Appendix 13D.B Watercourse Crossing Report

13D.B.1 Introduction

13D.B.1.1 Project Overview

The Ekwan Pipeline Project (the project) will extend approximately 83 km from northeast BC, east into Alberta. The Project requires a total of eight watercourse crossings; all crossings will be constructed during frozen ground conditions. Of these crossings, the four named crossings are determined to have potential fisheries value and may be flowing during the construction period although these watercourses were all frozen to substrate during winter 2003 (refer to Figures 13D.B-1 to 13D.B-5 for a view of the named watercourse crossings).

13D.B.1.2 Plan Objectives

This Watercourse Crossing Report forms part of the Environmental Protection Plan (EPP) to be implemented during project construction and operation. The report is intended to provide a reference for Project Supervisors, Environmental Inspectors and Contractors, as well as regulatory and permitting agencies. Specifically, this report provides the following information:

- site-specific descriptions and construction plans for major watercourse crossings
- general approaches and mitigation measures to be implemented for Horizontal Direction Drills
- general approaches and mitigation measures to be implemented for trenched crossings
- general approaches and mitigation measures to be implemented for vehicle crossing structures

13D.B.1.3 Proposed Site-Specific Pipeline and Vehicle Crossing Methods

Table 13D.B-1 provides a summary of the proposed crossing procedures for the eight defined watercourses crossed by the proposed pipeline. In the following subsections, more details are provided for the four named crossings: Kyklo Creek, Townsoitoi Creek, Hay River and Little Hay River.

13D.B.1.3.1 Kyklo Creek

Kyklo Creek is a slow flowing, meandering watercourse with an active channel width of 17 to 22 m in the vicinity of the crossing, and gently to moderately sloping banks that average less than 2 m in height. Approaches to the banks are gently sloping into aspen-dominated mixedwood forest on both sides of the creek. Its banks and substrates are predominantly fines (sand). This creek supports negligible to low flows (< 1 m^3/sec) in the winter.

Table 13D.B-1 Proposed Watercourse Crossing Methods

K.P.	Stream Name	Vehicle Crossing Method	Proposed Pipeline Crossing Method	Alternate Crossing Method
20.9	Kyklo Creek	Snow and ice fill bridge	Directional drill	Isolated trenched crossing if free water present; Trenched crossing without isolation if frozen to substrates[2]
35.4	Unnamed tributary to Kotcho River	Snow and ice fill bridge	Isolated trenched crossing if free water present[1]	Trenched crossing without isolation if frozen to substrates
46.6	Townsoitoi Creek	Snow and ice fill bridge	Directional drill	Isolated trenched crossing if free water present; Trenched crossing without isolation if frozen to substrates[2]
47.7	Unnamed tributary to Townsoitoi Creek	Snow and ice fill bridge	Isolated trenched crossing if free water present[1]	Trenched crossing without isolation if frozen to substrates
48.9	Unnamed tributary to Townsoitoi Creek	Snow and ice fill bridge	Isolated trenched crossing if free water present[1]	Trenched crossing without isolation if frozen to substrates
54.1	Hay River	Temporary bridge – double span	Directional drill	Isolated trenched crossing if free water present; Trenched crossing without isolation if frozen to substrates[2]
55.7	Unnamed tributary to Hay River	Snow and ice fill bridge	Isolated trenched crossing if free water present[1]	Trenched crossing without isolation if frozen to substrates
78.3	Little Hay River	Snow and ice fill bridge	Directional drill	Isolated trenched crossing if free water present; Trenched crossing without isolation if frozen to substrates[2]

Notes:

1. Isolated open cut crossings will incorporate either a dam and pump bypass or a dam and flume bypass.
2. Only to be used in event of failed HDD

A horizontal directional drill is proposed for the crossing. Drill entry and exit points will be located in flat, moderately drained, aspen dominated mixedwood stands, approximately 149 m southeast and 134 m northwest of the channel (see Figure 13D.B-1).

An eight m-wide access trail and associated ice bridge will run between the entry and exit points of the drill. The alignment of the access trail will fall slightly to the southwest of the drill path to take advantage of a narrowing of the channel and gently sloping approach slopes that will require limited grading (see Figure 13D.B-2). The ice bridge will be constructed of clean snow salvaged from surface of the frozen channel, using a wide pad, low ground pressure dozers, and frozen in with water applications. If free water is available beneath the ice, the creek may be used as a source of water for the ice bridge. If not, water will be trucked to the site. Bridge construction will be completed in 1 to 2 days.

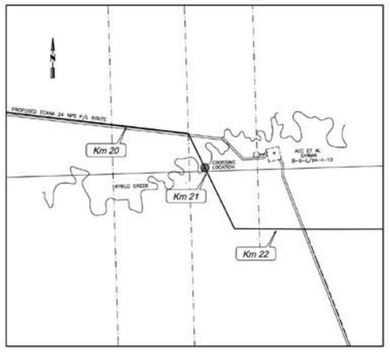
Restoration of the access trail within 20 m of the channel (i.e., approximate riparian zone) will involve the installation of one or two surface diversion berms across the access trail to prevent run-off from snowmelt or precipitation events from entering the creek. Shrub plantings or bundles using local on-site shrub species will be incorporated into the berms to provide long term stability and cover. The ice bridge will be notched in one or two locations at the time of clean-up to prevent ice jams in the watercourse during break-up.

13D.B.1.3.2 Townsoitoi Creek

Townsoitoi Creek is a slow flowing, meandering watercourse with an active channel width of less than 15 m in the vicinity of the crossing, and low bank structure. Approaches to the banks are flat on the west side of the creek, and gently sloping into spruce forest on the east side of the creek. Its banks and substrates are predominantly fines (sand). This creek supports negligible to low flows (< 1 m^3/sec) in the winter.

A horizontal directional drill is proposed for the crossing (see Figure 13D.B-3). The drill path has been shifted to the north of a seismic line that is generally followed by the ROW through this area to provide drier, better drained land for the drill set-up area. Drill entry and exit points will be located in flat, moderately drained, spruce dominated mixedwood stands, approximately 157 m northwest and 143 m southeast of the channel.

An eight m-wide access trail and associated ice bridge will run along the existing seismic line to provide access to the entry and exit points of the drill (see Figure 13D.B-4). The alignment of the access trail will take advantage of the gently sloping approach slopes to the creek that will require limited grading (see Figure 13D.B-2). The ice bridge will be constructed of clean snow salvaged from surface of the frozen channel or adjacent upland areas, using a wide pad, low ground pressure dozers, and frozen in with water applications. If free water is available beneath the ice, the creek may be used as a source of water for the ice bridge. If not, water will be trucked to the site. Bridge construction will be completed in 1 to 2 days.



LOCATION PLAN

SCALE 1 : 20000

B.C.G.S. 94I 067

CL RIVER FACING SW ALONG RIVER

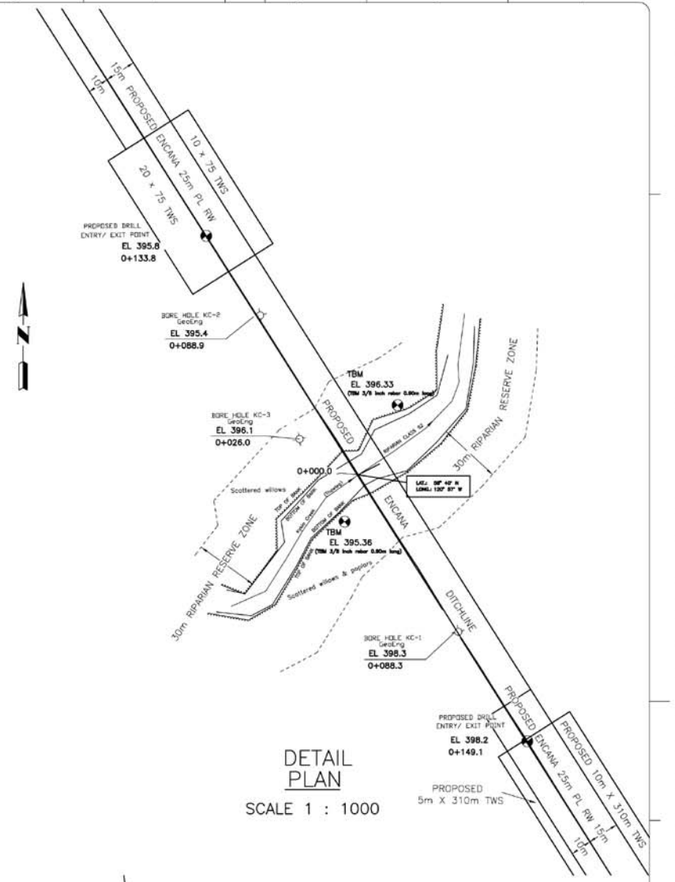
CL RIVER FACING NE ALONG RIVER

CL RIVER FACING SE ALONG DITCHLINE

CL CREEK FACING NW ALONG DITCHLINE

NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
2. PIPELINE CROSSING IS DESIGNED IN ACCORDANCE WITH CSA Z662-99.
3. MEDIUM CARRIED: SWEET NATURAL GAS.
4. MAXIMUM OPERATING PRESSURE: 9930 kPa.
5. LINE PIPE SPECIFICATION: NPS 24 X 7.9mm W.T., GR.483, CAT.II, -5°C, CSA Z245.1.
6. HEAVY WALL PIPE : 406.4 mm O.D. x 7.1 mm W.T., GR.414, CAT.II, NGTL SPEC. CSA Z245.1.
7. CORROSION TREATMENT: 30 MIL DUAL POWDER EPOXY ON HEAVY WALL AND FUSION BOND EPOXY COATING Z245.20 ON LINE PIPE.
8. CATHODIC PROTECTION: YES.
9. CONTRACTOR SHALL TAKE ADEQUATE MEASURES TO ENSURE THE SAFETY AND INTEGRITY OF EXISTING HOT LINES.
10. FOR ALL OTHER PERTINENT SPECIFICATIONS, REFER TO CONTRACT DOCUMENTS.

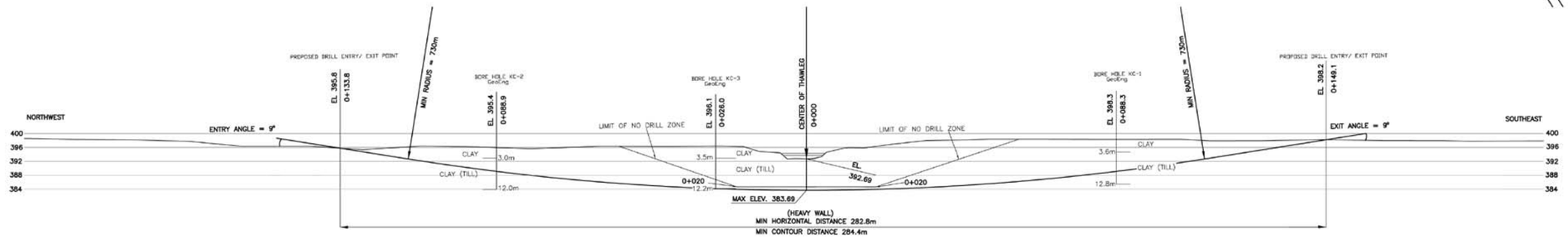


DETAIL PLAN

SCALE 1 : 1000

PROFILE ALONG THALWEG OF KYKLO CREEK

HORZ. 1 : 500
VERT. 1 : 500



DITCH LINE PROFILE FOR PROPOSED ENCANA P/L R/W

HORZ. 1 : 500
VERT. 1 : 500

REFERENCE DRAWINGS

DRAWING No	TITLE
391103053KYKLO	CROSSING KYKLO CREEK STA. 20+800 (DIRECTIONAL DRILL)

REVISION

REV No	DATE	DESCRIPTION
	Feb 24/03	Preliminary

APPROVAL

PROJECT CODE	DRAFTER	DRAFTING CHECKER	DESIGNER	DESIGN CHECKER	PROJECT MANAGER	COMPANY
	SD	SD	LT		RW	WLSL

PROFESSIONAL ENGINEER/RPT

PERMIT/ ENG. APPROVAL

DATE

REV. NO. | DATE | PERMIT NUMBER:

ENCANA

EKWAN PIPELINE

Proposed HDD Crossing of Kyklo Creek

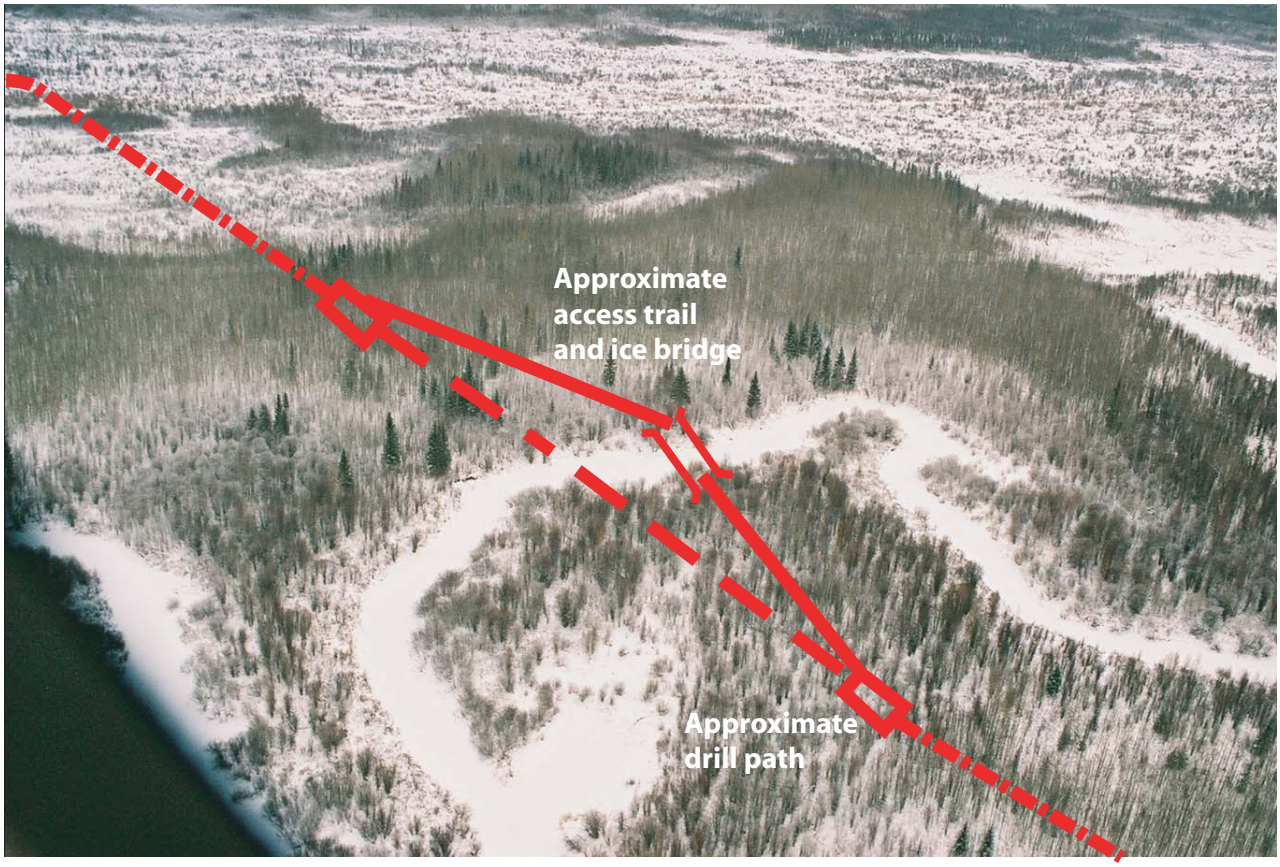
SCALE AS SHOWN | DRAWING No 13D.B-1 | REV 00

TIME DESIGN FILE

T8_BOR_B1.DWG 663X946

CADD DRAWING: DO NOT MAKE MANUAL REVISIONS

Active Channel Width	17-22 m
Bank Structure	Gently to moderately sloping banks that average less than 2 m in height; gentle approach slopes beyond banks
Substrate/Bank Materials	Fines (sand)
Instream Habitat Type	Run with no instream cover
Anticipated Winter Flow Rates	Negligible to < 1 m^3/sec



View looking south

LEGEND

- Access trail
- HDD path
- Cleared RoW
- Approximate location of HDD entry/exit point
- Ice/snow bridge span

EKWAN PIPELINE PROJECT

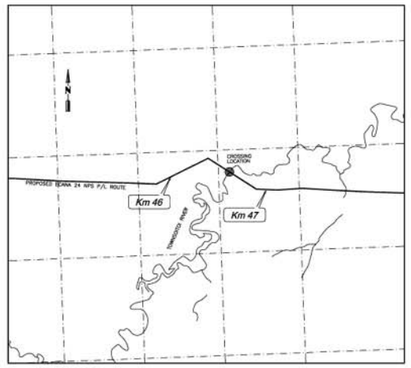
Kyklo Creek Crossing

Acknowledgements:
Original drawings prepared by AMEC Earth and Environmental

ENCANA

AXYS | Environmental Consulting Ltd

DRAFT DATE: February 28, 2003			SCALE: N/A	
REVISION DATE: March 10, 2003			PROJECT: POG1045	FIGURE NO.: 13D.B-2
DRAWN: L.A.T.	CHECKED: R.E.	APPROVED:	VOL:	



LOCATION PLAN

SCALE 1 : 20000
B.C.G.S. 94I 067

CL CREEK FACING UPSTREAM

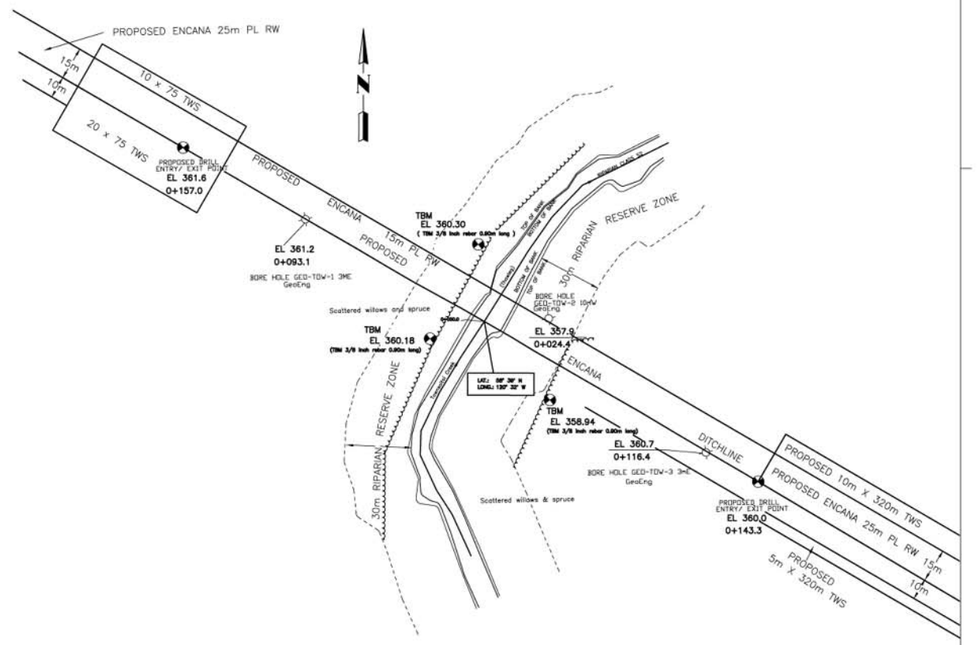
CL CREEK FACING NW TO DITCHLINE

CL CREEK FACING NW TO DITCHLINE

CL CREEK FACING DOWNSTREAM

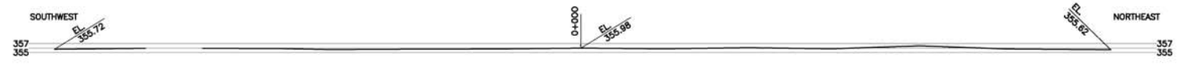
NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
2. PIPELINE CROSSING IS DESIGNED IN ACCORDANCE WITH CSA Z662-99.
3. MEDIUM CARRIED: SWEET NATURAL GAS.
4. MAXIMUM OPERATING PRESSURE: 9930 kPa.
5. LINE PIPE SPECIFICATION: NPS 24 X 7.9mm W.T., GR.483, CAT.II, -5°C, CSA Z245.1.
6. HEAVY WALL PIPE : 406.4 mm O.D. x 7.1 mm W.T., GR.414, CAT.II, NGTL SPEC. CSA Z245.1.
7. CORROSION TREATMENT: 30 MIL DUAL POWDER EPOXY ON HEAVY WALL AND FUSION BOND EPOXY COATING Z245.20 ON LINE PIPE.
8. CATHODIC PROTECTION: YES.
9. CONTRACTOR SHALL TAKE ADEQUATE MEASURES TO ENSURE THE SAFETY AND INTEGRITY OF EXISTING HOT LINES.
10. FOR ALL OTHER PERTINENT SPECIFICATIONS, REFER TO CONTRACT DOCUMENTS.



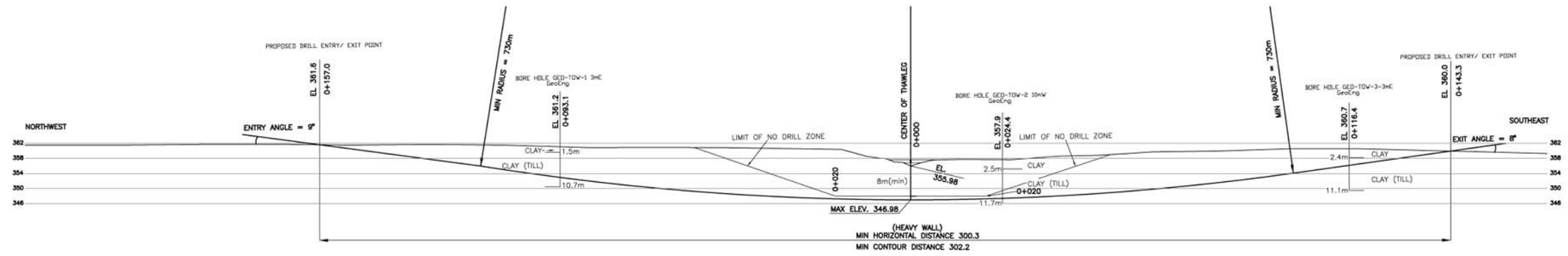
DETAIL PLAN

SCALE 1 : 1000



PROFILE ALONG THALWEG OF TOWNSOITOI CREEK

HORZ. 1 : 500
VERT. 1 : 500



DITCH LINE PROFILE FOR PROPOSED ENCANA P/L R/W

HORZ. 1 : 500
VERT. 1 : 500

REFERENCE DRAWINGS	
DRAWING No	TITLE
391103053TOWNSOI	CROSSING TOWNSOITOI CREEK STA. 46+500 (DIRECTIONAL DRILL)

REVISION		
REV No	DATE	DESCRIPTION
	Feb 24/03	Preliminary

APPROVAL						
PROJECT CODE	DRAFTER	DRAFTING CHECKER	DESIGNER	DESIGN CHECKER	PROJECT MANAGER	COMPANY
	SD	SD	LT		RW	MLSL

PROFESSIONAL ENGINEER/RPT | PERMIT/ ENG. APPROVAL | DATE

REV. NO. | DATE | PERMIT NUMBER:

CADD DRAWING: DO NOT MAKE MANUAL REVISIONS

ENCANA

EKWAN PIPELINE

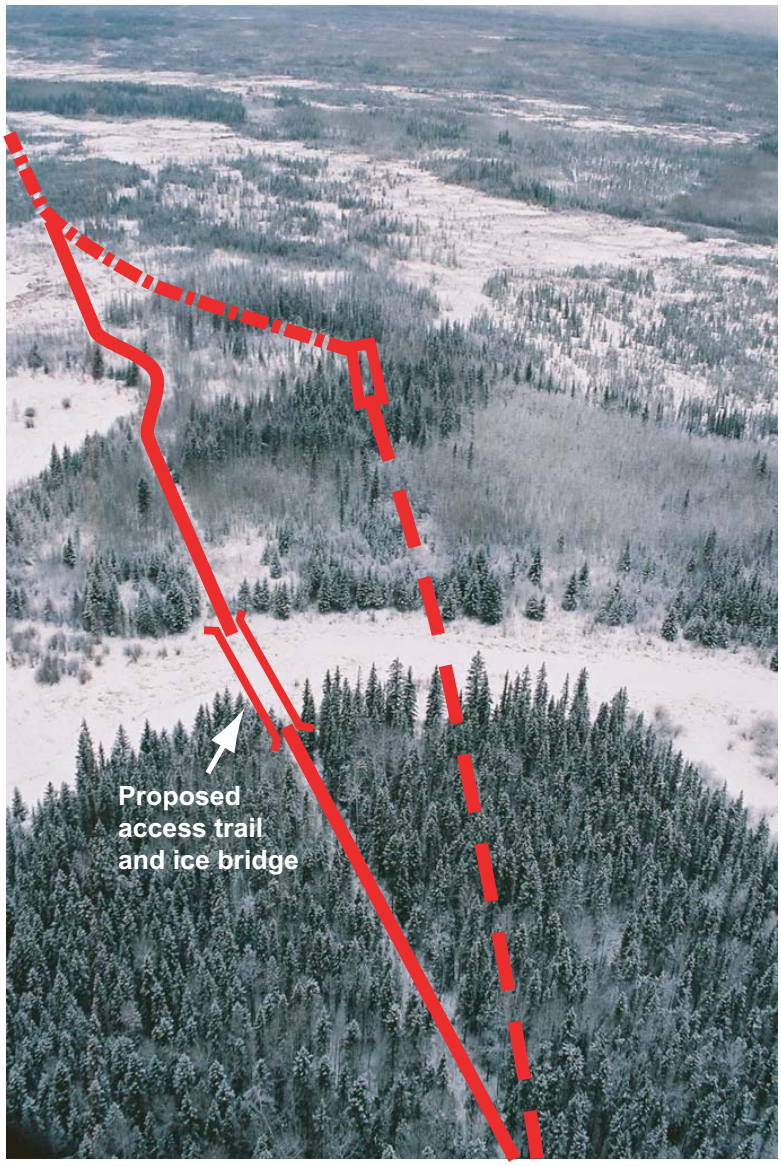
Proposed HDD Crossing of Townsoitoi Creek

SCALE AS SHOWN | DRAWING No 13D.B-3 | REV 00

TB_BOR_BI.DWG 663X940

TIME DESIGN FILE

Active Channel Width	<15 m
Bank Structure	Gently to moderately sloping banks that average less than 2 m in height; flat approaches to bank on west side, gentle approach to bank on east side
Substrate/Bank Materials	Fines (sand)
Instream Habitat Type	Run with no instream cover
Anticipated Winter Flow Rates	Negligible to < 1 m^3/sec



LEGEND

- Access trail
- HDD path
- Cleared RoW
- Approximate location of HDD entry/exit point
- Bridge span

View looking west/northwest

EKWAN PIPELINE PROJECT

Townsoitoi Creek Crossing

Acknowledgements:
Original drawings prepared by AMEC Earth and Environmental

ENCANA

AXYS | Environmental Consulting Ltd

DRAFT DATE: February 28, 2003			SCALE: N/A	
REVISION DATE: March 10, 2003			PROJECT: POG1045	FIGURE NO.
DRAWN: L.A.T.	CHECKED: R.E.	APPROVED:	VOL:	13D.B-4

On the west side of the channel, restoration of the access trail within 20 m of the channel (i.e., approximate riparian zone) will involve seeding of the trail with the approved reclamation mix for mineral soils. On the gentle slopes on the east side of the channel, restoration may involve the installation of one or two surface diversion berms across the access trail to prevent run-off from snowmelt or precipitation events from entering the creek (at the discretion of the Environmental Inspectors). If berms are installed, shrub plantings or bundles using local on-site shrub species will be incorporated into the berms to provide long term stability and cover. The ice bridge will be notched in one or two locations at the time of clean-up to prevent ice jams in the watercourse during break-up.

13D.B.1.3.3 Hay River

The Hay River is a slow flowing, meandering watercourse with an active channel width of approximately 45 to 50 m in the vicinity of the crossing, and 5 m-high steeply sloping bank structure. Approaches to the banks are flat on both sides of the river. Its banks and substrates are predominantly fines (sand). This river supports negligible to low flows (< 2 m^3/sec) in the winter. During low fall and winter flows, large sand bars are regularly exposed from the center of the channel to the west bank.

A horizontal directional drill is proposed for the crossing (see Figure 13D.B-5). The drill path generally follows an east-west trending seismic line that is generally followed by the ROW through this area. Drill entry and exit points will be located in flat, well drained, spruce and balsam poplar dominated mixedwood stands, approximately 159 m west and 127 m east of the channel.

An eight m-wide access trail and associated double span bridge will run between the entry and exit points of the drill. The alignment of the access trail will fall slightly to the north of the seismic line and drill path to approach the river at right angles to shorten the required span length (see Figure 13D.B-6). The bridge crossing structure will incorporate two 30 m long temporary bridge spans (prefabricated bridges with guard rails and 5 m of travel room) supported in the center of the river channel on temporary pilings resting on drilling mats on the exposed mid-channel sand bar within the Hay River (see Figure 13D.B-7). The pilings will likely be concrete lock blocks placed on drilling mats for easy retrieval.

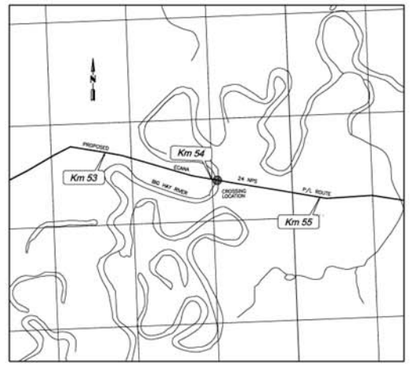
A tracked hoe will be required within the active (although frozen) channel to install the support pilings and to assist with the placement of the spans. The hoe will be “walked” down the riverbank at the bridge site without significant bank grading to minimize bank disturbance. The hoe will be used to level the sand bar as required to provide a safe, flat footing for mats and pilings. Once the pilings are in place, the bridge spans would be installed, one from either bank. The hoe would be used to support and elevate one end of each bridge span as it is pushed towards the pilings, and to direct the span onto the pilings. It is anticipated that the installation of the bridge structure would take 48 hours to complete with 4 to 6 hours of in-channel activity required for the piling and bridge span placement.

WEST BANK ON DITCHLINE FACING SOUTHEAST

EAST BANK ON DITCHLINE FACING NORTH

NOTES:

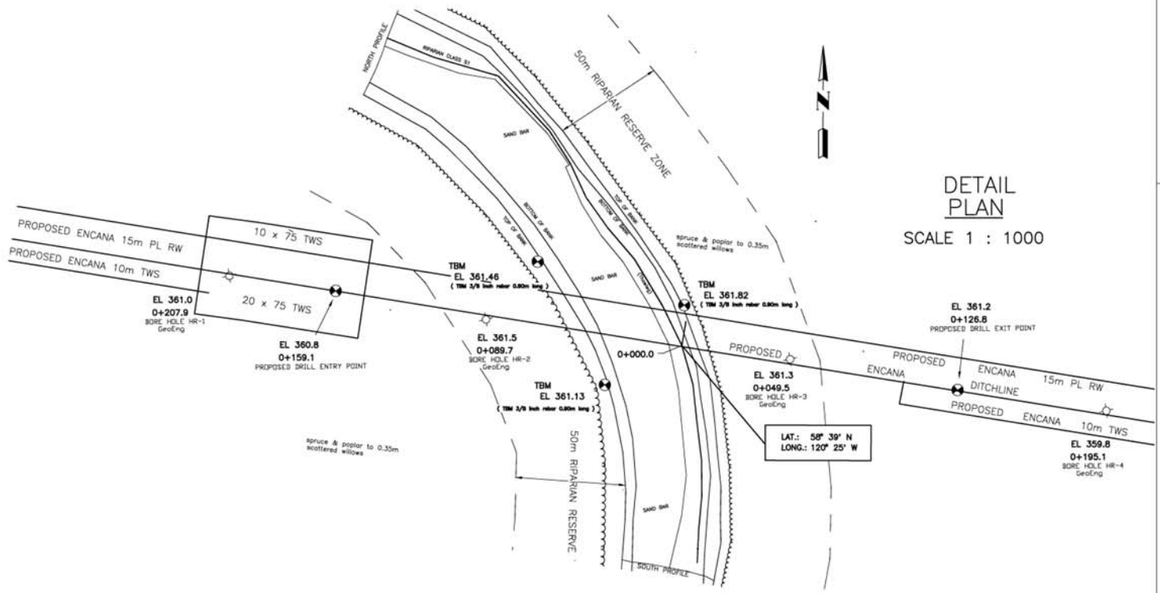
1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
2. PIPELINE CROSSING IS DESIGNED IN ACCORDANCE WITH CSA Z662-99.
3. MEDIUM CARRIED: SWEET NATURAL GAS.
4. MAXIMUM OPERATING PRESSURE: 9930 kPa.
5. LINE PIPE SPECIFICATION: NPS 24 X 7.9mm W.T., GR.483, CAT.II, -5°C, CSA Z245.1.
6. HEAVY WALL PIPE : 406.4 mm O.D. x 7.1 mm W.T., GR.414, CAT.II, NGTL SPEC. CSA Z245.1.
7. CORROSION TREATMENT: 30 MIL DUAL POWDER EPOXY ON HEAVY WALL AND FUSION BOND EPOXY COATING Z245.20 ON LINE PIPE.
8. CATHODIC PROTECTION: YES.
9. CONTRACTOR SHALL TAKE ADEQUATE MEASURES TO ENSURE THE SAFETY AND INTEGRITY OF EXISTING HOT LINES.
10. FOR ALL OTHER PERTINENT SPECIFICATIONS, REFER TO CONTRACT DOCUMENTS.



LOCATION PLAN

SCALE 1 : 20000

B.C.G.S. 94I 068

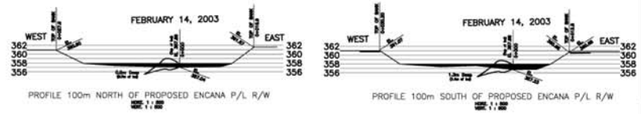


DETAIL PLAN

SCALE 1 : 1000

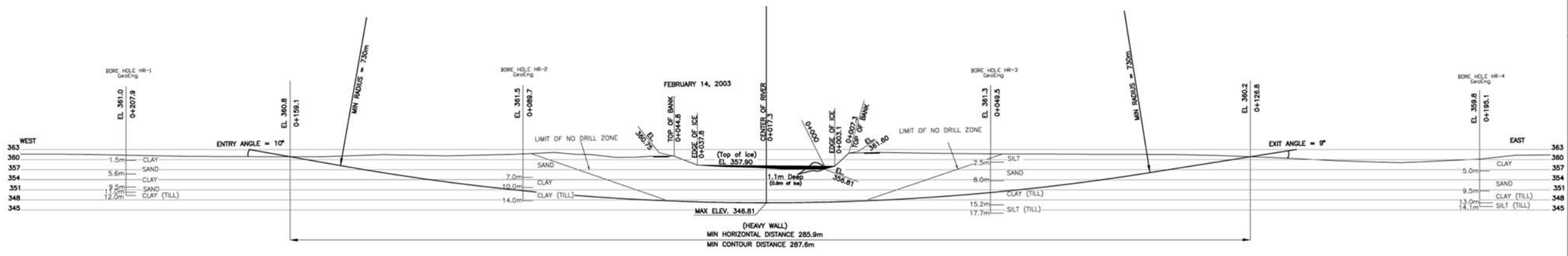
PROFILE ALONG THALWEG OF HAY RIVER

HORZ. 1 : 500
VERT. 1 : 500



PROFILE 100m NORTH OF PROPOSED ENCANA P/L R/W

PROFILE 100m SOUTH OF PROPOSED ENCANA P/L R/W



DITCHLINE PROFILE FOR PROPOSED ENCANA P/L R/W

HORZ. 1 : 500
VERT. 1 : 500

REFERENCE DRAWINGS	
DRAWING No	TITLE
391103053HAY	CROSSING HAY RIVER STA. 54+100 (DIRECTIONAL DRILL)

REVISION		
REV No	DATE	DESCRIPTION
	Feb. 24/03	Preliminary

APPROVAL						
PROJECT CODE	DRAFTER	DRAFTING CHECKER	DESIGNER	DESIGN CHECKER	PROJECT MANAGER	COMPANY
	SD	SD	LT		RW	MLSL

PROFESSIONAL ENGINEER/RPT	PERMIT/ ENG. APPROVAL
	DATE
REV. NO. / DATE / PERMIT NUMBER:	

ENCANA

EKWAN PIPELINE

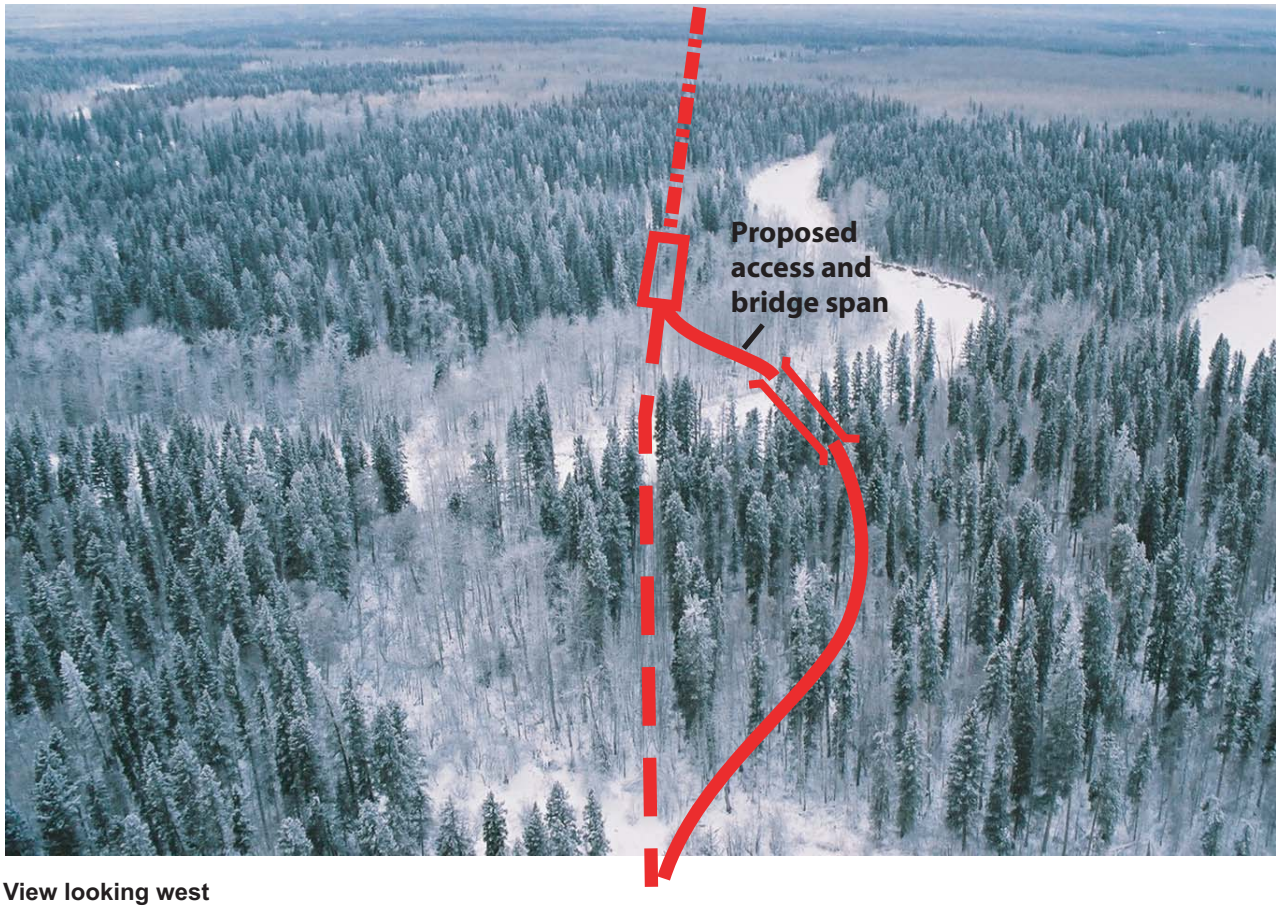
Proposed HDD Crossing of Hay River

SCALE AS SHOWN | DRAWING No 13D.B-5 | REV 00

TB_BOR_BLDWG 663X940

CADD DRAWING: DO NOT MAKE MANUAL REVISIONS

Active Channel Width	45-50 m
Bank Structure	5 m-high steep banks; flat approaches to banks on both east and west sides
Substrate/Bank Materials	Fines (sand)
Instream Habitat Type	Run with no instream cover
Anticipated Winter Flow Rates	Negligible to < 2 m^3/sec



View looking west

LEGEND

- Access trail
- HDD path
- Cleared RoW
- Approximate location of HDD entry/exit point
- Bridge span

EKWAN PIPELINE PROJECT

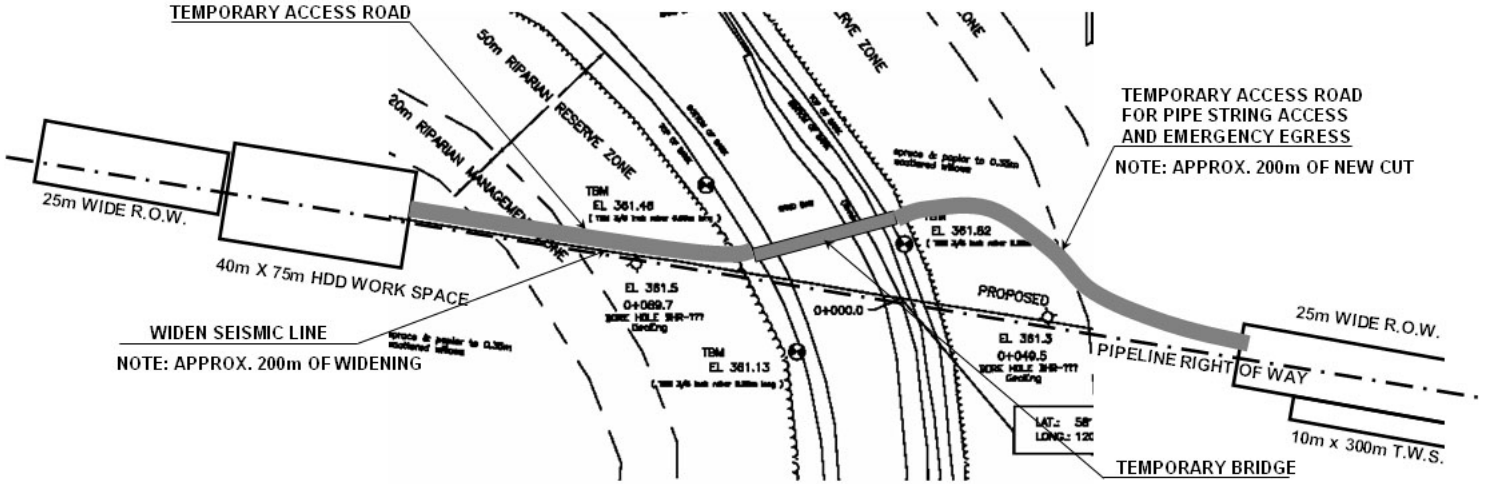
Hay River Crossing

Acknowledgements:
Original drawings prepared by AMEC Earth and Environmental

ENCANA

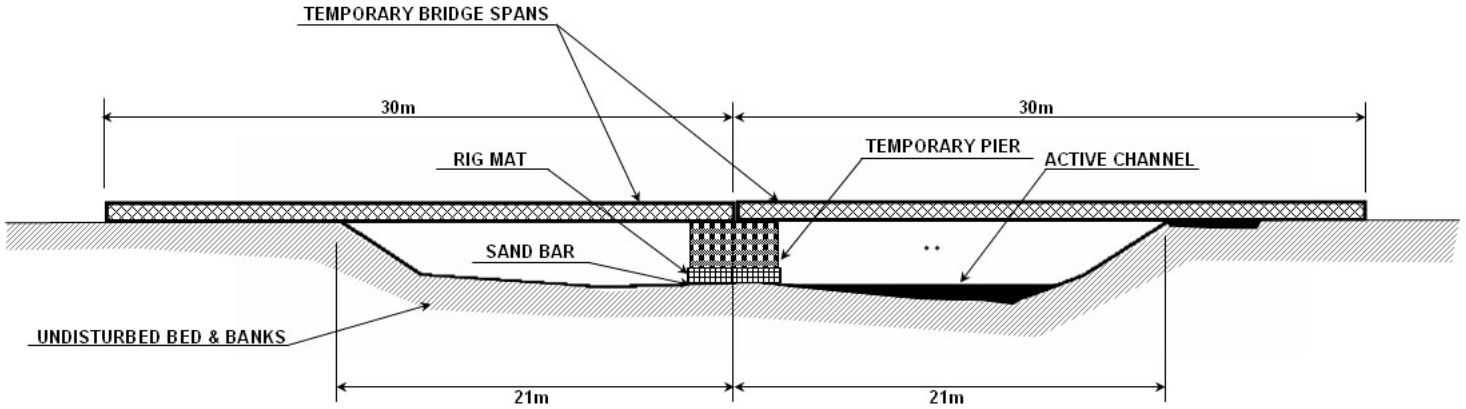
AXYS | Environmental Consulting Ltd

DRAFT DATE: February 28, 2003			SCALE: N/A	
REVISION DATE: March 10, 2003			PROJECT: POG1045	FIGURE NO.
DRAWN: L.A.T.	CHECKED: R.E.	APPROVED:	VOL:	13D.B-6



PLAN OF PROPOSED TEMPORARY BRIDGE

SCALE: 1:2000



PROFILE OF PROPOSED TEMPORARY BRIDGE

SCALE: 1:250

EKWAN PIPELINE PROJECT

Hay River Bridge Installation

Acknowledgements:
Original drawings prepared by AMEC Earth and Environmental

ENCANA

AXYS | Environmental Consulting Ltd

DRAFT DATE: February 28, 2003			SCALE: See above	
REVISION DATE: February 28, 2003			PROJECT: POG1045	FIGURE NO.: 13D.B-7
DRAWN: L.A.T.	CHECKED: M.M.	APPROVED:	VOL:	

Bridge removal at clean-up will require the use of a track hoe within the channel and large dozers on the access trail on either side of the channel. The hoe will lift the bridge sections off the piling and, in conjunction with the dozer, will shift each bridge span onto the access trail, where the span will be trucked away. The hoe may be required to level out the exposed sand bar and repair any damage to the channel banks prior to walking out of the channel).

Because of the flatness of the approaches to the river banks along the access trail, no special erosion control measures will be required as part of restoration of the riparian area disturbed by the trail or bridge installation on top of the banks. The approaches will be seeded to the approved reclamation mix for mineral soils encountered by the project. However, some bank recontouring and special reclamation measures will likely be required to repair damage to the bank caused by the exit of the hoe from the channel. At the discretion of the Environmental Inspectors, some shrub transplants using locally harvested species may be undertaken on the 5 m high banks to replace riparian shrub species and bank structure disturbed by the hoe.

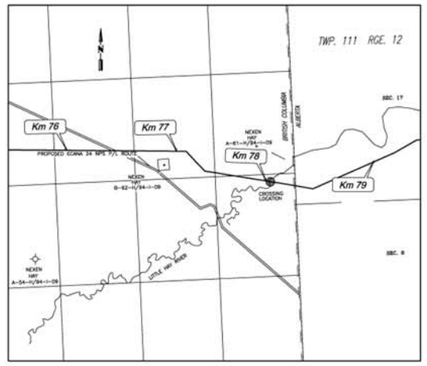
13D.B.1.3.4 Little Hay River

The Little Hay River is a slow flowing, meandering watercourse with an active channel width of approximately 15 m in the vicinity of the crossing, and gently to moderately sloping banks that average less than 2 m in height. Approaches to the banks are gently sloping into spruce-dominated mixedwood forest on both sides of the creek. Its banks and substrates are predominantly fines (sand). This creek supports negligible to low flows (< 1 m^3/sec) in the winter.

A horizontal directional drill is proposed for the crossing (see Figure 13D.B-8). The drill path has been shifted to the south of an existing winter road and seismic line that is generally followed by the ROW through this area to avoid conflicts with the river road and to shorten the drill path. Drill entry and exit points will be located in flat, moderately drained, spruce dominated mixedwood stands, approximately 129 m northwest and 136 m southeast of the channel.

An existing winter road and associated ice bridge will provide access to the entry/exit point of the drill on the west side of the river (see Figures 13D.B-9, 10). A new short access trail will be developed between the drill entry/exit point on the east side of the river and the east/west trending seismic line followed by the route into Alberta.

Because an existing winter road and ice bridge will be used to cross the Little Hay River, no special reclamation measures will be undertaken in association with the riparian area of the watercourse.



LOCATION PLAN

SCALE 1 : 20000

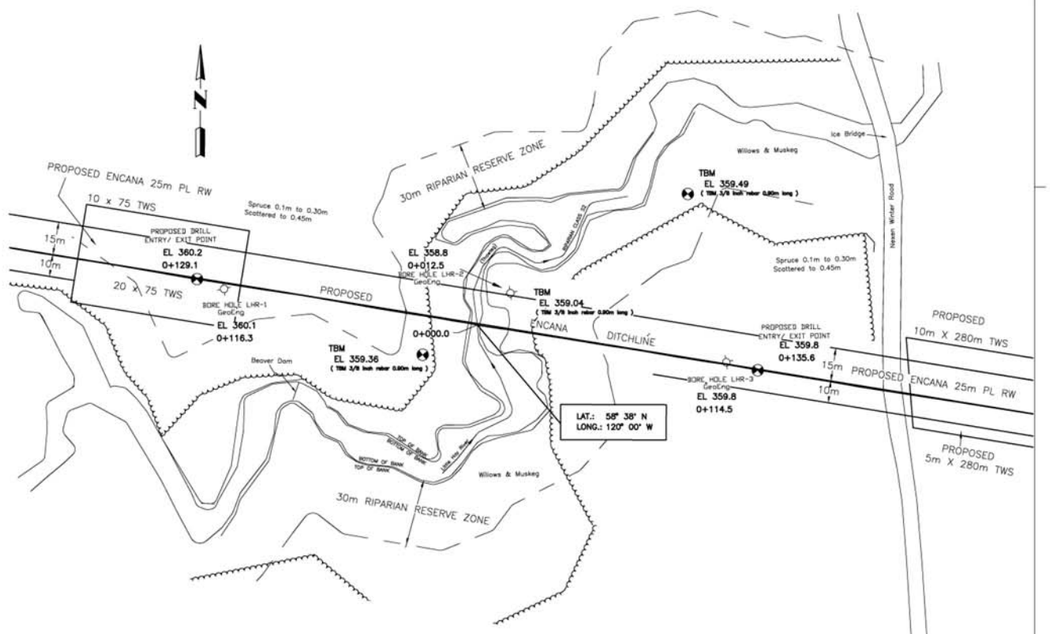
B.C.G.S. 94I 070

CL RIVER FACING WEST ALONG DITCHLINE

CL RIVER FACING EAST ALONG DITCHLINE

CL RIVER FACING UPSTREAM

CL RIVER FACING DOWNSTREAM

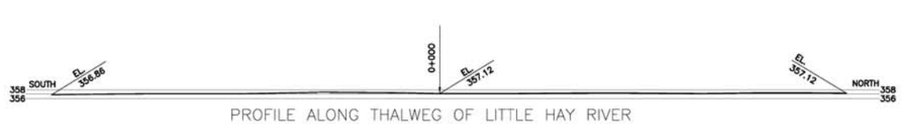


DETAIL PLAN

SCALE 1 : 1000

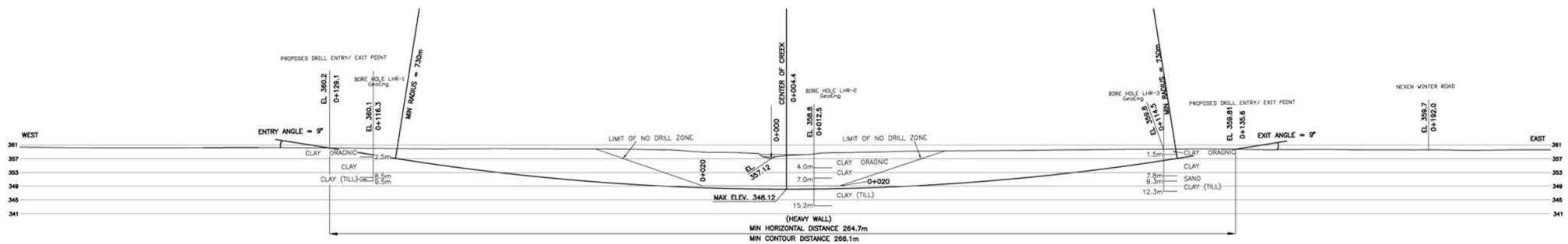
NOTES:

1. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
2. PIPELINE CROSSING IS DESIGNED IN ACCORDANCE WITH CSA Z662-99.
3. MEDIUM CARRIED: SWEET NATURAL GAS.
4. MAXIMUM OPERATING PRESSURE: 9930 kPa.
5. LINE PIPE SPECIFICATION: NPS 24 X 7.9mm W.T., GR.483, CAT.II, -9°C, CSA Z245.1.
6. HEAVY WALL PIPE : 406.4 mm O.D. x 7.1 mm W.T., GR.414, CAT.II, NGTL SPEC. CSA Z245.1.
7. CORROSION TREATMENT: 30 MIL DUAL POWDER EPOXY ON HEAVY WALL AND FUSION BOND EPOXY COATING Z245.20 ON LINE PIPE.
8. CATHODIC PROTECTION: YES.
9. CONTRACTOR SHALL TAKE ADEQUATE MEASURES TO ENSURE THE SAFETY AND INTEGRITY OF EXISTING HOT LINES.
10. FOR ALL OTHER PERTINENT SPECIFICATIONS, REFER TO CONTRACT DOCUMENTS.



PROFILE ALONG THALWEG OF LITTLE HAY RIVER

HORZ. 1 : 500
VERT. 1 : 500



DITCH LINE PROFILE FOR PROPOSED ENCANA P/L R/W

HORZ. 1 : 500
VERT. 1 : 500

REFERENCE DRAWINGS	
DRAWING No	TITLE
391103053JITLEHAY	CROSSING LITTLE HAY RIVER STA. 78+000 (DIRECTIONAL DRILL)

REVISION		
REV No	DATE	DESCRIPTION
	Feb 24/03	Preliminary

APPROVAL						
PROJECT CODE	DRAFTER	DRAFTING CHECKER	DESIGNER	DESIGN CHECKER	PROJECT MANAGER	COMPANY
	SD	SD	LT		RW	MLSL

PROFESSIONAL ENGINEER/RPT

PERMIT/ ENG. APPROVAL

DATE

REV. NO. | DATE | PERMIT NUMBER:

ENCANA

EKWAN PIPELINE

Proposed HDD Crossing of Little Hay River

SCALE AS SHOWN | DRAWING No 13D.B-8 | REV 00

TB_BOR_BLDWG 663X940

CADD DRAWING: DO NOT MAKE MANUAL REVISIONS

TIMC

DESIGNTITLE

Active Channel Width	15 m
Bank Structure	Gently to moderately sloping banks that average less than 2 m in height; gentle approach slopes beyond banks
Substrate/Bank Materials	Fines (sand)
Instream Habitat Type	Run with no instream cover
Anticipated Winter Flow Rates	Negligible to < 1 m^3/sec

View looking west/northwest

LEGEND

- Access trail
- HDD path
- Cleared RoW
- Approximate location of HDD entry/exit point
- Ice/snow bridge span

EKWAN PIPELINE PROJECT

Little Hay River Crossing

Acknowledgements:
Original drawings prepared by AMEC Earth and Environmental

ENCANA

AXYS | Environmental Consulting Ltd

DRAFT DATE: February 28, 2003			SCALE: N/A	
REVISION DATE: March 10, 2003			PROJECT: POG1045	FIGURE NO.: 13D.B-9
DRAWN: L.A.T.	CHECKED: R.E.	APPROVED:	VOL:	

Figure 13D.B-10 Existing Winter Road crossing on Little Hay River, Looking Northeast

13D.B.1.3.5 Unnamed Tributaries

The unnamed tributary to the Kotcho River, the two tributaries to Townsoitoi Creek, and the single tributary to the Hay River crossed by the proposed route are small drainages that have been heavily modified by beaver activity. All have limited bank structure, channel and banks dominated by fines, and flat approaches, and all are expected to be frozen to their substrates at the time of construction.

All of these drainages will be crossed with conventional trenching techniques. Should free water be present under the ice during construction, then isolation techniques would be employed. All will be equipped with ice bridges, constructed of clean snow salvaged from the surface of the frozen channel or adjacent upland areas, using a wide pad, low ground pressure dozers, and frozen in with water applications. If free water is available beneath the ice, the creek may be used as a source of water for the ice bridge. If not, water will be trucked to the site. Bridge construction will be completed in less than 1 day.

No special restoration measures are proposed for the crossings. The approaches will be seeded to the approved reclamation mix for mineral soils encountered by the project. The ice bridge will be notched in one or two locations at the time of clean-up to prevent ice jams in the watercourse during break-up.

13D.B.2 General Mitigation Measures for Crossings

13D.B.2.1 HDD Crossings

13D.B.2.1.1 Drilling Mud Specifications and Management

Drilling fluid employed at the proposed crossings will be made up primarily of water, bentonite, and native soil cuttings. Certain environmentally benign polymers and additives may be employed, depending on the actual subsurface conditions encountered.

13D.B.2.1.1.1 Mud Specifications

The specific additives to be employed are not known at this time because the directional drill contractor has not yet been selected. However, EnCana Ekwan will incorporate a requirement for the contractor to specify any additives to be used to drill and install the crossings. Drilling will not proceed until all necessary approvals for the use of these additives and their disposal are granted.

13D.B.2.1.1.2 Proposed Drilling Fluid Disposal Method

EnCana Ekwan will provide a drilling fluid dewatering and solid waste disposal plan to comply with all applicable permit requirements. The names of the environmentally benign polymers and additives used in the drilling mud will be provided to the regulatory authorities concerned before disposal.

EnCana Ekwan will locate an appropriate site, acquire all applicable permits and transport waste to the site. Drilling fluid wastes shall be managed and disposed of in accordance with all applicable guidelines and regulations.

13D.B.2.1.2 Loss of Circulation Contingency

13D.B.2.1.2.1 Fluid Loss Potential

With the four HDD crossings planned for the EnCana Ekwan, fractures in the hard clay (till) and beds of unconsolidated material, such as loose wet sand, can provide a conduit for drilling fluid, leading to loss of circulation. If connected to the surface, this could result in drilling mud introductions into the watercourse channels. All four crossings appear to possess a naturally consolidated clay mantle overlying the harder till layer, which tends to

reduce the potential for lost drilling fluid to circulate to the surface. However, even though the risk of such an occurrence is small, a contingency plan is outlined below.

13D.B.2.1.2.2 Contingency Plan

To ensure that the potential for an instream drilling mud release is minimized; or if it does occur, that negative environmental impacts are minimized, EnCana Ekwan will ensure that the Contractor has an instream drilling mud release contingency plan in place. The plan will include some or all of the following elements:

1. Install surface casing at the entry point to a depth that extends beyond the coarsest material, if warranted.
2. Ensure that drilling mud composition is limited to bentonite, fresh water and, if warranted, other inert additives.
3. Construct subsoil berm(s) or sump(s) downslope from the entry point and proposed exit point with a capacity adequate to capture anticipated volumes of drilling mud that could be release during pullback and other drilling operations.
4. Install surface casing at the exit point, after completion of the pilot hole if coarse-textured near-surface deposits could interfere with drilling mud circulation.
5. Develop a clean-up plan, prior to drilling. The plan will be prepared with the drill contractor in consultation with EnCana Ekwan inspection staff. Acquire the appropriate approvals to access the release area if off right-of-way and for mud pump-off.
6. Ensure that supervisory personnel are aware of the contingency plan and clean-up plan prior to commencement of drilling activity.
7. Certain equipment will be required onsite in sufficient quantities during drilling operations to contain any inadvertent drilling mud releases. This equipment may include sandbags, filter cloth (e.g., silt fence), t-bar posts, post pounders, straw bales, light towers, shovels, 6 mil polyethylene and 2 trash pumps c/w sufficient lengths of leak free hose and suction heads.
8. Maintain vacuum trucks onsite during pullback operations.
9. Maintain the appropriate water quality sampling equipment onsite during drilling operations to ensure that accurate water quality samples are taken. Onsite equipment to be required by EnCana Ekwan may include turbidity meters, sampling poles, chest waders, water sample bottles, ice augers, and coolers.
10. Ensure that the water quality sampling program is in place prior to drilling. The program will be amended if warranted by conditions (i.e., if the watercourse is dry or frozen to the substrate).The program will the following information:
    - sample locations (both an upstream control site as well as appropriate downstream sites)
    - frequency of sampling

- sampling procedures

13D.B.2.1.2.3 Monitoring

1. Supervisory personnel will be onsite at all times during drilling, reaming and pullback operations to ensure that emergency response measures will be implemented immediately and effectively. EnCana Ekwan will also assign inspection personnel to the site during all phases of drilling of the water body.
2. Monitor and record the amount of fluid return to the mud tank/pit and the amount of make up drilling fluid required in the mixing tanks during drilling of the pilot hole and hole opening (reaming).
3. Monitor both onshore and below channel portions of the drill path and surrounding area (i.e., within 200m minimum) for signs of drilling mud release. The size of the area to be monitored will be determined by evaluating geotechnical conditions (i.e., amount of fracturing, type and depth of substrate) and drilling conditions (i.e., depth of drill path, distance between watercourse and entry and exit points). Monitoring will be on a continual basis during drilling operations and will continue for at least 12 hours after shutdown. Ensure that contact is maintained at all times between monitoring and drilling personnel.
4. Establish monitoring stations at the following locations and obtain water samples for visual inspection at the noted intervals (Table 13D.B-2).
5. Increase the sampling frequency if monitoring of drilling mud returns indicate that a release may have occurred.

Table 13D.B-2 Sampling Locations and Intervals

Up and Downstream Monitoring Sample Sites (approximate distance in metres)	**Sampling Interval** (approximate length in hours)
25	2
100	2
200	4

13D.B.2.1.3 Crossing Abandonment Criteria

While arbitrary criteria, such as “make at least three attempts and then abandon” are both objective and quantitative, they are clearly not the most effective means of ensuring that HDD fulfils its mandate of minimizing environmental disturbance or damage, while providing a serviceable pipeline crossing. A logical decision making framework is needed, underpinned with the best information available at the time the decision must be made. The rationale for such a framework must balance the degree of the response to the severity of the problem.

As explained below, data quality improves throughout the pilot bore, reaming and pullback phases of each drill. During each of these three phases abandonment could be contemplated, as illustrated in the sections following Stratigraphy and Certainty.

13D.B.2.1.3.1 Stratigraphy and Certainty

Completing each of the four watercourse crossings in a timely fashion is to the advantage of all concerned. However, the greatest risk factor for any HDD is unpredictable soil behaviour. In order to manage this risk, EnCana Ekwan has commissioned a borehole investigation at each crossing, will design each crossing to optimize constructability with the subsurface conditions and will hire a competent contractor to install each crossing.

Although this approach is diligent, subsurface conditions pertinent to an HDD are never fully known in detail until after the crossing has been installed. Throughout investigation, design and construction, the state of knowledge of subsurface conditions advances significantly. Before the borehole investigation, stratigraphy underlying each site is based on remote data, such as air photos and regional geological maps and studies. After borehole sampling, the general stratigraphy might be more clearly identified, but is still not known with 100 percent certainty. At any juncture during the investigation-design-construction process, subsurface conditions, which may have initially appeared as generally benign, can turn out to possess undesirable details, which threaten the likely success of pipe pullback.

13D.B.2.1.3.2 Pilot Deviation Contingency Measures

Natural variations in stratigraphy encountered by the pilot bottom hole assembly (BHA) can interfere with steering accuracy. Occasional large boulders (which have been identified in the geotechnical report) can lead to pilot bore deviation. Layers of weak soil can also cause problems building angle with the pilot, resulting in the need to adjust pilot-hole specifications accordingly.

If the pilot bore encounters adverse stratigraphic conditions that interfere with steering accuracy, then the contractor, inspector and engineer will need to take the appropriate action to complete the crossing within the authorized pipeline alignment. Depending on the cause and severity of the problem, and its potential consequences to the environment and/or pipeline crossing, these actions could include:

- accepting the new drill path
- adjusting the depth of the borehole path so that the drill can avoid the problematic stratum
- pulling out, moving over and redrilling the pilot
- abandoning the pilot and employing an alternative crossing method

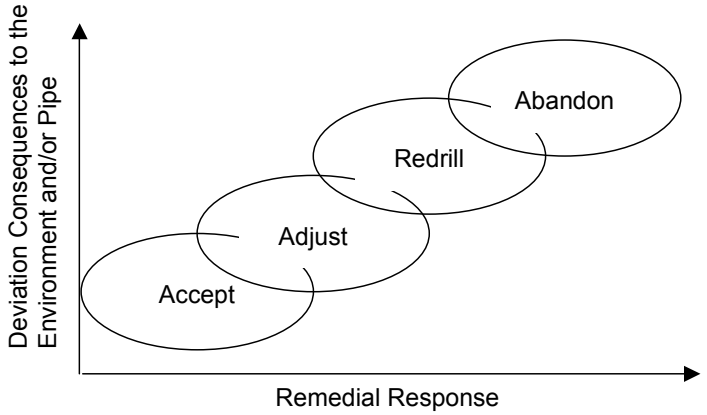


Figure 13D.B-11 Pilot Deviation Contingency Logic

13D.B.2.1.3.3 Circulation Loss Contingency Measures

Fluid loss to the surface has already been addressed in the context of monitoring and cleanup. This section addresses fluid loss in the context of remedial responses leading to abandonment. Loss of circulation can occur during any of the three phases of the drill. If loss of circulation is encountered during any crossing installation phase, then the contractor, inspector and engineer will need to assess the extent of fluid loss, determine its likely cause and take the best remedial action. These actions could include:

- deeming the fluid loss acceptable and continuing to drill/ream/pull
- stopping the operation, reestablishing circulation and restarting the operation
- abandoning the hole, moving over, and boring a new crossing path (redrill)
- abandoning the hole and employing an alternative crossing method (trench)

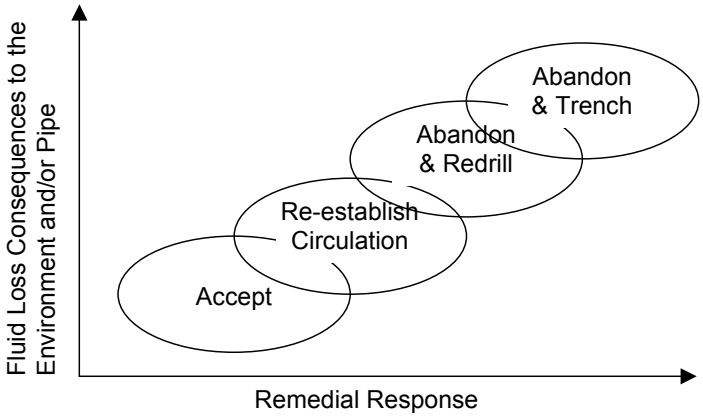


Figure 13D.B-12 Circulation Loss Contingency Logic

13D.B.2.1.3.4 Pipe Damage Contingency Measures

If severe pipe damage or collapse is experienced during the pipeline pull, then the contractor, inspector and engineer will need to take the appropriate action to complete the crossing within specifications. After assessing the damage, determining its likely cause and best remedial action, these actions could include:

- deeming the pipe damage acceptable
- removing the pipe from the bore, repairing or replacing the pipe, re-reaming the bore to the same or larger diameter and re-installing the pipe
- abandoning the pipe, moving over, and boring a new crossing path (redrill)
- abandoning the pipe and employing an alternative crossing method (trench)

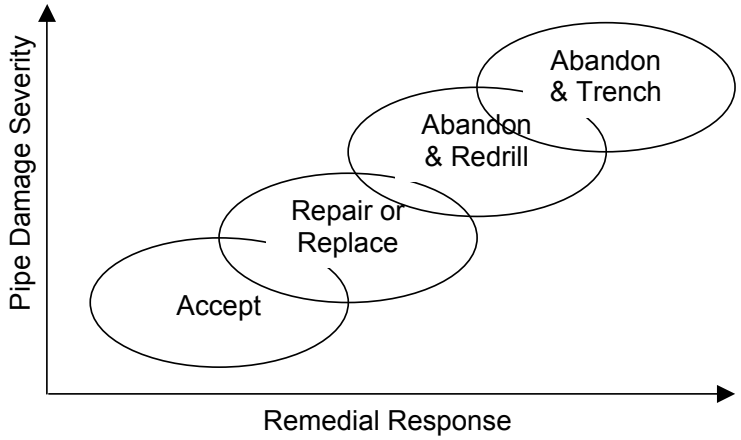


Figure 13D.B-13 Pipe Damage Contingency Logic

13D.B.3 Trenched Crossings

Trenched crossings (with isolation if flowing) will be used as primary crossing techniques on the tributary to Kotcho River, tributary to Hay River, and the two unnamed tributaries to Townsoitoi Creek. These techniques may also be used at the four named crossings as a contingency in the event of failure of the horizontal directional drill crossing. Most crossing can be completed within one day, with the exception of the Hay River (if HDD is unsuccessful) where excavation and installation may take two to three days.

13D.B.3.1 Methods

13D.B.3.1.1 Approach Slope and Bank Preparation

- at least 10 m of undisturbed vegetation will be left between the high water mark of the watercourse and any designated extra workspace. Where feasible, extra workspace will be located in existing natural openings to reduce clearing requirements. The buffer will also be retained during pipeline operations where the vegetation management activities will be restricted in the vicinity of a watercourse.
- any necessary grading of watercourse banks will be minimized wherever feasible and where necessary will be directed away from the active channel to minimize any potential for watercourse sediment loading
- within 10 m of the banks of watercrossings, root grubbing will be restricted to trenchline and approximately 6 m of workside to facilitate vehicle access and ice bridge installations
- burn areas will not be located within the high water perimeter of a watercourse. All partially burnt stumps and logs will be disposed of above the high water mark

13D.B.3.1.2 In-channel Activities

It is anticipated that most of the watercourses will be frozen to substrate and not flowing during construction. Any flows present are expected to be low (< 1 m3/sec), and easily managed with a dam and pump or dam and flume isolation technique:

- bank grading and pipe preparation and testing will be completed prior to commencement of crossing activities where flows are present
- temporary workspace will be acquired to construct containment sumps for ditch spoil storage and trench dewatering prior to beginning of crossing activities
- instream structures that provide cover for fish (i.e., large woody debris and boulders) will be removed from the anticipated area of disturbance before construction commences and replaced after construction is complete
- in frozen conditions, backhoes will work from both sides of the main channel of watercourses and ice will be broken and removed from over the ditchline for the length necessary for installation of a flume or dam and pump isolation. Care will be taken not to allow ice to flow downstream.
- the spring fisheries field program (see Section 13.8.1.3) will determine the presence of any spring spawning habitat on watercourses crossed by the pipeline. Should this habitat be found, actions will be taken to shift the final location of trenched crossings to avoid conflicts with such habitat.
- surface substrate material will be prepared as necessary for proper installation of the flume section or any dam installation. Cobble will also be removed and salvaged

from the area of excavation across the width of the channel. Salvaged substrate material will be stored at a temporary workspace location or on a dry watercourse channel location until cleanup.

- instream work will not begin until early morning following completion of all the above preparation activities
- during the crossing of a fish-bearing watercourse, the isolated area will be searched for stranded fish prior to the start of ditching. All fish captured will be released downstream from the work site.
- for a dam and pump installation, an upstream area will be prepared to allow installation of a dam structure (i.e., sheet piling, sand bags or potentially an aqua dam) for blocking flows that are to be pumped. A downstream dam will only be installed if it is needed to keep the isolated area dry.
- the upstream dam is to be located along the workside boundary edge to provide the largest amount of room for the installation of the pipe
- pumps of sufficient capacity will be installed as required to move watercourse flow past the area of isolation. Some streambed excavation may be required for adequate installation of the pumps. An energy dissipater, such as a perpendicular section of steel pipe, will be used on the downstream end prior to water entry into the main channel, where localized erosion is a potential concern.
- downstream ice will be removed in a amount to provide the water to flow back under the existing ice sheet and prevent ponding of water above the channel ice
- impervious dam materials to be used will be selected by the contractor in consultation with the Environmental Inspector and may include:
  - interlocking sheet piling driven into the surface substrate
  - metre bags and plastic sheeting
  - sand bags
  - aqua dams
- additional pumps (additional 100 percent capacity) shall be available at each flowing crossing as a contingency to assist in pump isolation or carry additional clean water over the trenchline from the upstream end of the installation
- hoes will work from both sides of the channel and trenching will begin immediately following isolation. Additional hoes and trucks may be used to facilitate spoil material handling and loading.
- if trench dewatering is required, water will be contained in sumps or pumped onto stable, well-vegetated areas (located in off-ROW areas) in a manner that does not cause erosion or allow any unfiltered water to re-enter the watercourse.

13D.B.3.1.3 Backfill

- backfilling will commence once the watercourse crossing section is in place and has been accepted by EnCana Ekwan
- backfilling will begin from the watercourse channel and proceed towards both banks
- ditch water trapped between the main channel and either bank will be pumped to settling ponds or onto stable well-vegetated areas or constructed sumps that will not allow direct flow back into the watercourse. Discharge areas shall be monitored to ensure no flooding, erosion or siltation of the main watercourse occurs.
- when all instream work activities are completed, the dam and bypass structure will be removed

13D.B.3.2 Water Quality Monitoring

Monitoring requirements for trenched crossings will be dependent on the findings of the fisheries surveys planned for this spring and flows encountered during construction. Based on preliminary investigations and the frozen conditions encountered this winter, it is probable that no monitoring will be required. However, if required, the major objectives of the monitoring program will be as follows:

- monitoring of suspended sediment levels in the vicinity of the watercourse crossings according to spatially (transects upstream and downstream) and temporally (sampling periods during each of the major construction events) stratified sampling regimes
- determination of the distance of downstream sediment travel with the downstream limit and termination of sampling established by existing provincial water quality guidelines (i.e., more than 25 mg/L from background levels for 24-h period or more than 5 mg/L for longer-term exposure)

13D.B.3.3 Contingency Planning/Shut-Down Criteria

The Environmental Inspectors have the responsibility for assuring effective execution of environmental design measures relating to crossing activities. Inspectors will have the authority to direct contractor personnel to mitigate any potential environmental impact. The Environmental Inspector has the authority to and will suspend operations where unacceptable situations with adverse environmental implications arise (e.g., where fish or fish habitat may be at risk).

13D.B.3.4 Channel and Bank Restoration

- As a minimum, contour grading, erosion control and surface stabilization will be undertaken at all watercourses and drainages. More detailed bank restoration

measures will be developed following detailed watercourse surveys in spring 2003. Potential bank reclamation measures could include the following methods:

- shrub transplants (i.e., in-tact sod transplants) from on-site areas into riparian zone
- incorporation of vegetation plugs or shrub facines (bundles) into surface diversion berms on approach slopes, using local on-site shrub species
- installation of geotextile rolls and brush layering at channel edge to reconstructed vertical bank structure

13D.B.3.5 Vehicle Access in the Vicinity of Streams

13D.B.3.5.1 Access Trails

All of the named watercourses (i.e., Kyklo Creek, Townsoitoi Creek , the Hay River and the Little Hay River) will require the development of access trails other than the ROW to accommodate vehicle traffic. Procedures to minimize the impacts of access development in the vicinity of watercourse crossings include:

- prior to the start of construction, the right-of-way boundaries, including pre-approved temporary workspace, will be clearly staked to prevent disturbance to unauthorized areas
- all merchantable trees and slash cleared from access trails developed at the named crossings will be salvaged and stockpiled for use as rollback during final clean-up
- nonmerchantable small diameter shrub stands encountered within riparian areas will be cleared mechanically, leaving the root mat intact. Where feasible, timber will be close-cut to reduce the need to grub and grade the right-of-way for smoothing. Root grubbing will be minimized wherever feasible along the entire access trail in order to maintain the root mat and improve surface stability.
- at the time of clean-up, the slash and the trees salvaged during clearing will be rolled back in an uncompacted fashion over the entire length of the access trail between the HDD exit and entry points and the watercourse channel

13D.B.3.5.2 Snow and Ice Bridges

- ice bridges will be constructed of clean snow salvaged from surface of the frozen channel or adjacent upland areas, using a wide pad, low ground pressure dozers, and frozen in with water applications.
- If free water is available beneath the ice, the creek may be used as a source of water for the ice bridge. If not, water will be trucked to the site.
- bridge construction will be completed in 1 to 2 days

- ice bridges will be notched in one or two locations at the time of clean-up to prevent ice jams in the watercourse during spring break-up

- at clean-up, the surface of the bridge will be scraped clean of mud or vegetative debris that may have been tracked onto the bridge during construction