followed by postglacial erosion and deposition. Glaciofluvial outwash deposits form a gently sloping terrace along the west wall of the Bow River Valley. These materials were deposited by streams emanating from glacial ice ablating toward the north. Major erosion

FIGURE 1

SITE PLAN

CANMORE SUBDIVISION

associated with the development of the Bow River Valley resulted in the formation of the prominent west facing slopes along the lower margin of the glaciofluvial deposits. Subsequent stream erosion has resulted in the dissection of these deposits, the main topographic features being those associated with Cougar Creek and a major gully near the north end of the site.

Recent or postglacial deposition is associated mainly with fluvial and mass wasting processes. Colluvial materials have collected at the bases of many of the steeper glaciofluvial slopes. Fluvial materials in the study area exist as alluvial fills and alluvial fans associated with intermittent streams. These streams have eroded gullies which are aligned transverse to the trend of the glaciofluvial deposits. In addition, alluvial flood plain deposits of the Bow River Valley exist on the west side of the site.

3.3 Hydrology

The major hydrologic feature in the Canmore area is the Bow River which flows in a braided pattern along the west side of the valley. Within the study area itself, the main hydrologic feature is Cougar Creek which flows intermittently in a southwest direction into the Bow River. Cougar Creek has a drainage basin roughly 4200 hectares in area. An unnamed intermittent stream which drains a small area on the west side of the Fairholme Range exists near the top of the study area above the cemetery.

3.4 Hydrogeology

Groundwater conditions are currently being monitored at eight locations at the site. Table 1 summarizes the results of the monitoring program.

TABLE 1

Canmore Subdivision Piezometers

Piezometer Number	Depth of Groundwater Below Surface (m)						
	May 14	May 21	May 28	June 5	June 11	June 20	June 27
P1	dry @ 10.4	dry	dry	dry	dry	dry	dry
P2	dry @ 9.1	dry	dry	dry	dry	destroyed	destroyed
P3	dry @ 9.1	dry	dry	dry	dry	dry	dry
P4	dry @ 12.0	dry	dry	dry	dry	dry	dry
P5	dry @ 10.4	dry	dry	dry	dry	dry	dry
P6	dry @ 9.1	dry	dry	dry	dry	dry	dry
P7	dry @ 10.9	dry	dry	dry	dry	dry	dry
P8			27.5	25.8	23.7	24.9	25.5
TP20			2.6	2.7	2.6	2.7	2.8
*Cougar Creek (estimated flow)	dry	dry	dry	dry	dry	dry	dry

*Measured at Trans Canada Highway Culvert

As indicated in the table, presently groundwater occurs at a relatively shallow depth in the flood plain area and at greater depths in the Cougar Creek alluvial fan. Monitoring of the piezometers should continue through the spring of 1981 in order to determine seasonal groundwater fluctuations.

4.0 SITE FEATURES

4.1 General

The site has a number of terrain types each with unique physical features and soil materials that will have an influence on site development. Drawing No. A-2 indicates the locations and spacial relationships of the various terrain types in the study area. Descriptions of the terrain units are presented in Table 2. In addition to natural features, a number of cultural features were noted at the site. Cultural features are defined as those site elements that were constructed or those landscapes that were altered by man. The following subsections present descriptions of the various terrain types and the pertinent physical and cultural features.

4.2 Alluvial Fans

The Cougar Creek alluvial fan is a relatively large feature that occupies much of the proposed residential and highway commercial areas as well as the entire proposed industrial area. Cougar Creek has been confined to its present course by a series of gravel and boulder dykes. Abandoned stream channels with a characteristic braided pattern are present on both sides of the existing channel, and are generally devoid of vegetation. These abandoned channels are readily discernable on

TABLE 2

CANMORE SUBDIVISION TERRAIN TYPES

Symbol	Unit Name	Unit Description	Material Description
A	Alluvial Fill	Steep gradient braided stream bed deposits. Associated with intermittent streams.	Coarse gravel, cobbles and boulders.
AFD	Alluvial Fan Deposit	Fan-shaped deposit with its apex pointing upstream and with a convex slope. Associated with intermittent streams.	Light grey coarse gravel with trace to some silt and sand, trace to some cobbles and boulders, dense, well-drained.
C	Colluvium	Heterogeneous unsorted material accumulated at the base of steep slopes bordering the flood plain. A result of mass-wasting processes. Interfingers with inactive flood plain deposits and alluvial fan deposits.	Brown gravel with some sand and cobbles, trace of silt.
GFD	Glaciofluvial Deposits	Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice.	Predominantly grey or light brown gravel with sand and silt lenses, some cobbles and boulders. Gravels mainly unconsolidated, poorly to well-sorted dolomite and limestone subrounded to rounded.
IFP	Inactive Flood Plain	Includes the flat portion of a river valley existing as low alluvial terraces adjoining the active flood plain of braided rivers.	Interbedded silt and fine sand overlying gravel.
T	Bow Valley Till	A thick cover of steeply sloping lodgement till deposited on bedrock. Modified by slope washing and often masked by colluvium.	Sandy clay with some gravel.

aerial photogrpahs and can be seen on Drawing No. A-2. The fan slopes at an average of 4 degrees along its longitudinal axis and has a convex shape inclined at 5 to 6 degrees toward the fan margins.

In general, the surficial soils in the Cougar Creek alluvial fan are composed of coarse gravels with some silt and sand and trace to some cobbles and boulders. The coarser materials, cobbles and boulders, often predominate in the existing creek channel and the recently abandoned channels. Thin discontinuous layers of silt and sand are common throughout the upper gravel section. The gravels are subangular to subrounded, dry to damp, moderately well stratified and have a dense to very dense consistency. An identifiable organic topsoil layer is present only in scattered locations. Fill materials exist in the form of gravel dykes bordering the existing creek channel. Because of the granular nature of the fan deposits, surface drainage is excellent. Ponding of surface water does not commonly occur on the fan.

Cultural features on the Cougar Creek fan include the dykes along the existing creek channel, three concrete box culverts under the Trans-Canada Highway, two rectangular borrow areas along the highway, a power transmission line right-of-way and a small cabin with out-buildings near the entrance to the cemetery access road. With the exception of the existing and recently abandoned stream channels, the old borrow areas and the power line right-of-way, the Cougar Creek fan is covered with a moderate density of coniferous trees.

Another small alluvial fan exists at the base of a gully near the north end of the study area. The Town of Canmore cemetery is located on the south margin of the fan where it overlaps onto the Cougar Creek fan. There is no indication of surface water flow over the fan in recent years as evidenced by a grave marker dated 1893. Surficial soils in the small fan consist mainly of silts and sands which indicate a lower energy depositional environment than that of the Cougar Creek fan.

4.3 Alluvial Fill Deposits

Alluvial fill deposits exist at two locations in the study area as shown on Drawing No. A-2. The confines of Cougar Creek alluvial fill are readily discernable in the field and in aerial photographs, however, the margins of the alluvial fill terrain located in the erosional gully above the small fan are masked by dense vegetative cover. The alluvial fill deposits are associated with relatively steep gradient, intermittent streams and consist of coarse gravel, cobbles and boulders. The contacts between the alluvial fill and alluvial fan terrain types are often indistinct and have not been shown on Drawing No. A-2.

4.4 Glaciofluvial Deposits

The glaciofluvial deposits form the uplands part of the study area and make up a large portion of the proposed residential subdivision. These deposits are bordered on the east by steeply sloping glacial till materials and on the west by the various alluvial and colluvial terrain types. As noted in Section 3.0, the glaciofluvial deposits are incised by two major east-west erosional features and a number of smaller randomly oriented gullies. In general, the terrain slopes at 5 to 10 degrees toward the Bow River Valley. Gully side slopes range from 15 to 30 degrees in most areas and from 40 to 80 degrees along the north side of the Cougar Creek Valley. The exposed slopes overlooking the Town of Canmore are inclined at 25 to 30 degrees and have a rolling profile.

The most anomolous topographic features of the glaciofluvial deposits are the hoodoos which have developed above the cemetery and which are currently forming along the north side of the Cougar Creek Valley. These pillars of cemented coarse gravel and cobbles have developed through differential erosion and/or solution of horizontal strata, probably as a result of heavy concentrated rainfall.

Several excellent exposures of the glaciofluvial deposits exist in the study area, including: the escarpment bordering the Cougar Creek Valley, the hoodoos above the cemetery, an earth fall on the exposed western slope and a small borrow pit adjacent the Cougar Creek alluvial fan. Soil materials are predominantly grey to light brown, fine to coarse gravel with some sand and cobbles and traces of silt and boulders. Exposed sections reveal horizontal stratification with discontinuous sand lenses. Gravel and cobbles are exposed on the steeper sloping terrain while the gently sloping upland areas often have a thin veneer of silt and fine sand. A thin organic topsoil layer is common in all areas but the steepest slopes. The hoodoo formations are highly cemented by a calcareous agent, but the majority of the deposits appear to be unconsolidated. It is postulated that a process of selective cementation occurred contemporaneous with or subsequent to the deposition of these materials.

In general the glaciofluvial deposits in sloping areas are stable. Only one location was noted in which substantial downslope movement has occurred. This area is along the exposed slope between the small borrow pit and Test Pit No. 7. The instability is classified as an

earth fall in which granular materials have migrated downslope by free fall, rolling and/or "leaps and bounds" movements. The cause of the instability is unknown, however, it is not believed that groundwater was a factor. Original slope angles at the site were 30 to 35 degrees. The backscarp is presently inclined in excess of 70 degrees and it appears as if the area may still be active. A relatively small volume of granular material is involved in this earth fall. The only other occurrences of instability are localized areas of minor surface erosion on some of the steeper exposed slopes. Some of the larger trees in the steeper areas show evidence of surface creep. Creep involves the slow mass movement of surficial soil materials down relatively steep slopes primarily under the influence of gravity but facilitated by water saturation and by alternate freezing and thawing. The cemented glaciofluvial materials stand almost vertically and are relatively stable, even when undercut, eg: along the Cougar Creek valley.

The glaciofluvial deposits are well drained although there is some evidence of ponding in the bottoms of some of the gullies where an abnormal thickness of fine grained materials (silts) has accumulated. No surface water accumulations or springs were noted during the site reconnaissance.

At present, the land is being used for livestock grazing. The "terraced" surface of the exposed glaciofluvial slopes may be attributed to this activity. Vegetation consists mainly of medium dense mixed forest with a ground cover composed of native grasses and low coniferous and deciduous bushes. It is interesting to note that the west and south facing exposed slopes are generally devoid of trees, while the north

and east facing slopes have a relatively dense tree cover.

4.5 Inactive Flood Plain

The inactive flood plain terrain type occupies the extreme northwest corner of the study area. It is a flat area cleared of trees and is presently being used for livestock grazing. Soil materials consist of 2.0 to 3.5 metres of sandy silt overlying alluvial gravels. The groundwater table at the time of the field investigation was 1.6 to 2.7 metres below existing grade. Surface drainage appears to be adequate.

4.6 Colluvium

Colluvial material exists at the base of slopes throughout the study area. Relatively large accumulations of these sediments are present at the base of the western most glaciofluvial slopes, and thus constitute a mapable terrain unit (Drawing No. A-2). The colluvial materials consist of a heterogeneous mixture of boulders, cobbles, gravel, sand and silt which accumulate as a result of mass-wasting processes. In the study area these deposits slope at 12 to 15 degrees and interfinger with inactive flood plain and alluvial fan deposits. The colluvium supports a light density of trees and, except for occasional indications of creep, appears to be stable.

4.7 Hydrological Features

Hydrological features in the study area mapped during the field reconnaissance include Cougar Creek and an unnamed stream bed whose gully

exits into the Bow River valley at the small alluvial fan. On April 20, 1980, Cougar Creek was flowing through the study area and into the Bow River. Observations made subsequent to May 14, 1980, however, indicate that Cougar Creek becomes influent at a point directly south of HA-12, ie: the creek water infiltrates into the alluvial materials and completes its downslope migration as groundwater. Upstream of the study area the creek was flowing at approximately 1.5×10^{-2} m^3/sec (200 Igpm) over a rock outcrop in the creek bed.

The unnamed stream bed was dry at the time of the field reconnaissance but is obviously intermittently active, as evidenced by the lack of vegetation in its upper reaches. The channel is well developed near the top of the study area, but becomes rather indistinct as it spreads downslope and becomes covered with vegetation. There is no evidence of the stream bed below HA-1 and it is assumed that any stream flow becomes influent near this point.

5.0 SUMMARY AND CONCLUSIONS

The following section summarizes the findings of the field exploration program and makes some conclusions regarding the suitability of the area for the proposed development.

1. Five terrain types were identified in the study area. In order of areal importance these include: glaciofluvial deposits forming the upland areas; alluvial fan deposits (Cougar Creek fan and the "cemetery fan"); alluvial fill deposits (upper reaches of both Cougar Creek and the gully above the "cemetery fan"); inactive flood plain deposits and the colluvial deposits bordering the front slopes of the upland areas.

2. Granular soil types predominate in all of these terrain types. The alluvial fan, colluvial and glacial deposits consist mainly of gravel while the inactive flood plain soil section is composed of silts and fine sands overlying gravel.
3. In general, a thin organic topsoil layer has developed over the entire site. Exceptions to this trend exist on the steeper glaciofluvial slopes, the alluvial fills and the presently and recently active portions of the Cougar Creek fan.
4. Coniferous trees are the predominant vegetation throughout the study area. Ground cover is generally composed of native grasses and low coniferous and deciduous shrubs and bushes. Very little deadfall exists.
5. The cultural features of the study area are confined mainly to the relatively low lying alluvial fan and flood plain areas.
6. Surface drainage is excellent throughout the study area, with the possible exception of the inactive flood plain where the groundwater table is relatively shallow. A piezometer installed in TP 20 indicated water at 2.8 metres below existing grade on June 27, 1980.
7. The only indication of groundwater in the other terrain units occurred at a depth of 23 to 28 metres in P8, near the apex of the Cougar Creek fan. None of the other test pits or piezometers above the flood plain area have encountered water to date. It is recommended that the piezometer monitoring program be extended through the spring of 1981 in order to determine the extent of season groundwater fluctuations. In addition all piezometers should be surveyed so that groundwater elevations can be established.

8. Both Cougar Creek and the unnamed stream above the cemetary are influent to the extent that surface flow often infiltrates completely into the granular subsurface. The locations at which these streams become influent are a function of both the thickness of permeable materials overlying bedrock within the channel and the quantity of flow. The point of complete infiltration will vary throughout the year and will correspond to the location where the granular stream bed materials have the capacity to transmit the entire surface flow as groundwater. This capacity is dependent upon the cross sectional area, gradient and permeability of the stream bed materials.

9. Slope stability in the study area is a consideration only in the glaciofluvial and colluvial deposits. The other terrain types do not have natural slopes of sufficient inclination to be of concern. In general, the glaciofluvial and colluvial deposits in sloping areas are stable. Only one location of instability of any significance was noted during the site reconnaissance.

10. The results of this investigation have shown that the study area will be suitable for the proposed residential subdivision and highway commercial developments. Geotechnical considerations pertinent to development are presented in the following section.

6.0 DEVELOPMENT CONSIDERATIONS

6.1 General

Development considerations and preliminary recommendations are based on the geotechnical information collected during the current study and on generally accepted engineering concepts. Because of physical constraints, the level of investigative effort varied throughout the study area. In the alluvial fan and flood plain areas, subsurface information was collected in some detail. In the upper glaciofluvial deposits, however, only reconnaissance level work was carried out and the amount of subsurface information collected was minimal. If unusual or unexpected conditions are encountered at specific locations during site development, additional investigative work may be required. Since it is not practical to anticipate all minor or localized construction problems, it is recommended that the site development proceed using the following recommendations as guidelines. Any future geotechnical related problems should then be solved on a site-specific basis, as they are encountered.

6.2 Site Preparation and Grading

Because of the topographic irregularities in the study area, especially in the upland areas, a substantial amount of site preparation and grading will be necessary. This will involve the cutting of existing deposits and the placement of fill materials. The following recommendations pertain to the general grading and preparation of the site.

6.2.1 Cutting Operations

1. Permanent cut slopes should not exceed an inclination of 2.5 horizontal to 1.0 vertical (22 degrees). This recommendation

is based on the performance of existing slopes at the site.

2. Existing exposed slopes (west facing glaciofluvial slopes) should not be steepened.
3. Site grading near slope edges should direct water away from the slopes to minimize the effects of erosion.
4. All organic material in cut areas should be stripped and stockpiled for later placement.
5. All cut slopes should be revegetated with a local grass species as soon as possible after excavation in order to limit surface erosion and gullying.
6. During construction qualified personnel should be on site to monitor the construction of cut slopes and evaluate their performance so that changes in preliminary design can be made should problems arise.

6.2.2 Filling Operations

1. All organic materials and soft compressible soils in fill areas should be stripped and stockpiled for later placement.
2. Fill should be placed in uniform, continuous layers. If fine grained soils (silts and clays) are being placed, a cross slope of approximately 2% should be maintained on the fill surface during construction to provide surface drainage.
3. For fill placed on sloping terrain, the existing slope should be benched, so that the contact surface between the natural

materials and the fill is non-planar. This will reduce the potential for development of a sliding surface at the contact. For stability reasons, fill should not be placed on natural slopes which are steeper than 22 degrees.

4. Good quality fill material devoid of organic material should be used. Should quantities of granular material (sand and gravels) be available as fill, they should be placed either in one continuous layer or at the toe of the slope in order to provide drainage. Precautions should be taken not to place a localized pocket of granular material within the fill as this pocket could become an enclosed reservoir of water.
5. Good quality fill materials can be placed with a slope angle of 2.5 horizontal to 1 vertical (22 degrees). The final slope may then be flattened to 3 horizontal to 1 vertical (18 degrees) using poorer quality material (ie: material containing organics). A 3 to 1 slope is considered to be consistent with stability and maintenance considerations.
6. All fill should be placed in lifts not exceeding 15 cm in compacted thickness unless it can be proven by the contractor that thicker lifts can be compacted to the specified density.
7. All fill materials with the exception of organic material (landscape fill) should be compacted to a uniform dry density of 95% Standard Proctor maximum dry density (ASTM Test Method D698). Random landscape fill should be compacted to a modest dry density (about 90% of Standard Proctor dry density) to prevent excessive settlement which may impede surface drainage.

8. Vegetation should be encouraged on fill slopes to limit surface water erosion or gullying. Use of a native species of grass is recommended.
9. During construction, qualified personnel should be on site to monitor and control the character of fill materials. Fill placement should be carefully tested to ensure adequate densification.

Slope stability analyses should be carried out to establish set-backs in areas where structures are to be located near cut slopes or on fill materials with sloping margins. Stability chart analyses utilizing typical soil strength parameters, anticipated pore water pressures and measured or design slope geometries would be appropriate. More detailed studies involving borehole drilling and laboratory testing of representative samples are recommended in cases where the stability chart approach indicates a low factor of safety.

6.3 Slope Stability

Stability of natural slopes will be of concern in the upland areas where sloping terrain is composed mainly of glaciofluvial deposits. Although most slopes in the study area are presently stable, some precautions must be taken with respect to development in steeply sloping terrain mainly because of the hydrogeological changes that urbanization brings. The most significant result of residential development is the general rise in groundwater elevations and the establishment of perched water tables. Factors that contribute to changes in groundwater conditions include the reduction of evapo-transpiration, lawn and garden irrigation,

leaks from underground water mains and the indiscriminant filling of minor gullies and runoff courses. Because of the granular nature of the glaciofluvial deposits, it is not anticipated that there will be a widespread build-up of seepage pressures, but the potential for local downslope movements induced by seepage pressures cannot be ignored, especially during late winter and spring when slope icing can occur. The following recommendations pertain to development adjacent to natural slopes at the site.

1. Undercutting or steepening of natural slopes inclined at 22 degrees or more should be avoided.
2. Fill materials should not be placed on the crest of natural slopes.
3. Vegetation on natural slopes should be maintained or replaced.
4. A development setback from the toe of natural slopes similar to that used by the City of Calgary is recommended, ie. structures can be safely located behind the upper edge of an imaginary plane drawn at a 3 horizontal to 1 vertical inclination from the toe of the slope. As an example, for a 40 metre high slope inclined at 30 degrees, the setback from the slope toe is 120 metres and from the slope crest is 51 metres. A setback regulation provides passive protection for structures located within the approved development zone. If it is considered desirable to locate structures closer to natural slopes, it is recommended that a slope stability analysis be carried out to confirm a minimum factor of safety against slope failure of 1.5. As previously noted, stability

chart solutions utilizing typical soil parameters would be appropriate. Should a safety factor of less than 1.5 be derived, it may be prudent to conduct a detailed subsurface investigation.

5. The use of lands excluded from development under the above recommendations depends on the stability hazard. Low risk areas may be used for roadways or recreational (playground, greenbelt, etc.) areas. High risk areas are usually excluded from public use.
6. Slope stabilization measures may be utilized in order to reduce the setback distances. Such measures include terrain regrading, surface and subsurface drainage, retaining walls and special techniques such as grouting, freezing, etc. Terrain regrading may be the most appropriate stabilization technique in the study area. It usually involves modification of existing slopes by engineered cuts and fills which reduce slope height, flatten the slope angle or create a bench in the upper part of the slope.
7. The very steep slopes along the Cougar Creek valley may be sensitive to development in that any change in groundwater elevations may have an adverse effect on the cementation which the deposits in this area possess. It is recommended that the 3 to 1 setback recommendation apply to all types of development in this area and that terrain regrading be avoided.

6.4 Construction Practises

A number of recommended construction practises are outlined below for the founding of structures, construction of roadways and installation of

underground utilities in the study area. Most of these recommendations are general in nature and apply to normal construction situations. Unique construction problems may require special solutions and, therefore, should be given particular consideration.

6.4.1 Structures

6.4.1.1 General

Spread footings are considered to be the most feasible foundation type for residential and light commercial structures. Because loose silts and sands and a high water table exist in the inactive flood plain, the allowable bearing pressure for structures in this area should be determined from a detailed drilling and sampling program. The natural soils in the other areas have sufficient bearing capacity to support spread footings. Fills, if properly constructed, will also have adequate strength to support the loads normally exerted by light commercial/residential structures. The following recommendations apply to structures on both natural soil and engineered fill.

6.4.1.2 Foundations

Exterior and interior footings for heated structures should be located at minimum depths of 1.8 and 1.2 metres respectively below final grade to limit the effects of seasonal moisture variations and frost penetration. Footings for unheated structures should be at least 1.8 metres below final grade. Minimum footing widths of 0.45 m and 0.90 m are recommended for strip and square footings, respectively. No loose, disturbed or remoulded materials should be allowed to remain in footing excavations.

Hand cleaning will be required if a clean surface cannot be prepared by mechanical equipment. Footing excavations should be protected from rain, snow, freezing temperatures and free water.

6.4.1.3 Floor Slab Support

Slabs supported on grade are feasible providing certain precautions are undertaken. Any organic material and surface boulders beneath floor slab areas must be removed. All localized disturbed material should then be compacted. It is recommended that final grade be achieved with a select granular material.

6.4.1.4 Excavation Backslopes

It is believed that temporary construction side slopes of 1 vertical to 2 horizontal may be used in the granular materials existing at the site except in areas where groundwater exists within the depth of excavation. Much shallower slopes will be necessary in these areas. All excavations greater than 1.2 metres in depth should be sloped or shored for worker protection.

6.4.1.5 Backfill Materials

The local inorganic granular soils excavated on site will be suitable for backfill adjacent to footings. This material should be placed in layers not exceeding 15 centimetres in compacted thickness. A thin granular levelling course of at least 15 centimetres in compacted thickness is recommended beneath all slabs-on-grade. Coarse material (exceeding

2.5 centimetres) should be avoided directly beneath the slab, to limit potential stress concentrations within the slab. Random landscape fill material may be obtained on site with little regard for engineering quality.

6.4.1.6 Compaction Standards

Granular levelling courses beneath floor slabs should be compacted to a uniform dry density of 97% of Standard Proctor maximum dry density (ASTM Test Method D698). General engineered fill (cohesive or cohesionless) in excess of 15 centimetres in thickness should be compacted to 95% of Standard Proctor maximum dry density (ASTM Test Method D698). Random landscape fill should be compacted to a modest dry density (about 90% of Standard Proctor dry density), to prevent excessive settlement which may impede surface drainage.

6.4.1.7 Drainage

At present the site is well drained. It is recommended that final site grading direct water to areas remote from the proposed structures. Because of the granular, free draining nature of the site soils, drainage tile systems will not be necessary. High groundwater levels will probably preclude the construction of basements in the flood plain areas.

6.4.1.8 Cement Type

Negligible concentrations of water soluble sulphates were measured in the site soils. Therefore Type 1, Normal Portland Cement will be adequate

for concrete in contact with natural soil. A minimum '28-day' compressive strength of 20 MPa is recommended for concrete foundation elements. Air entrainment is recommended for all concrete exposed to freezing conditions.

6.4.2 Roadways

In the absence of specific data on traffic volumes and loadings, only general recommendations can be given for roadway development. City of Calgary pavement specifications may be used as a guide for preliminary design.

Surficial soils at the site consist of silts and fine grained sands in the flood plain and glaciofluvial deposits and gravels in the alluvial fan deposits. The former are frost susceptible. Differential frost heave can occur where abrupt transitions in soil conditions occur, such as from wetter to drier, or from silt to gravel. To reduce the potential for differential frost heave, it is recommended that all roadways and areas beneath curbs, gutters and sidewalks be subcut to a minimum of 60 centimetres below final grade. Excavated material should be blended, using blade mixing, to achieve uniformity, and then recompacted in 15 centimetre layers to dry densitites of 98% of the maximum dry density, as determined by Test Method ASTM D698 (Standard Proctor). This procedure will not eliminate frost heave, but it will be of substantial benefit in minimizing differential movements. In areas where a thin surficial layer of silt overlies gravel, it is recommended that the silt be removed prior to roadway construction.

Roadways should maintain a minimum of 2 metres clearance above maximum groundwater levels. Where roadways are located in natural gullies, provision of adequate surface drainage will be very important.

6.4.3 Underground Utilities

6.4.3.1 General

For protection against freezing all water and sewer pipes should have at least 2.4 metres of cover. Excavations to this depth will encounter granular materials ranging from silts and fine sands to coarse gravels with cobbles and boulders. Conventional equipment will be suitable for excavation of utility trenches. Some problems may be encountered in cemented glaciofluvial deposits or where a high water table occurs.

6.4.3.2 Trench Excavations

The primary concern with any excavation is for the safety of workers in or around the excavation. Construction must, therefore, be in accordance with good practice, and comply with the requirements of the responsible regulatory agencies, such as the Workers' Compensation Board of Alberta. Trenches will be cut into granular soils. Above the water table, these materials can be expected to exhibit generally good stability. Cut material from the trench excavations must be stored away from the trench to avoid introducing a surcharge factor into slope stability considerations.

Trenches should be exposed for the shortest possible time, compatible with service installation. Slopes which must be exposed for periods

exceeding 5 days should be sloped at 2 horizontal to 1 vertical or less. Safe slope angles cannot be predicted over the entire site and must be judged, based on the depth of excavation and specific conditions encountered.

Depending on the location and time of the installation, some service lines may require excavation to depths below ground water levels. For these conditions, flatter slopes will be required. Groundwater flow rates may be of sufficient volume to require advance dewatering. Excavation should be done in sections, beginning at the lower end and proceeding toward the upper end. This will facilitate the drainage of excavations as the work proceeds. Soil in the trench bottom, which is softened by exposure to water, should be removed and replaced with well compacted backfill.

6.4.3.3 Pipe Bedding and Trench Backfill

Since the site is underlain mainly by granular materials, Class C bedding will be appropriate for underground service lines. This method of bedding pipe consists of laying the pipe on a compacted gravel or sand material shaped to fit the lower quadrant of the pipe exterior. Bedding materials depend on the type of pipe used, but in general should be free of organic material, cobbles and boulders. Granular bedding material should be compacted to 95% of the Standard Proctor maximum dry density (ASTM Test Method D698).

Trenches may be backfilled using locally derived granular soils. Compaction of backfill materials should be in the order of 95% of Standard Proctor maximum dry density. Under roadways, the upper 60 cm of backfill (final zone) should be compacted to at least 98 percent of Standard Proctor maximum density. Frozen soils should not be used for pipe

bedding or backfill. During construction, qualified personnel should be on site to observe the character of bedding and fill materials and to ensure that the specified compaction is achieved.

6.4.3.4 Concrete for Underground Utilities

Negligible concentrations of water soluble sulphates were measured in the site soils. Type 10, Normal Portland Cement may be used for concrete to be utilized in utility construction.

7.0 LIMITATIONS

This report has been prepared in accordance with generally accepted geotechnical engineering practices for the exclusive use of Engineering Canada Associates Ltd. and the Alberta Housing Corporation. It is intended for specific application to the proposed residential and commercial developments in Canmore, Alberta. The report was prepared for preliminary design purposes only and may not provide sufficient information for final design or the preparation of accurate bids by contractors.

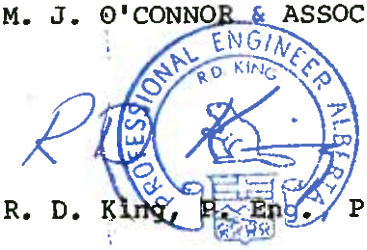
Information presented herein is based on the geotechnical evaluation of subsurface data from 46 locations and a geological reconnaissance of the study area. If conditions other than those presented herein are noted during subsequent phases of the project, we should be notified in order that our findings may be re-evaluated in light of the new information.

It is further recommended that M. J. O'CONNOR & ASSOCIATES LTD. be provided with the opportunity for a general review of the final design and

specifications to ensure that site development recommendations have been properly interpreted and implemented in the contract documents. Recommendations outlined herein for site examinations and compaction monitoring by qualified geotechnical personnel during construction of the facility should also be implemented. If M. J. O'Connor & Associates Ltd. is not accorded the privilege of undertaking the above reviews and construction monitoring, we can assume no responsibility for misinterpretation of our recommendations.

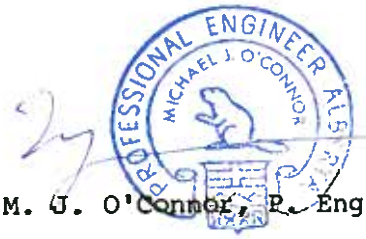
Respectfully submitted,

M. J. O'CONNOR & ASSOCIATES LTD.



R. D. King, P. Eng. P. Geol.

J. G. Agar, P. Eng.



M. J. O'Connor, P. Eng., P. Geoph.

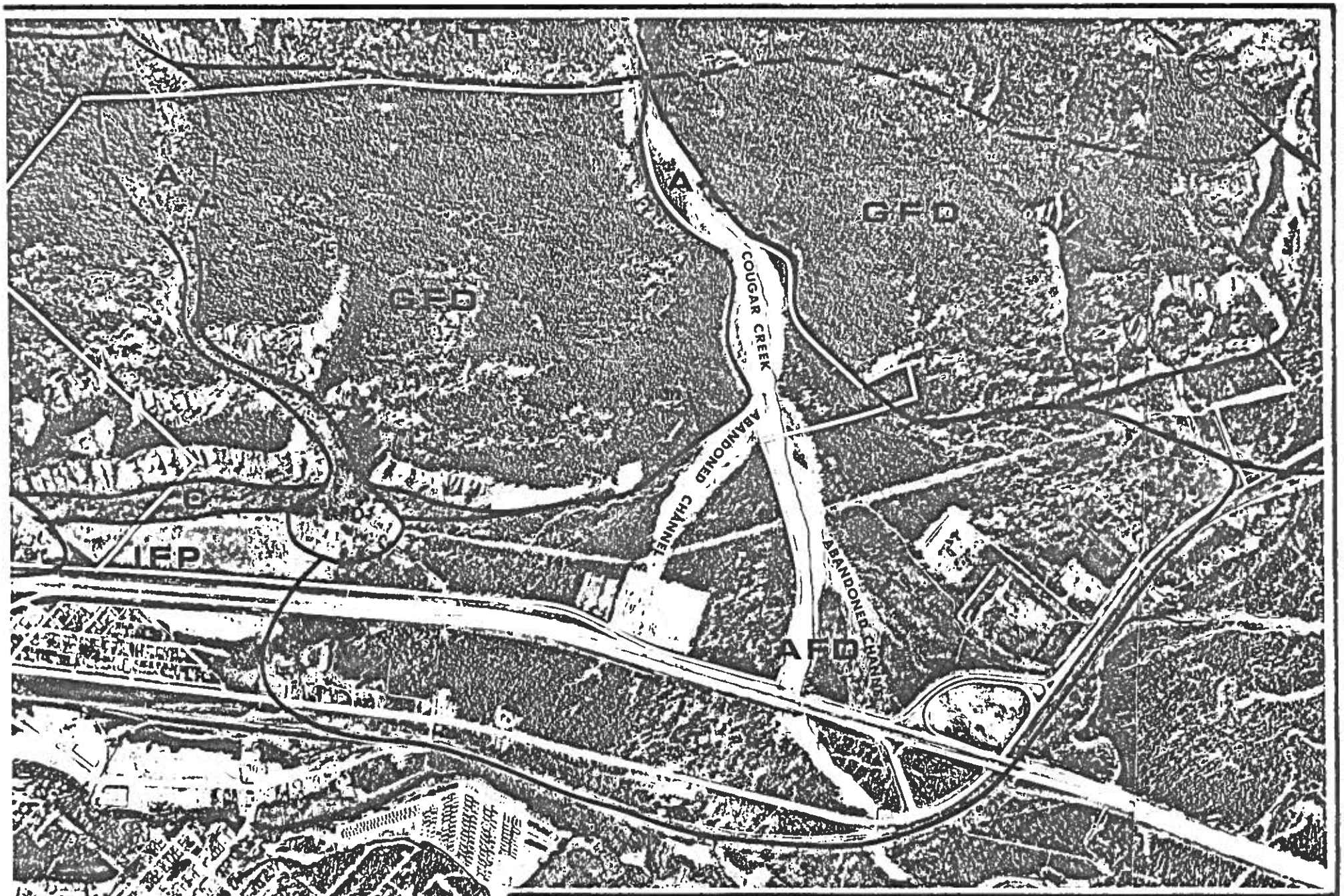
RDK/kh

APPENDIX A

AERIAL PHOTOGRAPHS

TEST LOCATIONS

M.J. O'CONNOR & ASSOCIATES LTD.	
JOB NO.: 10-038	DATE: 06/80
DRAWN BY: RDK	DWG. NO.: A-1



TERRAIN TYPES

M.J. O'CONNOR & ASSOCIATES LTD.	
JOB NO.: 10-038	DATE: 06/80
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APPENDIX B

BOREHOLE LOGS

TERMS AND SYMBOLS USED IN THE REPORT

CLASSIFICATION BY PARTICLE SIZE

BOULDERS - greater than 300 mm
COBBLES - 75 mm to 300 mm
GRAVEL - 5 mm to 75 mm

SAND - 0.075 mm to 5 mm
SILT - .002 mm to 0.075 mm
CLAY - finer than .002 mm

DESCRIPTION OF CONSTITUENT PARTS OF A SOIL

Descriptive Term	Range of Proportion
Trace	1 - 10%
Some	11 - 20%
Adjective (eg: sandy, silty)	21 - 35%
and	36 - 50%

CONSISTENCY OF COHESIONLESS SOILS

Descriptive Term	Density Index	Standard Penetration Test (blows per 300 mm)
Very Loose	0 - 20%	0 - 4
Loose	20 - 40%	5 - 10
Medium Dense	40 - 70%	11 - 30
Dense	70 - 90%	31 - 50
Very Dense	90 - 100%	over 50

CONSISTENCY OF COHESIVE SOILS

Descriptive Term	Unconfined Compressive Strength (Qu) - kPa	Standard Penetration Test (blows per 300 mm)
Very Soft	Less than 25	Less than 2
Soft	25 - 50	2 - 4
Firm	50 - 100	5 - 8
Stiff	100 - 200	9 - 15
Very Stiff	200 - 400	16 - 30
Hard	over 400	over 30

CONSISTENCY LIMITS

Descriptive Term	Plasticity Index
Non-plastic	0 - 3
Low plastic	4 - 9
Medium plastic	10 - 30
Highly plastic	over 30

.../2

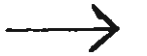
DESCRIPTIVE SOIL TERMINOLOGY

Glacial Till	-	An unstratified glacial deposit of clay, silt, sand, gravel, cobbles and boulders in any combination.
Topsoil	-	Weathered surface materials which are capable of supporting plant life.
Inclusion	-	An anomolous substance or fragment incorporated in a soil or rock mass.
Well-Graded	-	Having wide range of grain sizes and substantial amounts of all intermediate sizes.
Poorly Graded	-	Predominantly of one grain size.
Stratified	-	Containing layers of different soil types.
Laminated	-	Composed of thin layers of varying colour and texture.
Desiccated	-	Dried by moisture evaporation - desiccated clays are sometimes described as fissured or having nugget structure.
Fissured	-	Containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Sensitive	-	Exhibiting loss of strength on remolding.
Friable	-	A soil consistency term pertaining to the ease of crumbling of soils. Easily crumbled between the fingers.
Calcareous	-	Containing appreciable quantities of calcium carbonate.

OTHER TESTS

GSD	-	Grain size distribution
k	-	Hydraulic conductivity
pp	-	Pocket penetrometer strength kPa
q	-	Triaxial compression test
C	-	Consolidation test
Qu	-	Unconfined compressive strength kPa
SO_4	-	Soluble sulphate concentration
γb	-	Bulk (weight) density or bulk unit weight kN/m^3
ρb	-	Bulk (mass) density (Mg/M^3)

ADDITIONAL GRAPHIC SYMBOLS


seepage


water level surface

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P1
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ◪ SHELBY ☒ SPLIT SPOON ▦ CORE ◫ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
1	GRAVEL - grey to light brown - some cobbles and boulders - traces of sand and silt - dry - dense to very dense			5			
2							
3				10			
4							
5				15			
6				20			
7				25			
8							
9				30			
	END OF HOLE AT 10.4 m.						

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 14/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-1

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P2
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ◪ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
1	GRAVEL FILL - some cobbles and boulders - some sand - dry - loose to compact			5			
2	GRAVEL - some cobbles and boulders - some sand and silt - dry to damp - compact to dense			10			
3							
4				15			
5							
6				20			
7							
8				25			
9	END OF HOLE			30			

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PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P3
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ◪ SHELBY ☒ SPLIT SPOON ▦ CORE ◫ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
1	GRAVEL - light brown - some cobbles and boulders - traces of sand and silt - dry - dense to very dense			5			
2							
3				10			
4							
5				15			
6				20			
7							
8				25			
9	END OF HOLE			30			

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	LOGGED BY: WAO	DRAWING NO.: B-3

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P4
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ▨ SHELBY ☒ SPLIT SPOON ▤ CORE ▥ DISTURBED ▧ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
1	GRAVEL - light brown - some cobbles and boulders - traces of sand and silt - damp - dense to very dense			5			
2							
3				10			
4							
5				15			
6	- loose to compact from 6 to 7.5 m.			20			
7							
8				25			
9				30			

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DATE: May 14/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-4

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P4
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
11	GRAVEL - as above			35			
12	END OF HOLE			40			
13							
14				45			
15							
16				50			
17				55			
18							
19				60			
				65			

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 14/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-4(a)

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P5
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
1	GRAVEL - grey to light brown - some cobbles and boulders - trace to some sand - dry - loose to 1.5 m. - below 1.5 m. dense to very dense			5			
2							
3				10			
4							
5				15			
6				20			
7							
8				25			
9				30			
	END OF HOLE AT 10.4 m.						

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 14/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-5

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P6
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
1	SILT - dark brown - sandy - trace of gravel - loose			5			
2	GRAVEL - light brown - some cobbles and boulders - traces of sand and silt						
3				10			
4	SAND - brown - fine grained - some silt						
5	GRAVEL - light brown - some cobbles and boulders - traces of sand and silt - dry - dense to very dense			15			
6				20			
7	- loose from 7 to 8.2 m.						
8				25			
9				30			
	END OF HOLE						

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 14/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-6

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P7
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ◪ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	GRAVEL - as above						
11	END OF HOLE			35			
12				40			
13							
14				45			
15							
16				50			
17				55			
18							
19				60			
				65			

m.j. o'connor & associates ltd.	DATE: May 14/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-7(a)

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: P7
LOCATION: Canmore, Alberta	DATUM:	DRILL: Becker Hammer

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
1	SILT - dark brown - some organics GRAVEL - light brown - some cobbles and boulders - traces of sand and silt - dry - dense to very dense			5			
2							
3				10			
4							
5				15			
6				20			
7							
8				25			
9				30			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 14/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-7

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 1
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ◫ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
	ORGANIC TOPSOIL - dark brown to black						Soluble Sulphate 0.001%
1	SILT - olive brown to light brown - some fine sand - some clay - organic layers in upper metre - damp to moist - loose to compact			5			
2							
3	GRAVEL AT 3.3 m - some cobbles			10			
	END OF HOLE - water at 2.45 m						
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 28/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-8

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 2
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	SILT - sandy						G.S.D.
	ORGANIC SILT						
	SILT - reddish brown - some clay						
	SILT - light brown - some clay - some fine sand - damp to moist - loose to compact						
1							
				5			
2							
3				10			
	GRAVEL AT 3.5 m - some cobbles						
	END OF HOLE - water at 1.6 m						
4							
				15			

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 28/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-9

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 3
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
	ORGANIC TOPSOIL - dark brown						
	GRAVEL						
	SAND						
	GRAVEL						
1	SILT - brown - sandy - trace of clay						
	GRAVEL - greyish brown - some cobbles - some silt - trace of sand - dry to moist - dense			5			
2							
3				10			
	END OF HOLE						
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.	DATE: May 28/80	JOB NO.: 10-038
	LOGGED BY: WAO	DRAWING NO.: B-10

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 4
LOCATION: Canmore, Alberta	DATUM:	DRILL: backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
1	ORGANIC TOPSOIL SILT - fine to medium grained - trace to some silt - moist - compact			5			
2							
3	SAND AND SILT - dark reddish brown - moist			10			
4	END OF HOLE			15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 28/80	JOB NO.: 10-038
LOGGED BY: WAO	DRAWING NO.: B-11

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 5
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ◫ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	SILT AND GRAVEL						
1	GRAVEL - greyish brown - some sand - trace of silt - trace of cobbles						
2	GRAVEL - light brown - sandy - some cobbles - trace of silt - dense			5			
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 28/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-12

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 6
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	GRAVEL - grey - some sand						
1	GRAVEL - grey to light brown - some sand - trace to some cobbles - moist						G.S.D.
	SILT - grey to light brown - some sand - trace of gravel			5			
2	GRAVEL - grey to light brown - some sand - some cobbles - trace of boulders - moist - compact to dense						
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-13

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 7
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	GRAVEL - some silt and organics - trace of sand						
1	GRAVEL - greyish brown - some sand - some cobbles - trace of silt						
	GRAVEL - greyish brown - some sand - some cobbles - trace to some boulders - trace of silt - dry to damp			5			
2							
3	END OF HOLE			10			
4							
				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80

JOB NO.: 10-038

LOGGED BY: WAO

DRAWING NO.: B-14

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 8
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ◫ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
1	GRAVEL - some sand - some cobbles - trace of boulders - trace of silt - damp to moist - dense			5			
2							
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-15

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 9
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	GRAVEL - some sand - trace of silt and cobbles - organics						
	COBBLES						
1	GRAVEL - some cobbles - some sand - trace of boulders - trace of silt - dense			5			
2							
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-16

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 10
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
.1	GRAVEL - some sand - some cobbles and boulders - trace of silt - organics						
2	GRAVEL - some sand - some cobbles - trace of boulders - trace of silt - compact to dense			5			
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80

JOB NO.: 10-038

LOGGED BY: WNO

DRAWING NO.: B-17

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 11
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
	GRAVEL - some sand and silt - some cobbles - organics						
	GRAVEL - some sand - trace of cobbles						
1	GRAVEL - some sand - some silt - trace to some cobbles - trace of boulders - damp to moist - dense			5			
2							
3	END OF HOLE			10			
4							
				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80

JOB NO.: 10-038

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 12
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
1	GRAVEL - some sand - some cobbles - trace of boulders - trace of silt - dense to very dense			5			
2							
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80 | JOB NO.: 10-038

LOGGED BY: WAO | DRAWING NO.: B-19

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 13
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
	SAND - brown - some silt - organics - moist						
.1	COBBLES AND BOULDERS - some gravel - trace of sand - trace of silt - dry to damp - very dense			5			
2							
3	END OF HOLE			10			
4							
				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80 JOB NO.: 10-038

LOGGED BY: WJO DRAWING NO.: B-20

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 14
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	GRAVEL AND SAND - trace to some silt - organics						
1	GRAVEL - some cobbles - some sand - trace of boulders - trace of silt - dry to damp - very dense			5			G.S.D.
2							
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80

JOB NO.: 10-038

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 15
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	GRAVEL - organics - some silt						
	SAND						
	GRAVEL - some sand						
	SILT - sandy - trace of gravel						
1	GRAVEL - some cobbles - some sand - trace of boulders - trace of silt - very dense			5			
2							
3				10			
	END OF HOLE						
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80 JOB NO.: 10-038

LOGGED BY: WAO DRAWING NO.: B-22

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 16
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ☒ CORE ☐ DISTURBED ☐ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANICS - dark brown - some silt - trace of sand						
1	SILT - light brown - sandy - dry to damp - compact to dense			5			
2	GRAVEL - light brown - some cobbles - trace to some sand - trace of silt - dry to damp - compact to dense						
3				10			
	END OF HOLE						
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 28/80

JOB NO.: 10-038

LOGGED BY: WAO

DRAWING NO.: P-22

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 17
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT W_p W_n W_l (10 20 30 40)	N	OTHER TESTS
	SILT - dark brown - sandy - some organics						
	SILT - greyish brown - sandy						Soluble Sulphate 0.001%
1	SILT AND GRAVEL - light brown - sandy						
	SILT - reddish brown - some sand - trace of clay			5			
	GRAVEL						
2	SILT - reddish brown - some sand - trace of clay - loose to compact						
3				10			
	END OF HOLE						
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 28/80

JOB NO.: 10-038

LOGGED BY: WAO

DRAWING NO.: B-24

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 18
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	SILT - organic, sandy						
	SILT AND SAND - light brown - trace of gravel						
1	GRAVEL - light brown - some silt and sand - some cobbles - dry to damp - compact			5			
2							
3	END OF HOLE			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 28/80

JOB NO.: 10-038

LOGGED BY: WRO

DRAWING NO.: B-25

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 19
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☑ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	SAND - reddish brown - silty - fine grained - trace of gravel						Soluble Sulphate 0.001%
1	GRAVEL - greyish brown - some silt/sand - some cobbles - trace of boulders - dry to moist - dense			5			G.S.D.
2							
3	END OF HOLE			10			
4							
				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 28/80 JOB NO.: 10-038

LOGGED BY: WAO DRAWING NO.: B-26

PROJECT: Canmore Subdivision	ELEVATION:	HOLE NO.: TP 20
LOCATION: Canmore, Alberta	DATUM:	DRILL: Backhoe

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ▦ CORE ▯ DISTURBED ▨ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	U.S.C.	SAMPLE TYPE	FEET	WATER CONTENT (W_p W_n W_l) 10 20 30 40	N	OTHER TESTS
	ORGANIC TOPSOIL						
	SAND - greyish brown - fine grained - organic silt layer at 5 m						
	SILT - dark reddish brown - some sand						
1	SILT - light brown - some sand - compact - moist			5			
2	GRAVEL - brown - some sand - trace to some cobbles - moist to wet						
3	END OF HOLE - piezometer installed			10			
4				15			

M.J. O'CONNOR & ASSOCIATES LTD.

DATE: May 29/80

JOB NO.: 10-038

LOGGED BY: WAO

DRAWING NO.: P-27

HAND AUGER HOLE LOGS

HA 1	0 - 0.46 m	reddish brown fine sand, trace of silt, fine gravel and organics
	Below 0.46 m	sandy gravel
HA 2	0 - 0.15 m	brown silt and fine sand
	Below 0.15 m	sandy gravel
HA 3	0 - 0.05 m	organic topsoil
	Below 0.05 m	coarse gravel, some sand and cobbles
HA 4	0 - 0.60 m	light brown fine silty sand
	Below 0.60 m	sandy gravel
HA 5	0 - 0.60 m	silty fine sand, trace of fine gravel
	Below 0.60 m	sandy gravel
HA 6	0 - 0.05 m	reddish brown sandy silt
	Below 0.05 m	coarse sandy gravel and cobbles
HA 7	0 - 0.05 m	organic topsoil
	0.05- 0.30 m	silty fine sand, trace of gravel
	Below 0.30 m	sandy gravel
HA 8	0 - 0.46 m	brown silty fine sand
	Below 0.46 m	sandy gravel
HA 9	0 - 0.46 m	light brown silty fine sand
	Below 0.46 m	sandy gravel

JOB NO. 10-038
DWG NO. B-28

HAND AUGER HOLE LOGS

HA 10	0 - 0.30 m	silty fine sand, some gravel and organics
	Below 0.30 m	sandy gravel
HA 11	0 - 0.05 m	organic topsoil
	Below 0.05 m	coarse gravel, some cobbles and silty sand
HA 12	0 - 0.05 m	organic topsoil
	Below 0.05 m	gravel, some silty sand
HA 13	0 - 0.15 m	organic topsoil
	0.15- 0.30 m	light brown silty sand
	0.30- 0.90 m	silt, some sand, trace of coarse gravel
	Below 0.90 m	coarse sandy gravel
HA 14	0 - 0.05 m	organic topsoil
	Below 0.05 m	sandy silty gravel
HA 15	0 - 0.05 m	organic topsoil
	0.05- 0.20 m	brown silt, some organics
	Below 0.20 m	silty gravel
HA 16	0 - 0.05 m	organic topsoil
	Below 0.05 m	silty gravel, some cobbles
HA 17	0 - 0.30 m	organic topsoil
	0.30- 0.46 m	grey to reddish brown silt
	Below 0.46 m	sandy gravel

JOB NO. 10-038
DWG NO. B-29

HAND AUGER HOLE LOGS

HA 18	0 - 0.05 m	organic topsoil
	0.05- 1.22 m	brown silt and fine sand
	Below 1.22± m	sandy gravel
HA 19	0 - 0.05 m	organic topsoil
	0.05- 0.46 m	brown silt and fine sand
	Below 0.46 m	sandy gravel

NOTE:

1. All hand auger holes penetrated topsoil. Topsoil thickness less than 0.05 m are not documented above.
2. All hand auger holes terminated in gravel materials.

JOB NO. 10-038
DWG NO. B-30

APPENDIX C

SITE PHOTOGRAPHS

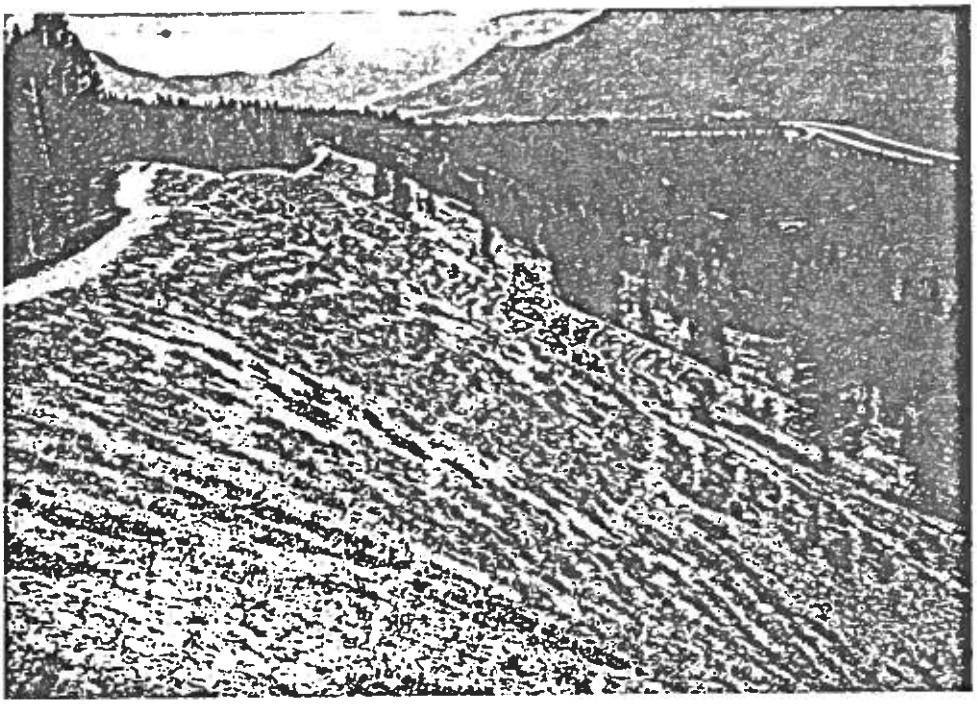


PLATE NO. 1

View looking southeast of exposed glaciofluvial slopes at north end of site. Note "terraced" profile of slope accentuated by the vegetation pattern.

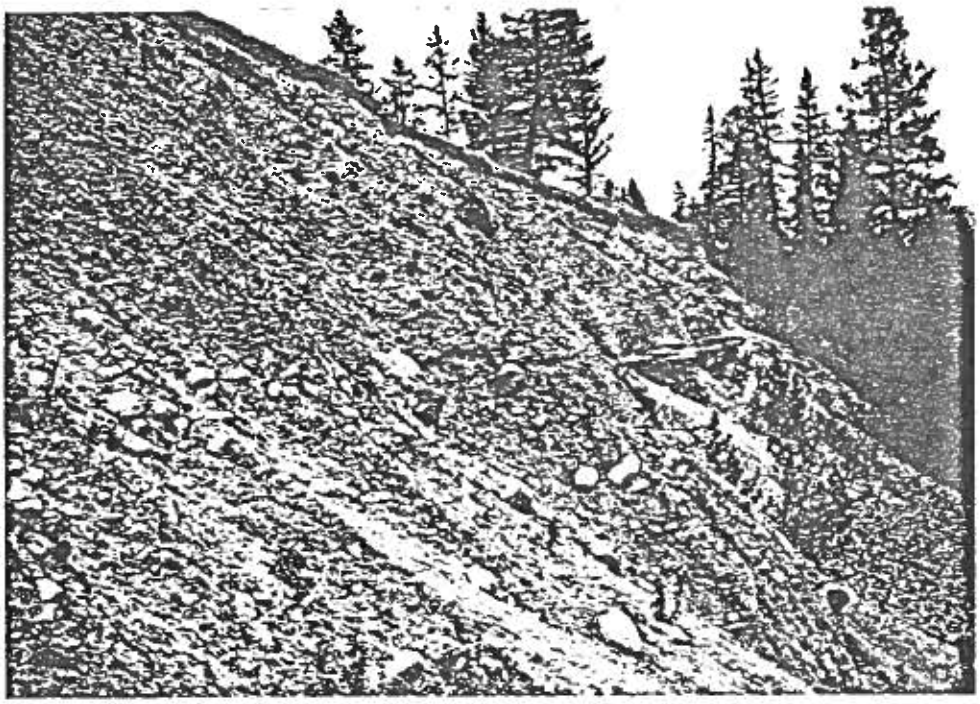


PLATE NO. 2

Close-up view of earth fall in glaciofluvial deposits near TP #7.

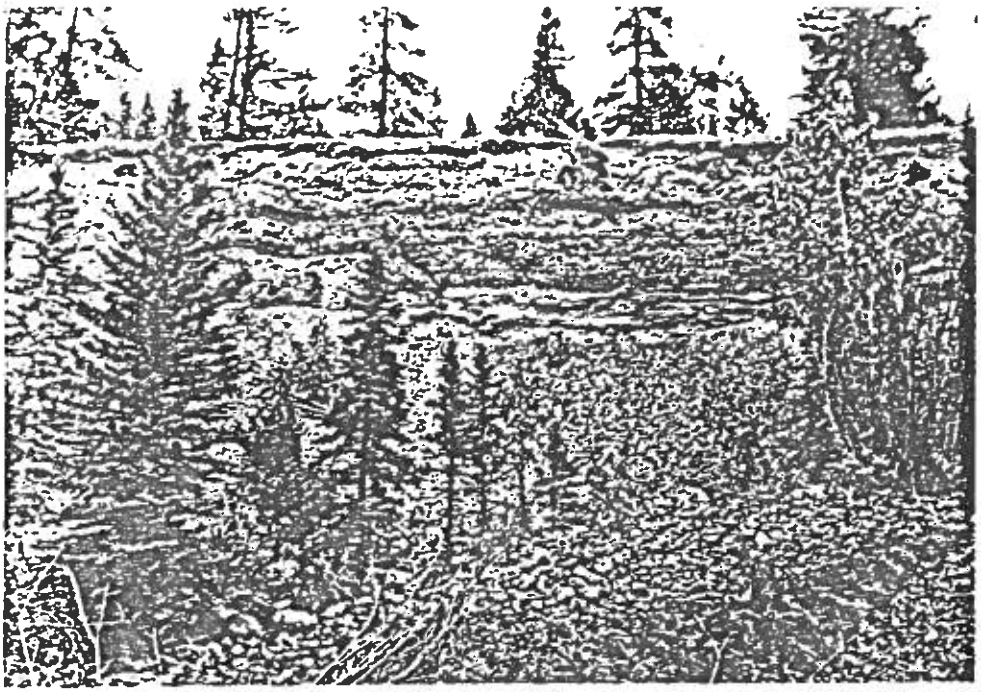


PLATE NO. 3

Sectional view of earth fall in glaciofluvial deposits. Note stratification of sands and gravels and the sorted colluvium at base of slope.

PLATE NO. 4

Close-up view of minor sloughing occurring in steeply sloping glaciofluvial deposits.

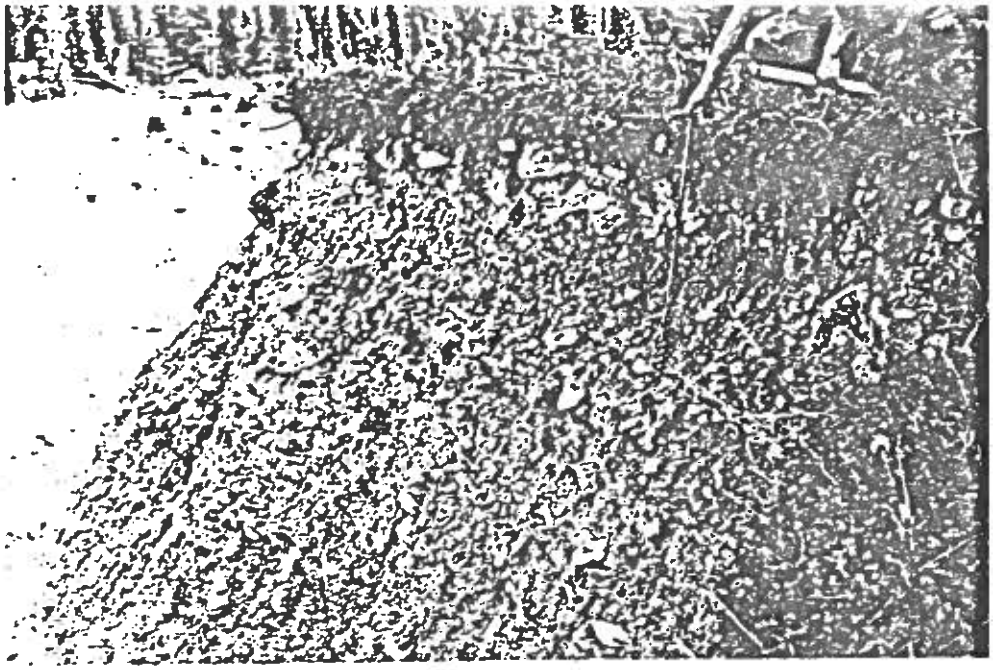


PLATE NO. 5

Close-up view of glaciofluvial deposits along Cougar Creek valley.

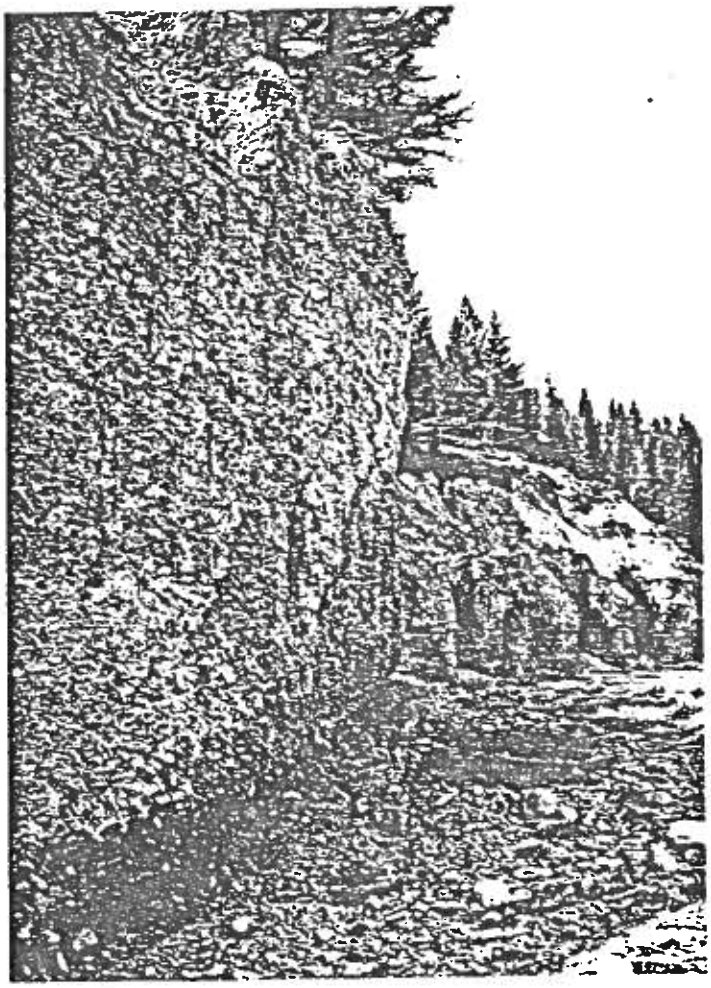


PLATE NO. 6

Near vertical exposure of glaciofluvial materials located along Cougar Creek valley. Note undercutting at the base of the formation.

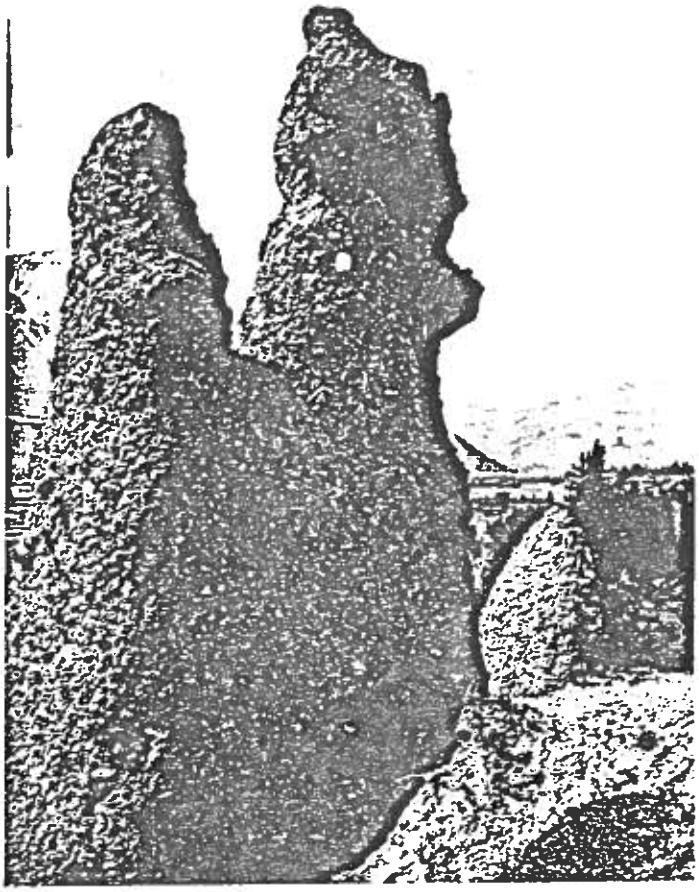


PLATE NO. 7

Hoodoos located above cemetary. Composed of cemented glaciofluvial deposits.

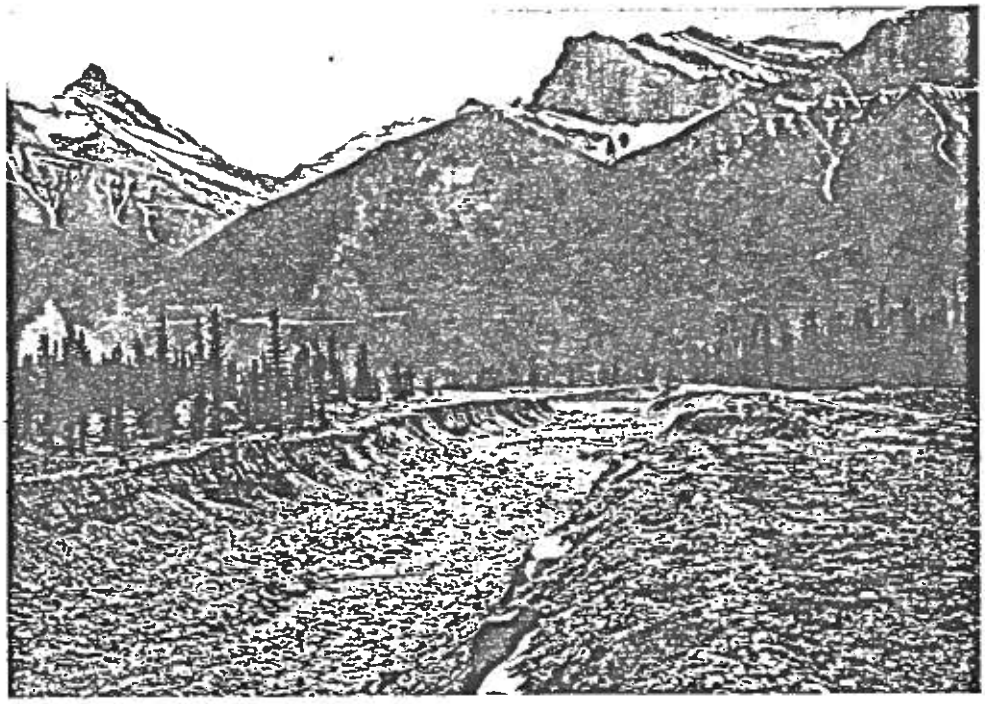


PLATE NO. 8

View looking down the man-made channel of Cougar Creek.

APPENDIX D

LABORATORY TEST RESULTS

SUMMARY OF TEST RESULTS

JOB No. _____

TEST HOLE	DEPTH	NATURAL WATER CONTENT	Atterberg Limits			MECHANICAL ANALYSIS (M.L.T. CLASSIFICATION)				SO_4 %	ORGANIC CONTENT %	BULK DENSITY Mg/m^3	STRATA CLASSIFICATION
			W_L	W_P	PI								
	metres	%	%	%	%	% CLAY	% SILT	% SAND	%GRAVEL				
TP 1	0.1 - 0.2									0.001			flood plain
	1.5	28.3											
TP 2	0.1 - 0.2	42.4				26	66	8					flood plain
	0.25- 0.5	52.8											
	0.5 - 3.5	21.3											
TP 6	0.45- 1.2						4	29	67				alluvial fan
TP 14	0.9 - 3.0						3	26	71				alluvial fan
TP 17	0.5 - 0.7									0.001			alluvium
TP 19	0.05- 0.5									0.001			glaciofluvial
	0.8 - 2.9						17	21	62				
TP 20	0.15- 0.5	13.3											flood plain
	0.5 -0.55	44.1											
	0.55- 0.7	30.0											
	0.7 - 1.9	24.1											
HA 1	0 -0.46	13.6											glaciofluvial
HA 2	0 -0.15	8.3											glaciofluvial

Drwg No D-1

SUMMARY OF TEST RESULTS

JOB No. 10-038

TEST HOLE	DEPTH	NATURAL WATER CONTENT	Atterberg Limits			MECHANICAL ANALYSIS (M.L.T. CLASSIFICATION)				SO_4 %	ORGANIC CONTENT %	BULK DENSITY Mg/m^3	STRATA CLASSIFICATION
			W_L	W_P	PI								
	metres	%	%	%	%	% CLAY	% SILT	% SAND	%GRAVEL				
HA 3	0 - 0.23	10.9											glaciofluvial
HA 4	0 - 0.6									0.003			glaciofluvial
HA 5	0 - 0.6	9.7											glaciofluvial
HA 6	0 -0.05									0.001			glaciofluvial
HA 7	0 -0.15	11.7											glaciofluvial
HA 8	0 - 0.3	12.2											glaciofluvial
HA 9	0 -0.46	10.9											glaciofluvial
HA 10	0 - 0.3									0.001			glaciofluvial
HA 11	0 -0.15	5.5											glaciofluvial
HA 12	0 -0.15	0.4											glaciofluvial
HA 14	0 -0.15	4.2											glaciofluvial
HA 15	0 -0.15	22.2											glaciofluvial
HA 16	0 -0.15	7.9											glaciofluvial
HA 17	0.3 -0.46									0.006			glaciofluvial
HA 18	0 - 1.2									0.001			glaciofluvial
HA 19	0 - 0.46	26.7											glaciofluvial

Drwg. No. D-2

GRAIN SIZE ANALYSIS

PROJECT: Canmore

JOB NUMBER: 10-038

DATE TESTED: June 23/80 TESTER: W.A.O.

REMARKS: Clayey silt, trace of fine sand

TEST HOLE NUMBER: TP 2

SAMPLE DEPTH: 0.1 - 0.2 m

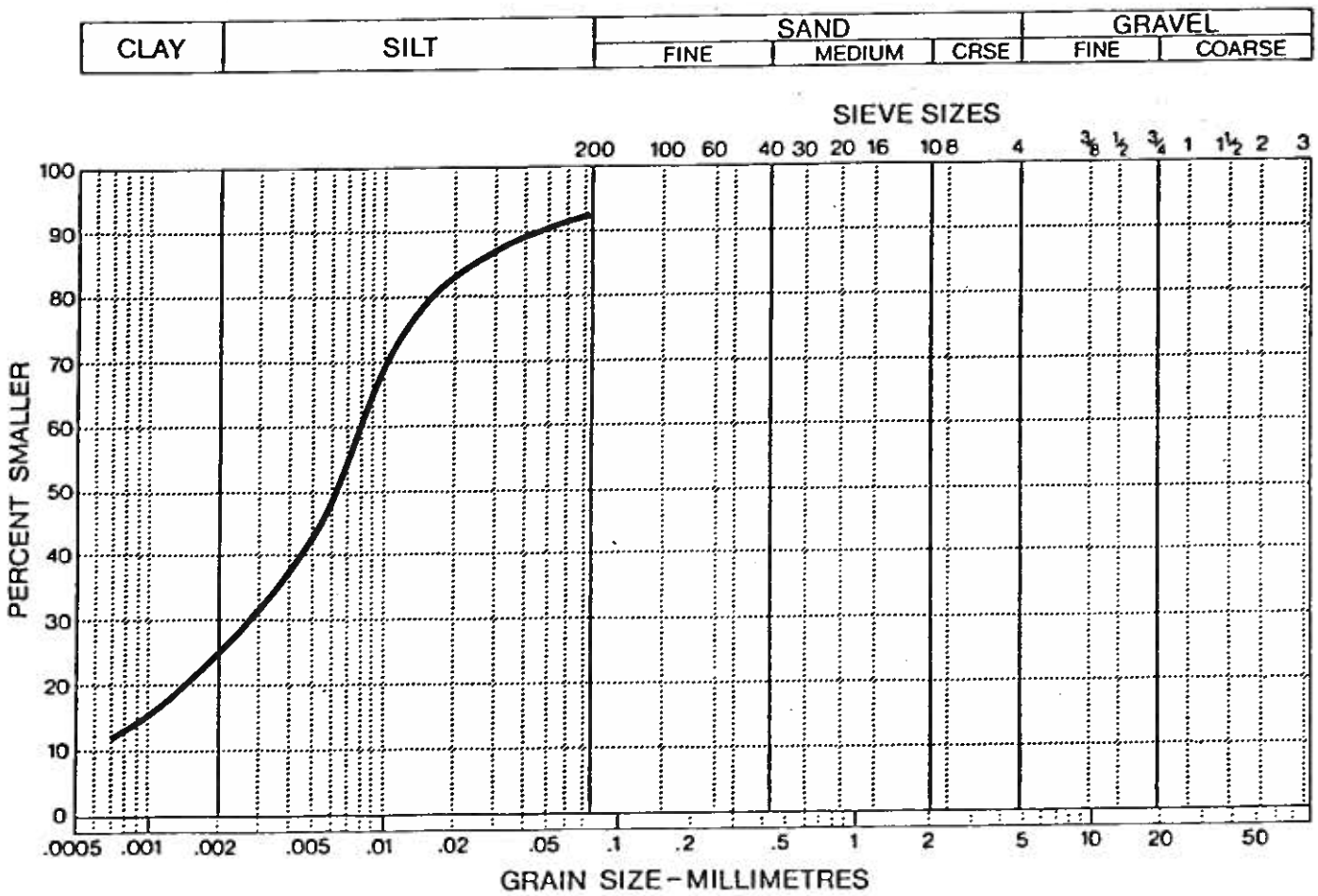
SUMMARY

GRAVEL:

SAND: 8%

SILT: 66%

CLAY: 26%



Drawing No. D-3

GRAIN SIZE ANALYSIS

PROJECT: Canmore

JOB NUMBER: 10-038

DATE TESTED: June 23/80 TESTER: W.A.O.

REMARKS: Fine to coarse gravel, some sand, trace of silt

TEST HOLE NUMBER: TP 6

SAMPLE DEPTH: .45 - 1.2 m

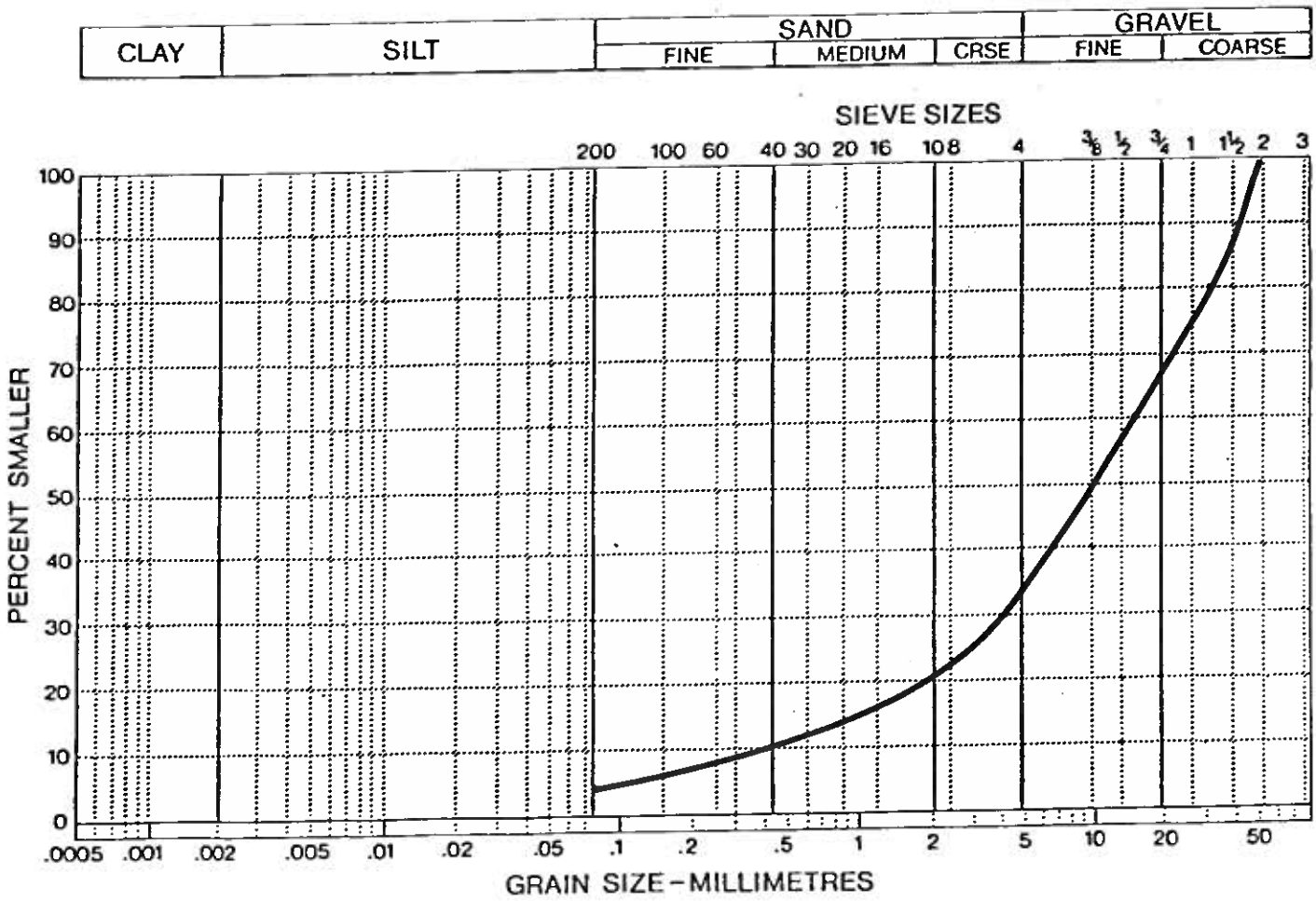
SUMMARY

GRAVEL: 67%

SAND: 29%

SILT: 4%

CLAY:



Drawing No. D-4

GRAIN SIZE ANALYSIS

PROJECT: Canmore

JOB NUMBER: 10-038

DATE TESTED: June 25/80 TESTER: W.A.O.

REMARKS: Fine to coarse gravel, some sand,
trace of silt

TEST HOLE NUMBER: TP 14

SAMPLE DEPTH: .9 - 3.0 m

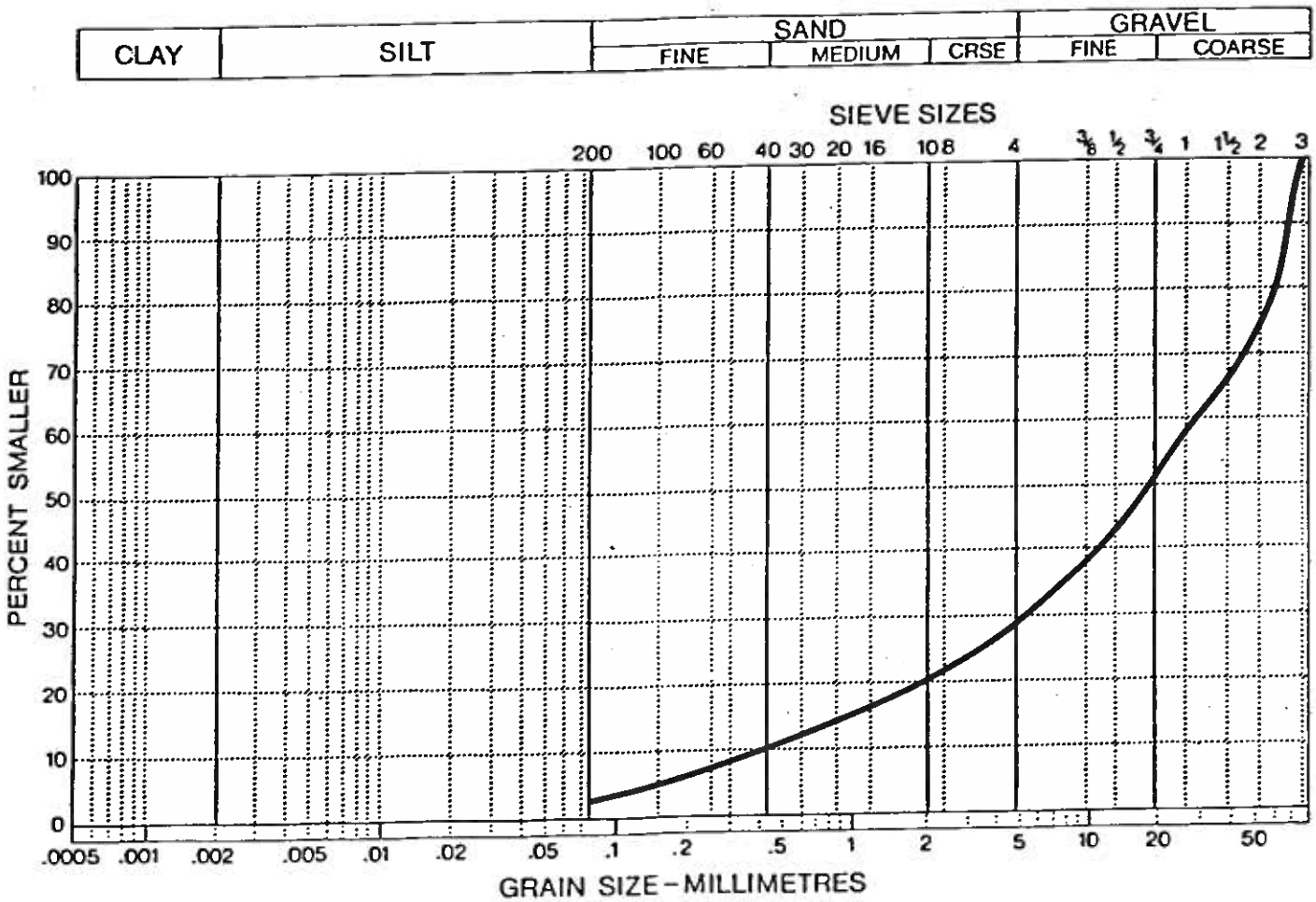
SUMMARY

GRAVEL: 71%

SAND: 26%

SILT: 3%

CLAY:



Drawing No. D-5

GRAIN SIZE ANALYSIS

PROJECT: Canmore

JOB NUMBER: 10-038

DATE TESTED: June 25/80 TESTER: W.A.O.

REMARKS: Silty, fine to coarse gravel with some sand

TEST HOLE NUMBER: TP 19

SAMPLE DEPTH: .8 - 2.9 m

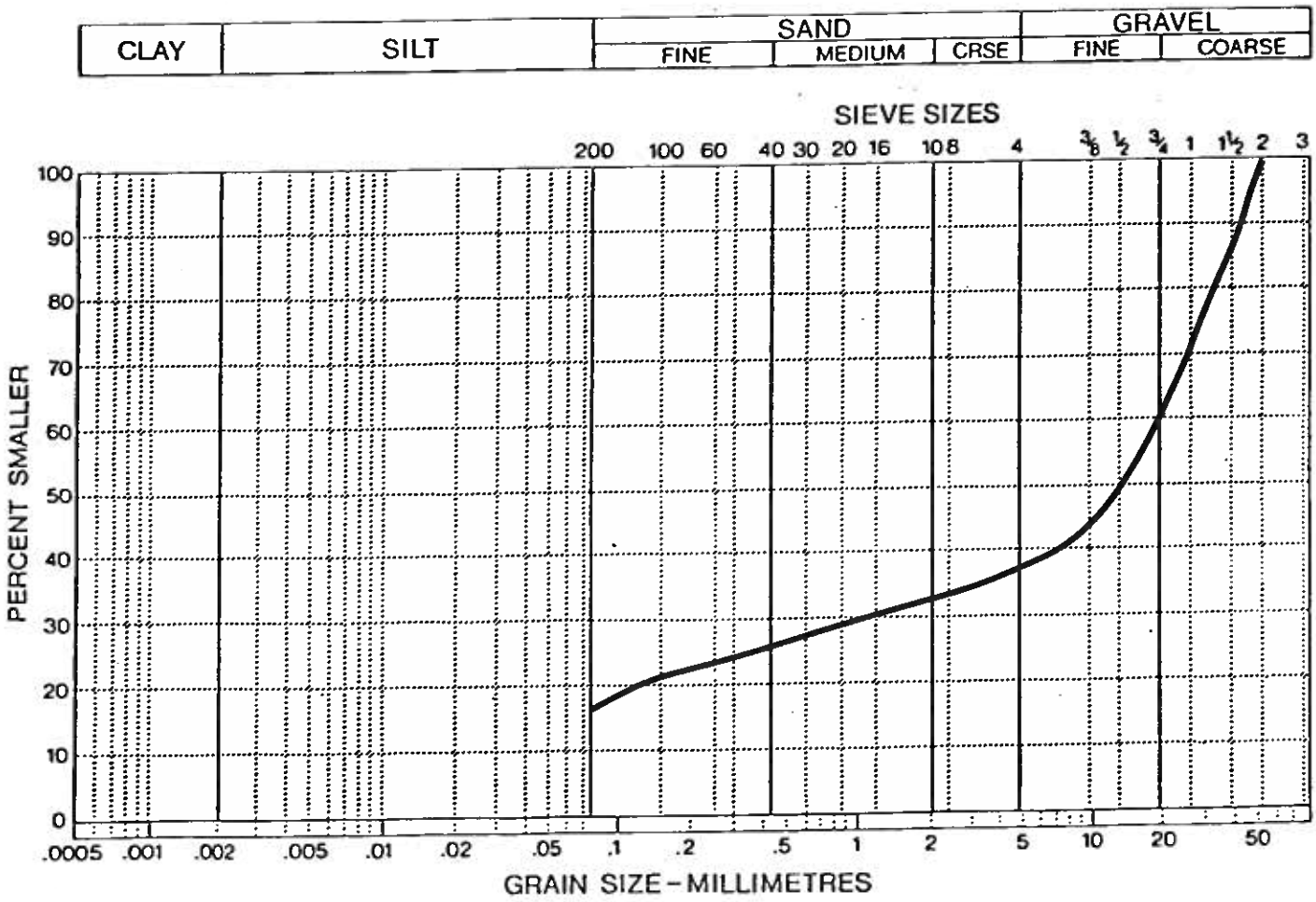
SUMMARY

GRAVEL: 62%

SAND: 21%

SILT: 17%

CLAY:



Drawing No. D-6