



Northwest
Territories Public Works and Highways

PROJECT CONSTRUCTION REPORT
PROJECT NO. 85-9207
CONTRACT NO. 86-1137-01

EQUIPMENT RENTAL,
DEMPSTER HIGHWAY GRADE REPAIR
km 8.5 to km 50.9
DEMPSTER HIGHWAY (NO. 8) N.W.T.

Transportation Engineering



Set No. 4

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prepared by:

EBA ENGINEERING CONSULTANTS LTD.
EDMONTON, ALBERTA

submitted to:

DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
YELLOWKNIFE, N.W.T.

December, 1986



EBA Engineering Consultants Ltd.

Civil, Geotechnical and Materials Engineers

1986 12 05

Department of Public Works and Highways
Highways Division
Government of the Northwest Territories
P.O. Box 1320
YELLOWKNIFE, N.W.T. X1A 2L9

File No: 0201-4551

Attention: Mr. R. Doerries

Dear Rolf:

Subject: Final Report - Dempster Highway Grade Repairs

We are pleased to enclosed 11 copies of our final report on the Dempster Highway Grade Repairs. The report summarizes all aspects of design, construction planning and construction supervision. We have essentially followed your suggested outline with minor deviations that seem appropriate for this project. We have also enclosed full size copies of the as-built drawings for your file.

We have enjoyed working with you on this interesting reconstruction project. In particular, we appreciated the opportunity to be involved in the entire project from development of remedial measures through to their implementation. We look forward to examining the performance data as it is collected throughout 1987.

Please give us a call if you have any questions or comments on the final report.

Yours very truly,

EBA Engineering Consultants Ltd.



Don W. Hayley, P. Eng.
Project Director

DWH:chb

cc: J.R. Trimble - EBA, Whitehorse



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1.0 SUMMARY

The Highways Division, Government of N.W.T. identified three sites along the Dempster Highway between km 8.5 and 50.9 where an unstable subgrade resulted in an unacceptable traffic hazard. Repairs to the three sites were undertaken between October 7 and 27, 1986. EBA Engineering Consultants Ltd. (EBA) of Whitehorse, Yukon were responsible for design and construction management for the project. Mr. D.W. Hayley was the Project Director and Mr. T.R. Murphy was the Field Engineer for EBA. North Star Services and Construction Ltd. (North Star) of Inuvik, N.W.T., supplied all equipment, men and camp facilities to complete the project. Mr. G. Campbell directed all operations and Mr. P. Chaubin was the Field Superintendent for North Star. Mr. J. Bowen was the Project Manager and Mr. R. Doerries was the Project Officer for the Design and Construction Highways Division, of Public Works and Highways, Government of the N.W.T. (the Department). The Project Manager for D.I.A.N.D. was Mr. E.S. Bies.

The principal activities carried out, and their corresponding dates are presented on Figure 1.1. The first site repaired was the site of a subgrade collapse located at km 8.5. Repairs at km 8.5 consisted of placement of synthetic insulation on the existing road grade and a buildup of the grade by addition of 550 mm of granular fill. The insulation was underlain by a heavy, woven geotextile and thermistor cables were installed to monitor ground temperature below the insulation.

At km 46.9, grade stabilization measures consisted of extending the existing culvert, placement of insulation along the toe of the toe berm and construction of a toe berm along the south side of the existing road grade. At km 50.9, the existing grade was extended on both sides of the highway. On the north side of the highway, fill was placed in depressions that had formed at the toe of the slope to divert runoff away from the road subgrade. A stabilizing toe berm was constructed on the south side of the highway. Insulation was placed below the toe of the berm and a thermistor cable was installed beneath the insulation to monitor ground temperature.



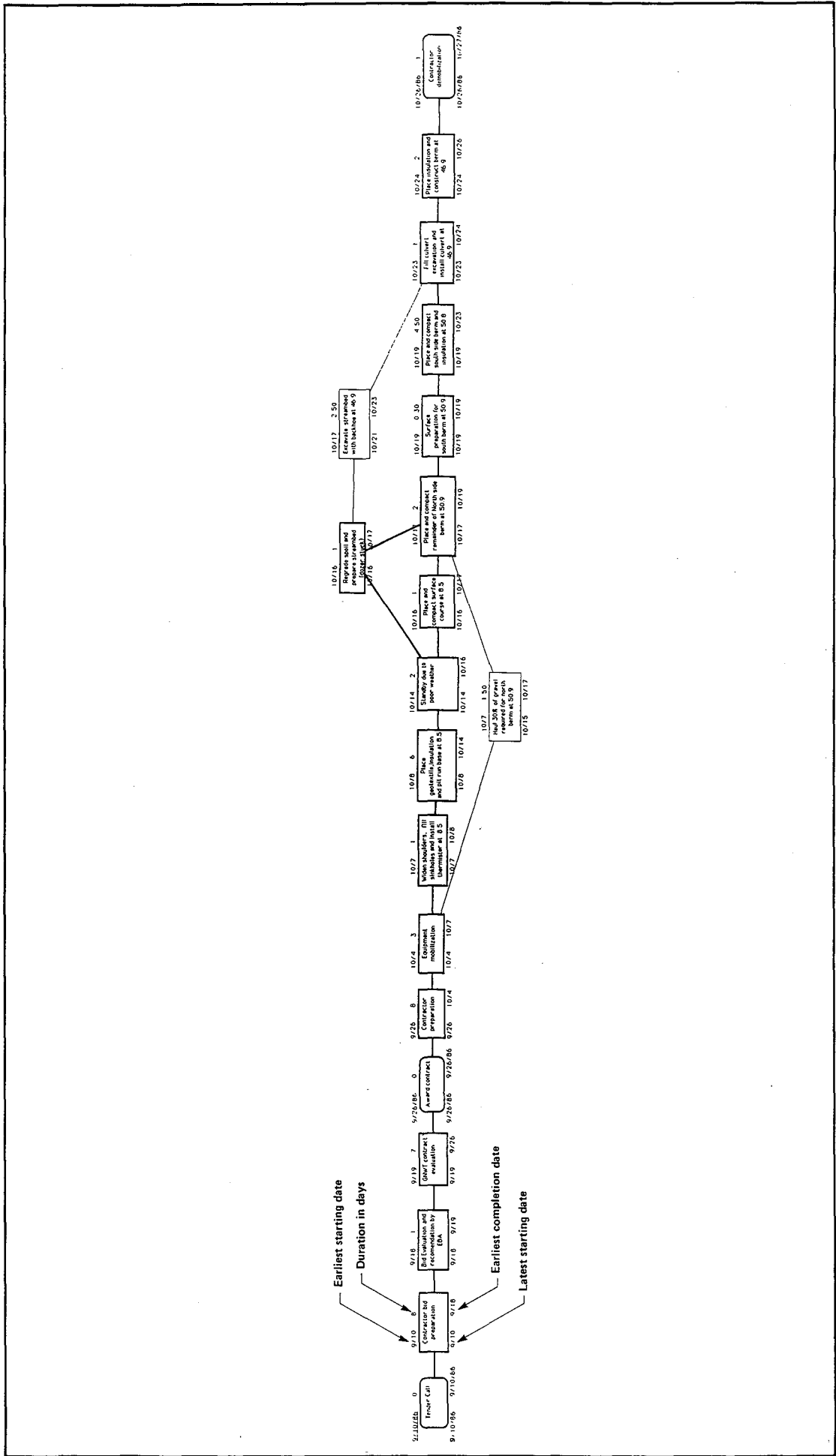


FIGURE 1.1 DEMPSTER HIGHWAY GRADE REPAIRS AS BUILT SCHEDULE

Pitrun gravel used for granular fill at all three sites was obtained from a stockpile at Midway Lake pit, km 44, and the topping course placed at km 8.5 was obtained from a stockpile of crushed gravel located at km 24. North Star established a construction camp at Midway Lake which provided subsistence for to all personnel involved in the construction project.

Approximately 4800 cu m of granular fill was placed and spread at the three sites during a 21 day construction program. In spite of cold stormy weather that prevailed throughout the October 1986 construction season, the majority of fill was placed in an unfrozen condition. The construction was completed within the allotted time and the estimated construction budget. Modest re-dressing of the surface and slopes will be required during the 1987 construction season because snow and freezing conditions inhibited final grading.

The initial contractors estimate to complete the project in 20 days was \$149,010. The final contractor costs to complete the 21 days of construction was \$144,185.


2.0 GEOGRAPHIC LOCATION

The three sites and construction camp are located between the N.W.T./Yukon Border and Ft. McPherson, N.W.T., on the Dempster Highway. The approximate locations for the sites, borrow pits and construction camp are presented on Figure 2.1.

3.0 PROJECT OBJECTIVES AND RATIONAL FOR REMEDIAL MEASURES

3.1 General

The Dempster Highway, within the Northwest Territories, is underlain by continuous permafrost soils. Permafrost is not present only within river or stream beds and their immediate banks. Ground ice in the soils along the route vary widely with the soil type and the depositional environment.



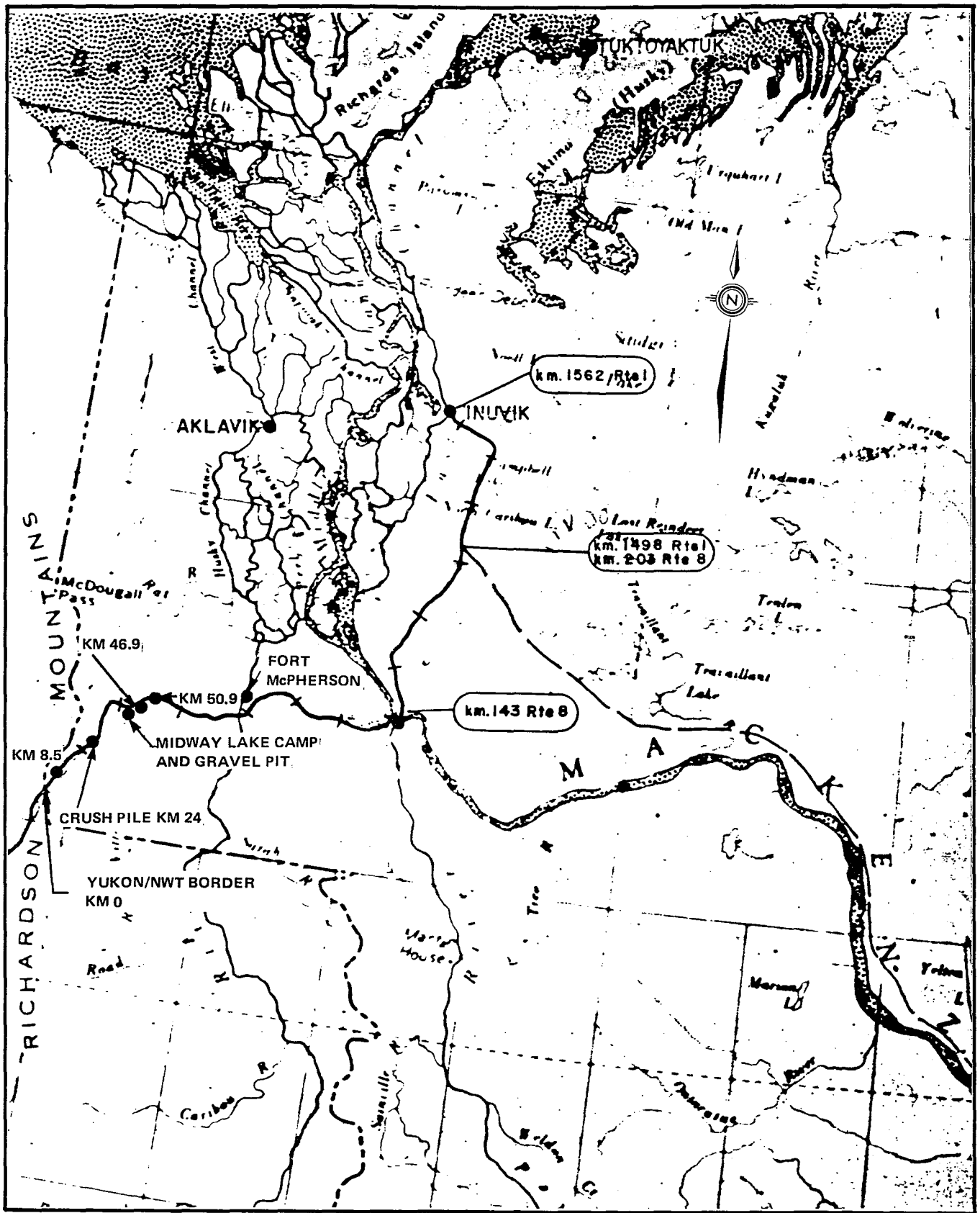


FIGURE 2.1 GENERAL LOCATION MAP

Thaw of natural permafrost soils underlying the gravel subgrade has resulted in instability of the grade at all three sites where remedial construction was planned. The nature of the instability and its effect on the highway is different at the various sites, however, permafrost thaw is a common causative factor in the instability. The mechanism resulting in instability and a brief description of the intended purpose of the reconstruction at each site is described in this section.

3.2 Subgrade Collapse at km 8.5

This location, 8.5 km east of Rat Pass on the eastern slope of the Richardson Mountains, was the site of a subgrade collapse resulting in a fatal accident. Collapse of the grade has been attributed to thaw of one or more ice wedges that are prevalent beneath the gravel subgrade. The intent of the original highway design in this region was to provide sufficient gravel fill over the ice-rich tundra to retain the natural permafrost foundation soils, restricting seasonal thaw to the thaw-stable gravel subgrade. Typical minimum fill thickness for preservation of the permafrost is 2 metres.

At the accident site (km 8.5) the highway is on the apex of a vertical curve as it dips from flat-lying upland terrain into an adjacent deep valley. The apex of the curve is also a transition from a cut in thaw stable shale bedrock on the valley slope to the typical 2 m thick gravel fill design for the upland terrain. At this particular upland location, a thick mantle of fine-grained colluvial soil overlies shallow shale bedrock. The colluvial soils have concentrations of ice present as stratified ice lenses typically occupying 50% of the total soil volume. Superimposed on this are closely spaced ice wedges that are clearly evident as polygonal patterned ground on the airphotos.

Geotechnical boreholes drilled at the site in the fall of 1985 (EBA, 1985) show that the thickness of the gravel subgrade averages only 1.6 m at the site and is as thin as 1.0 to 1.2 m at several locations. The thinner fill



section reflects the transition from cut to the design fill thickness of 2 m. A general warming and progressive thaw of the underlying ice-rich terrain is occurring where the gravel fill is thin. Thaw settlement resulted in formation of substantial depressions or "sinkholes" on both sides of the grade at km 8.5. The depressions were located at the extremities of a major system of ice wedges that extend beneath the roadway embankment.

The sinkholes on the north side of the roadway trapped runoff water during spring. Seepage was initiated beneath the road from the north sinkhole to the south sinkhole. The hydraulic gradient was provided by a differential water head, plus the regional slope of the terrain from north to south across the road. Subsurface water followed a path of least resistance through cracks and other defects in the wedge ice. Progressive warming of subsurface ice below the thin subgrade accelerated initiation of a drainage path. Convective heat transfer from subsurface flow caused thermal erosion of the core of the ice wedge, leaving an ice bridge to support the overlying gravel subgrade.

The gravel embankment was probably quite soft at this location in late summer because of upward movement of melt water from slow, progressive thaw of ice-rich soils. An appropriate combination of warm air temperature, soil temperature and wheel loading ultimately resulted in collapse of the road surface into the void causing the accident.

Two approaches were considered for remedial measures at km 8.5; excavation of ice-rich subgrade soils or rebuilding the grade with sufficient insulation capacity to draw the permafrost up into the fill. The risks and costs associated with each approach were compared at the outset of the project and excavation of existing soils was rejected in favour of building up the grade. Considerable uncertainty was attributed to the extent of the excavation required and potential negative thermal effects of replacing fine-grained frozen soils with relatively dry granular fill. The granular fill would conduct more heat into the ground during the summer thaw season, potentially aggravating thaw-settlement problems.



Design of the surface insulating layer was developed based on research on an insulated subgrade south of Inuvik as reported by Johnston (1983). A 50 mm thick layer of high density, high strength extruded polystyrene insulation (Dow Styrofoam HI 60) was chosen to cover the existing road surface for a distance of 40 m in the vicinity of the grade collapse. The design specifies covering the insulation with 400 mm of pit run gravel and 150 mm of crushed surfacing materials. The design was subsequently checked by thermal analysis to predict long-term position of the permafrost table and ground temperatures within the permafrost after placement of the insulation and fill. The thermal analyses is described in Appendix B. Although the thickness of insulation is somewhat less than recommended by Johnston for placement directly on the tundra, the long-term predictions were considered acceptable. Unlike the design tested by Johnston, which does not permit thaw below the insulation, the design adopted for km 8.5 limits summer thaw to one metre below the insulation, or within the existing gravel embankment.

A layer of heavy woven geotextile (Propex I-996 supplied by Nilex Geotechnical Products Inc.) was placed below the insulation on the existing road fill. The presence of the geotextile provides additional safety against instantaneous collapse of the road surface should another cavity develop within the ice-rich subgrade. Research conducted in Alaska (Kinney, 1985) has shown that the geotextile is capable of bridging voids caused by ice wedge erosion. A cavity would be distinguished by a dip in the road surface rather than collapse, alerting maintenance personnel to potential future problems.

A program to monitor ground temperatures below the insulation layer was recommended and implemented to verify performance of the system. Installation of two thermistor cables on October 9 and data collected to date is presented in Appendix B. As-built drawings that adequately represent the design developed for km 8.5 are included in Appendix A.



3.3 Embankment Sloughing at km 46.9 and 50.9

At both remaining sites designated for remedial construction, the road grade crosses a broad gully on a deep fill. Existing maximum fill thickness is typically between 4 m and 6 m. The regional slope of the terrain is from north to south, thus the elevation difference from the top of grade to the bottom of the natural gully is about twice as great on the south side as it is on the north side of the road. At both sites, lateral spreading of the fill has resulted in longitudinal tension cracking along the south shoulder and sloughing of the south facing slope.

It is postulated that permafrost thaw has progressed into ice-rich fine-grained soils beneath the south facing embankment slope. The recently thawed soils do not possess sufficient shear strength to support the embankment, resulting in shear displacement along the frozen-unfrozen interface. Thaw was initiated and perpetuated by the unfavourable orientation of the sloping gravel surface relative to the sun and by changing patterns of snow accumulation caused by extensive winter drifting on the south shoulder of the embankment. These effects would substantially alter the mean annual ground temperature by enhancing the summer heat input and by restricting the winter heat extraction. At km 46.9 groundwater seepage below the existing culvert may also have contributed to the degradation of the permafrost.

Embankment stability at both sites will be improved by construction of a stabilizing toe berm at the toe of the south facing slope. A berm approximately 1.5 m thick and 13 m wide has been designed for each site. The purpose of the toe berm is to consolidate recently thawed soils, improving their strength and to draw the permafrost up to the original ground surface (base of berm). A layer of synthetic insulation 50 mm thick has been provided beneath the south slopes of the berm to limit thaw and instability beneath the new embankment. The presence of a stable berm will



buttress the slope of the existing embankment. At km 50.9, a thermistor cable located beneath the toe insulation will allow monitoring of the effectiveness of the berm at arresting progressive thaw of the permafrost.

Thaw-settlement induced troughs have formed along the north toe-of-slope at km 50.9. These settlement troughs trap spring runoff water, forming temporary ponds. Filling of these settlement troughs and general slope flattening was also adopted in order to prevent ponding at the immediate toe of the subgrade. As-built drawings that adequately reflect the restoration measures adopted for km 46.9 and 50.9 are included in Appendix A on Drawings 2 and 3 respectively.

4.0 CONSTRUCTION

The sites are discussed in order of completion. Photographs showing various phases of construction at each site are included in Appendix D.

An equipment rental contract was let to North Star Services and Construction Ltd. of Inuvik. According to the terms of the contract, North Star provided and operated all equipment to complete the construction, provided a superintendent and labourers, and provided and operated a construction camp. All equipment and personnel rates were based on an hourly rate, and camp and subsistence rental was based on a daily rate. The hourly charges were approved each day by the Project Engineer from EBA.

Tenders were sent out on September 10, 1986, to five companies and responses were received from three; Storr and Sons Ltd. (Aklavik), Points North Transportation (PNT), and North Star Services and Construction Ltd., both of Inuvik. The contract was awarded to North Star on September 26, 1986. A summary of the bid prices are presented on Figure 4.1. Construction started on October 7, 1986, at km 8.5. Figure 1.1 presents a flow chart of subsequent activities for the project.



Unit	Storr			PNT			Northstar			EBA
	Unit	Condition	Price	Unit	Condition	Price	Unit	Condition	Price	Estimate
Dozer	D7(Ripper)	Excel.	\$150	D7(Ripper)	VG	\$97	D6D Cat	Good	\$85	\$85
Loader	950 Cat	Excel.	\$150	966 Cat	VG	\$97	31K2656	Good	\$85	\$100
Dump truck 1	11m. KW	Good	\$130	8m. ?	?	\$77	10m. KW	Good	\$65	\$75
Dump truck 2	11m. KW	Good	\$130	8m. ?	?	\$77	10m. KW	Good	\$65	\$75
Dump Truck 3	13.5m. KW	Good	\$130	8m. ?	?	\$77	8m. INT.	Good	\$65	\$75
Compactor	Tampo ?	Excel.	\$110	Tampo RS280	Good	\$97	Ferg. SP75B	Good	\$70	\$65
Grader	Cat 140G	Excel.	\$150	24R540	Good	\$97	72U4359	Good	\$120	\$120
Lowboy	LTL 900	Excel.	\$130	40 Ton	VG	\$107	?		\$90	\$90
Superintendant	No Info		\$45	8 yrs. Exp.		\$53	Owner		\$40	\$40
Labourer			\$30			\$25			\$30	\$20
Camp Rental	No Info		\$1,100			\$100			\$500	\$600
Camp Subsistence			\$30			\$65			\$65	\$80
Mob/Demob			\$15,000			\$41,000			\$8,000	\$16,650
Insulation			\$23.75			\$21.53			\$18.00	\$19.17
Geotextile			\$3.15			\$2.14			\$3.25	\$3.00
Culvert			\$140.00			\$83.20			\$150.00	\$92.00
Standby %			30			50			0	
Total Price			\$227,292			\$194,538			\$149,010	\$169,554

FIGURE 4.1 DEMPSTER HIGHWAY GRADE REPAIRS
CONTRACTOR BID COMPARISON

4.1 Construction at km 8.5

At km 8.5 construction repairs were initiated by regrading approximately 60 m of highway and prepare the surface for placement of geotextile and insulation. During regrading, two holes were drilled in the subgrade at the backfilled sinkhole location and thermistor cables were installed. The subgrade buildup was started on the right lane by first placing Propex I-996 geotextile on the leveled road surface. HI 60, rigid 50 mm polystyrene insulation, was placed directly on the geotextile. The joints of adjacent rows of insulation were staggered to prevent gaps from occurring during placement of the overlying gravel fill. The gravel was placed in 200 mm lifts and compacted by driving loaded gravel trucks over each lift until no more wheel ruts appeared. The vibratory drum roller was used when it was serviceable. Traffic was diverted to the right lane once all geotextile, insulation and the first lift of compacted fill were in place. The left lane was constructed in the same fashion. The final 200 mm lift was placed and compacted and prepared for the topping course. A topping course of crushed gravel was placed in one 150 mm lift. Grading was completed with a grader and compaction was accomplished using a vibratory compactor. The final measurements and quantities, and details of the thermistor cable configuration are presented on Drawing No. 1 in Appendix A.

4.2 Construction at km 50.9

At km 50.9 on the north side of the highway, fill was placed with nominal compaction in the ditch and the small pond adjacent to the existing fill area. The north shoulder required a considerable amount of fill and was often used as a dump site when trucks were unable to haul to km 8.5 for one reason or another.

On the south side of the highway a toe berm was constructed. Prior to the toe berm construction, the frozen ground surface was leveled as-best possible, small ponds of water were removed, and a thermistor cable was installed beneath the area to be insulated. A detailed drawing of the



thermistor cable configuration is presented on Drawing No. 3 in Appendix A. Insulation placed along the toe of the berm comprised both HI 60 and HI 40, 50 mm rigid insulation. The insulation was subsequently covered with pitrun. The fill was generally placed in 300 mm lifts and compaction was achieved primarily by driving loaded gravel trucks over each lift. Approximate quantities and dimensions for the work completed on the north and south sides of the highway at km 50.9 are presented on the as-built drawings in Appendix A.

4.3 Construction at km 46.9

At km 46.9 construction of the toe berm commenced by constructing an access ramp to the toe berm area, on the south side of the highway. A 12 m extension to the existing culvert was necessary prior to fill placement. Approximately 1.5 m of soft silty clay was excavated from beneath the culvert extension and replaced with granular fill. Several old spoil piles, located at the toe of the slope, were removed from the toe berm site and leveled in an area southeast of the toe berm.

The 12 m culvert extension comprised two 6 m long sections, 800 mm in diameter. The culvert extension was mated to the existing culvert (760 mm diameter) by sliding the larger diameter extension over the smaller diameter culvert. The fit was relatively tight and an overlap of approximately 300 mm was provided. As an added measure of safety, a standard coupler was fastened around the connection. Rigid 50 mm insulation (HI 60 and HI 40) was then placed along the toe of the toe berm and covered with fill. The fill was generally placed in 300 mm lifts and compacted by driving loaded gravel trucks over each lift. Approximate quantities and dimensions for the work completed are presented on the as-built drawing presented in Appendix A.

A change order for the contractors invoice was issued on November 10, 1986 and is presented in Appendix C. All interim certificates and final certificates of completion are presented in Appendix C.



5.0 CONSTRUCTION COSTS

The following summarizes the expenditures for the engineering consulting fees and construction costs for the project:

Consulting Fees (EBA)

1. Engineering Design	\$ 5,836.00
2. Preparation of specifications	\$ 13,769.00
3. Site supervision	\$ 29,685.00
4. Thermal analysis	\$ 3,500.00
5. Report Costs	\$ 6,353.00

TOTAL Consulting Fee \$ 59,143.00

Total Construction Costs (Northstar) \$144,185.00

6.0 DESIGN PROBLEMS

A thermal analysis of the insulation configuration at km 8.5 was completed by EBA. Although results of the analyses were not available until construction commenced, they confirm the effectiveness of the insulation. A copy of the report presenting the analysis is presented in Appendix B. The predictions will form a useful comparison with measured ground temperatures. Temperature plots showing ground temperature data collected at km 8.5 and km 50.9 between the time of installation and November 27, 1986, follow the thermal analysis report in Appendix B.

Placement of the insulation was easily attained. Minor sliding of the insulation during the fill covering process was reduced by carefully directing the dozer operator. In some areas minor gaps (less than 300 mm) between boards of insulation exist. The plans and specifications were complete with only minor discrepancies. It was observed; however, that some of the profiles varied from those on the drawing.



It was apparent that maintenance personnel had placed and removed fill in certain areas. These changes did not have a significant impact on completion of the repairs.

The baselines and temporary benchmarks established in October, 1985, at all three sites, were very useful during the "layout" process. A considerable amount of time was saved by not having to establish these baselines and temporary benchmarks, as well as establish survey sections close to the proposed design.

The culvert foundation pad at km 46.9, could not be constructed as specified on the design drawings. Frozen ground was encountered in the middle of the excavation for the extension and proved to be too difficult to remove. The unfrozen ground in the culvert extension excavation was extremely soft and a backhoe was required to complete the excavation. The dozer was initially used, but became stuck in the soft silt and clay. An approximate profile showing the lobe of frozen ground remaining below the culvert extension is included on the as-built drawing, for km 46.9, in Appendix A.

7.0 SPECIFICATIONS AND STANDARDS

Compaction specifications developed were appropriate; however, some difficulty in attaining specified compaction at the three sites was experienced. The contractors compaction equipment did not work for 76% of the project or when operating, did not function adequately. Compaction was generally attained by driving gravel trucks over each lift. This method of compacting each lift provided adequate compaction for the toe berms. Because winter conditions prevailed during construction, some of the fill was placed in a partially frozen state.

8.0 QUALITY ASSURANCE AND INSPECTION

Site supervision and inspection was provided on a continuous basis by a Project Engineer from EBA. Compacting testing was performed at all three



sites using a nuclear densometer. Approximately twelve tests were performed at each site. The results show that specified compaction of 95% Standard Proctor was usually attained at each site. Results of the compaction tests are summarized and presented in Appendix B.

9.0 CONTRACTOR APPRAISAL

The quality of work provided by the contractor was adequate for this particular project. However, the equipment supplied arrived on site in need of repair and the operators supplied were in some cases unskilled. It is believed that if the contractor had bid the project on the basis of a fixed price then more attention would have been given to operator skill and equipment condition. The contractor's camp provided good food and adequate shelter. However, little effort for cleaning shower areas and rooms was provided. The superintendent supplied by the contractor was very cooperative and conscientious with regard to cleaning up garbage and spilled oil around the camp. However, because the equipment and camp was in continuous need of repair, he was required to spend a considerable amount of time as a mechanic rather than superintendent.

The project was completed in 21 days. Approximately 4.5 days were lost due to bad weather and road conditions.

10.0 OVERRUNS AND UNDERRUNS

A summary of overruns and underruns is presented in Table 10.1.

11.0 MAINTENANCE RECOMMENDATIONS

Heavy snow and cold winter weather during the construction period often made the final grading process very difficult. Minor redressing and slope



TABLE 10.1 OVERRUN AND UNDERRUN SUMMARY
 DEMPSTER HIGHWAY GRADE REPAIRS 1986

DESCRIPTION	NO. OF TENDER HOURS	NO. OF FINAL HOURS	PERCENT OVERRUN	PERCENT UNDERRUN	COMMENTS
1. Crawler tractor	190	201.5	6.0		
2. Front end loader	150	176.0	17.3		Longer hours and snow removal
3. Dump trucks	450	491.5	9.2		
4. Compactor	190	45.5		76.0	Broke down
5. Motor grader	20	18.5		7.5	
6. Low boy truck	40	18.5		53.7	Haul from Inuvik not required
7. Superintendent	190	203.0	6.8		
8. Labourers	300	320.0	6.6		
9. Camp rental	20	21.0	5.0		
10. Camp subsistence	240 ¹ .	205.0 ¹ .		14.5	

NOTE: Percentages are based on tender estimates.

¹Total number of people.

grading will be required to properly cleanup the sites after snowmelt in 1987. As well, shaping of the toes of the toe berms may be necessary to ensure proper drainage.

11.1 km 8.5

Performance of the reconstructed subgrade at km 8.5 must be carefully monitored for the next 2 to 3 years. In addition to systematic collection of ground temperature data, a bi-annual topographic survey is recommended (Spring and Fall). The survey should include a centre line profile and several cross-sections that extend beyond the zone of disturbance on both sides of the highway. Survey profiles should be determined before maintenance fill is placed and careful records should be kept of additional gravel that is placed at this site. There is a potential for subgrade collapse elsewhere on the eastern slope of the Richardson Mountains. Monitoring the effectiveness of remedial measures developed for km 8.5 could benefit prediction of future problematic sites and provide confidence in mitigation measures adopted.

The tendency for ponding adjacent to the subgrade during spring runoff must be monitored and prevented. Some additional fill may be required in reoccurring sinkholes to eliminate closed depressions.

11.2 km 46.9

At km 46.9 minor settlements of the culvert should be expected, as the fill was only nominally compacted and all soft soils remaining beneath the culvert may not re-freeze. The streambed adjacent to the culvert exit must remain unobstructed and water must not be allowed to pond at the toe of the berm. Additional fill was placed on the slope of the existing grade above the new berm at approximately station 46 + 864. Its purpose is to prevent runoff from entering the fill at the contact with the new toe berm. This area should be observed for potential erosion caused by runoff.



A ramp was required to provide access for the gravel trucks during toe berm construction. On completion of the berm the ramp was frozen and could not be removed with the available equipment. Reshaping of this frozen ramp gravel will be required in the spring.

11.3 km 50.9

At km 50.9 it is likely that additional fill will be required in the old pond area on the north side of the highway. Fill was placed over the snow and ice in the pond. Some settlement did occur during fill placement; however, more settlement is expected. Fill should be added to prevent ponding once settlement occurs in the spring. Reshaping along the toe of the new berm, on the south side of the highway, may be necessary in the spring once the snow melts. The final shaping of the berm took place during blizzard conditions and consequently, areas requiring levelling may have been missed because they were covered with snow. A thermistor cable was installed beneath the insulation, and it was recommended that temperature readings be taken each month for the first year and the readings forwarded to EBA.

12.0 SOURCES OF MATERIAL

The topping course used at km 8.5 was obtained from the stockpile of crushed gravel at km 24. Approximately 180 m³ of crushed material was removed.

The general fill used at the three sites was taken from the stockpiles at Midway Lake pit, km 44. It is estimated, from as-built measurements, that approximately 4800 m³ of pit run were removed. Because the construction was undertaken during winter conditions many large chunks of frozen gravel were left in the pit. Minor cleanup will be necessary for the next user of the pit.



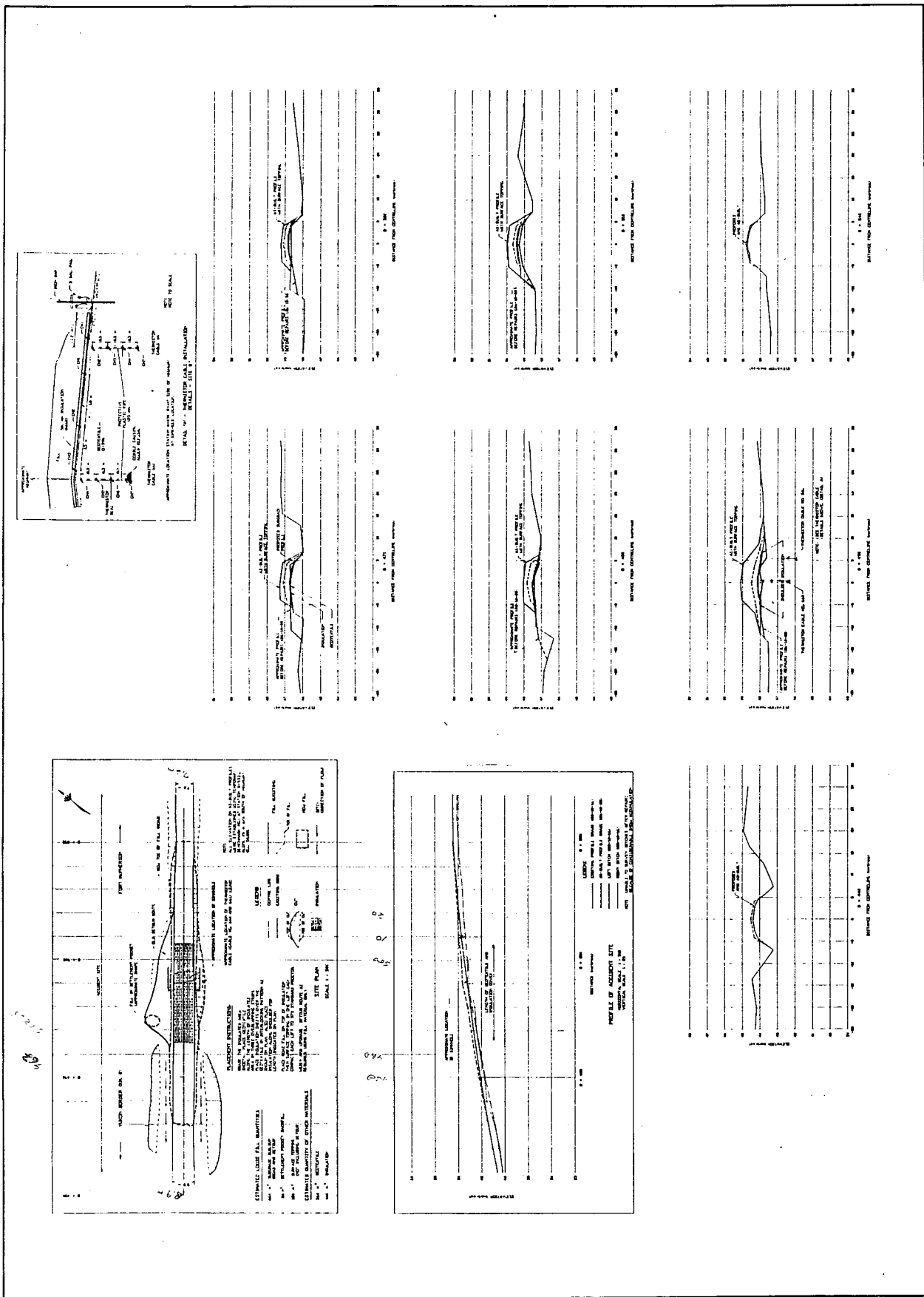
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- KINNEY, T.C., 1986. Reinforced Roads Bridging Voids, Proceedings of the Fourth International Conference for Cold Regions Engineering, 1986, Anchorage, Alaska, pp. 320-329.



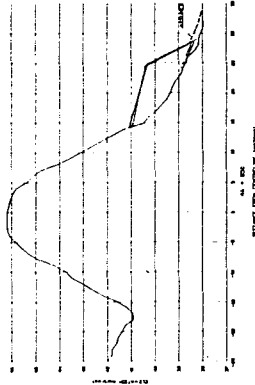
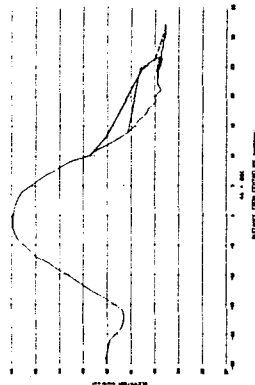
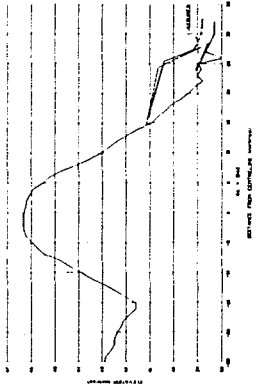
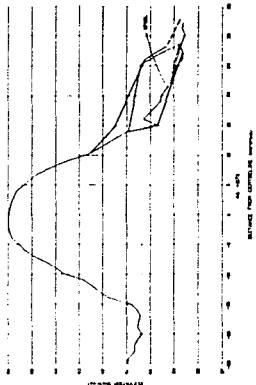
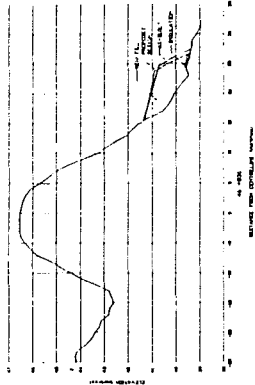
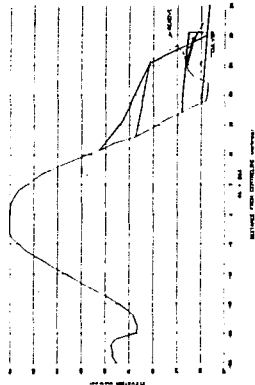
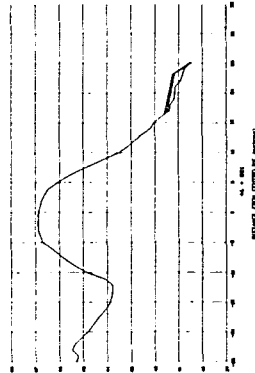
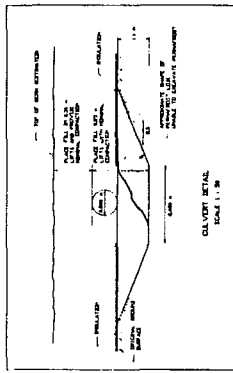
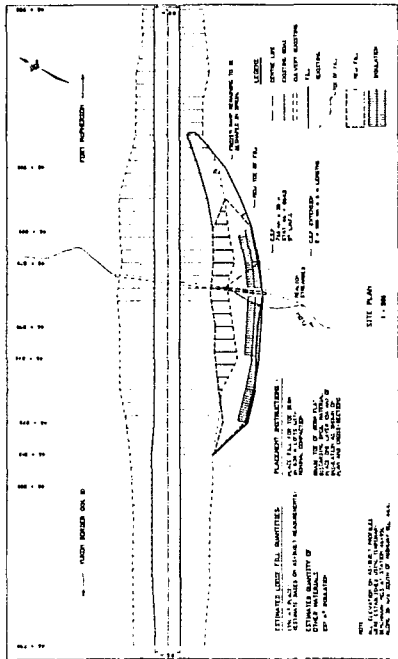
APPENDIX "A"

APPENDIX A
AS-BUILT DRAWINGS



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				DESIGNED		
				CHECKED		
				APPROVED		

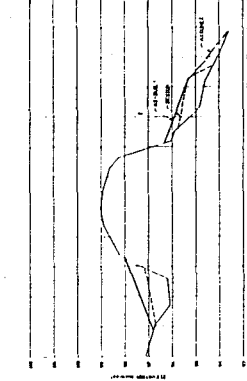
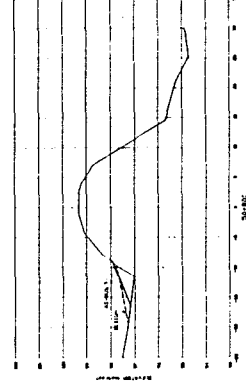
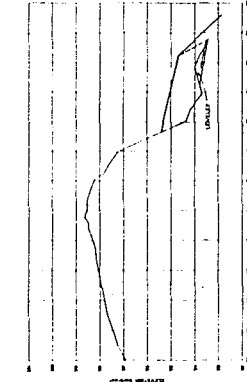
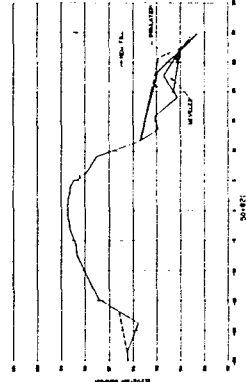
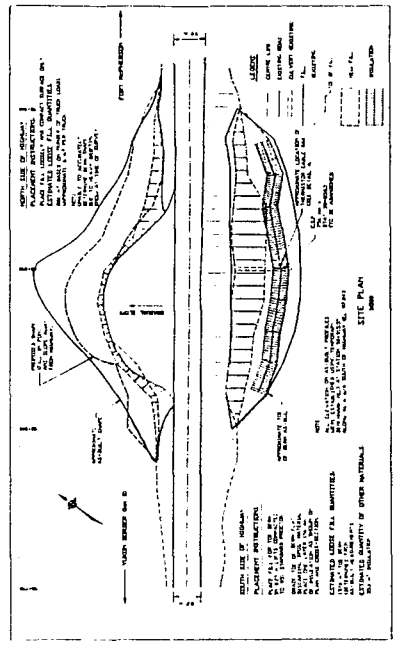
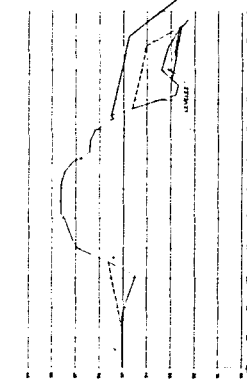
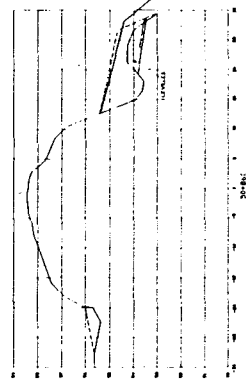
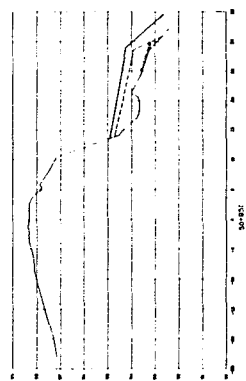
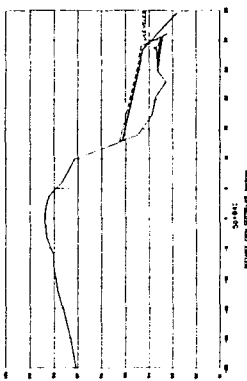
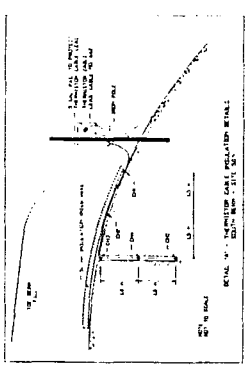
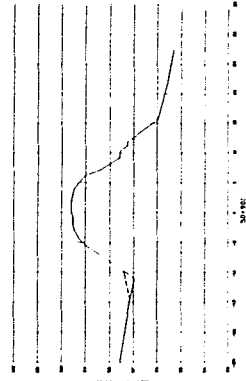
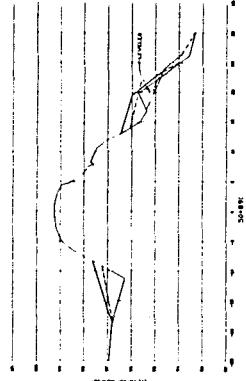
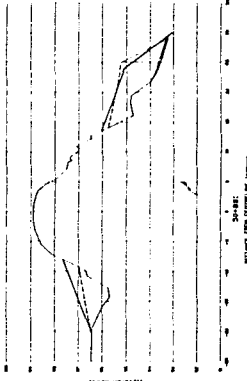
CLIENT: DEPARTMENT OF PUBLIC WORKS
 AND HIGHWAYS
 PREPARED BY:
 EBA Engineering Consultants Ltd.
 (Incorporated in the Republic of Singapore)



NO. REVISION	BY	DATE	DESIGNED	BY	DATE	
			DRAWN			
			CHECKED			
			APPROVED			

CLIENT
 DEPARTMENT OF PUBLIC WORKS
 STATE OF NEW YORK
 PREPARED BY
 PERI Engineering Consultants Ltd.
 100 West 100th Street
 New York, N.Y. 10025

DEWATER HIGHWAY, N.Y.T.
 1986 REPAIRS TO LEO 459
 AS-BUILT MEASUREMENTS



CLIENT: DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
PROJECT: DEMPFSTER HIGHWAY, N.W.T. 1986 REPAIRS TO Km 50.9
PREPARED BY: EMA Engineering Consultants Ltd.
 (Incorporated in the Province of Ontario)

DATE: 1986
BY: [Signature]
CHECKED: [Signature]
APPROVED: [Signature]

NO. 1 | **NO. 2** | **NO. 3** | **NO. 4** | **NO. 5** | **NO. 6** | **NO. 7** | **NO. 8** | **NO. 9** | **NO. 10**

CLIENT: DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
PROJECT: DEMPFSTER HIGHWAY, N.W.T. 1986 REPAIRS TO Km 50.9
PREPARED BY: EMA Engineering Consultants Ltd.
 (Incorporated in the Province of Ontario)

DATE: 1986
BY: [Signature]
CHECKED: [Signature]
APPROVED: [Signature]

NO. 1 | **NO. 2** | **NO. 3** | **NO. 4** | **NO. 5** | **NO. 6** | **NO. 7** | **NO. 8** | **NO. 9** | **NO. 10**

APPENDIX "B"

APPENDIX B

1. Thermal Analysis Report
2. Temperature Profiles
3. Compaction Test Results

EBA Engineering Consultants Ltd.

Civil, Geotechnical and Materials Engineers

1986 10 20

Department of Public Works and Highways
Highways Division
Government of the Northwest Territories
P.O. Box 1320
YELLOWKNIFE, N.W.T. X1A 2L9

File No: 0201-4551

Attention: Mr. R. Doerries

Dear Rolf:

Subject: Thermal Analyses
Dempster Highway, N.W.T.
1986 Repairs to km 8.5

1.0 INTRODUCTION

A section of the Dempster Highway in the vicinity of km 8.5 requires repairs due to thaw subsidence of the ice-rich permafrost beneath the roadfill. The gravel roadfill averages 1.6 m in thickness which was constructed over the natural permafrost terrain.

The repair measure adopted is to place a 50 mm thick insulation board over the existing road surface. On top of the insulation, an additional roadfill of about 0.6 m thick is to be placed. The objective of such an insulation arrangement is to contain the seasonal thaw depth within the existing gravel road fill so that the underlain natural terrain will remain frozen.

This letter summarizes results of a thermal analyses on ground temperatures under the insulation arrangement.



2.0 SUBSURFACE CONDITIONS

A summary of subsurface soil conditions has been presented in the following report:

"Geotechnical Evaluation, Dempster Highway, N.W.T. (Selected Site)".
A report submitted to Government of the Northwest Territories by EBA Engineering Consultants Ltd., December, 1985.

A total of eighteen boreholes were drilled at the site. Figure 1 shows the borehole location. A thermistor cable was installed in Borehole No. 15 (Figure 2) which is off the highway embankment. One set of ground temperatures was measured on 85-10-21. The information on this borehole represents the ground temperature condition in the natural terrain near the site, which is useful for model calibration with respect to climatic input parameters.

Borehole No. 5 (Figure 2) is believed to represent the worst soil condition at the site based on the available data. This borehole is therefore selected as the design case for the thermal analyses. The soil profile consists of 1.25 m of gravel fill overlying a thin layer of organic soil (0.3 m). Beneath the organic soil lies an ice layer of 2.5 m in thickness. The objective of placing a 50 mm insulation board over the existing road surface is to contain the seasonal thaw depth within the existing roadfill so as to prevent future thermal degradation in the natural terrain beneath the roadfill.

3.0 THERMAL PROPERTIES AND CLIMATE DATA

The geothermal model developed at EBA (Hwang, 1972) has been used for the thermal analysis. The computer program has been well verified through numerous comparisons with theoretical and measured ground temperature. Input parameters for the thermal analysis including soil thermal properties and climatic data are summarized in this section.



3.1 Thermal Properties

Thermal properties of soils and insulation board are listed in the following table:

MATERIAL TYPE	THERMAL CONDUCTIVITY (W/M.C.)		TOTAL DENSITY (mg/m ³)		SPECIFIC HEAT (KJ/KG.C)		LATENT HEAT (MJ/m ³)
	Frozen	Unfrozen	Frozen	Thawed	Frozen	Unfrozen	
Gravel (w=10%)	2.86	2.59	1.03	2.03	0.86	1.05	61.5
Insulation*0.03		0.03	0.04	0.04	1.26	1.26	0
Peat (w=100%)	0.81	0.43	1.3	1.3	1.9	3.0	239.0
Ice	2.13	0.57	0.92	1.0	2.05	4.20	344.0
Sandy Till (w=243%)	2.46	0.99	1.23	2.11	1.75	3.18	288.0
Silt (w=77%)	2.10	1.14	1.55	2.21	1.43	2.24	215.0
Bedrock (shale)	1.46	1.46	2.40	2.40	0.66	0.66	0

NOTE: * Styrofoam HI 60 or equivalent

3.2 Climatic Data

The climatic data from Fort McPherson, N.W.T. was used for the thermal analyses. The climate at Site km 8.5 is anticipated to be colder than Fort McPherson due to the higher elevation and greater wind speed. However, the use of warmer climatic data is considered to be a conservative estimate of climate that is appropriate for design purposes.



Mean monthly values of the climatic data at Fort McPherson, N.W.T. are listed below:

DATE	AMBIENT TEMPERATURE	AVERAGE WIND VELOCITY	SNOW DEPTH	AVERAGE SOLAR RADIATIONS
(M-D)	(°C)	(KM/H)	(MT)	(WATTS/MT2)
11-15	-20.30	7.90	.28	5.00
12-15	-26.90	7.40	.40	.11
1-15	-29.40	7.90	.50	2.22
2-15	-27.90	7.30	.56	22.50
3-15	-21.50	9.40	.62	86.40
4-15	-11.10	10.90	.59	180.01
5-15	1.40	12.70	.31	235.57
5-15	6.50	13.00	.00	245.00
6-15	11.50	13.30	.00	254.19
7-15	14.80	12.20	.00	217.24
8-15	11.40	11.70	.00	141.12
9-15	3.50	11.00	.00	73.62
10- 9	-4.90	10.12	.00	36.95
10-15	-7.00	10.10	.00	27.78
10-21	-9.57	9.67	.13	23.37

Properties of Snow Cover

Thermal Conductivity	.43 Watts/MT.C.
Surface Emissivity	.90
Surface Absorptivity	.40

Properties of Road Surface (No Snow Cover)

Surface Emissivity	0.80
Surface Absorptivity	0.80

Average Greenhouse Factor = 0.82

Evapotranspiration Factor of Road Surface = 0



4.0 RESULTS OF THERMAL ANALYSES

4.1 Model Calibration

The thermal properties and climatic data listed in Section 3.0 was initially used to predict seasonal ground temperatures in the natural terrain, in order to compare the predicted values with data measured in Borehole No. 15. This procedure allows calibration of the parameters representative of ground surface heat flux. Figure 4 shows the ground temperature predicted and the measured values on October 21, 1985. A surface evapotranspiration factor 0.5 times the Thornthwaite value has been adopted for this prediction. The predicted temperature at depth is slightly warmer than the measured values.

4.2 Ground Temperatures Under Existing Grade

The second phase of the thermal analyses was to predict the ground temperatures under the existing road fill, as shown in Figure 5. The results show that seasonal thaw penetrates into the ice layer, consistent with observations at the site.

4.3 Ground Temperatures Under 50 mm Insulation

To simulate the construction sequence, a 50 mm insulation board is placed on top of the existing road surface, and covered by an additional 0.6 m roadfill. Figures 6 and 7 present the predicted ground temperatures one year and ten years after remedial construction. The results show that thermal degradation under the road fill has been arrested (Figure 6), and the ground temperatures cool with time (Figure 7). The ground temperature variations beneath the road fill are shown in Figure 8. A steady-state is reached in about 3 years after construction.



5.0 CONCLUSION

The thermal results presented have demonstrated the effectiveness of the 50 mm insulation board. Under such an insulation arrangement, the seasonal thaw depth is contained within the existing gravel roadfill; and the ground temperatures within the road embankment is slowly cooling with time.

The thaw depth predicted by the EBA geothermal model is consistent with the observations made by Johnson (1983)¹ at the Inuvik test site. He suggests that 50 mm of insulation is not sufficient for construction of an insulated road over natural tundra at Inuvik. However, for the repair program at km 8.5 on the Dempster Highway, 1.2 metres of existing subgrade is present below the insulation. Some seasonal thawing can therefore be tolerated below the insulating layer.

It is hoped that the above information meets with your present requirements. If you have any questions, please feel free to contact Don Hayley or myself.

Respectfully submitted,

EBA Engineering Consultants Ltd.

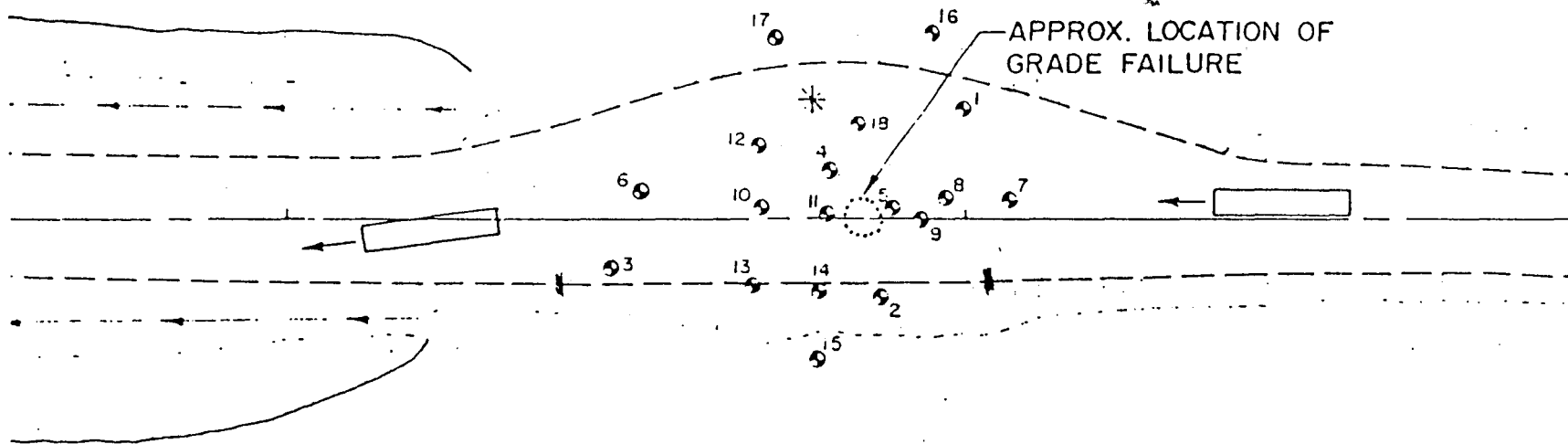


for
C.T Hwang, P. Eng.
Principal Consultant

CTH:chb



¹ "Performance of an Insulated Roadway on Permafrost, Inuvik, N.W.T." by G.H. Johnston, Proc. 4th International Conference on Permafrost, Fairbanks, Alaska, 1983.





SITE PLAN AND BOREHOLE LOCATIONS
 ACCIDENT SITE
 km 8.5, DEMPSTER HIGHWAY, N.W.T.

SCALE 1:500

EBA Engineering Consultants Ltd. 	
JOB NO. 0201-4426	DATE: 1985-12-16
DRAWN BY:	DRAWING NO.:
REVIEWED BY: 	4426-A1


NOTE: Drawing provided by Nordzone Consultants Ltd.

FIGURE 1

BOREHOLE LOG – PERMAFROST

0201-4426
DEMPSTER HIGHWAY

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION	BULK DENSITY (Mg/m ³) ▲							
				1.4	1.6	1.8	2.0	2.2			
				MOISTURE CONTENT							
					10	20	30	40	50		
1	GRAVEL (ROAD FILL) (SW)-sandy, angular, damp, dark grey		SEASONAL FROST								
			UNFROZEN								
2	ORGANICS (PT)-peat, wet		FROZEN Ice 100% T=-0.51°C								
	ICE - occasional organic inclusions	C								2598%	→
3	- snowy in texture and appearance - occasional silty inclusions	C	T=-0.51°C							1126%	→
		C	T=-0.51°C								
4	SAND (TILL) (SW)-gravelly, some silt, dark grey, sub-angular to sub-rounded particles	C	T=-0.51°C							3695%	→
		C	ICE 40% to 60%							2883%	→
5	SILT (ML)-some clay, olive brown to dark grey	C	T=-0.51°C T=-0.52°C Vs 30% Vx 30%	1	1					253%	→
		C	T=-0.52°C							233%	→
6		C	Vx, Vs 50% T=-1.69°C							117%	→
		C	lenses up to 0.25 mm thick T=-1.87°C								
7		C	Vs 10% to 15% T=-2.9°C								
		C	Vs, Vr 20% T=-2.02°C							38%	→
SHALE (BEDROCK) AT 7.5 m											
END OF HOLE											

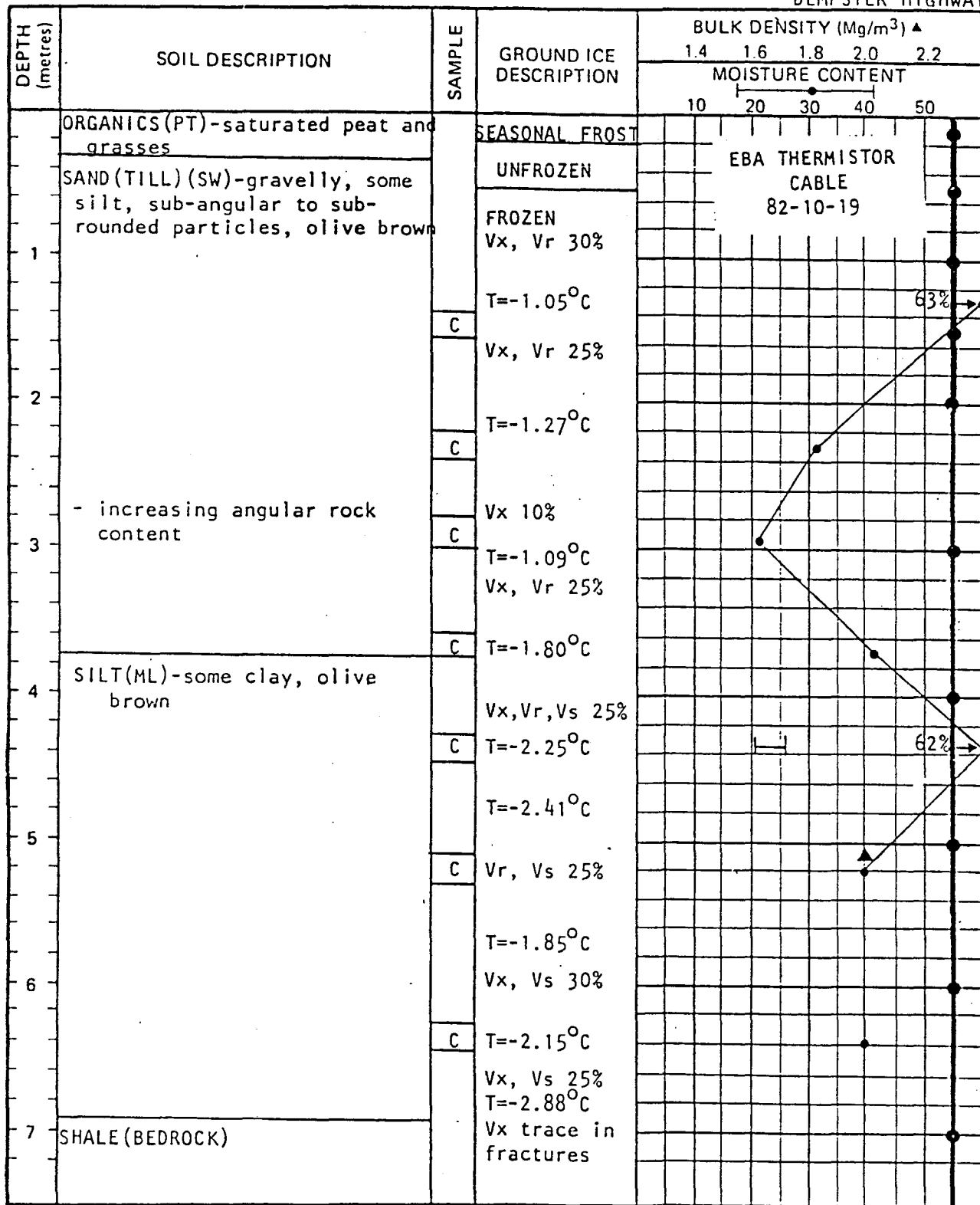
	SFC. ELEVATION (m)	DATE DRILLED	1985-10-11	BOREHOLE No. 5	
	COMPLETION DEPTH (m)	7.7	LOGGED BY		JRT
	DRILLING RIG	CME 750	LOCATION		km 8.5 (NWT)
				PAGE 1 OF 1	

This log is a compilation of subsurface conditions and soil or rock classification obtained from the field as well as from laboratory testing of samples from the boreholes. Soil zones have been interpreted according to commonly accepted practice. The change from one zone to another, as indicated on the log, may be transitional and approximate in nature. Groundwater conditions refer only to those observed at the times and places indicated and that may vary with time, hydrologic conditions, and construction activity.

FIGURE 2

BOREHOLE LOG – PERMAFROST

0201-4426
DEMPSTER HIGHWAY



SFC. ELEVATION (m)	DATE DRILLED 1985-10-12
COMPLETION DEPTH (m) 8.9	LOGGED BY JRT
DRILLING RIG CME 750	LOCATION km 8.5 (NWT)

BOREHOLE No.
15
PAGE 1 OF 2

This log is a compilation of subsurface conditions and soil or rock classification obtained from the field as well as from laboratory testing of samples from the boreholes. Soil zones have been interpreted according to commonly accepted practice. The change from one zone to another, as indicated on the log, may be transitional and approximate in nature. Groundwater conditions refer only to those observed at the times and places indicated and that may vary with time, geologic conditions, and construction activity.

FIGURE 3

BOREHOLE LOG - PERMAFROST

0201-4426
DEMPSTER HIGHWAY

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION	BULK DENSITY (Mg/m ³) ▲				
				1.4	1.6	1.8	2.0	2.2
				MOISTURE CONTENT				
				10	20	30	40	50
8	SHALE (BEDROCK)		FROZEN Vx trace in fractures					
9	END OF HOLE (Auger refusal)							
10	NOTE: EBA Thermistor cable 82-10-19 installed in this borehole.							
11								
12								
13								
14								

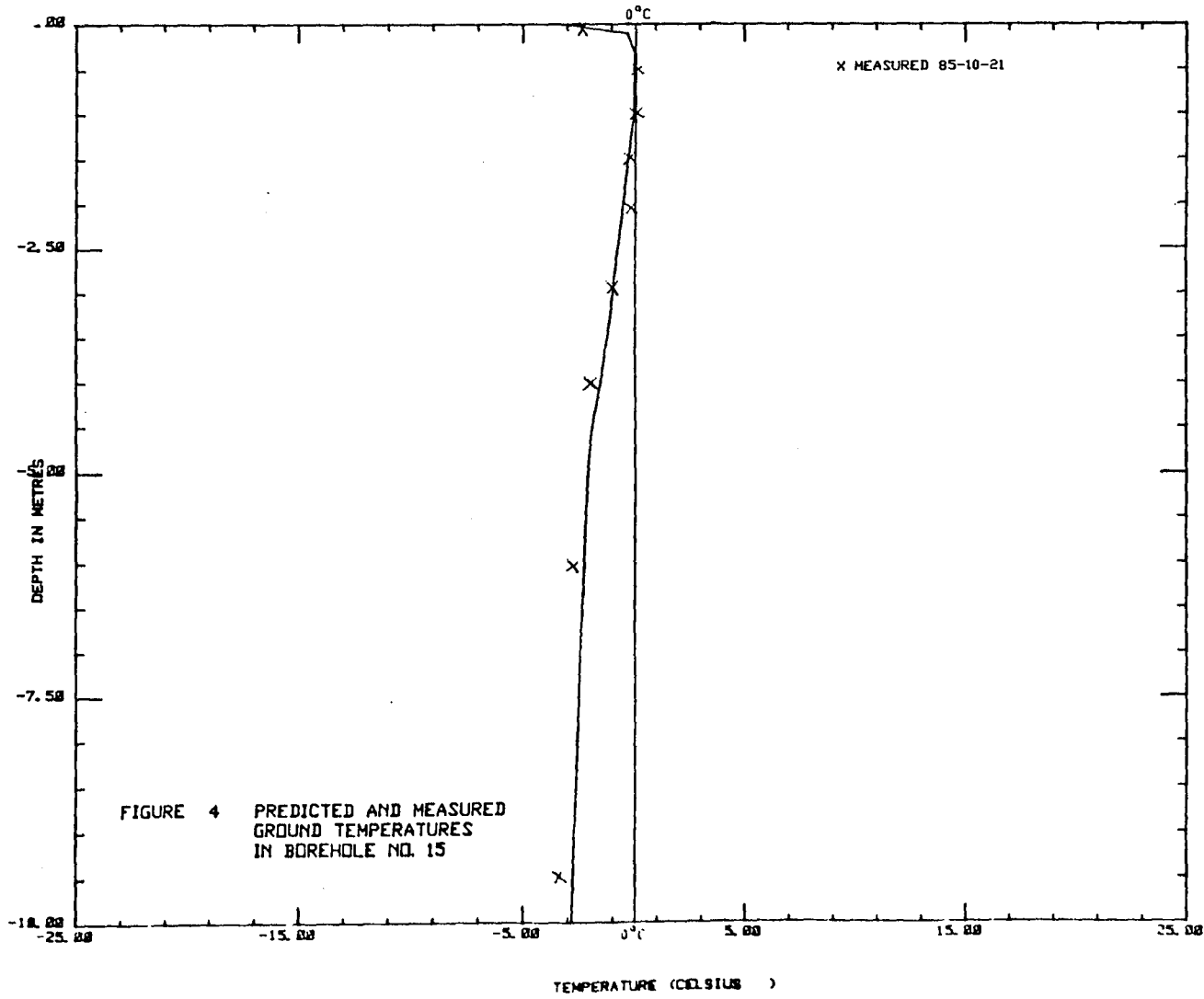


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COMPLETION DEPTH (m) 8.9	LOGGED BY JRT	
DRILLING RIG CME 750	LOCATION Km 8.5 (NWT)	PAGE 2 OF 2

This log is a compilation of subsurface conditions and soil or rock classification obtained from the field as well as from laboratory testing of samples from the boreholes. Soil zones have been interpreted according to commonly accepted practice. The change from one zone to another, as indicated on the log, may be transitional and approximate in nature. Groundwater conditions refer only to those observed at the times and places indicated and that may vary with time, geologic conditions, and construction activity.

FIGURE 3 - continue

4551bh15d02- Dempeter Highway B.H.15 Calibration $\alpha f=0.5$
TEMPERATURES AT X= .00 SECTION



4551bh05d01- Dempeter Highway B.H. 5 Analysis (NO Insulation/gravel)
 TEMPERATURES AT X= .00 SECTION

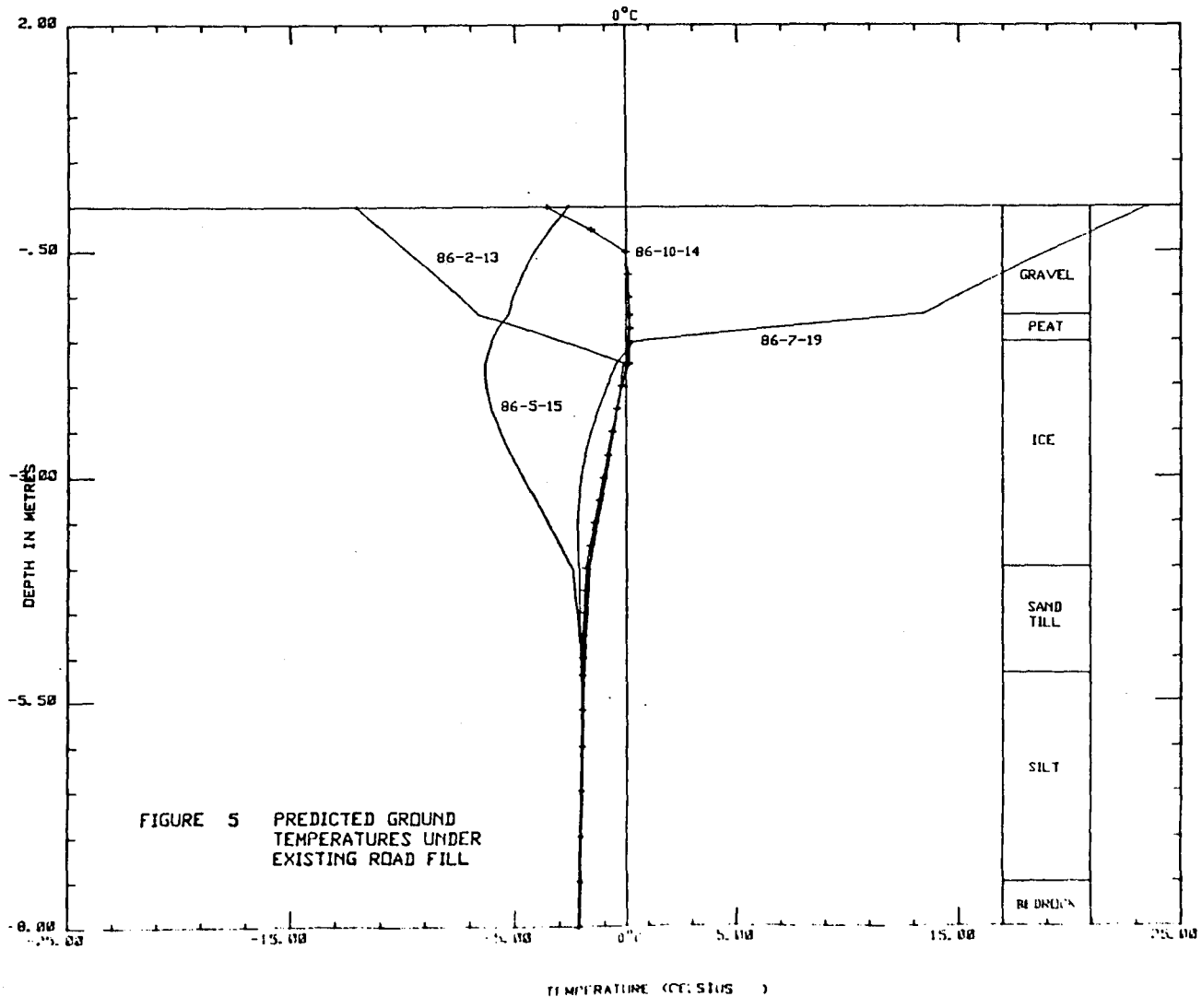


FIGURE 5 PREDICTED GROUND TEMPERATURES UNDER EXISTING ROAD FILL

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 TEMPERATURES AT X= .00 SECTION

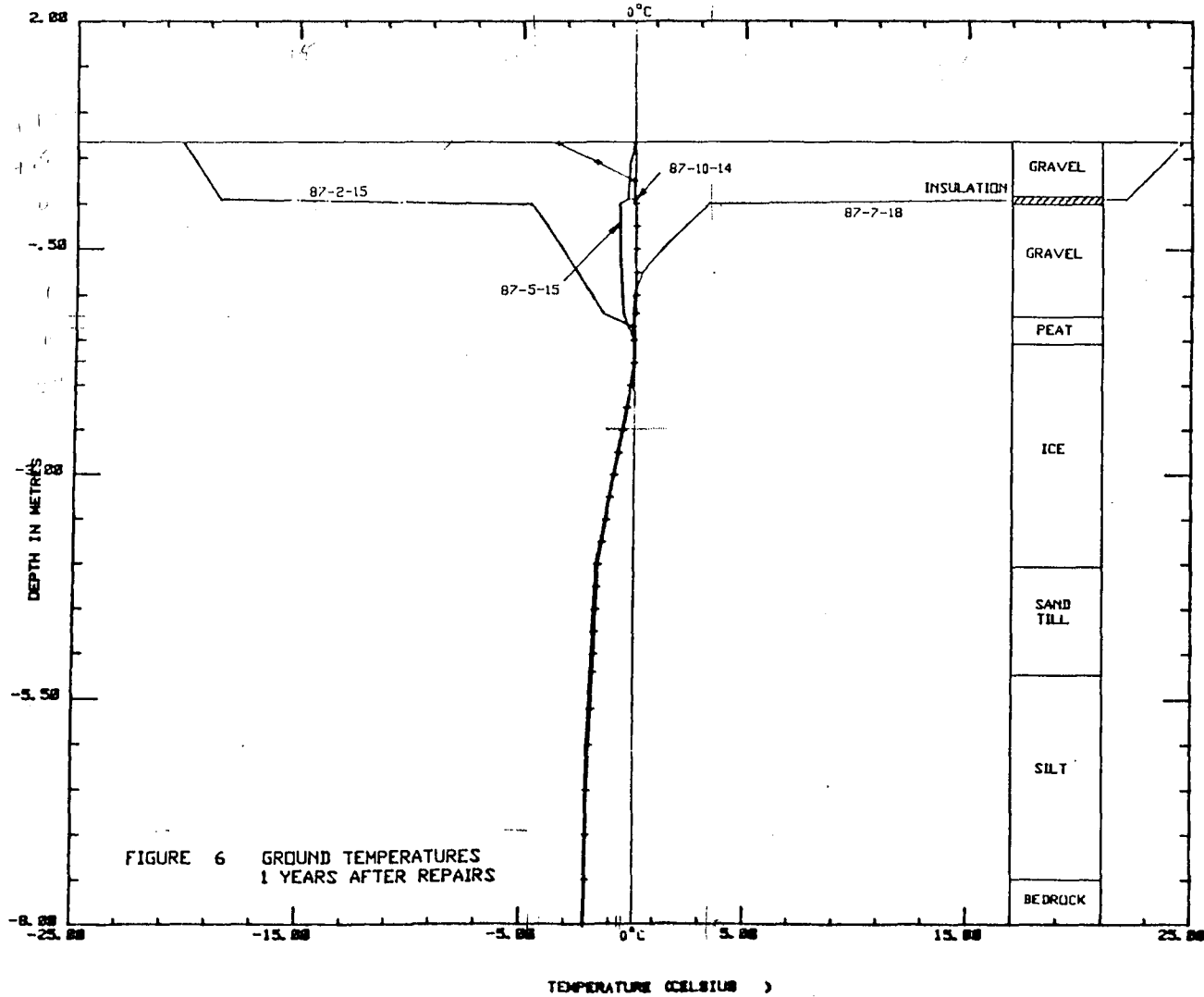
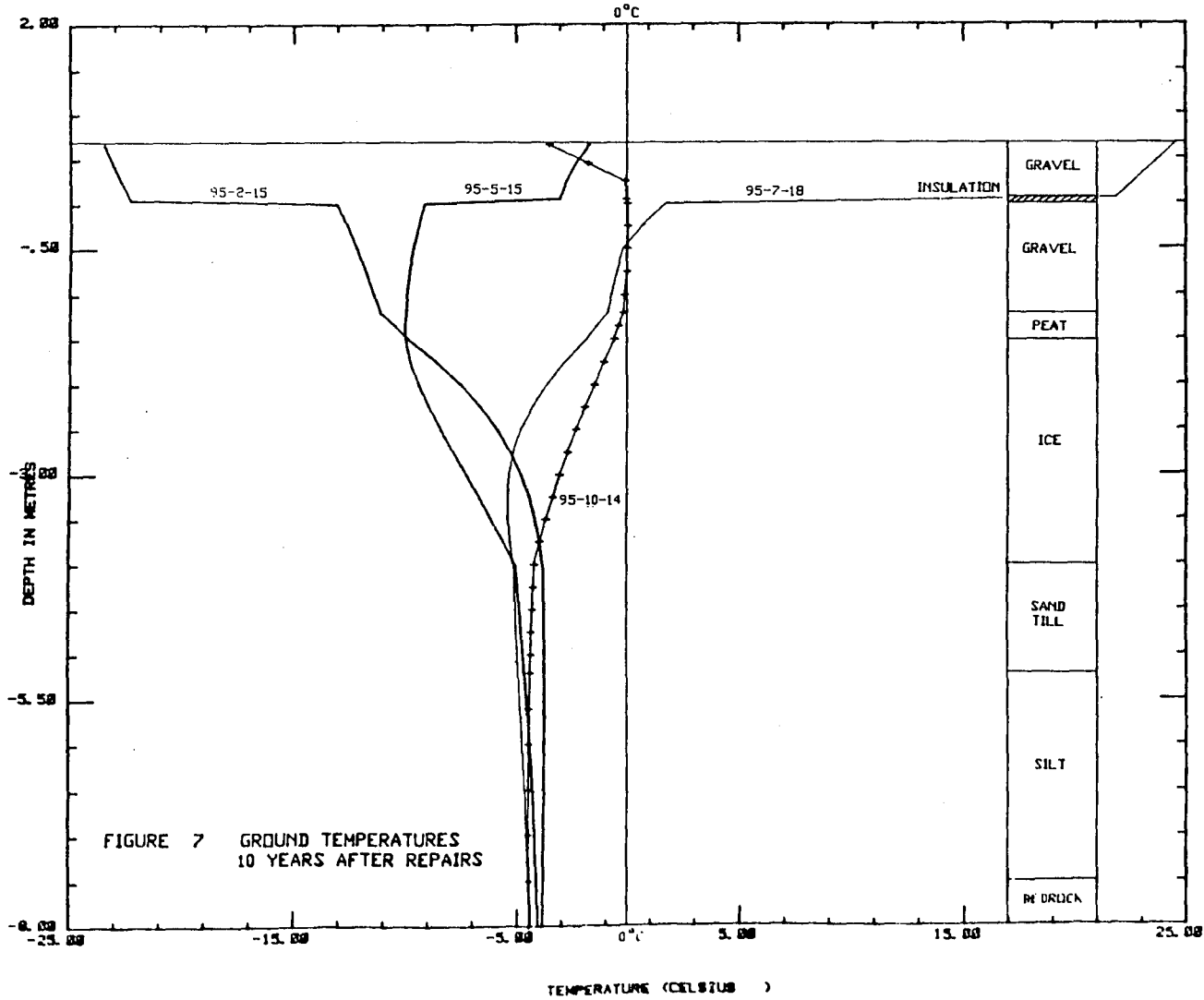


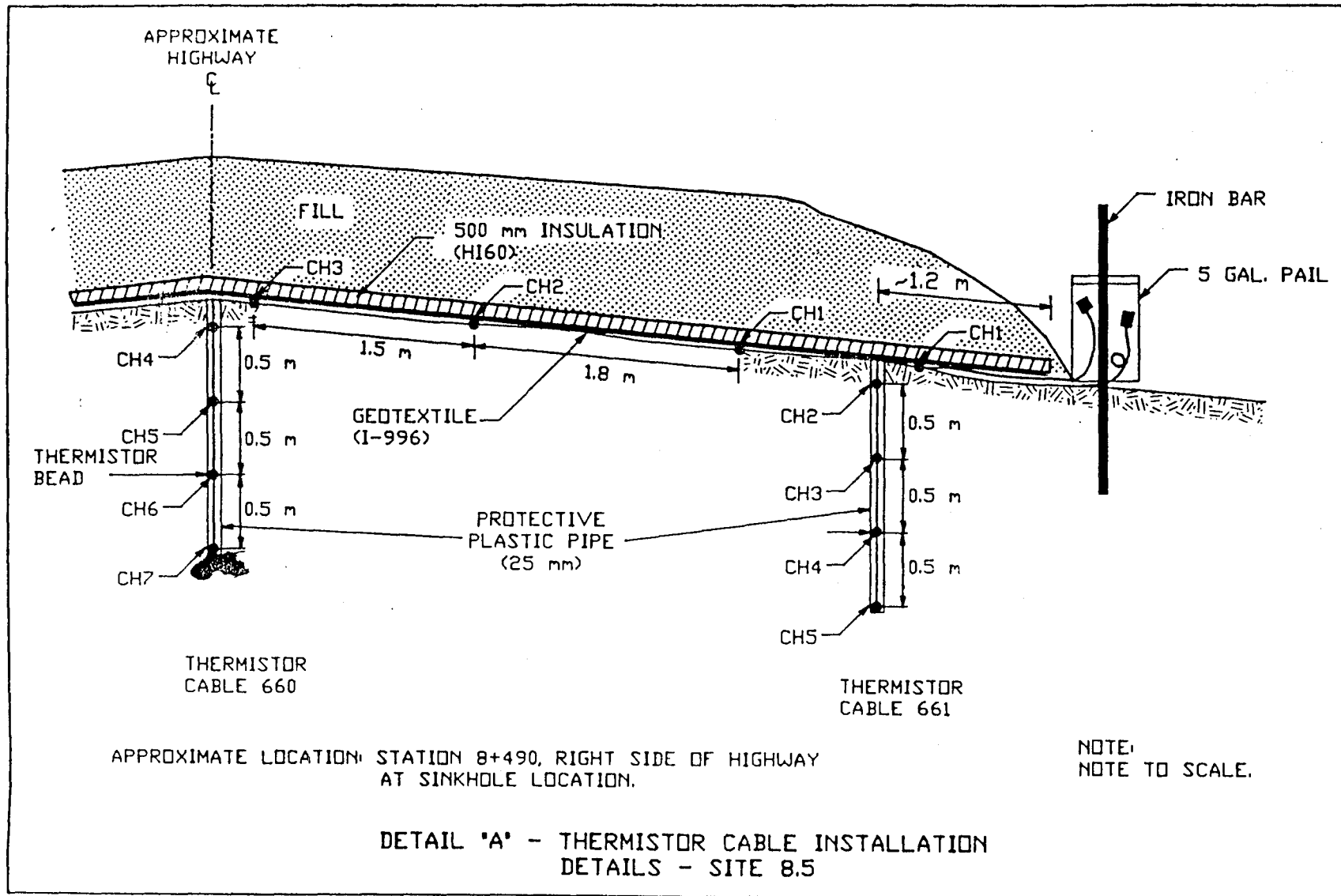
FIGURE 6 GROUND TEMPERATURES
 1 YEARS AFTER REPAIRS

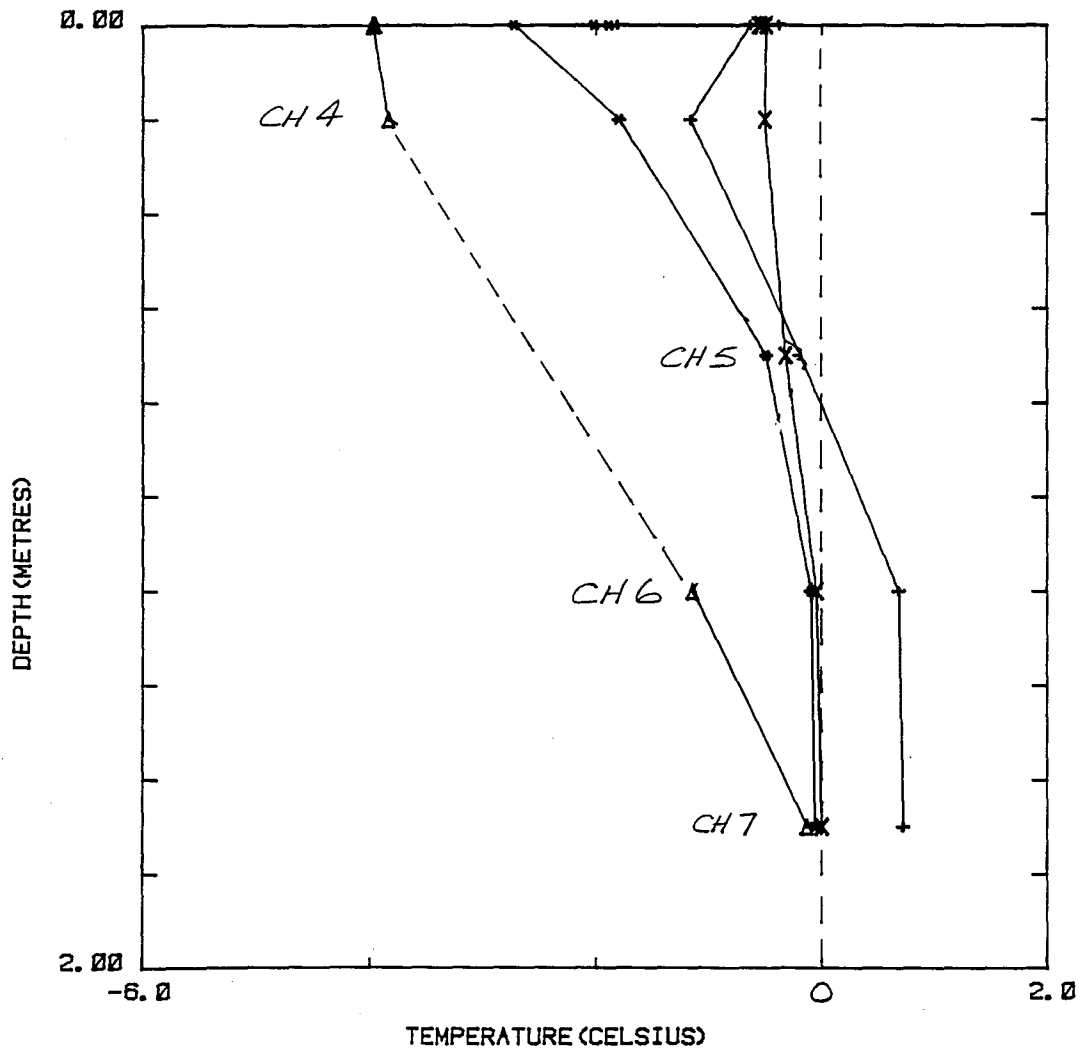
4551bh05d04- Dempeter Highway B.H. 5 Analysis 10 yrs. run
 TEMPERATURES AT X= .00 SECTION



APPENDIX B

THERMISTOR CABLE DATA

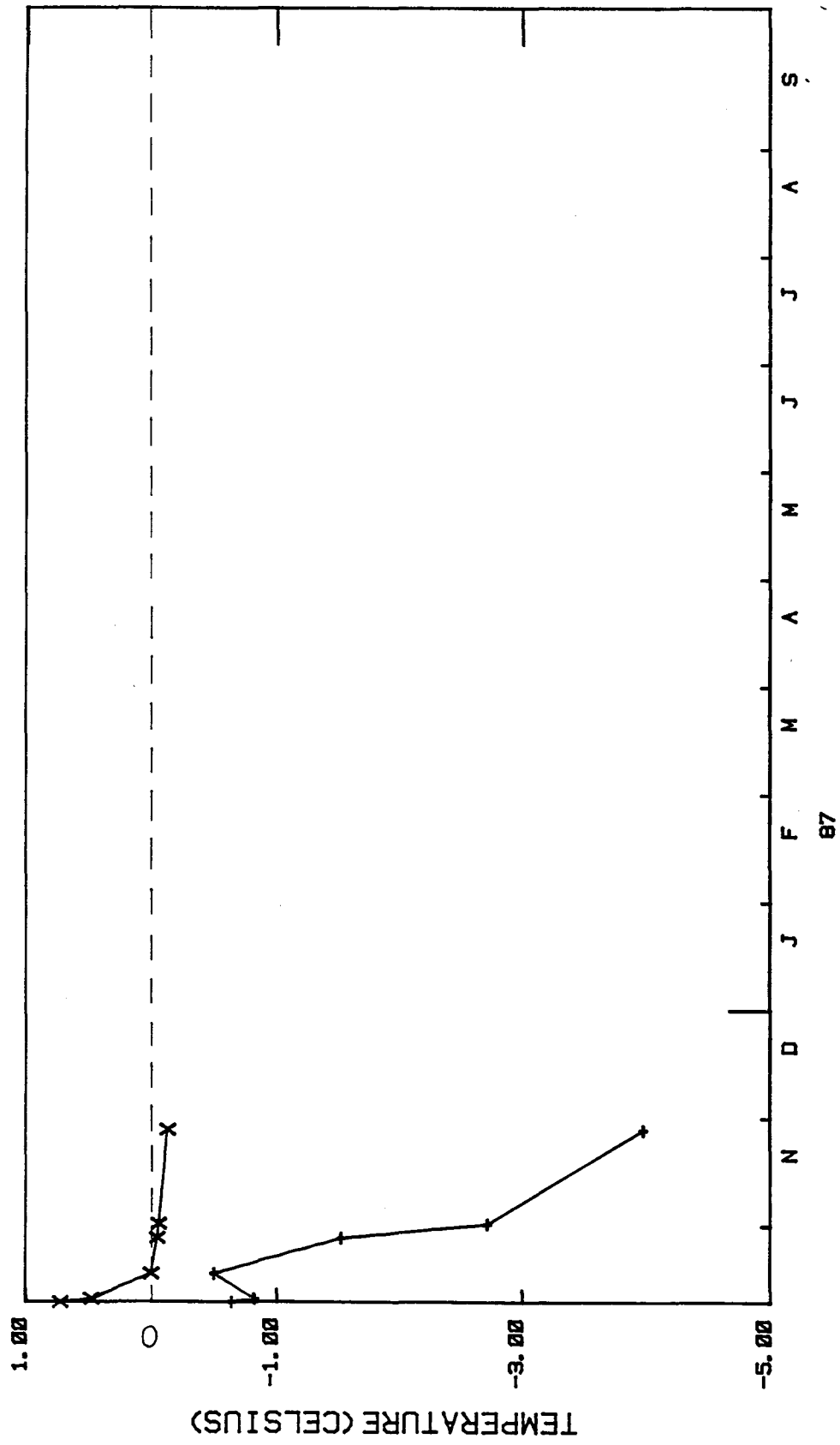




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DATE INSTALLED 86-10-9

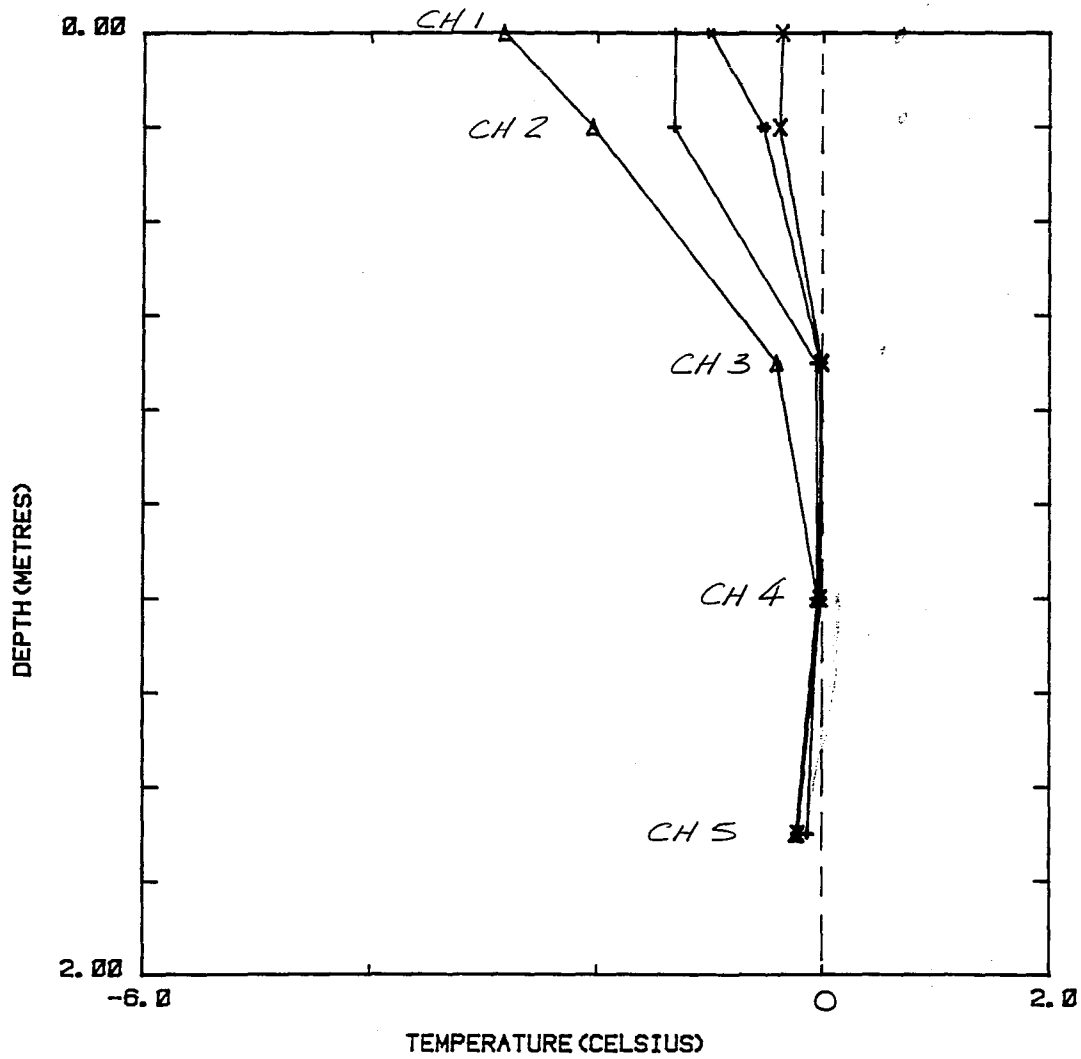
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x	86-10-17
*	86-10-31
Δ	86-11-27



THERMISTOR NUMBER 0660
 DATE INSTALLED 86-10-9

+ 0.00 METRE DEPTH
 X 1.70 METRE DEPTH

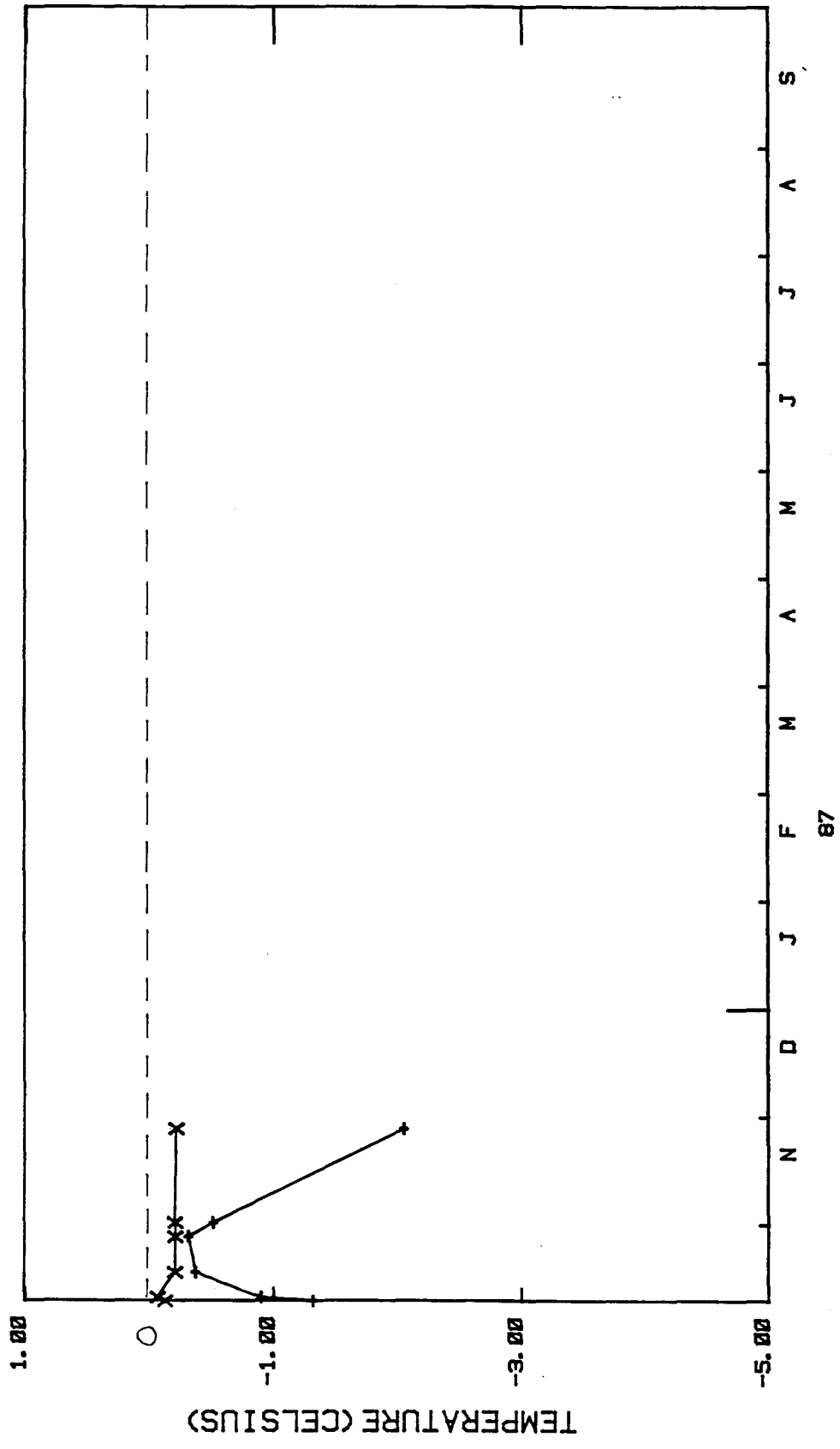
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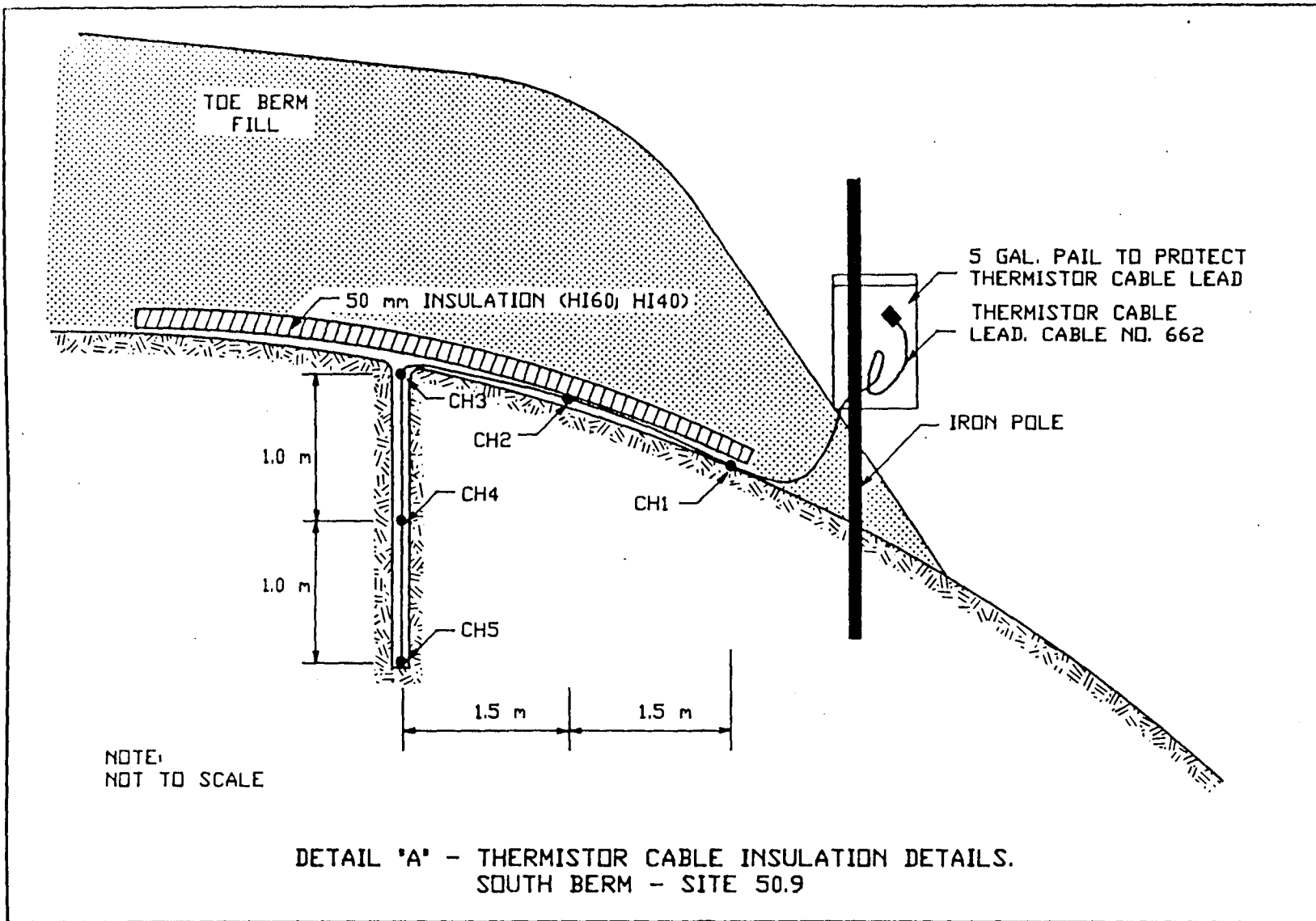
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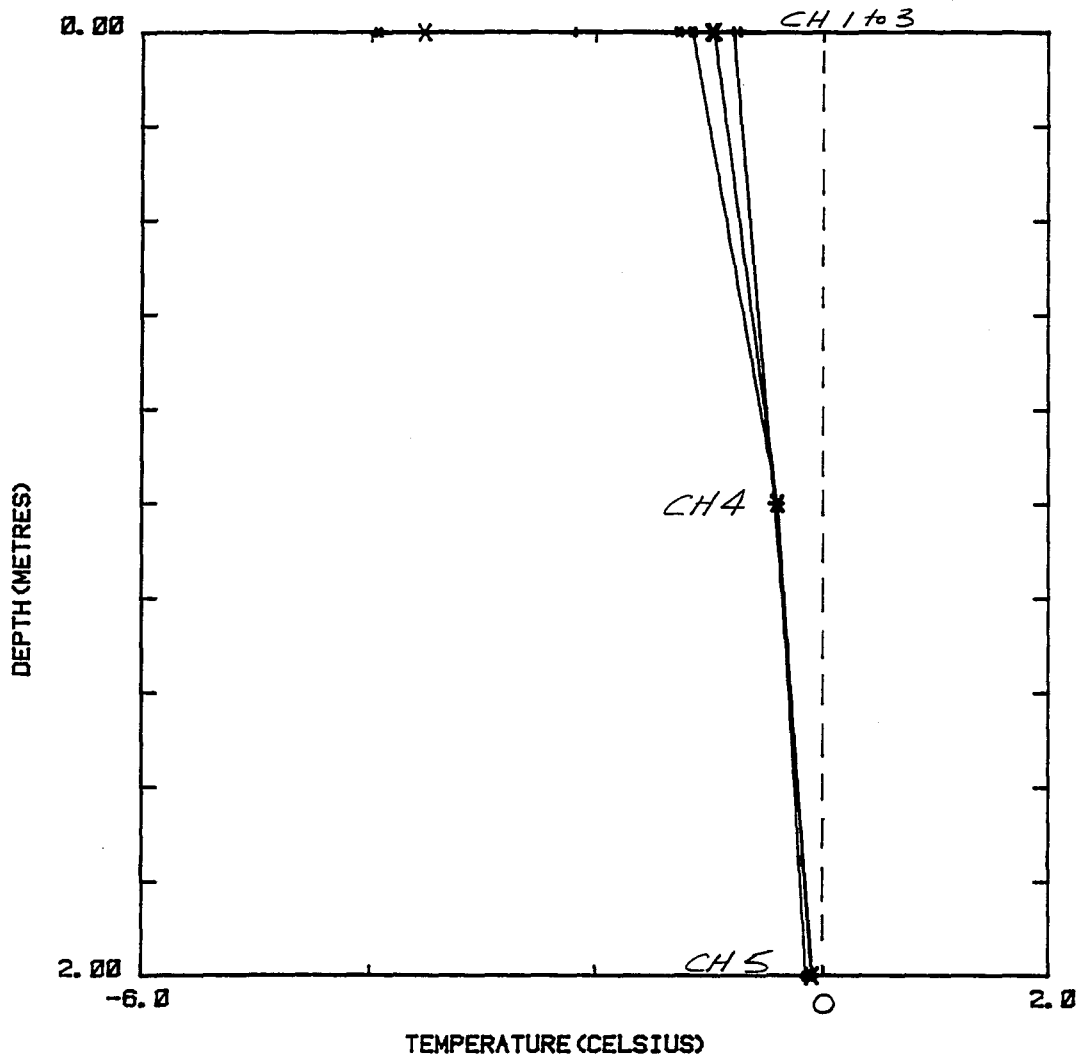
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- x 86-10-17
- * 86-10-31
- A 86-11-27



THERMISTOR NUMBER 0661
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 x 1.70 METRE DEPTH





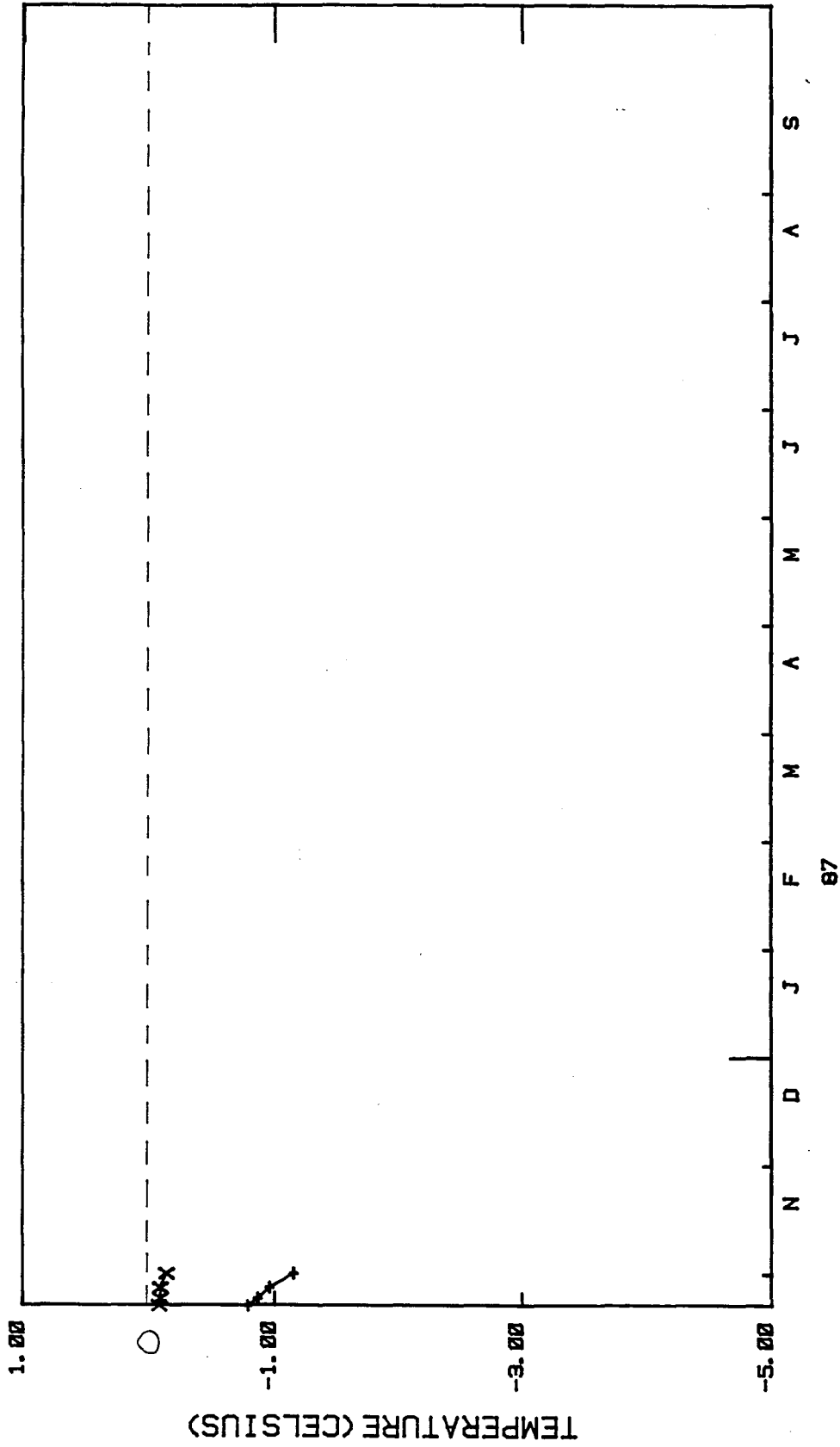
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DATE INSTALLED 86-10-22

+ 86-10-22

x 86-10-27

* 86-10-31



THERMISTOR NUMBER 0662
 DATE INSTALLED 86-10-22

+ 0.00 METRE DEPTH
 X 2.00 METRE DEPTH

APPENDIX B

COMPACTION TEST RESULTS

EBA Engineering Consultants Ltd.



DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 201-4551	Test Apparatus: NUCLEAR Mach. No.: 7866
Project: DEMPSTER HIGHWAY REPAIRS KM 8.5	Soil Description: PIT RUN FROM MIDWAY LAKE - SAND & GRAVEL, SOME SILT
Client: PUBLIC WORKS AND HIGHWAYS DESIGN & CONST., HIGHWAYS DIV. GOVERNMENT OF N.W.T. MR. R. DOERRIES, PROJ.OFFICER	Temperature Air: -15. °C Soil: **** °C Specified Compaction: 97 Compaction Standard: STANDARD PROCTOR Minimum Dry Density: Maximum Dry Density: 2100 Optimum M.C.: 6.5 Date Tested: 861009 By: TRM

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m ³	% Compaction
1 / 100	STA 8+490 ON CENTRE LINE	+250MM	6.6	2104.0	100.2
2 / 150	STA 8+500, LEFT LANE SHOULDER	+250MM	6.5	2106.0	100.3
3 / 150	STA 8+500, 1M RIGHT OF CENTRE LINE	+250MM	6.1	1917.0	91.3
4 / 100	STA 8+475, 1.2M RIGHT OF CENTRE LINE	+250MM	6.2	2066.0	98.4
5 / 100	STA 8+482, 1.2M LEFT OF CENTRE LINE	+250MM	7.1	2228.0	100.0+
6 / 100	STA 8+482, N CENTRE LINE	+250MM	6.1	1977.0	94.1
7 / 100	STA 8+482, N CENTRE LINE	+250MM	7.8	2095.0	99.8
8 / 100	STA 8+485, CENTRE OF RIGHT LANE	+250MM	7.8	2073.0	98.7
9 / 200	STA 8+472, CENTRE OF LEFT LANE	+400MM	7.1	2259.0	100.0+
10 / 200	STA 8+485, CENTRE OF LEFT LANE	+400MM	7.7	2108.0	100.4
11 / 200	STA 8+497, CENTRE OF LEFT LANE	+400MM	7.0	2156.0	100.0+

Remarks: SITE B.5
ELEVATIONS FROM ABOVE INSULATION.

Reviewed By: _____ P.Eng.	CC PUBLIC WORKS AND HIGHWAYS
ATTENTION: MR. R. DOERRIES, PROJ.OFFICER	
PUBLIC WORKS AND HIGHWAYS	
DESIGN & CONST., HIGHWAYS DIV.	
GOVERNMENT OF N.W.T.	
YELLOWKNIFE, N.W.T.	

The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance of material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering Consultants Ltd.



DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 201-4551 Test Apparatus: NUCLEAR Mach. No.: 7866
 Project: DEMPSTER HIGHWAY REPAIRS Soil Description: PIT RUN
KM 46.9
 Temperature Air: **** °C Soil: **** °C
 Client: PUBLIC WORKS AND HIGHWAYS Specified Compaction: 95
DESIGN & CONST., HIGHWAYS DIV. Compaction Standard: STANDARD PROCTOR
GOVERNMENT OF N.W.T. Minimum Dry Density: _____
MR. R. DOERRIES, PROJ.OFFICER Maximum Dry Density: 2100
 Optimum M.C.: 6.5
 Date Tested: B61025 By: TRM

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m ³	% Compaction
1 /250	STA 46+820, CENTRE OF BERM	~1.5M	5.7	1878.0	89.4
2 /250	STA 46+840, CENTRE OF BERM	~1.5M	5.3	1901.0	90.5
3 /250	STA 46+860, CENTRE OF BERM	~1.5M	5.0	1899.0	90.4
4 /250	STA 46+830, SHOULDER	~0.5M	6.0	1926.0	91.7
5 /250	STA 46+850, SHOULDER	~0.6M	5.2	1949.0	92.8
6 /250	STA 46+870, SHOULDER	~0.3M	5.0	1960.0	93.3

Remarks: SITE 46.9
ELEVATIONS FROM GRADE.

Reviewed By: _____ P.Eng. PUBLIC WORKS AND HIGHWAYS
ATTENTION: MR. R. DOERRIES, PROJ.OFFICER
PUBLIC WORKS AND HIGHWAYS
DESIGN & CONST., HIGHWAYS DIV.
GOVERNMENT OF N.W.T.
YELLOWKNIFE, N.W.T.

The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance of material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering Consultants Ltd.



DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 201-4551 Test Apparatus: NUCLEAR Mach. No.: 7899
 Project: DEMPSTER HIGHWAY REPAIRS Soil Description: PIT RUN
KM 50.9
 Client: PUBLIC WORKS AND HIGHWAYS Temperature Air: **** °C Soil: **** °C
DESIGN & CONST., HIGHWAYS DIV. Specified Compaction: 95
GOVERNMENT OF N.W.T. Compaction Standard: STANDARD PROCTOR
MR. R. DOERRIES, PROJ.OFFICER Minimum Dry Density: _____
 Maximum Dry Density: 2100
 Optimum M.C.: 6.5
 Date Tested: B61021 By: TRM

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m ³	% Compaction
7 /200	STA 50+820, 1M SOUTH OF HWY. SHOULDER	0.2M	5.8	1960.0	93.3
8 /200	STA 50+840, 1M SOUTH OF HWY. SHOULDER	0.2M	5.5	1954.0	93.0
9 /200	STA 50+870, 1M NORTH OF TOP OF SHOULDER	0.1M	5.5	1928.0	91.8
10 /200	STA 50+830, 1M NORTH OF TOP OF SHOULDER	~GRADE	5.7	1917.0	91.3
11 /200	STA 50+850, 2M NORTH OF TOP OF SHOULDER	~GRADE	5.5	1905.0	90.7

Remarks: SITE 50.9
ELEVATIONS FROM BELOW GRADE.

Reviewed By: _____ P.Eng. cc PUBLIC WORKS AND HIGHWAYS
ATTENTION: MR. R. DOERRIES, PROJ.OFFICER
PUBLIC WORKS AND HIGHWAYS
DESIGN & CONST., HIGHWAYS DIV.
GOVERNMENT OF N.W.T.
YELLOWKNIFE, N.W.T.

The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance of material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

EBA Engineering Consultants Ltd.



DENSITY TEST RESULTS

ASTM Designation D2922 & D3017, or D1556

Project No.: 201-4551 Test Apparatus: NUCLEAR Mach. No.: 7866
 Project: DEMPSTER HIGHWAY REPAIRS Soil Description: PIT RUN
KM 50.9
 Client: PUBLIC WORKS AND HIGHWAYS Temperature Air: **** °C Soil: **** °C
DESIGN & CONST., HIGHWAYS DIV. Specified Compaction: 95
GOVERNMENT OF N.W.T. Compaction Standard: STANDARD PROCTOR
MR. R. DOERRIES, PROJ.OFFICER Minimum Dry Density: _____
 Maximum Dry Density: 2100
 Optimum M.C.: 6.5
 Date Tested: 861020 By: TRM

Test No./ Probe Depth	Location	Elevation	% Moisture Content	Dry Density Kg/m ³	% Compaction
1 /150	STA 50+830	0.4M	5.2	2077.0	98.9
2 /150	STA 50+840	0.4M	4.6	2068.0	98.5
3 /150	STA 50+820	0.2M	4.7	2011.0	95.8
4 /150	STA 50+850	0.2M	5.2	1995.0	95.0
5 /150	STA 50+860, 1M NORTH OF SHOULDER	0.2M	5.7	1954.0	93.0
6 /150	STA 50+820, 1M NORTH OF SHOULDER	0.2M	5.5	1966.0	93.6

Remarks: SITE 50.9
ELEVATIONS FROM BELOW GRADE.

Reviewed By: _____ P.Eng. cc PUBLIC WORKS AND HIGHWAYS
ATTENTION: MR. R. DOERRIES, PROJ.OFFICER
PUBLIC WORKS AND HIGHWAYS
DESIGN & CONST., HIGHWAYS DIV.
GOVERNMENT OF N.W.T.
YELLOWKNIFE, N.W.T.

The testing services reported herein have been performed by an EBA technician to recognized industry standards, unless otherwise noted. No other warranty is made. These data do not include or represent any interpretation or opinion of specification compliance of material suitability. Should engineering interpretation be required, EBA will provide it upon written request.

APPENDIX "C"

APPENDIX C

1. Financial Management Board Original Submission
2. Financial Management Board Approval for Amendment No. 1
3. Project Authorization
4. Call for Tenders
5. Tender Register
6. Letter of Award - Minor Works
7. Minor Works - Tender and Contract
8. Contract Change Orders
9. Final Certificate of Completion - Statutory Declaration
10. Detailed Sheet for Unit Price Contract - Request (Final)
11. Final Certificate of Completion

Department: PUBLIC WORKS AND HIGHWAYS

F.M.B. Submission Number: EN-

Program Title: ENGINEERING SERVICES AGREEMENT

Amount: ~~500,000~~ 510,395 Program Analyst: Robert Taggart.

Type of Project:

- new
- ongoing
- included in main estimates

Administration Fee:

- less than \$5,000 = none reqrd.
- \$5,000 to \$10,000 = \$500 fee
- over \$10,000 = 6.5% fee
- over \$10,000 = cost to GNWT
- waiver requested

Review:

- department of finance
- department of justice

Support Material:

- draft copy of agreement
- old agreement
- current agreement
- documentation of 3rd party commitment
- budget voucher

Financing:

- less than \$100,000 = advance in full
- over \$100,000 = advance quarterly or monthly
- billed after work commences (interest @ prime+1%)
- other (see 'comments') * 2 ✓

FINANCIAL MANAGEMENT SECRETARIAT COMMENTS:

1. Pursuant to the Engineering Services Agreement the department is requesting approval of the following projects:

PROJECT	TOTAL FUNDING	ADMIN FEE	PROJECT AMOUNT
Dempster Highway Culvert Replacement, Km 229.8	\$ 15,925	\$ 1,035	\$ 14,890
Arctic Red River Ferry Camp Flood Damages	26,000	1,690	24,310
Dempster Highway Grade Upgrades	100,000	6,500	93,500 ✓
Peel River Ferry Camp, Dempster Highway, Km 76.8	98,000	6,370	91,630
Ingraham Trail, Highway # 4, Km 55	17,000	1,105	15,895
Culvert Replacement, Liard Highway, Km 101.3	205,545	13,360	192,185
Cansell Bend Ferry Camp, Highway #1, Km 553	47,925	3,115	44,810
	\$510,395	\$33,175	\$447,220

2. The agreement specifies that the department is to be advised during the year at times and in such amounts as is reasonably required to meet the financial obligations of the project

Recommend approval.

Alvin Yang
 Manager

SECRETARY
 JUL - 9 1988
 FINANCIAL MANAGEMENT BOARD

Paulsen
 Date: July 9/88 APPROVED

Department: PUBLIC WORKS AND HIGHWAYS

F.M.B. Submission Number: EN-

Program Title: ENGINEERING SERVICES AGREEMENT

Amount: \$175,000

Program Analyst: *Robert Taggart*

Type of Project:

- new
- ongoing
- included in Main Estimates

Administration Fee:

- less than \$5,000 = none reqrd.
- \$5,000 to \$10,000 = \$500 fee
- over \$10,000 = 6.5% fee
- over \$10,000 = cost to GNWT
- waiver requested

Review:

- Department of Finance
- Department of Justice

Support Material:

- draft copy of agreement
- old agreement
- current agreement
- documentation of 3rd party commitment
- budget voucher BV320021

85-9207

Financing:

- less than \$100,000 = advance in full
- over \$100,000 = advance quarterly or monthly
- billed after work commences (interest @ prime+1%)
- other (see 'comments') * 2

FINANCIAL MANAGEMENT SECRETARIAT COMMENTS:

1. Pursuant to the Engineering Services Agreement the department is requesting approval to amend the Dempster Highway Grade Repairs project. The original approval established the project at \$100,000 pending substantiation of work and cost estimates to Indian and Northern Affairs by DPWH. IAND has received and agreed with the substantiation and cost estimate. The funding is summarized as follows:

	FISCAL YEAR	TOTAL FUNDING	ADMIN FEE	PROJECT AMOUNT
Dempster Highway Grade Repairs	1986/87	\$175,000	\$11,375	\$163,625

2. The agreement specifies that funds will be advanced during the year at times and in such amounts as is reasonably required to meet the financial obligations of the project

Recommend approval.

SECRETARY
SEP 26 1986
FINANCIAL MANAGEMENT BOARD

Mayorie Lousret
for Manager
Program Budgets and Analysis

Sept. 29/86
Date

[Signature]
APPROVED
Secretary to the



INVITATIONAL TENDER
TENDER DATA FORM

PROJECT NO. 85-9207 PROJECT TITLE Dempster Highway Repairs & Geotechnical
DIVISION/REGION Highways/Headquarters CLIENT INAC

ADVERTISING INFORMATION

PROJECT DESCRIPTION Equipment rental, Dempster Highway grade repairs. Various equipment including crawler tractor, loader, haul trucks, compactor, grader and low boy truck, plus purchase/ installation of insulation & geotextile material and minor culvert purchase/installation.

PROJECT LOCATION Dempster Highway (No. 8), N.W.T. km. 8.5 - 50.9

TENDER CLOSING: TIME 3:00 Local time DATE September 18, 1986

LOCATION(S) Inuvik, N.W.T.

TENDER DOCUMENTS: AVAILABLE AT To be forwarded to Regional Engineer's Office

DATE September 10, 1986

CHECK ONE OF THE FOLLOWING

DEPOSIT:
 AMOUNT TO BE PUBLISHED \$ _____ CERTIFIED CHEQUE OR CASH DEPOSIT POLICY WAIVED FOR THIS PROJECT ONLY
SECURITY:
 ACCOMPANIED BY SECURITY STATED IN TENDER DOCUMENTS BONDING WAIVED FOR THIS PROJECT ONLY

ENQUIRIES TO:
PROJECT OFFICER Rolf Doerries TELEPHONE (403) 920-8809

CONSULTANT Don Hayley, EBA Engineering Consultants Ltd, 14535-118 Ave; Edmonton, Alberta. T5L 2M7 TELEPHONE (403) 451-2121

FORMAT REQUIRED: SINGLE PROJECT GROUPED PROJECTS

DATES TO ADVERTISE _____ NUMBER OF INSERTIONS _____

LOCATIONS TO ADVERTISE _____

DOCUMENT INFORMATION

NO. OF COPIES REQUIRED 20

DISTRIBUTION DETAILS (NAME OF PERSON): _____ COMMUNITY OFFICE _____

PROJECT OFFICER Rolf Doerries, 1 copy N.W.T. CONSTRUCTION ASSOCIATION, _____

OPERATIONS DIVISION _____

CLIENT DEPARTMENT To be forwarded by Hwy's Office, 1 copy P.O. BOX 1425, HAY RIVER, N.W.T. _____

SAFETY DIVISION Head, Occupational Health & Safety, 1 copy P.O. BOX 2320, INUVIK, N.W.T. Secretary, 1 copy

REGIONAL ENGINEER Ken Redmond, Inuvik, 1 copy OTHER _____

Tender Type:

MAJOR WORKS MINOR WORKS

UNIT PRICE STIPULATED SUM COST PLUS OTHER

Estimates of Costs:

a) PRE-CONSTRUCTION ESTIMATE (THIS TENDER) \$ 211,000
b) CONSTRUCTION BUDGET (THIS TENDER) \$ 100,000 See Note

FINANCIAL CODING

5 0 7 0 4 6

APPROVED

PROJECT OFFICER- ~~MANAGER~~ _____ DATE _____

DIVISION CHIEF/REGIONAL ENGINEER _____ DATE _____

CHIEF OF CONTRACTS
(NOT REQUIRED IN REGIONS) _____ DATE _____

ASSISTANT DEPUTY MINISTER
(AS REQUIRED) _____ DATE _____

DEPUTY MINISTER
(AS REQUIRED) _____ DATE _____

COMMENTS

JUSTIFICATION FOR INVITATIONAL TENDER

In order to complete the work prior to winter freeze-up and prior to the seasonal closure of ferry services across the Peel and Mackenzie Rivers we request approval for invitational tendering.

NOTE

Current project budget was restricted to \$100,000 by INAC pending further substantiation of work and cost estimates. The final design and cost estimate have been completed and forwarded to INAC for approval. INAC has indicated that upon their approval of the final design and cost estimate, they will increase the funding level accordingly.

In order to be ready to commence the work upon additional funding by INAC we ask approval to proceed with invitational tendering.

INITIATIONAL TENDERERS

- 1. Storr & Sons Contracting Ltd.,
P.O. Box 56,
Aklavik, N.W.T.

INVITATIONAL TENDER
TENDER DATA FORM

Page 2 of 2

INVITATIONAL TENDERERS CONT'D

2. North Star Service & Construction (Inuvik) Ltd.,
P.O. Box 1005,
Inuvik, N.W.T.
XOE 070
3. Gruben's Transport Ltd.,
Box 177,
Tuktoyaktuk, N.W.T.
4. Points North Transportation Inc.,
Box 1778,
Inuvik, N.W.T.
5. Inuvik Inn,
Box 1557,
Inuvik, N.W.T.
XOE 070
6. Rowe's Construction Ltd.,
Inuvik, N.W.T.

Northwest
Territories Inuvik Region
Public Works and Highways

Project Title: Dempster Highway Grade Repairs

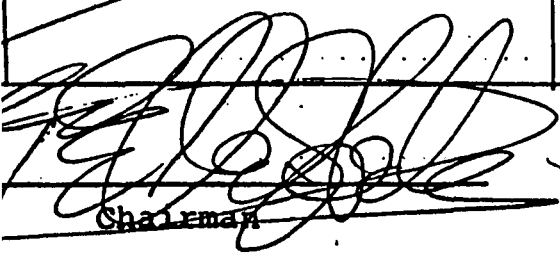
Project No.: 85-9207

Project Officer: Rolf Doerris

Closing Date & Time: 3 p.m. Sept. 18, 1986

Estimate: _____

Tenderer	Security	Price	Adjustments	Final Price	Comments
Storr & Sons Cont. LTD.		227,292.00			
POINIS North TRANSPORTATION		199,538.07			
North Star Service & Cont. (INUVIK) LTD.		149,010.00			


Chairman


Secretary


Witness

Sept. 18/86
Date

MINOR WORKS

Northwest
Territories Public Works

DATE: September 26, 1986

CONTRACTOR: North Star Sevice & Construction Ltd.
ADDRESS: 65 Franklin Road, Box 1005, Inuvik, N.W.T. X0E 0T0
ATTENTION: Gordon Campbell

Gentlemen:

Re: Project Title: Equipment Rental - Dempster Hwy. Grade Repairs
Project Number: 85-9207

Thank you for your tender in the amount of \$ 149,010.00.

This is your authorization to proceed with the work in accordance with the contract documents.

Please obtain and submit the following documents as soon as possible and before commencing activities at the site:

1. Workers' Compensation Board Certificate of Good Standing;
2. Proof of Registration under the Companies' Ordinance of the N.W.T.
3. Certified Copies of Insurance Policies.

Please contact the Project Officer noted below for any further information.

Project Officer's Name: Rolf Doerries

Address: D.P.W. & H., Highways Division, Y.K., N.W.T.

Phone Number: 920-8809

Yours sincerely,

D. Williston

for Donna Williston,
Contracts Co-Ordinator,
Contracts & Capital Planning
Division,
Department of Public Works.



Northwest
Territories Public Works and Highways

Construction and Repairs

Minor Works

Tender and Contract

Project No. 85-9207

Name of Project Equipment Rental, Dempster Highway Grade Repairs,
km 8.5 to km 50.9, Dempster Highway (No. 8), N.W.T.

Contractor *North Star Service & Construction (Inovik) Ltd.*

Contract No. *CT 86.1137.01*

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INSTRUCTIONS TO TENDERERS

1. INSTRUCTIONS TO TENDERERS

- .1 Sealed tenders will be received at the Tender Address until the Tender Closing Time shown on the face of the Tender and Acceptance Form.
- .2 Tender envelopes must show the Project Name, Closing Date, Name and Address of the Tenderer in the space provided on the Exterior of the Envelope.
- .3 Tenders must be on the form provided. No substitutions will be considered.

2. RECEIPT OF TENDERS

- .1 Tenders must be received at the Tender Address by the Department of Public Works on or before the exact time and date fixed for their reception.
- .2 Any Tenders received after the closing time will be rejected and returned unopened to the Tenderer.

3. AMENDMENTS TO TENDERS

- .1 Tenderer may revise his Tender by letter or by telex provided it is transmitted via the Department's telex number 034-45535 and,
 - .1 It is received on or before the exact time and date fixed, for the reception of Tenders.
 - .2 It is addressed: To the Tender Address, Department of Public Works and Highways, Government of the N.W.T.
 - .3 It contains the time and date of transmission, Project Name, Closing Date, Name and Address of Tenderer.
- .2 Verbal instructions will not be considered as a valid instruction for tender purposes, nor shall they be considered as having any bearing upon the tender submission.

4. SECURITY REQUIREMENTS

The Government of the Northwest Territories is committed to the support of local northern contractors. To this end and in view of the difficulty many northern contractors have in providing the usual bonding, bonding requirements have been waived on this project.

The waiving of bonding requires a commitment from all Tenderers to honour their bids, should they be selected for contract award. To protect the Government, and the integrity of the tendering system, any Tenderer failing to honour a bid will be required to provide full bonding with future tenders on N.W.T. Government work, whether or not such bonding is required by the tender documents. This requirement will remain in force until the Government is satisfied that the offending contractor will act responsibly on future tenders.

5. ACCEPTANCE OF OFFER

The Department will not necessarily accept the lowest or any of the offers.

6. COMPLETION OF TENDER AND ACCEPTANCE FORM

- .1 If No classes of labour, plant or material, units of measure and estimated quantities are shown on the Tender and Acceptance form, insert the total amount of the tender in Clause 3 only and make No entry in Clause 4.
- .2 If classes of labour, plant or material, units of measure and estimated quantities are shown in Clause 4 on the Tender and Acceptance form, insert the price per unit against each item, multiply by the respective estimated quantity, extend the answers in the total column and add the Total column to obtain the Total Amount of the Tender in Clause 4 and make No entry in Clause 3.
- .4 Sign the Tender and Acceptance form in the space provided as indicated below:

Sole Proprietorship: Signature of sole proprietor in the presence of a witness who will sign where indicated. Insert the words "Sole Proprietor" under Title/s.

Partnership: Signatures of all partners in the presence of a witness or witnesses who will sign where indicated. Insert the word "Partner" against each signature under Title/s.

Limited Company: If this tender is made by a Limited Company, the tender must be signed by duly authorized signing officers of the company in their normal signatures designating against each signature the official capacity in which the signing officer acts. The corporate seal of the company must also be affixed to the tender. If the tender is signed by officials other than the President and Secretary of the company or the President and Secretary-Treasurer of the company, a copy of a by-law or resolution of the Board of Directors authorizing them to do so must be submitted with the tender documents.

.5 Tenders are to be submitted in two copies, duly completed, in the envelope provided. The tenderer should retain the third copy of the tender for his record.

7. NORTHERN BUSINESS INCENTIVE

One of the priorities of the G.N.W.T is to ensure Northern labour, materials and equipment are used to the fullest extent practical on our construction projects. Tenderers, therefore, are required to complete the attached appendices as herein stated:

- .1 Appendixes A-1, A-2 - Submit With Tender
- .2 Appendix A-3 - Comply With
- .3 Appendix A-4 - Complete at the end of the project and submit prior to final payment.

8. UPON NOTIFICATION OF ACCEPTANCE

1. Upon notification of acceptance of the Tender, the Tenderer shall furnish within 14 days of the date of the notification of acceptance:
 1. proof of Registration under the Companies' Ordinance of the Northwest Territories.
 2. proof of the compliance with the provisions of the Workers' Compensation Ordinance of the Northwest Territories.
 3. the Insurance Policies specified in the General Conditions.

9. ADDENDA

1. Addenda issued during the Tender period shall be incorporated into the proposal and shall become part of the Tender Documents. Receipt of Addenda shall be acknowledged on the Tender Form in space provided.

10. FINANCIAL ADMINISTRATION ACT

The attention of the Contractor is drawn to the following statutory provision:

"It is a condition of every contract providing for the payment of any money by the Territories that payment pursuant to the contract is subject to there being a sufficient unencumbered balance in the appropriate activity for the fiscal year in which the funds would be required under the same contract."

Section 25(1) Financial Administration Act, 1982 (2nd), c.2.

END OF INSTRUCTIONS TO TENDERERS

SUBMISSION COPY

TENDER AND ACCEPTANCE

Tender Address Deputy Minister, Department of Public Works & Highways, Government of the N.W.T., c/o Regional Engineer's Office, Bag Service 1, Inuvik, N.W.T. XOE 0T0		Tender Closing Time Hour - 3:00 P.M. (Local Time) Date - September 18, 1986
Project No. 85-9207	Description Of Works Equipment rental, Dempster Highway grade repairs. Various equipment including crawler tractor, loader, haul trucks, compactor, grader and low boy truck; plus purchase/installation of insulation and geo- textile materials and minor culvert purchase/in- stallation.	
Contract No.		
Requisition No.		
Code No.		

1. OFFER

The Undersigned tenderer (hereinafter called the "Contractor") hereby offers to the Government of the Northwest Territories (hereinafter called the "G.N.W.T.") as represented by the Minister of Public Works and Highways (hereinafter called the "Minister") to furnish all necessary tools, plant, services, materials and labour to execute and complete in a careful and workmanlike manner the work set out under the "Description of Works" hereon, which is more particularly described in the Plans and Specifications for the prices as set out in clause 3 or 4 of this Tender. The Tenderer hereby acknowledges receipt of Addenda No. 6 to No. 6 inclusive and hereby agrees they form part of this Tender.

2. GENERAL AGREEMENT

The Contractor agrees:

- .1 To complete the work within twenty-five (25) days from the date of notification of acceptance of his tender.

- .2 that he has carefully examined the site of the work, described herein; has become familiar with local conditions and the character and extent of the work; has carefully examined every part of the proposed contract and thoroughly understands its stipulations, requirements, and provision and, has determined the quality and quantity of materials required; has investigated the location and determined the sources of supply of the materials required; has investigated labour conditions and has arranged for the continuous prosecution of the work herein described,
- .3 that this Tender and Acceptance, the Instructions to Tenderers, the Plans and Specifications referred to in Clause 1 above, and the General Conditions shall be and are the complete tender and this offer is made subject to the provisions contained therein,
- .4 that this tender supersedes and cancels all communications, negotiations, and agreements relating to the work other than contained in the completed tender.
- .5 that this tender may not be withdrawn for a period of 30 days following the tender closing date,
- .6 that the complete tender together with and subject to all the provisions contained therein shall, when accepted and executed on behalf of the G.N.W.T., constitute a binding contract between the Contractor and the G.N.W.T.
- .7 that the parties hereto agree that in any proceeding arising out of this contract, the G.N.W.T. may bring such action in its own name and the Contractor may commence such an action against the G.N.W.T. in the G.N.W.T.'s name.

~~3. LUMP SUM COSTS~~

~~The Contractor agrees that the following is the lump sum referred to in Clause 1 of this Tender and Acceptance Form:~~

~~(Amount to be in Words)~~

~~(\$ _____)
(Numbers)~~

4. UNIT PRICE COSTS

- (a) The quantities shown in the schedule of Contract Unit Prices are estimated. The Contract Price shall be in the final sum of the products of the actual quantities that are incorporated in, or made necessary by the Work, as confirmed by count and measurement, and the appropriate Contract Unit Prices together with any adjustments that are made in accordance with the provisions of the Contract Documents.

(b) The Estimated Contract Price shall be the sum of the products of the estimated quantities and the appropriate Contract Unit Prices in the Schedule.

* (c) Schedule of Contract Unit Prices referred to in Clause 1 are as follows:

Item	Description	Estimated Quantity	Unit	Unit Price	Estimated Total Price
1	Crawler Tractor Div. 1 Sec. 1.5.1	190	Hour	85.00	16150.00
2	Front-End Loader Div. 1 Sec. 1.5.3	150	Hour	85.00	12750.00
3	Dump Trucks Div. 1 Sec. 1.5.2	450	Hour	65.00	29250.00
4	Compactor Div.1 Sec. 1.5.5	190	Hour	70.00	13300.00
5	Motor Grader Div. 1 Sec. 1.5.4	20	Hour	120.00	2400.00
6	Lowboy Truck Div. 1 Sec. 1.5.6	40	Hour	90.00	3600.00
7	Superintendent Div. 1 Sec. 1.6(a)	190	Hour	40.00	7600.00
8	Labourers Div. 1 Sec. 1.6(b)	300	Hour	30.00	9000.00
9	Camp Rental Div. 1 Sec. 1.5.7	20	Day	500.00	10000.00
10	Camp Subsistence Div. 1 Sec. 1.5.7	240	Person-Day	65.00	15600.00
11	Mobilization/Demo- bilitation Of Equip- ment And Personnel	—	Lump Sum	8000.00	8000.00
12	Purchase/Delivery Of Insulation Div. 1 Sec. 1.12.2	1000	Square Metre	18.00	18000.00
TOTAL ESTIMATED CONTRACT PRICE THIS PAGE					145,650.00

If space for listing items is insufficient, annex a list and make reference thereto.

UNIT PRICE COSTS CONT'D.

Item	Description	Estimated Quantity	Unit	Unit Price	Estimated Total Price
13	Purchase/Delivery Of Geotextile Div. 1 Sec. 1.12.3	480	Square Metre	3.25	1560.00
14	Purchase/Delivery Of 800 mm Diameter Culvert Div. 1 Sec. 1.12.1	12	Linear Metre	150.00	1800.00
15	Standby Rate For Operating Equipment Div. 1 Sec. 1.9.2	N.A.	Percentage	0	N.A.

TOTAL ESTIMATED CONTRACT PRICE THIS PAGE

3360.00

TOTAL ESTIMATED CONTRACT PRICE PREVIOUS PAGE

145,650.00

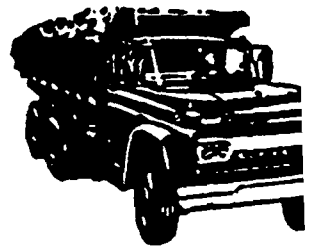
TOTAL ESTIMATED CONTRACT PRICE

149010.00

Handwritten notes:
 e.c.
 14/09/82
 [Signature]

5. The Contractor agrees that the following list is the complete description of plant and equipment He/They propose to use in the execution of this contract. Such equipment is available for inspection prior to the award of contract and shall be moved to the project site upon direction and shall not be removed without written approval of the G.N.W.T.; until the completion of the contract. ~~It is not to be used for any other purpose than the specified work.~~

Description Of Unit, Make, Model, Year and Serial No.	Capacity, etc. Size, Capacity and Horsepower Rating	Auxiliary and/or Special Equipment, Power Take-off, Power Control Units, etc.	Condition	Present Location
GRADER 72U4359	150 HP	BLADE	GOOD	INUUIK
LOADER 31K2656		3M BUCKET	GOOD	INUUIK
D6DCAT ^H X935 74A1246	140 HP	BLADE	GOOD	INUUIK
KENWORTH TANDEM TRUCK 908638C		10M ³ BOX PTO	GOOD	INUUIK
KENWORTH TANDEM TRUCK 908655C		10M ³ BOX PTO	GOOD	INUUIK
INTERNATIONAL TANDEM TRUCK D0712HA23742		10M ³ BOX PTO	GOOD	INUUIK
CAMP		KITCHEN-WASH ROOM - LIGHT PLANT, SLEEPER	GOOD	ARCTIC RED
FERGUSON ROLLER PACKER SP75B			GOOD	INUUIK



... agrees that the following list is the complete list of plant and equipment He/They propose to use in the this contract. Such equipment is available for prior to the award of contract and shall be moved to the upon direction and shall not be removed without the approval of the G.N.W.T.; until the completion of the work.

for reference only. Bidder will supply price of 17 cu hydraulic angle dozer and ripper.

Capacity, etc. Size, Capacity and Horsepower Rating	Auxiliary and/or Special Equipment, Power Take-off, Power Control Units, etc.	Condition	Present Location
150 HP	BLADE	GOOD	INUUIK
130 H.P.	3m ³ BUCKET	GOOD	INUUIK
230 H.P.	10m ³ BOX	GOOD	INUUIK
80 HP	10m ³ BOX	GOOD	INUUIK
230 HP	8m ³ BOX	GOOD	INUUIK
140'	KITCHEN, WASHHOUSE, LIGHT PLANT SLEEPER	GOOD	INUUIK

TS
PT OF HIGHWAYS
CAMPBELL

GOOD INUUIK

70XVCA 6165			
380	FIFTH WHEEL	GOOD	INUUIK
24	FWORKIN DECK	GOOD	INUUIK

7. Contractor's Proposed Daily and Weekly Work Schedule
~~Information to be used to bar and initial the space below~~

Daily Hours: From 7 AM To 7 PM

No. Of Shifts per day ONE

Days of the Week: Monday to Sunday inclusively.

8. The following are the Sub-Contractors we propose to use for the Divisions or Sections of Work listed hereunder and I/We agree that if any changes are made without written authorization of the G.N.W.T., the contract may be terminated at the option of the G.N.W.T. (If not used, bar and initial the space below).

Division or Section of Work	Name Of Subcontractor

SIGNED, SEALED AND DELIVERED
in the presence of:

CONTRACTOR

Contractor's Full Business Name and Address

North Star Service & Construction (Inuvik) Ltd.

65 FRANKLIN ROAD BOX 1001

INUVIK N.W.T. X0E 0T0

Contractor's Seal

Gordon L. Campbell
Signature

GORDON L. CAMPBELL PRESIDENT
Name And Title

SEPT 17, 1986
Date

Signature

Janice Sawyer
Witness

Name and Title

Janice Sawyer Bookkeeper
Name and Title

OP

JG
C.C.
18/09/86.

GOVERNMENT OF THE NORTHWEST TERRITORIES
(G.N.W.T.)

[Signature]
Signature

Assistant Deputy Minister
Name and Title

86/09/26
Date

[Signature]
Witness

Secretary to
Name and Title

Sept 26/86
Date

BUSINESS INCENTIVE FOR NORTHERN CONTRACTORS

The Government of the Northwest Territories has implemented a Business Incentive Policy to promote the use of Northern labour and the purchase of Northern materials, and to encourage the development and competitiveness of Northern business. Information which explains the policy is available from the Department of Government Services.

All Tenderers wishing to apply for a bid adjustment for this Tender, SHALL provide the following information with their Tender. No changes with respect to this information will be allowed without the written authorization of the Deputy Minister. By signing this Tender, the Tenderer is certifying that the contents attributed to Northern Contractors is correct.

NOTE: ALL NORTHERN CONTENT SHALL BE LISTED. This may include the General's portion of the Tender and/or the subcontractor's portion of the Tender. All Northern Contractors must be registered with Government Services, Government of the Northwest Territories.

NAME OF NORTHERN CONTRACTOR	NORTHERN CONTENT 1. AMOUNT (\$)
<p>I. GENERAL North Star Service & Construction (Inuvik) Ltd.</p> <p>1.</p> <p>II. SUBCONTRACTORS</p> <p>1.</p> <p>2.</p> <p>3.</p> <p>4.</p> <p>5.</p> <p>6.</p> <p>III. MATERIAL SUPPLIERS</p> <p>1.</p> <p>2.</p>	<p>149010.00</p>

1. The amount listed in this column shall be the total amount of the Northern General Contractor's portion of the Tender and the amount of each Northern Subcontract and Northern Suppliers. If required, substantiation of the above information (copies of Subcontracts) shall be furnished by the Contractor when requested by the Contract Authority.

LOCAL/NORTHERN PROPOSED INVOLVEMENT

In addition to the bid adjustment given under the Business Incentive Policy, it is the intent of the G.N.W.T. that Local/Northern Involvement be used to the fullest extent possible on this project. For this reason, Contractors are required to submit the following information with their Tender. This information may be a factor in determining the successful Tenderer; failure to complete this form may result in this Tender being disqualified.

ESTIMATED EXPENDITURE	GENERAL CONTRACTOR		SUBCONTRACTORS	
	NORTHERN	LOCAL	NORTHERN	LOCAL
PAYROLL		27540.00		
MATERIAL		50000.00		
EQUIPMENT		350000.00		
TRANSPORTATION		8000.00		
ACCOMMODATION		10000.00		
* OTHER				
TOTAL				
* UNDER "OTHER COSTS" PLEASE LIST ANY OTHER LOCAL/NORTHERN INVOLVEMENT ASSOCIATED WITH THIS CONTRACT AS HEREIN DESCRIBED: _____ _____				
PROPOSED TRAINING PROGRAMS: _____ _____ _____				
COMMENTS: _____ _____ _____				

Note: For the purposes of this form, a Local Contractor is a Northern Contractor (as defined in the Business Incentive Policy) with an office in the community where the work is to be undertaken. This form must be submitted either with the Tender or within 24 hours after the Tender closing time.



Northwest Territories

Contract Change Order

Formal-Construction
 Informal-Service

CHANGE ORDER NO. 1	CONTRACT NO. 86-1137-01	PROJECT NO. 85-9207	DATE November 10, 1986
CONTRACTOR NORTH STAR SERVICE & CONSTRUCTION (INUVIK) LTD.		LOCATION 65 FRANKLIN ROAD, BOX 1005, INUVIK, N.W.T., XOE 0T0	
PROJECT EQUIPMENT RENTAL, DEMPSTER HIGHWAY GRADE REPAIRS, KM 8.5 to KM 50.9, DEMPSTER HIGHWAY (NO. 8), N.W.T.			

THE ABOVE CONTRACT IS TO BE CHANGED AS FOLLOWS:

ITEMS TO BE INCREASED:

ITEM	DESCRIPTION	UNIT PRICE (\$)	QUANTITY CHANGE	TOTAL PRICE
1	Crawler Tractor	85.00	+ 11.5 Hrs.	+ 977.50
2	Front-End Loader	85.00	+ 26.0 Hrs.	+ 2,210.00
3	Dump Trucks	65.00	+ 41.5 Hrs.	+ 2,697.50
7	Superintendent	40.00	+ 13.0 Hrs.	+ 520.00
8	Labourers	30.00	+ 20.0 Hrs.	+ 600.00
9	Camp Rental	500.00	+ 1 Day	+ 500.00

ITEMS TO BE DECREASED:

4	Compactor	70.00	-144.5 Hrs.	-10,115.00
5	Motor Grader	120.00	- 1.5 Hrs.	- 180.00
6	Lowboy Truck	90.00	- 21.5 Hrs.	- 1,935.00
10	Camp Subsistence	65.00	- 35 Person Days	- 2,275.00

ITEMS TO BE ADDED:

16	Backhoe	75.00	29.0 Hrs.	+ 2,175.00
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Contract amount to be reduced by by: \$ 4,825.00	Completion date was: N/A	And is now: N/A
ORIGINAL AMOUNT \$ 149,010.00	TOTAL ADDITIONS \$ 0	TOTAL DEDUCTIONS \$ 4,825.00
		REVISED CONTRACT \$144,185.00

ACCEPTED Contractor _____ Date _____	ACCEPTED <i>[Signature]</i> _____ 10 11 86 Engineer _____ Date _____
ACCEPTED Contractor _____ Date _____	APPROVED <i>[Signature]</i> _____ 13 Nov. '86 Date _____

FINANCIAL CODING 507046	COMMITTED Authorized Treasury Signature _____ Date _____
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LOCAL/NORTHERN EMPLOYMENT

Further to our emphasis on Local/Northern Involvement, the Contractor and all his Subcontractors shall work with the Local/Regional Canada Employment Center as specified in the General Conditions to ensure local labour is used to the extent to which it is available.

The Federal Government has Employment Centers in the N.W.T. at the following locations:

- | | |
|------------------|--------------|
| 1. Yellowknife | 403-920-8400 |
| 2. Fort Simpson | 403-695-2238 |
| 3. Fort Smith | 403-872-2747 |
| 4. Frobisher Bay | 819-979-5315 |
| 5. Hay River | 403-874-6739 |
| 6. Inuvik | 403-979-2122 |
| 7. Rankin Inlet | 819-645-2853 |

The Federal Government also has Outreach Offices in the N.W.T. at the locations listed below. These positions change frequently, however, and should there be a problem, the Yellowknife Office should be contacted.

- | | |
|--------------------|--------------|
| 1. Baker Lake | 819-793-2874 |
| 2. Rae/Edzo | 403-392-6500 |
| 3. Fort Providence | 403-699-3461 |
| 4. Fort Norman | 403-588-4351 |
| 5. Pangnirtung | 819-473-8953 |
| 6. Pond Inlet | 819-899-8917 |
| 7. Igloodik | 819-934-8933 |
| 8. Fort Resolution | 403-394-4471 |
| 9. Eskimo Point | 819-857-2841 |

The Contractor is required to contact the nearest available Employment Center or Outreach Office noted above to determine the availability of capable local labour prior to the commencement of the work, and on an ongoing basis as additional labour is required. The G.N.W.T. will check with the Employment Center or Outreach Office to ensure this requirement is being met.

The Contractor is required to report on a monthly basis, or as specified, the amount of all Local/Northern Involvement during the period in question. This report shall be submitted to the Engineer with the Contractor's progress payment request. No payments shall be due or payable to the Contractor if the Contractor fails to supply this report to the G.N.W.T. A copy of this form is herewith attached, Appendix B-4.

For the purposes of this report, a Northerner will be classified as a person who has been resident in the N.W.T. for the past three years.



~~Interim~~ **FINAL** Certificate of Completion
STATUTORY DECLARATION

CANADA
 NORTHWEST TERRITORIES

IN THE MATTER OF a contract bearing no. 85-9207
 between the Government of the N.W.T. and

North Star Service & Construction (Territory) Ltd.
(insert full name of contractor)

herein referred to as the Contractor,

for EQUIPMENT RENTAL
(briefly describe the work to be performed)

dated the 26 day of

SEPTEMBER 1986, and

IN THE MATTER OF the Interim Certificate of Completion
 relating thereto

TO WIT:

I, BERTHA CAMPBELL of INUUIK NWT
(print or type full name of declarant) (declarant's address)

DO SOLEMNLY DECLARE:

(1) That I am THE CONTRACTOR
(print or type declarant's position or title with the contractor or state that the declarant is the contractor)

And as such have a personal knowledge of the said contract and of the facts and matters stated herein.

(2) That all the contractor's lawful obligations with respect to the Labour Conditions, subcontractors and suppliers of material in respect of the work contracted for have been discharged and satisfied.

And I make this SOLEMN DECLARATION conscientiously believing it to be true, and knowing that it is of the same force and effect as if made under oath, and by virtue of the LAWS OF CANADA and the NORTHWEST TERRITORIES.

DECLARED before me at Inuvik

in the NWT

this 29th day of

October 19 86

Bouchard
(signature of person before whom declaration is made)

Jeanne Bouchard
(print name of person before whom declaration is made)

A Notary Public, Commissioner, etc.

NS-692-85 Exp. 12/07/88

(please state clearly authority for receiving solemn declarations - notaries to affix notary seal)

B Campbell
(signature of declarant)

-NOTICE ON BACK-

NOTICE

If this declaration is not complete in every detail, it will be returned for completion and payment will be delayed.

The following section of the Criminal Code of Canada is hereby brought to the attention of the Declarant:

"122. Everyone who, not being a witness in a judicial proceeding but being permitted, authorized or required by law to make a statement by affidavit, by solemn declaration or orally under oath, makes in such statement, before a person who is authorized by law to permit it to be made before him, an assertion with respect to a matter of fact, opinion, belief or knowledge, knowing that the assertion is false, is guilty of an offence and is liable to imprisonment for fourteen years.

122.1 (1) Everyone who, not being specially permitted, authorized or required by law to make a statement by affidavit, by solemn declaration or orally under oath, makes in such a statement, before a person who is authorized by law to permit it to be made before him, an assertion with respect to a matter of fact, opinion, belief or knowledge, knowing that the assertion is false, is guilty of an offence punishable on summary conviction."

DETAILED SHEET FOR
UNIT PRICE CONTRACT

Original
Contract
Quantities

Claimed
This
Period

Total to
Date

DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT	AMOUNT	AMOUNT	
1. CRAWLER TRACTOR	HOUR	190	85.00	201 1/2	17127.50	201 1/2	17127.50
2. FRONT END LOADER	HOUR	150	95.00	176	14960.00	176	14960.00
3. DUMP TRUCKS	HOUR	450	65.00	491 1/2	31947.50	491 1/2	31947.50
4. COMPACTOR	HOUR	190	70.00	45 1/2	3185.00	45 1/2	3185.00
5. MOTOR GRADER	HOUR	20	120.00	19 1/2	2220.00	19 1/2	2220.00
6. LOW BOY TRUCK	HOUR	40	90.00	19 1/2	1665.00	19 1/2	1665.00
7. SUPERINTENDENT	HOUR	190	40.00	20 3	8120.00	20 3	8120.00
8. LABOURERS	HOUR	300	30.00	320	9600.00	320	9600.00
9. CRIMP RENTAL	DAY	20	500.00	21	10500.00	21	10500.00
10. CAMP SUBSISTENCE	PERSON DAY	240	65.00	205	13325.00	205	13325.00
11. MOBILIZATION DEMOS	PERMANENT	—	8000.00	1	8000.00	1	8000.00
12. INSULATION	SQ. M.	1000	18.00	1000	18000.00	1000	18000.00
13. GEOTEXTILE	SQ. M.	480	3.25	480	1560.00	480	1560.00
14. CULVERT	L.M.	12	150.00	12	1800.00	12	1800.00
15. BACK HOE	HOUR	—	75.00	29	2175.00	29	2175.00

6 Nov. 10/186

I agree with the above
unit rates and the quantities
stated
CONSULTANT'S
J. L. Murphy
EBA Engineering
Consultants Ltd.

Gross Amount This Period 144185.00 To Date 144185.00
Gross Amount Previous Period ...
Gross Amount This Period ...
Less Hold Back ...
Net Amount This Period 144185.00



Northwest
Territories

FINAL CERTIFICATE OF COMPLETION

Contractor's Name and Address <i>North Star Service & Construction (Inuvik) Ltd. 65 Franklin Road, P.O. Box 1005 Inuvik, NWT X0E 0T0</i>	File No. <i>85-9207</i>
	Contract No. <i>86-1137.01</i>
Name and Location of Work <i>Equipment Rental, Dempster Highway Grade Repairs, km. 8.5 to km. 50.9, Dempster Highway (No. 8), N.W.T.</i>	Contract Date <i>September 29, 1986</i>
	D.P.W. Division/Region <i>Highways / Headquarters</i>

PART I - FINAL INSPECTION AND AMOUNT PAYABLE

The undersigned certify (certifies) that the above work has been inspected and has been found completed in accordance with the terms of the contract.

Inspected By	Position or Title	Representing
<i>T. Murphy</i>	<i>Field Engineer</i>	<i>EBA Engineering Consul- tants Ltd.</i>
D.P.W. Inspecting Officer		

Value of Work \$ <i>144,185.00</i>	* Previously Paid \$ <i>∅</i>	Gross Payable \$ <i>144,185.00</i>	Assessments \$ <i>∅</i>	Net Payable \$ <i>144,185.00</i>
* Previously paid is gross amount payable on interim certificate of completion or net value to date on previous progress report.				Date <i>Nov. 10/1986</i>

PART II - CERTIFICATES

I certify that the work has been completed and that the contractor has complied with the contract and all orders and directions thereto.

Pursuant to the authority of the general conditions, I hereby issue this final certificate of completion effective

November 03, 1986. The amount shown as 'Net Payable' is approved for payment and requisitioned pursuant to the financial administration ordinance. No item in this account has been previously certified.

I recommend that the security deposit be returned to the contractor.

Comments

Engineer <i>[Signature]</i>	Date <i>10 11 86</i>	Approved by Div. Chief Reg. Engineer <i>[Signature]</i>	Date <i>86-11-13</i>
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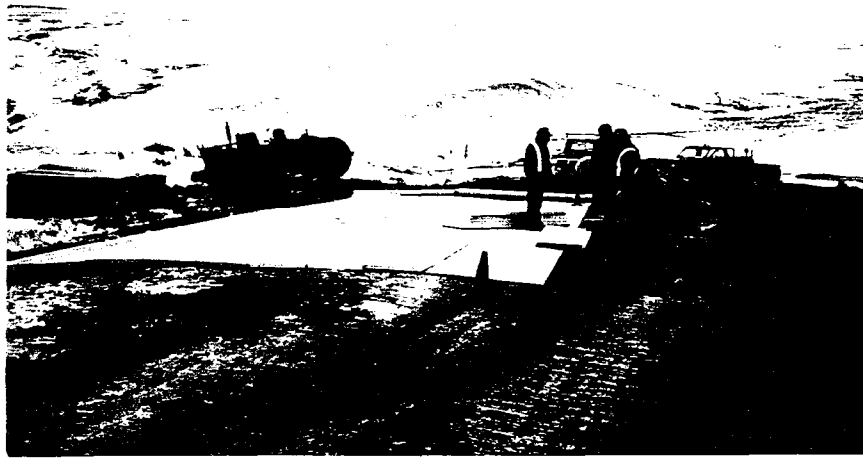
AUTHORIZED CONTRACT VALUES

Original Contract <i>149,010.00</i>	Approved Additions <i>∅</i>	Approved Deductions <i>4,825.00</i>	Total Authorized <i>144,185.00</i>
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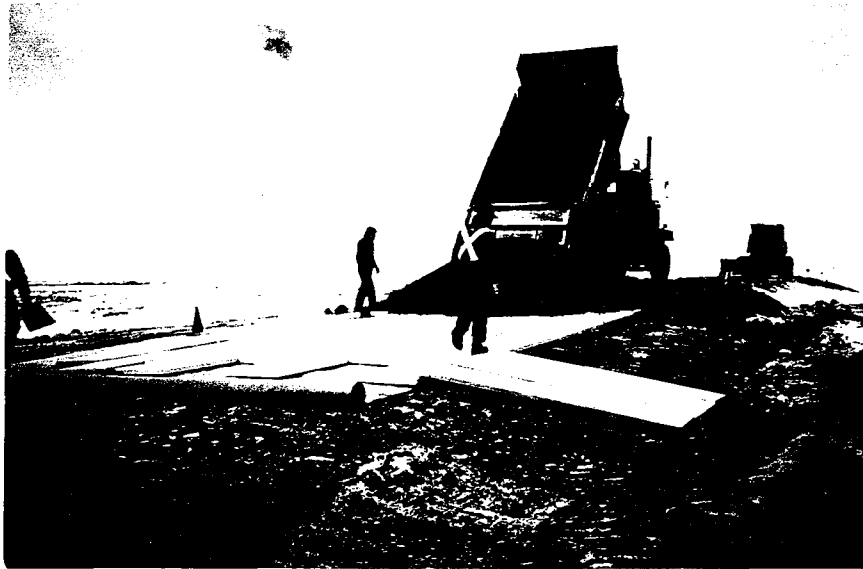
APPENDIX "D"

APPENDIX D

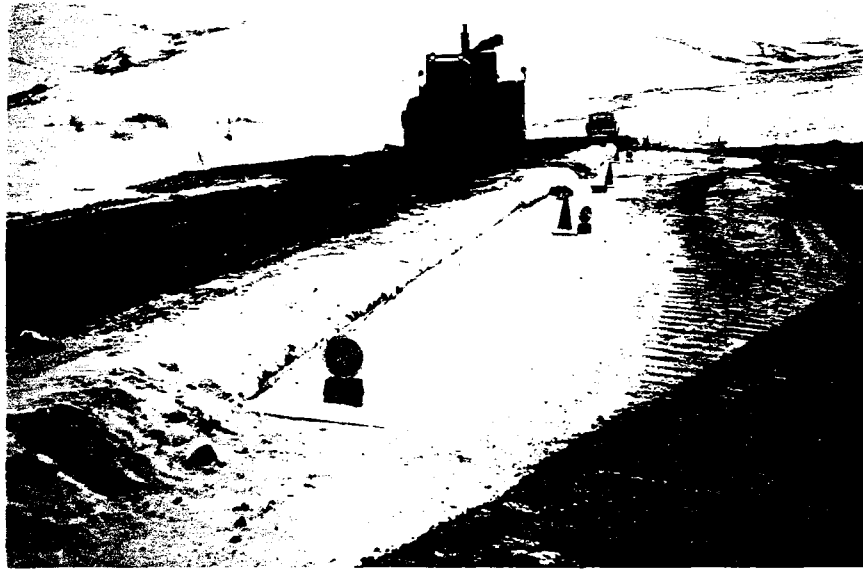
1. Km 8.5 Photographs Showing Construction
2. Km 46.9 Photographs Showing Construction
3. Km 50.9 Photographs Showing Construction



KM 8.5 PLACING GEOTEXTILE AND 50 mm
INSULATION IN RIGHT LANE -
LOOKING WEST



KM 8.5 PLACING LIFT OF FILL OVER GEOTEXTILE
AND INSULATION IN RIGHT LANE -
LOOKING EAST



KM 8.5 FIRST LIFT OF FILL OVER GEOTEXTILE
AND INSULATION ON RIGHT
LANE - LOOKING WEST



KM 8.5 FINAL SHAPING OF SURFACE TOPPING
COURSE - LOOKING WEST



KM 46.9 CULVERT EXCAVATION PRIOR TO
PLACEMENT OF FILL



KM 46.9 INSTALLATION OF CULVERT EXTENSION
AND PORTION OF 50 mm INSULATION



KM 46.9 PLACING FILL AT TOE BERM



KM 46.9 FINAL SHAPE OF TOE BERM
NOTE FROZEN RAMP STILL
INTACT AT FAR END OF BERM



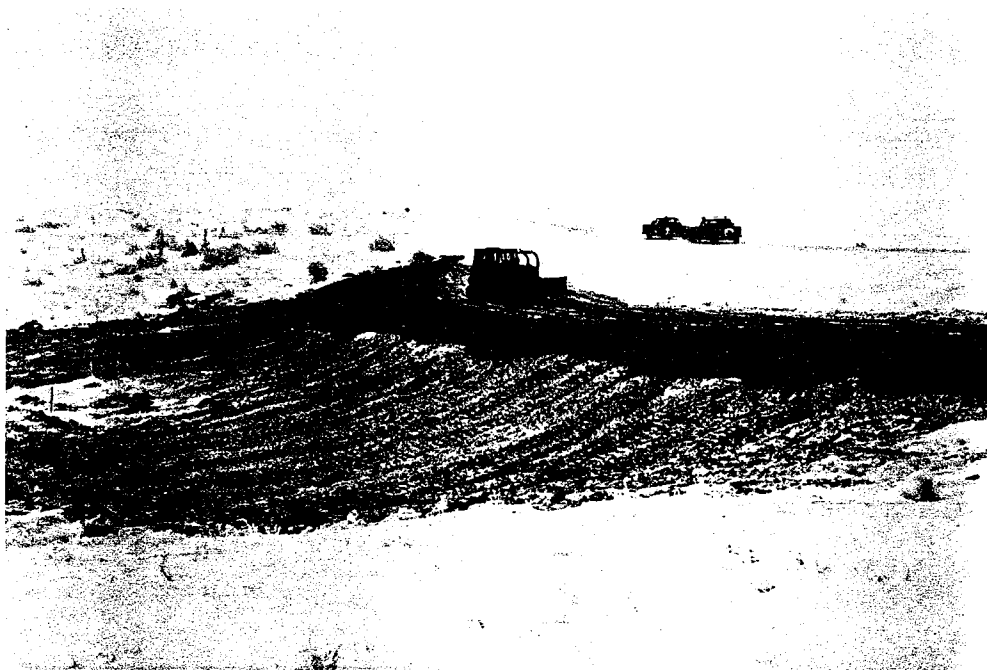
KM 50.9 PLACING FILL AT NORTH SIDE OF
HIGHWAY - LOOKING WEST



KM 50.9 SITE OF TOE BERM BEFORE
CONSTRUCTION - SOUTH SIDE OF
HIGHWAY LOOKING SOUTH EAST



KM 50.9 PLACING LIFT OF FILL OVER
50 mm INSULATION



KM 50.9 FINAL SHAPE OF TOE BERM
SOUTH SIDE OF HIGHWAY
LOOKING WEST