

Canada

Public Works Travaux publics Canada

Western Region

Région de l'Ouest



MACKENZIE HIGHWAY N.W.T. MILE 411.5-425.4 FINAL DESIGN SUBMISSION FEBRUARY, 1975

*	Government of Canada	Gouvernement du Canada	MEMORANDUM	NOTE DE SERVICE
	Mr. W. Progra Design OTTAWA	R. Binks m Manager (Civil) & Construction A, Ontario		SECURITY - CLASSIFICATION - DE SÉCURITÉ OUR FILE - N/RÉFERENCE 9305-52-300
FROM DE	F. E. Projec N.W.T. Wester	Kimball t Manager Roads n Region		VOUR FILE - V/REFERENCE DATE February 7th, 1975

SUBJECT FINAL DESIGN SUBMISSION - MACKENZIE HIGHWAY MILE 411.6 - 425.4, FEBRUARY, 1975

In accordance with the D.R.C.G. meeting of December 14, 1973 and subsequently as requested by the Director of Engineering and Architecture Branch, two (2) sets of design plans with varying degrees of information were developed; one for review purposes and one for contract purposes.

Review Purposes - E.W.G.

Enclosed are twenty-four (24) copies of the narrative portion of the above-noted Design Submission. Two (2) sepia mylar copies of the plans have been forwarded under separate cover.

Six (6) copies of the narrative and one (1) set of sepia mylar copies of the plans have been forwarded to Mr. C. Amos of D.I.N.A. in Yellowknife. Single copies of the narrative and a single set of prints have been forwarded to D.O.E. in Edmonton and Winnipeg and E.M.R. in Calgary.

Contract Purposes - D.I.N.A.

One (1) set of sepia mylar copies of the design plans for the abovementioned Submission have been forwarded to G. D. Reid for printing and distribution and one (1) set of prints has been forwarded to Mr. C. Amos of D.I.N.A. in Yellowknife.

Items included in the Review Set of the design plans, in addition to the information included in the Contract Set of the Design Plans are:

- 1. Location and nature of all off-take ditches plotted on the orthomapping.
- 2. Cross sections of cuts and fills over fifteen feet plotted on the Plan-Profile Mile Sheets.
- 3. Plan shape of every borrow area and planned location of access roads by a line marking the precise boundary of the natural ground surface proposed to be disturbed.

F. E. Kimball Project Manager N.W.T. Roads

MACKENZIE HIGHWAY

FINAL DESIGN SUBMISSION

MILE 411.6 - MILE 425.4

AMENDED FEBRUARY, 1975

Department of Public Works of Canada Western Region Edmonton, Alberta

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INTRODUCTION

The Final Design Submission, Miles 411.6 - 425.4 February, 1975 has been prepared as a resubmission to include the Information Omissions as observed and noted by the Project Manager in the review of the Preliminary Design Submissions, Miles 390 - 428.

The missing geotechnical information in the alignment revision areas will be obtained by Department of Public Works forces during the winter of 1974-75.

The reader should note that this report forms part of a total design resubmission, the major portion of which is contained in separate plan forms.

CHAPTER 1

REFERENCE: Response to Information Omissions Noted in Letter of Direction for Final Design Submission, Mile 348 -390, d.d. January 15, 1974.

INFORMATION OMISSIONS

The information omissions for the 'Final' Design Submission, Mile 348 to 390 noted in our letter to you dated January 15, 1974 have also been noted in this design submission. You are therefore requested to ensure this information is provided in subsequent submission for this section.

As noted in our letter of May 21, 1974 two (2) sets of plans (one for review purposes and one for contract purposes) will be required in order to provide requested information.

1. Orthophoto Mapping

As the orthophoto mapping requested was not available at the time the interim final design submission was submitted, you are requested to submit the final design with the orthophoto mapping as soon as it becomes available.

- Orthophoto mapping has been included on the Mile Sheets of the Final Design Submission, Mile 411.6 - 425.4.

- 2. Ditching
 - (a) The location and nature of all off-take
 ditches should be plotted on the orthophoto
 mapping to the detail and accuracy that can
 be determined from information available.
 - All off-take ditches have been plotted as requested.
 - (b) Typical Design Details of other methods of special treatments for ditches that will be employed in addition to the variable spacing of ditch checks are requested.
 - Appendix A of this report describes the various methods proposed for special treatment for ditches.
 Typical details of ditch blocks, ditch checks and ditch linings are illustrated on the "Typical Drawings for Erosion Control" sheet contained in the Final Design Submission, Mile 411.6 - 425.4.
 - (c) Please provide an explanation of how ditch checks will be protected against crest erosion whenever flow occurs during periods when culverts upstream from ditch checks are frozen solid together with more design information about ditch checks. In

particular, details concerning size, shape, method of construction, composition, design lifetime and maintenance requirements are requested.

- It is obvious confusion of interpretation between ditch checks and ditch blocks still exists. Appendix A of this report should clarify the intended meaning of a ditch check and the "Typical Drawings for Erosion Control" Sheet of the amended Final Design Package contains a typical drawing of a ditch block.
- Assuming the above comment refers to ditch blocks, it is intended that maintenance will provide that culverts upstream from ditch blocks are opened prior to spring run-off.
- Construction of the ditch block is similar to embankment construction. Details concerning size, slope and rip-rap are contained in the typical drawing of ditch blocks.

3. Cross Sections of Cuts and Fills

Please ensure that cross sections for all cut and fill sections over 15 feet are provided on all future final design submissions. Please note that the letter of direction dated December 10, 1973

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requested that the sideslope angles for the design sections, wherever possible, take into account the material type to be used in the cut or fill.

- Cross sections for all cut and fill sections over
 15 feet have been provided in the Final Design Sub missions Mile 411.6 425.4.
- The slope angles for material type to be used in cut or fill sections as recommended by Acres, Volume 1, Geotechnical Investigations, Mile 346 - 450 have been considered as being over conservative. The more realistic slope angles for slope stability as determined by the design team, are indicated on the cross sections for cuts and fills over 15 feet.

4. Borrow Pits

It is noted that not all of the information requested by our Letter of Direction dated Pecember 10, 1973 has been provided. All information available to P.P.W. should be submitted on the 1"=200' mapping. The information should continue to be shown on the 1"=1000' mosaics as well.

If at any time subsequent to the submission of a Final Design, requirements for borrow areas additional to those shown on the design plans are identified, this Department should receive for approval:

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- (a) a plan showing areas where new pits are to be developed accompanied by all the information required for borrow areas;
- (b) a plan indicating those borrow areas that are to be increased in volume by a factor greater than three or in areal extent by a factor greater than three over the anticipated sizes indicated by the Final Design Submission along with all relevant information.
- All information on borrow areas available to D.P.W. at the time of this Design Submission has been included on the 1"=200' orthomapping and/or on the 1"=1000' mosaics.

5. Effects of Construction of Fish and Wildlife

After consultation with the Canadian Wildlife Service and Fisheries Service you are requested to provide specific recommendations regarding limitations in construction operation, practice and scheduling to protect wildlife and fish.

Results of consultations to date are reflected in the scheduling restrictions included in the draft specification. Consultations with these agencies are continuing to provide general guidelines for the protection of fish and wildlife. 6. Waste Material Disposal Sites

Information as requested by the Letter of Direction dated December 10, 1973 on waste material disposal sites other than borrow pits was not provided with the design submission. It is understood that the only waste material disposal sites contemplated between Miles 348 - 390 are borrow pits. However, in such cases, written confirmation is requested.

 Completed borrow pits have been chosen as disposal sites for waste material, if required, for this section, Mile 411.6 -425.4.

7. Submission of Final Design Plans

As noted in the letter of May 21, 1974 two (2) sets of plans (one for review purposes and one for contract purposes) will be required in order to provide the requested information.

- Two (2) sets of design plans have been prepared; one for review purposes and one for contract purposes.
- Distribution of the two sets of design plans is outlined in the opening Memorandum of this Report.

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CHAPTER 2

<u>REFERENCE</u>: Letter of Direction for Final Design Submission Mile 428 - 470 d.d. June 15, 1974

I. Information Omissions

The information omissions for the 'Final' Design Submission, Mile 348 to 390 noted in our letter to you dated January 15, 1974 have also been noted in this design submission. You are therefore requested to ensure this information is provided in the subsequent submission for this section.

 The information requested is provided in Chapter 1 of this report

II. Alignment

(1) Horizontal

The horizontal alignment for miles **390** to 424 has been previously approved. The section from mile 424 - 428 falls within the Wrigley area where possible revisions are being considered. Further alignment approvals in this area cannot be given at this time.

- Mile 425.4 was chosen as the northern limit of this submission as the right-of-way has already been cleared to that point. Revisions being considered for the Wrigley area will not result in any changes in the alignment from Mile 425.4 south.

(2) Vertical

- (a) The vertical alignment in this section appears to be well integrated with the landscape and continuous with the horizontal alignment.
 - No Department of Public Works comment required.
- (b) We are in agreement with your recommendations to investigate the possibilities of reducing the rather steep gradients near the Willowlake River. Your attention is drawn to the recommendations of the EWG concerning information requirements for this investigation.
- Willowlake River section does not fall within the limits of this submission.

(3) Typical Cross Sections

Typical cross sections are requested for all cuts and fills over 15 feet. The locations for which these have not been provided are:

Mile 392, Station 842 Mile 393, Stations 936-947 Mile 394, Stations 948-963 Mile 394, Stations 985-995.

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- Typical sections for all cuts and fills over 15 feet have been shown on the plan profile mile sheets.
- III. Drainage
 - (1) Culverts
 - (a) It is requested that the culvert exit velocity
 at design discharge be provided for the following
 culverts:

Mile 411.9 Mile 418.4 Mile 424.3

- Exit velocities at design discharge are shown on the hydrologist's culvert drawings for the above noted culverts.
- (b) Concern is expressed that in some cases the culvert spacing may be extreme for the gradients encountered. The locations identified are:

Mile 401-402 Stations 329-364 Mile 402-403 Mile 413-414 Mile 414-415 Mile 425-426 The design of the sections noted above which are within the section 411.6 - 425.4 have been reviewed with the following results:

Mile 413 - 414 - Additional culverts added
Mile 414 - 415 - Additional culverts added
Mile 425 - 426 - Design considered adequate.

- (c) A ditch check is required at Mile 399 400, Station 240.
- The section referred to above is not within the limits of this submission.
- (d) It is requested that the expected tailwater elevations for fish migration discharge be provided for the culverts located at the following mileages: 396.1, 406.2, 412.8, 422.7, 426.5 and 427.5.
- Expected tailwater elevations for fish migration design culverts within the section Mile 411.6 425.4 are shown on the hydrologist's drawings for the respective culverts.
- (e) The culvert inlet velocity for both design discharge and fish migration discharge should be provided for all large culverts. The exit velocity at fish migration should also be provided for all large culverts.

- Inlet and exit velocities at fish migration discharge have been shown for all culverts subject to fish migration design criteria. Inlet velocities at design discharge are
- (f) Significant differences have been noted between the drainage areas recommended for use by your hydrology consultant and those recommended by your environmental consultant for the culverts located at the following mileages: 396.1, 407.5, 418.4 and 419.5. Please request your consultants to verify their information on these culverts.
 - The discrepancy in drainage area for the culverts at Mile 419.5 was due to a typographical error. The environmental consultants figure should have been 0.7 square miles. Note that the Base Data Report shows the area as less than one square mile.

The environmental consultant agrees with the hydrologists drainage area of 2.6 square miles for the culvert at 418.4.

(g) In addition to the culverts recommended by your environmental consultants for fish migration design, those located at Mile 392.0, 396.1 and 412.8 are also to be designed for fish migration.

shown for all large culverts.

The culvert at Mile 412.8 has been designed for fish migration.

The others noted are not included in this section.

- (h) It is noted that at a number of locations, your hydrology consultant has recommended baffle installation to allow for fish migration rather than reducing the slope of the culvert. At this time, it is not known if baffle installation will produce satisfactory results. Further direction will be forthcoming when the MHEWG have fully evaluated their Baffle Study.
- No Department of Public Works comment required at this time.
- (i) When streams are identified as having moderate to high fishery potential, scheduling constraints should be indicated. If scheduling constraints are not considered important at a particular culvert, it should be so indicated. For the design submission Mile 390 428, scheduling constraints have not been indicated for the culverts located at the following mileages: 392.0, 394.7, 406.4, 407.5 411.6 and 412.0.

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- Scheduling constraints are included in Division 1, Section 2, paragraph 3.3(a) of the draft specifications.
- (2) Special Treatment of Ditches
 - (a) Appropriate special ditch treatment and silt trapping devices should be shown for Mile 426.5, Stations
 1654 1659 and Station 1667 1689.
 - The areas referred to are not within the limits of this submission.
 - (b) There appears to be a contradiction between two tables in the Detail Design Data Report. Table on Page 49 shows several sections where the average slope exceeds 4% while table C - 1, appendix A indicates that gradients should not exceed 4% for any drainage course.
 - Table C 1, referred to above, has been deleted from appendix 'A' as it was considered that the limiting velocity table was more realistic.

IV. Soils

 (a) We wish to reiterate our concern that D.P.W. design teams allow for a general greater distribution and generally larger ice contents in fine-grade soils then reported by the consultants.

- Where sufficient geotechnical data is lacking the design team has assumed a generally greater ice content distribution than indicated by the available geotechnical information.
- (b) No geotechnical information has been provided for Mile 393 - 395. The geotechnical information previously collected in this area should be shown on the next design submission for this section.
- The area referred to is not within the limits of this submission.
- (c) Geotechnical information has not been collected for
 Mile 419 427 due to its closeness to the Wrigley area.
 Once the alignment in this area is approved for investigation, appropriate geotechnical information should be collected.
- Available soils information to Mile 425.4 is shown on the plans. Additional geotechnical data will be obtained during the winter of 1974-75.

V. Borrow Areas

- (1) Location of Pits
 - (a) The proposed borrow pit located at Mile 391 should
 be located so as not to encroach upon the stream
 banks and to avoid any disturbance to, or siltation

of, the stream.

The borrow pit referred to is not within the limits of this submission.

(2) Location of Borrow Area Access Roads

- (a) It is understood that the borrow pit at mile 406.1
 is not being used due to its high moisture content.
 However, should the pit be used consideration
 should be given to relocation of the access road
 as originally proposed on the Final Design for
 the Training Section Mile 399 410.9.
- The area referred to is not within the limits of this section.
- (b) The access road to the borrow pit at Mile 399 should be relocated or a culvert installed in the access road to accommodate fish migration.
- The access road referred to is not within the limits of this submission.

VI. Wildlife and Fish Resources

(a) As requested by our Letter of Direction dated January
 15, 1974 D.P.W. are to consult with the Canadian Wild Life Service and Fisheries Service and provide specific
 recommendations regarding limitations in construction

operation, practice and scheduling to protect fish and wildlife.

- Consultation between D.P.W. and representatives of
 D.O.E. have taken place for the design submission
 Mile 411.6 to Mile 425.4 and results of these consultations are reflected in the scheduling restriction
 included in the draft specifications.
- (b) It is requested that the detailed information on wildlife and fish resources gathered by your consultants be made available to the Canadian Wildlife Service and Fisheries and Marine Service respectively, to enable these agencies to adequately assess the data provided on the Environmental Data Sheets. Such information should include data regarding beaver. and water-fowl concentrations for evaluations of wildlife resources. For evaluation of fish resources, the information should include the number of visits to a site, dates, numbers of fish observed/caught, species and age.
- The environmental consultants have prepared 'Base Data Reports' which detail the information on which the Environmental Data Sheets are based. Copies of these reports have been provided to C.W.S. and Fisheries and Marine Services.

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- (c) At Mile 395.9 the Right-of-Way crosses a lake outlet near a presently active beaver dam. Disturbance of this dam should be avoided.
- The area referred to is not within the limits of this submission.
- (d) The preliminary design submission had identified trap lines extending along the CNT line and proposed highway near the Willowlake River. The final design submission now states "No anticipated trap line conflict. Main trapping area is far to the east of R.O.W. location". Please explain whether there are no anticipated trap line conflicts along this entire section or just at Mile 395 and if there are no anticipated conflicts, why change from the preliminary design assessment.
- The area referred to is not within the limits of this submission.

VII. Sensitive Areas

- (a) All disturbances of the ground surface and vegetation mat should be minimized. All travel along the C.N.T. line and the highway R.O.W. prior to construction should be kept to a minimum.
- The field engineers are well aware of the above direction.

(b) Concern is expressed that flow slides may occur in fine grained soils with high water content. In these areas special precautions or construction techniques may be necessary. The areas identified are:

> Mile 413-414 Stations 955-960 Stations 960-970 Mile 414-415 Station 1017+80 Station 1027+00 Mile 427-428 Stations 1704-1715

- The areas referred to above will receive particular attention during construction and special precautions taken and/or special construction techniques employed. Slope protection will be used if required.
- (c) Future Design Submissions are to identify sensitive areas which would be particularly vulnerable to clearing one year or more in advance of construction.
- This section, Mile 411.1 425.4, has already been cleared.

Sensitive areas which would be particularly vulnerable to clearing one year or more in advance are now being identified and excluded from right-of-way clearing activities by Hire North.

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VIII. Aesthetics

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Appropriate selective clearing and revegetation procedures will be carried out after roadbed construction, with appropriate field supervision required to supervise the integration of the highway into the surrounding landscape.

Borrow pits on eskers and drumlines should be located on the crest of the land forms or excavation carried out, to the extent possible, in such a manner as to maintain the natural land form shape.

- The above recommendations are accepted by D.P.W. and field construction engineers will be advised.

IX. Sequential Land Use of Construction Camp Sites

It is noted that the information requested by Recommendations 44 and 45 of our letter of direction dated December 10, 1973 has not been provided.

In this regard, recommended sites for maintenance depots should be developed in conjunction with Mr. John Hamilton. Camp sites identified as a result of discussions with the pipeline consortium for possible use in a pipeline construction program should be indicated on the design plans.

All other sites will be rehabilitated in accordance with directions to be given by field representatives of this Department.

- Designation of multi-use sites is to be based on recommendations of the Department of Indian Affairs and Northern Development Roadside Services Subgroup.
- X. <u>Willowlake River Crossing, Mile 393 399</u> The Willowlake River Crossing is not within the limits of this submission.

CHAPTER 3

DESIGN COMMENTS

- (1) The stream crossing at Mile 419.2 has been changed from a bridge to a bank of 6 - 60" culverts to reduce cost in view of recent increases in bridge costs. Details of the structure are shown on hydrologist's drawing 115-3-77.
 - (2) The two 36" culverts at Mile 424.8 have been designed to accomodate icing. The invert of the lower pipe will be set at stream bed and the upstream invert of the upper pipe at the same elevation as the crown of the lower culvert. Minimum pipe spacing will be 20 feet.

APPENDIX "A"

SPECIAL DITCH TREATMENT

Amended June, 1974

SPECIAL TREATMENT FOR DITCHES

Roadway and offtake ditches are often necessary elements in highway design and construction. These ditches require the removal of the vegetative cover from their respective areas, thus increasing the potential for scour erosion. This scour erosion in highway ditches is dependent upon numerous factors including discharge, channel gradient, sediment in water, soil characteristics such as grain size, density, organic binder, cementation and ice content. Some methods used in highway construction to control or prevent scour erosion are: blanketing the ditch floors with stable, free-draining granular materials, reducing the effective ditch gradient by constructing a series properly spaced ditch checks on the ditch floor and by diverting run-off water out of the ditch onto natural vegetation by using ditch blocks.

Design equations exist for open channel flow, which relate flow velocity to the gradient and cross-sectional configuration of the channel. The Manning formula, is such an equation and is commonly employed for open channel flow calculations. The formula is as follows:

 $V = (1.486/n) R^2/3 S^1/2 (1)$

- 1 -

where V=velocity of water, in feet per second
R=hydraulic radius (water area divided by
wetted perimeter)
S=slope of channel gradient, in feet per foot.
n=Coefficient of Roughness (Manning's "n")

One of the principles followed in designing the Mackenzie Highway was to avoid excavation in permafrost wherever and whenever possible. Therefore, the use of standard engineering texts for use in non-permafrost areas was considered applicable for deriving ditch lining and ditch check spacing charts for the Mackenzie Highway.

When cuts through ice-rich permafrost areas are unavoidable it is intended to sub cut and back fill with a sufficient depth of ice-free material, which would provide soil conditions similar to non permafrost areas.

The Handbook of Steel Drainage and Highway Construction Products, second Edition, 1971, lists limiting velocities for non erosion of channels. The following tabulated Manning's "n" and limiting velocities for the general soil types found on the Mackenzie Highway right-of-way are excerpts from this Handbook.

- 2 -

Material	Manning "n"	Velocity ft./sec. For Clear Water
Fine sand	.020	1.50
Silty sand	.020	1.75
Fine gravel	.020	2.50
Stiff clay	.025	3.75
Coarse gravel Well graded gravel	.025	4.00
Cobbles	.035	5.00

.025

TABLE 1

Using the limiting velocities as tabulated above and Manning's formula, discharge versus gradient curves were calculated for a twelve foot wide "B" type road ditch. (See figure 2).

Ditch Lining

Shale, hard pan

For a given soil type a curve in Figure 2 indicates the limiting discharge for a given gradient above which scour erosion may occur. Therefore, theoretically, by lining the ditch with an adequate depth of material selected higher in the graph scour erosion should be arrested or minimized.

Ditch Checks

As an alternate to ditch lining ditch checks, within their limits, would be adequate and possibly more economical in some areas for scour prevention.

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See Figure 7 of this report for a schematic explanation of ditch check theory.

Figures 3 to 6 inclusive of this report are recommended ditch check spacing charts calculated for discharges up to 20 c.f.s. over various soil types. The derivation of these ditch check spacing charts was based on the effective gradient required for non-erosion of a soil type at a given discharge.

Due to the physical limitations of the highway ditch depth the ditch check crest is one foot above the ditch floor. A forty-foot minimum spacing of ditch checks was considered to be reasonable for construction, maintenance and effectiveness.

Discharge Determination

The Rational formula developed in 1889 by sewage engineers is probably the most widely used formula for estimating discharges. The formula is:

Q = CiA.(2)

Q = discharge in c.f.s.

where

C = the run-off coefficient

i = the intensity of rainfall in inches per hour.

A = the drainage area in acres.

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This approach with the following modifications was considered to be an acceptable one for small drainage areas up to about one square mile.

Bolter, Parish, Trimble, consulting engineers, have in their publication, Hydrology Study and Design of Culverts, Mile 297 to Mile 345, Mackenzie Highway, November, 1972, developed a modified Rational formula for large drainage areas in the following form: $Q_i = 26.7 \text{ ARr} (100 - \text{L}) \text{ M} (3)$ where $Q_i = \text{maximum instantaneous discharge} - \text{c.f.s.}$

- A = drainage area square mile
- R = rainfall in 24 hours
- r = rainfall reduction factor
- L = percent water loss

where

M = conversion factor mean daily discharge to maximum instantaneous.

Rationalizing the variables in the above formula as they are effected in the Mackenzie Valley small drainage areas the following empirical formula was developed for estimating small drainage area discharges:

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- (a) ".584" is the resultant of 26.7, R, r, M and the conversion of square miles to acres $(\frac{1}{640})$
 - "R" 4 inches per 24 hours was considered a conservative estimate.
 - "r" 1.0 was used since no appreciable reduction can be expected in small drainage areas.
 - "M" a value of 3.5 was considered conservative for small drainage areas.
- (b) "C" run-off coefficient is similar to (100-L). Bolter, Parish, Trimble arrived at an "L" value of 75% for large drainage areas (550 acres and greater). The accepted run-off coefficient for concrete and pavement is 0.8 suggesting a water loss of 20%. It was considered conservative to use this 20% water loss for drainage areas of 45 acres and less. Joining these limits with a porabolic curve, expected water losses for intermediate drainage areas were interpolated and converted to the following run-off coefficients:

TABLE 2

Expected run-off coefficients for small drainage areas in the Mackenzie Highway

	Ac	cres		"C"
Up	to	45	·	0.80
Up	to	98	-	0.65
Up	to	222	-	0.50
Up	to	550	-	0.25

The selection of a particular type of ditch treatment or whether it is required will ultimately rest on the experience of the resident engineer.

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LIMITING CHANNEL GRADES FOR THE DESIGN OF "B" TYPE DITCHES



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DITCH CHECK SPACING

(DESIGN DISCHARGE - 3 CFS)



DITCH CHECK SPACING - FT.

DITCH CHECK SPACING

- 10 -

(DESIGN DISCHARGE - 5 CFS)



DITCH CHECK SPACING - FT.

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Figure 5

DITCH CHECK SPACING

(DESIGN DISCHARGE - 10 CFS)



DITCH CHECK SPACING - FT.

CONTIGUOUS DITCH GRADE - PERCENT

DITCH CHECK SPACING

(DESIGN DISCHARGE - 20 CFS)



DITCH CHECK SPACING - FT.

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The ditch checks will be constructed with non-erodible materials.

HYDROLOGY SUMMARY

APPENDIX "B"

1	L	ſ	I	т. Ж	l	1	1	(1	1	l	\$ 1	1	I)	1
								ТАВ	LE 1							

. CULVERT VELOCITIES

		1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 -	DESIGN	DISCHARGE	n a lang da lang na pang dan kanang dan kanan		FISH M	IGRATION DISC	CHARGE
		NORMAL DESIG	N	DESIGN DISC	CHARGE FOR F	ISH CULVERT	FIS	H MIGRATION	DESIGN
Creek Mileage	Inlet Velocity (f.p.s.)	Maximum Velocity Inside Culvert (f.p.s.)	Exit Velocity	Inlet Velocity (f.p.s.)	Maximum Velocity Inside Culvert	Exit Velocity	Inlet Velocity (f.p.s.)	Maximum Velocity Inside Culvert (f.p.s.)	Exit Velocity
411.9	-	-	-	4.5	4.5	4.4	2.1	2.1	1.6
412.8 🛆	-	-	-	12.5	15.7	12.5	8.1	10.2	4.3
418.4	- -	-	6.9 🖄 6.0 🖄	-	-	- -	- -	-	
419.24	2.6	2.7	2.7	-	-	-	-	-	-
422.7	-	-	-	11.9	14.5	9.5	7.6	8.8	3.1
424.3	8.4	11.4	5.5	х <u>–</u> 1	-	-	- -		-
						-		· · · · · ·	
			~						
A Neg Assu	lecting Effecturing Slope	cts of Baffle = 1%, L 58	es for 48" Di	a. C.M,P.	A A	Assuming S Assuming e	lope = 1% , each culvert	L 58' for 3 carries 50 c	6" Dia. C.M.F .f.s.

1

TABLE 2

HYDROLOGY SUMMARY

MILE 411.6 to MILE 425.4

MILE	411.9	412.8	418.4	419.2	422.7	424.3
Drainage Area (A) Total (sq. miles)	1.0	2.4	2.6	2.8	29.0	1.8
Qhwm (c.f.s.)	100	840 *	n/a	n/a	1450 **	125
Drainage Area (Ae) EFFECTIVE (sc. miles)	1.0	0.5	0.1	2.8	7.0	0.5
Relief (feet)	100	400	50	1900	1600	50
(100 - L) Water Retained for Runoff	0.19	0.21	0.19	0.28	0.26	0.19
Rainfall (inches in 24 hours)	3.5	3.5	3.5	3+5	3.5	3.5
M Ratio	4.20	4.50	5.20	4.05	3.73	4.5
Qe (c.f.s.)	75	4414	9	297	634	40
Drainage Area (Alc) LAKE CONTROL (sq.mi.)		0.8	2.5	-	22.0	1.3
Relief (fest)		600	600	-	1775	50
(100 - L)	-	0.22	0.22	а а а а а а а а а а а а а а а а а а а	0.27	0.19
Rainfall (Inches In 24 hours	-	3.5	3.5	_	3.5	3.5
Qlc (c.f.s.)	AND .	16	51	-	555	23
Drainage Area (Am) MUSKEG (sq. miles)].]	-	- ·	-	-
Qm (c.f.s.)		11		-	-	-
Q rational (c.f.s.) (Qe + Qlc + Qm)	75	71	60	297	1190	63
) design (c.f.s.)	100	840	60	300	1450	125

Backwater from Mackenzie River affects Highwater.
 May be high, assumed due to icing - used in design to be conservative.

TABLE 2

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HYDROLOGY SUMMARY

MILE 411.6 to MILE 425.4

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Part 2

MILE	424.8				
Drainage Area (A) Total (sq. miles)	0.4				
Qhwm (c.f.s.)	18				
Drainage Area (Ae) EFFECTIVE (sq. miles)	0.2				
Relief (feet)	50		ve and by		
(100 – L) Water Retained for Runoff	0.19				
Rainfall (inches in 24 hours)	3.5			*.	
M Ratio	4.9		n Antonio Antonio Antonio		9 3 3 4 4 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
Qe (c.f.s.)	16		ť		
Drainage Area (Alc) LAKE CONTROL (sq.mi.)	0.2	· ·			
Rollef (feet)	25				
(100 - L)	0.18	and the state of t			
Reinfall (inches in 24 hours	3.5				
Qlc (c.f.s.)	3				
Drainage Area (Am) MUSKEG (sq. miles)	 				new other and the second second
Qm (c.f.s.)	- '				4 1
Q rational (c.f.s.) (Qe + Qlc + Qm)	19				
Q design (c.f.s.)	20				

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