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REPORT ON

REVIEW OF HISTORICAL FISHERIES INFORMATION FOR TRIBUTARIES OF THE ATHABASCA RIVER IN THE OIL SANDS REGION

Submitted to:

Regional Aquatics Monitoring Program (RAMP), Steering Committee

TABLE OF CONTENTS

SECTION **PAGE**

1 INTRODUCTION 1

2 STUDY AREA 2

3 OVERVIEW OF HISTORICAL INFORMATION 7
3.1 SOURCES OF INFORMATION 10

4 THE DATABASE 11

5 SUMMARY OF HISTORICAL INFORMATION BY TRIBUTARY WATERSHED 13
5.1 TRIBUTARY WATERSHED #1 – HORSE RIVER 14
5.1.1 Fish Community 14
5.1.2 Habitat 17
5.1.3 Habitat Use 18
5.1.4 Data Gaps 19
5.2 TRIBUTARY WATERSHED #2 – CLEARWATER RIVER 20
5.2.1 Fish Community 20
5.2.2 Habitat 22
5.2.3 Habitat Use 24
5.2.4 Data Gaps 25
5.3 TRIBUTARY WATERSHED #3 – CONN CREEK 25
5.3.1 Fish Community 25
5.3.2 Habitat 25
5.3.3 Habitat Use 27
5.3.4 Data Gaps 27
5.4 TRIBUTARY WATERSHED #4 – UNNAMED WATERCOURSE 27
5.4.1 Fish Community 27
5.4.2 Habitat 27
5.4.3 Habitat Use 28
5.4.4 Data Gaps 28
5.5 TRIBUTARY WATERSHED #5 – CLARKE CREEK 28
5.5.1 Fish Community 28
5.5.2 Habitat 29
5.5.3 Habitat Use 29
5.5.4 Data Gaps 29
5.6 TRIBUTARY WATERSHED #7 – PARSONS CREEK 29
5.6.1 Fish Community 29
5.6.2 Habitat 30
5.6.3 Habitat Use 30
5.6.4 Data Gaps 30
5.7 TRIBUTARY WATERSHED #8 – UNNAMED WATERCOURSE 30
5.7.1 Fish Community 31
5.7.2 Habitat 31
5.7.3 Habitat Use 31
5.7.4 Data Gaps 31
5.8 TRIBUTARY WATERSHED #9 – DONALD CREEK 31
5.8.1 Fish Community 32
5.8.2 Habitat 32

TABLE OF CONTENTS

SECTION **PAGE**

5.8.3 Habitat Use 32
5.8.4 Data Gaps 32
5.9 TRIBUTARY WATERSHED #10 – UNNAMED WATERCOURSE 33
5.9.1 Fish Community 33
5.9.2 Habitat 33
5.9.3 Habitat Use 33
5.9.4 Data Gaps 34
5.10 TRIBUTARY WATERSHED #11 – UNNAMED WATERCOURSE 34
5.10.1 Fish Community 34
5.10.2 Habitat 34
5.10.3 Habitat Use 35
5.10.4 Data Gaps 35
5.11 TRIBUTARY WATERSHED #12 – MCLEAN CREEK 35
5.11.1 Fish Community 35
5.11.2 Habitat 36
5.11.3 Habitat Use 37
5.11.4 Data Gaps 37
5.12 TRIBUTARY WATERSHED #13 – WOOD CREEK 37
5.12.1 Fish Community 38
5.12.2 Habitat 39
5.12.3 Habitat Use 40
5.12.4 Data Gaps 41
5.13 TRIBUTARY WATERSHED #14 – POPLAR CREEK 41
5.13.1 Fish Community 41
5.13.2 Habitat 44
5.13.3 Habitat Use 45
5.13.4 Data Gaps 46
5.14 TRIBUTARY WATERSHED #15 – LEGGETT CREEK 46
5.14.1 Fish Community 46
5.14.2 Habitat 47
5.14.3 Habitat Use 48
5.14.4 Data Gaps 48
5.15 TRIBUTARY WATERSHED #17 – UNNAMED WATERCOURSE (SHIPYARD LAKE OUTLET) 48
5.15.1 Fish Community 48
5.15.2 Habitat 49
5.15.3 Habitat Use 49
5.15.4 Data Gaps 50
5.16 TRIBUTARY WATERSHED #18 – STEEPBANK RIVER 50
5.16.1 Fish Community 51
5.16.2 Habitat 54
5.16.3 Habitat Use 56
5.16.4 Data Gaps 58
5.17 TRIBUTARY WATERSHED # 21 – UNNAMED WATERCOURSE (HORSESHOE LAKE OUTLET) 58
5.17.1 Fish Community 58
5.17.2 Habitat 59
5.17.3 Habitat Use 59
5.17.4 Data Gaps 60

TABLE OF CONTENTS

SECTION **PAGE**

5.18 TRIBUTARY WATERSHED #26 – BEAVER RIVER 60
5.18.1 Fish Community 60
5.18.2 Habitat....................63
5.18.3 Habitat Use 65
5.18.4 Data Gaps....................68
5.19 TRIBUTARY WATERSHED #27 – MUSKEG RIVER 68
5.19.1 Fish Community 69
5.19.2 Habitat....................80
5.19.3 Habitat Use 92
5.19.4 Data Gaps....................98
5.20 TRIBUTARY WATERSHED #31 – MACKAY RIVER....................99
5.20.1 Fish Community 99
5.20.2 Habitat....................104
5.20.3 Habitat Use 107
5.20.4 Data Gaps....................110
5.21 TRIBUTARY WATERSHED #34 – UNNAMED WATERCOURSE (ISADORE'S LAKE OUTLET) 110
5.21.1 Fish Community 110
5.21.2 Habitat....................111
5.21.3 Habitat Use 112
5.21.4 Data Gaps....................112
5.22 TRIBUTARY WATERSHED #36 – ELLS RIVER 112
5.22.1 Fish Community 113
5.22.2 Habitat....................114
5.22.3 Habitat Use 116
5.22.4 Data Gaps....................117
5.23 TRIBUTARY WATERSHED #37 – TAR RIVER....................117
5.23.1 Fish Community 117
5.23.2 Habitat....................119
5.23.3 Habitat Use 120
5.23.4 Data Gaps....................120
5.24 TRIBUTARY WATERSHED #38 – FORT CREEK....................120
5.24.1 Fish Community 121
5.24.2 Habitat....................122
5.24.3 Habitat Use 122
5.24.4 Data Gaps....................123
5.25 TRIBUTARY WATERSHED #39 – CALUMET RIVER....................123
5.25.1 Fish Community 123
5.25.2 Habitat....................125
5.25.3 Habitat Use 126
5.25.4 Data Gaps....................126
5.26 TRIBUTARY WATERSHED #42 – PIERRE RIVER....................126
5.26.1 Fish Community 128
5.26.2 Habitat....................129
5.26.3 Habitat Use 129
5.26.4 Data Gaps....................130
5.27 TRIBUTARY WATERSHED #43 – UNNAMED WATERCOURSE (SUSAN LAKE OUTLET) 130
5.27.1 Fish Community 131
5.27.2 Habitat....................131

TABLE OF CONTENTS

SECTION **PAGE**

5.27.3 Habitat Use 132
5.27.4 Data Gaps....132
5.28 TRIBUTARY WATERSHED #44 – EYMUNDSON CREEK 132
5.28.1 Fish Community 132
5.28.2 Habitat....133
5.28.3 Habitat Use 133
5.28.4 Data Gaps....133
5.29 TRIBUTARY WATERSHED #45 – UNNAMED WATERCOURSE 133
5.29.1 Fish Community 134
5.29.2 Habitat....134
5.29.3 Habitat Use 135
5.29.4 Data Gaps....135
5.30 TRIBUTARY WATERSHED #47 – UNNAMED WATERCOURSE 135
5.30.1 Fish Community 135
5.30.2 Habitat....136
5.30.3 Habitat Use 136
5.30.4 Data Gaps....136
5.31 TRIBUTARY WATERSHED #48 – REDCLAY CREEK....136
5.31.1 Fish Community 136
5.31.2 Habitat....137
5.31.3 Habitat Use 137
5.31.4 Data Gaps....137
5.32 TRIBUTARY WATERSHED #50 – FIREBAG RIVER 137
5.32.1 Fish Community 138
5.32.2 Habitat....140
5.32.3 Habitat Use 145
5.32.4 Data Gaps....147

6 SPECIES DISTRIBUTION MAPS 148

7 CLOSURE....149

8 REFERENCES....150

LIST OF TABLES

Table 1 Tributary Watershed Identification 5
Table 2 Tributary Watershed Historical Information Summary 7
Table 3 Common and Scientific Names of Fish Species 13
Table 4 Fish Species and Life Stages in Tributary Watershed #1 (Horse River) 14
Table 5 CPUE for Fish Species Captured in Tributary Watershed #1 (Horse River) – 1978[(a)] 16
Table 6 CPUE for Fish Species Captured in Tributary Watershed #1 (Horse River) – 1997[(a)] 17
Table 7 Fish Species and Life Stages in Tributary Watershed #2 (Clearwater River) 21
Table 8 CPUE for Fish Species Captured in Tributary Watershed #2 (Clearwater River) – 1978[(a)] 22
Table 9 CPUE for Fish Species Captured in Tributary Watershed #2 (Clearwater River) – 1994[(a)] 22
Table 10 Fish Species and Life Stages in Tributary Watershed #3 (Conn Creek) 25
Table 11 Fish Species and Life Stages in Tributary Watershed #5 (Clarke Creek) 28
Table 12 Fish Species and Life Stages in Tributary Watershed #7 (Parsons Creek) 29
Table 13 Fish Species and Life Stages in Tributary Watershed #9 (Donald Creek) 32
Table 14 Fish Species and Life Stages in Tributary Watershed #10 (Unnamed Watercourse) 33
Table 15 Fish Species and Life Stages in Tributary Watershed #11 (Unnamed) 34
Table 16 Fish Species and Life Stages in Tributary Watershed #12 (McLean Creek) 35
Table 17 CPUE for Arctic Grayling Captured in Tributary Watershed #12 (McLean Creek) – 1997**[(a)]** 36
Table 18 CPUE for Fish Species Captured in Tributary Watershed #12 (McLean Creek) – 1998**[(a)]** 36
Table 19 Fish Species and Life Stages in Tributary Watershed #13 (Wood Creek) 38
Table 20 CPUE for Fish Species Captured in Tributary Watershed #13 (Wood Creek) – 1995**[(a)]** 38
Table 21 CPUE for Fish Species Captured in Tributary Watershed #13 (Wood Creek) – 1998**[(a)]** 39
Table 22 Fish Species and Life Stages in Tributary Watershed #14 (Poplar Creek) 41
Table 23 CPUE for Fish Species Captured in Tributary Watershed #14 (Poplar Creek) – 1978[(a)] 43
Table 24 CPUE for Fish Species Captured in Tributary Watershed #14 (Poplar Creek) – 1997[(a)] 43
Table 25 Fish Species and Life Stages in Tributary Watershed #15 (Leggett Creek) 46
Table 26 Fish Species and Life Stages in Tributary Watershed #17 (Shipyard Lake Outlet) 48
Table 27 Fish Species and Life Stages in Tributary Watershed #18 (Steepbank River) 51
Table 28 Summary of Fish Counting Fence Results for Tributary Watershed #18 (Steepbank River) – 1977[(a)] 52
Table 29 CPUE for Fish Captured in Tributary Watershed #18 (Steepbank River) – 1995[(a)] 53
Table 30 Fish Species and Life Stages in Tributary Watershed #21 (Horseshoe Lake Outlet) 59
Table 31 Fish Species and Life Stages in Tributary Watershed #26 (Beaver River) 61
Table 32 Summary of Fish Counting Fence Results, Tributary Watershed #26 (Beaver River) – Spring 1973**[(a)]** 61

LIST OF TABLES

Table 33 CPUE for Fish Captured in Tributary Watershed #26 (Beaver River) – 1978[a] 62
Table 34 CPUE for Fish Captured in Tributary Watershed #26 (Beaver River) – 1978[a] 62
Table 35 Fish Species and Life Stages in Tributary Watershed #27 (Muskeg River)....71
Table 36 Fish Species Distribution in Watercourses in Tributary Watershed #27 (Muskeg River Basin) 72
Table 37 Summary of Fish Counting Fence Results for Large-Bodied Species for Tributary Watershed #27 – Mainstem Muskeg River 74
Table 38 Summary of Upstream Fish Trap Results in Tributary Watershed #27 – Jackpine Creek 75
Table 39 Percent of Catch for Large-Bodied Species Captured in Tributary Watershed #27 – Muskeg River 75
Table 40 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1976[a] 76
Table 41 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1977[a] 76
Table 42 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1985[a] 77
Table 43 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1988[a] 77
Table 44 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1985[a] 78
Table 45 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1988[a] 78
Table 46 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1995[a] 79
Table 47 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1997[a] 80
Table 48 Fish Species and Life Stages in Tributary Watershed #31 (MacKay River)....99
Table 49 CPUE for Fish Species Captured in Tributary Watershed #31 (MacKay River) – 1977[a] 101
Table 50 Summary of Fish Sampling for Tributary Watershed #31 (MacKay River) – 1978[a] 102
Table 51 Percent Composition for Fish Species Captured in Tributary Watershed #31 (MacKay River) – 1984[a] 103
Table 52 CPUE for Fish Species Captured in Tributary Watershed #31 (MacKay River) – 1992[a] 104
Table 53 CPUE for Fish Captured in Tributary Watershed #31 (MacKay River) – 1997[a] 104
Table 54 Fish Species and Life Stages in Tributary Watershed #34 (Isadore's Lake Outlet) 111
Table 55 Fish Species and Life Stages in Tributary Watershed #36 (Ells River)....113
Table 56 Fish Species as Percentage of Total Catch, Tributary Watershed #36 (Ells River) – 1978[a] 114
Table 57 Fish Species and Life Stages in Tributary Watershed #37 (Tar River) 118
Table 58 CPUE for Fish Species Captured in Tributary Watershed #37 (Tar River) – 2001[a] 118
Table 59 Fish Species and Life Stages Documented in Tributary Watershed #38 (Fort Creek)....121

LIST OF TABLES

Table 60 CPUE for Fish Species Captured in Tributary Watershed #38 (Fort Creek) – 2000[(a)] 121
Table 61 Fish Species and Life Stages in Tributary Watershed #39 (Calumet River) 123
Table 62 Summary of Fish Captured in Tributary Watershed #39 (Calumet River) – 1977[(a)] and 1982[(b)] 124
Table 63 CPUE for Fish Species Captured in Tributary Watershed #39 (Calumet River) – 2001[(a)] 124
Table 64 Fish Species and Life Stages in Tributary Watershed #42 (Pierre River) 128
Table 65 Summary of Fish Captured in Tributary Watershed #42 (Pierre River) 129
Table 66 Fish Species and Life Stages in Tributary Watershed #43 (Susan Lake Outlet) 131
Table 67 Fish Species and Life Stages in Tributary Watershed #44 (Eymundson Creek) 132
Table 68 Fish Species and Life Stages in Tributary Watershed #45 (Unnamed Watercourse) 134
Table 69 Fish Species and Life Stages in Tributary Watershed #47 (Unnamed Watercourse) 135
Table 70 Fish Species and Life Stage in Tributary Watershed #48 (Redclay Creek) 136
Table 71 Fish Species and Life Stages in Tributary Watershed #50 (Firebag River) 138
Table 72 Fish Species Distribution in Tributary Watershed #50 (Firebag River) 139
Table 73 CPUE Values for Fish Species Captured in Tributary Watershed #50 (Firebag River) – 1978[(a)] 140
Table 74 Fish Species Reported from the Athabasca River Basin 148

LIST OF FIGURES

Figure 1 Existing, Approved, and Planned Developments in the Oil Sands Region 3
Figure 2 Location of Tributaries to the Athabasca River in the Oil Sands Region 4
Figure 3 Historical Study Locations – Tributary Watersheds #1 and #2 15
Figure 4 Historical Study Locations – Tributary Watersheds #3 to #13 and #15 to #18 26
Figure 5 Historical Study Locations – Tributary Watersheds #14, # 19 to #26 and #28 to #31 42
Figure 6 Historical Study Locations – Tributary Watersheds #27 and #32 to #41 70
Figure 7 Historical Study Locations – Tributary Watersheds #42 to #50 127

LIST OF APPENDICES

Appendix I Fish Species Distribution Maps for Tributaries to the Athabasca River – Large-bodied Species (by life stage)
Appendix II Fish Species Distribution Maps for Tributaries to the Athabasca River – Small-bodied species

1 INTRODUCTION

The Oil Sands Regional Aquatics Monitoring Program (RAMP) is a long-term, multi-stakeholder initiative funded by industry that assesses the aquatic environment in the Athabasca Oil Sands Region of northeastern Alberta. RAMP began environmental monitoring in 1997 and has compiled eight years of data. As part of the fisheries component of RAMP, attributes of fish populations are monitored in the Athabasca River and selected tributary watercourses. To provide a context for the results of current monitoring activities and to compare to previous conditions in the Oil Sands Region, an understanding of the historical fisheries is required. To synthesize historical fisheries information, a review of the existing information for tributaries of the Athabasca River in the Oil Sands Region was conducted.

The objectives of the historical data review for Athabasca River tributaries were:

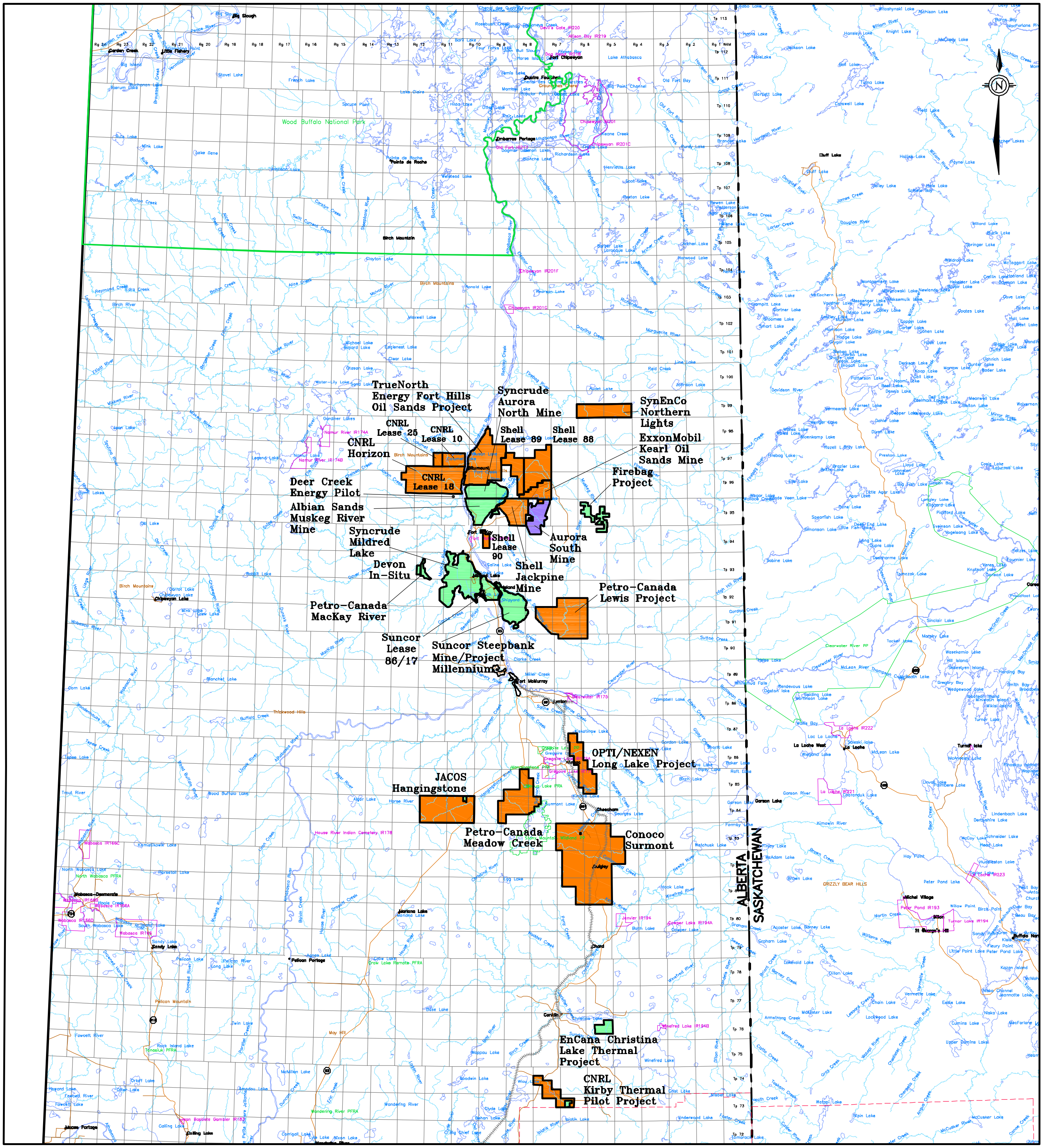
- to construct a database containing fisheries information from past fisheries reports;
- to produce fish species distribution maps for the tributary watersheds;
- to synthesize the existing data and to provide an overview of fish communities and fish habitats in the tributary watersheds;
- to provide data for comparison with current and future RAMP monitoring data for trend analysis; and
- to identify knowledge gaps and provide recommendations for future work to improve RAMP.

2 STUDY AREA

The tributary watersheds in the information review are those which are or may be influenced by Oil Sands development. Tributaries that were included were selected by their proximity to existing, approved and planned developments in the Oil Sands Region (Figure 1). The mouths of the tributary watersheds are within a 130 km section of the Athabasca River, extending from just upstream of Fort McMurray northward to the confluence with the Firebag River. This river section includes all tributaries from the Horse River to the Firebag River. All tributary watersheds in this section of the Athabasca River were identified by examination of 1:50:000 scale NTS maps. Named and unnamed creeks and rivers, regardless of size, were included.

The 130 km study area includes 50 tributary watersheds. The location of each of the 50 tributary watersheds is provided in Figure 2. Each tributary is labelled with a watershed identification number (WID#), starting with the southern-most tributary and proceeding northward (Figure 2). The WID# is used to identify each of the watersheds discussed in this report.

In total, 22 of the 50 tributary watersheds are named. The watersheds in order of their WID# and the tributary name, if available, are provided in Table 1. Some of the unnamed tributaries drain named waterbodies; in these cases the tributary is identified as the outlet channel of the named waterbody. Table 1 provides the coordinates of the tributary mouth and the direction that the tributary enters the Athabasca River (i.e. east or west). Coordinates are based on the Universal Transverse Mercator grid (UTM) for Zone 12, using a 1927 North American Datum (NAD 27) projection.



40 0 40

SCALE KILOMETRES

LEGEND

(green)	EXISTING and APPROVED DEVELOPMENTS
(orange)	PLANNED DEVELOPMENTS
(purple)	EUB APPROVED DEVELOPMENT

REFERENCE

ALBERTA NTDB DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001. NAD 83 ZONE 12. SHEETS 74D, E AND 74L IN NAD 27 ZONE 12. SASKATCHEWAN NTDB DATA OBTAINED FROM ISC, AUG. 2001. NAD 83 ZONE 13. ALL DATA CONVERTED TO NAD 83 UTM ZONE 12.

PROJECT

RAMP

TITLE

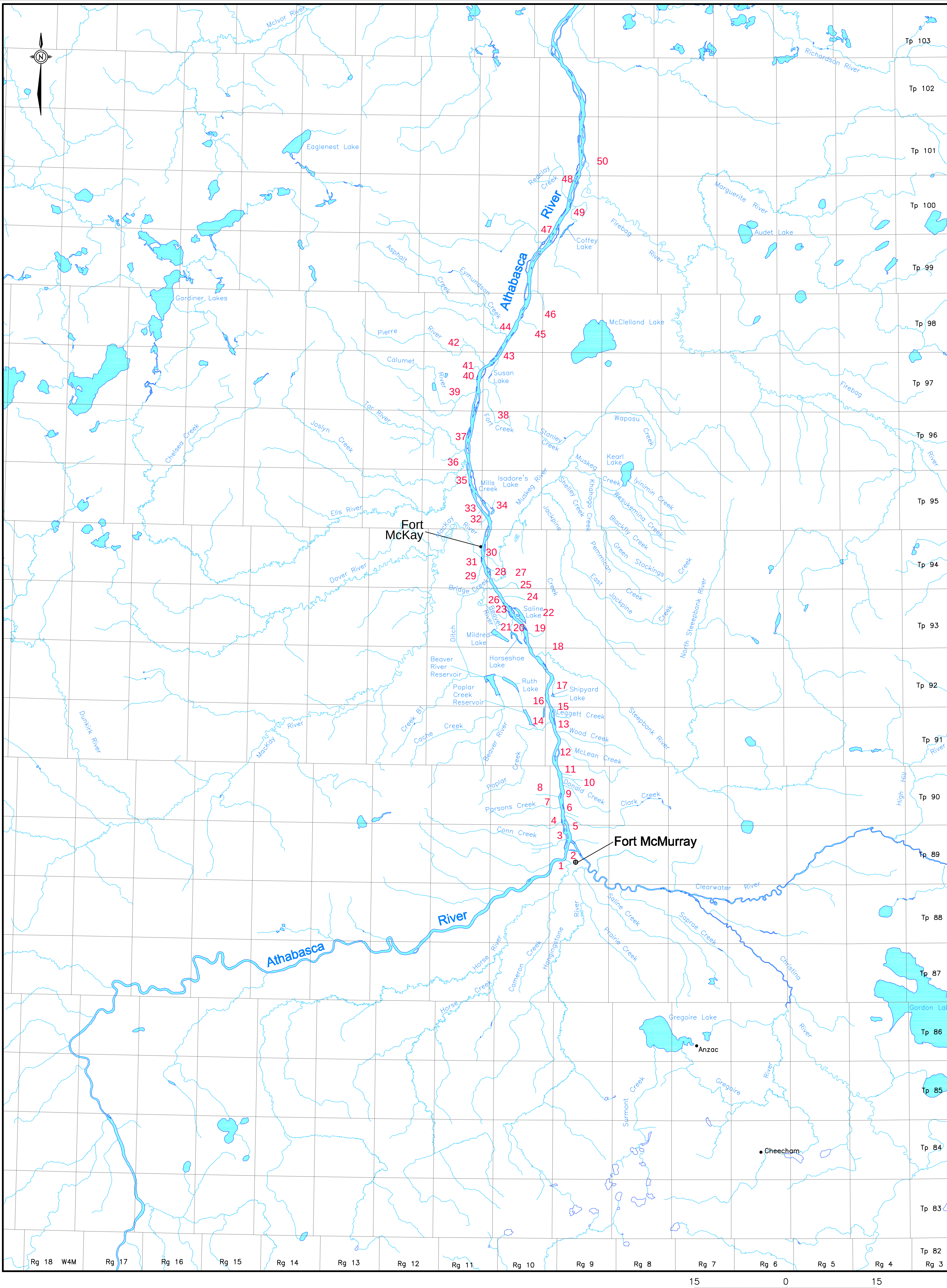
EXISTING, APPROVED, AND PLANNED DEVELOPMENTS IN THE OIL SANDS REGION

Golder Associates
Calgary, Alberta

PROJECT 04-1335-001.1000			FILE No.	Existing-Planned
DESIGN	RM	23/02/04	SCALE AS SHOWN	REV. 1
CADD	CJS	20/02/04	FIGURE: 1	
CHECK	CB	23/02/04		
REVIEW	CB	23/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: Existing-Planned.dwg Feb 26, 2004 - 12:21pm

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: FishHab-BASE.dwg Feb 26, 2004 – 12:28pm



LEGEND

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

PROJECT

RAMP

TITLE

LOCATION OF TRIBUTARIES TO THE ATHABASCA RIVER IN THE OIL SANDS REGION

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	FISH-HAB-BASE
DESIGN	CB	03/02/04	SCALE AS SHOWN	REV. 4
CADD	GMF	18/02/04		
CHECK	CB	19/02/04	**FIGURE: 2**	
REVIEW	CB	19/02/04		

Table 1 Tributary Watershed Identification

Tributary WID#	Tributary Watershed Name	Tributary Mouth[a]		
		UTM Coordinates		Enters Athabasca
		Northing	Easting	River From: (E/W)
1	Horse River	6285917	476539	East
2	Clearwater River	6287764	476549	East
3	Conn Creek	6287764	476549	West
4	Unnamed	6293200	474800	West
5	Clarke Creek	6293330	476580	East
6	Unnamed	6293700	475500	East
7	Parsons Creek	6293342	474540	West
8	Unnamed	6295700	474500	West
9	Donald Creek	6297060	474562	East
10	Unnamed	6299300	474100	East
11	Unnamed	6300400	474800	East
12	McLean Creek	6304473	474607	East
13	Wood Creek	6308191	474630	East
14	Poplar Creek	6310051	472615	West
15	Leggett Creek	6310045	473631	East
16	Unnamed	6312200	472300	West
17	Unnamed (Shipyard Lake Outlet)	6315800	473600	East
18	Steepbank River	6319342	471662	East
19	Unnamed	6322500	469600	East
20	Unnamed	6324600	468400	West
21	Unnamed (Horseshoe Lake Outlet)	6325700	466800	West
22	Unnamed (Saline Lake Outlet)	6327500	466600	East
23	Unnamed	6327700	465600	West
24	Unnamed	6328600	465500	East
25	Unnamed	6330800	464300	East
26	Beaver River	6330536	463666	West
27	Muskeg River	6332384	463682	East
28	Unnamed	6333800	463400	East
29	Unnamed	6334200	462200	West
30	Unnamed	6334900	462500	East
31	MacKay River	6336120	461701	West
32	Unnamed	6342800	462200	West
33	Unnamed	6344100	461300	West
34	Unnamed (Isadore's Lake Outlet)	6344500	462500	East
35	Unnamed	6348800	459700	West
36	Ells River	6350978	459826	West

Table 1 Tributary Watershed Identification (continued)

Tributary WID#	Tributary Watershed Name	Tributary Mouth[a]		
		UTM Coordinates		Enters Athabasca
		Northing	Easting	River From: (E/W)
37	Tar River	6352837	459844	West
38	Fort Creek	6362091	461942	East
39	Calumet River	6363959	460057	West
40	Unnamed	6365400	461000	West
41	Unnamed	6366500	461500	West
42	Pierre River	6367666	460992	West
43	Unnamed (Susan Lake Outlet)	6368400	464500	East
44	Eymundson Creek	6373187	466037	West
45	Unnamed	6375000	468500	East
46	Unnamed	6379500	469900	East
47	Unnamed	6387500	471600	West
48	Redclay Creek	6395381	476159	West
49	Unnamed (Coffey Lake Outlet)	6394500	476900	East
50	Firebag River	6400931	479168	East

(a) See Figure 2 for Tributary Locations.

3 OVERVIEW OF HISTORICAL INFORMATION

The fisheries reports that were reviewed for the 50 tributary watersheds are identified in Table 2. For the larger watersheds with sufficient existing information, the summary is divided into watercourses that comprise the watershed.

There were 18 tributaries for which no fisheries information was located (Table 2). These tributaries were small, unnamed watercourses between 0.5 and 11.0 km in length; it is likely that their small size and limited potential to support a fish community precluded their study.

The remaining 32 tributary watersheds each had at least one report that provides fisheries information. These tributaries include 22 named and 10 unnamed watercourses (Table 2). Nine of the ten unnamed watercourses were small (2.2 to 9.0 km long), but were examined to provide baseline information for environmental impact assessments (EIAs) for proposed Oil Sands developments or to provide information for modification of Highway 63 crossing sites. The sixth unnamed tributary is larger (35 km in length) and was examined during investigations for the Alberta Oil Sands Environmental Research Program (AOSERP).

Table 2 Tributary Watershed Historical Information Summary

Tributary WID#	Tributary Watershed Name	Watercourse	Number of Reports
1	Horse River	Horse River	6
		Horse Creek	3
2	Clearwater River	Clearwater River	15
		Christina River	4
		Gregoire River	2
		Hangingstone River	4
		High Hill River	1
		Surmont Creek	2
3	Conn Creek	Conn Creek	2
4	Unnamed	Unnamed	1
5	Clarke Creek	Clarke Creek	1
6	Unnamed	Unnamed	0
7	Parsons Creek	Parsons Creek	1
8	Unnamed	Unnamed	1
9	Donald Creek	Donald Creek	2

Table 2 Tributary Watershed Historical Information Summary (continued)

Tributary WID#	Tributary Watershed Name	Watercourse	Number of Reports
10	Unnamed	Unnamed	2
11	Unnamed	Unnamed	2
12	McLean Creek	McLean Creek	4
13	Wood Creek	Wood Creek	4
14	Poplar Creek	Poplar Creek	12
15	Leggett Creek	Leggett Creek	4
16	Unnamed	Unnamed	0
17	Unnamed (Shipyard Lake Outlet)	Shipyard Lake Outlet	5
18	Steepbank River	Steepbank River	12
		North Steepbank River	3
19	Unnamed	Unnamed	0
20	Unnamed	Unnamed	0
21	Unnamed (Horseshoe Lake Outlet)	Horseshoe Lake Outlet	1
22	Unnamed (Saline Lake Outlet)	Saline Lake Outlet	0
23	Unnamed	Unnamed	0
24	Unnamed	Unnamed	0
25	Unnamed	Unnamed	0
26	Beaver River	Beaver River and Reservoir	14
		Bridge Creek	3
		Ruth Lake	4
		Poplar Creek Reservoir	4
27	Muskeg River	Muskeg River	25
		Jackpine Creek	15
		East Jackpine Creek	3
		Blackfly Creek	4
		Green Stockings Creek	4
		Iyinimin Creek	4
		Muskeg Creek	7
		Khahago Creek	5
		Pemmican Creek	2
		Shelly Creek	4
		Stanley Creek	3
		Wapasu Creek	5

Table 2 Tributary Watershed Historical Information Summary (continued)

Tributary WID#	Tributary Watershed Name	Watercourse	Number of Reports
		Wesukemina Creek	6
28	Unnamed	Unnamed	0
29	Unnamed	Unnamed	0
30	Unnamed	Unnamed	0
31	MacKay River	MacKay River	14
		Dover River	5
		Dunkirk River	3
		Unnamed	2
32	Unnamed	Unnamed	0
33	Unnamed	Unnamed	0
34	Unnamed (Isadore's Lake Outlet)	Unnamed	4
35	Unnamed	Unnamed	0
36	Ells River	Ells River	9
		Chelsea Creek	1
		Joslyn Creek	1
37	Tar River	Tar River	5
38	Fort Creek	Fort Creek	3
39	Calumet River	Calumet River	5
40	Unnamed	Unnamed	0
41	Unnamed	Unnamed	0
42	Pierre River	Pierre River	5
43	Unnamed (Susan Lake Outlet)	Susan Lake Outlet	1
44	Eymundson Creek	Eymundson Creek	2
45	Unnamed	Unnamed	1
46	Unnamed	Unnamed	0
47	Unnamed	Unnamed	2
48	Redclay Creek	Redclay Creek	1
49	Unnamed (Coffey Lake Outlet)	Unnamed	0
50	Firebag River	Firebag River	6
		Marguerite River	4

The remainder of this report is concerned with the 32 tributary watersheds for which existing fisheries information was available.

3.1 SOURCES OF INFORMATION

The following provide the historical and recent fisheries information for the tributaries:

- Research reports prepared for AOSERP. This program was designed to direct and co-ordinate research concerned with the environmental effects of development of the Athabasca Oil Sands in Alberta.
- Reports by Government Agencies responsible for resource management, in particular Fish and Wildlife division reports, unpublished files and fish collection permit returns.
- Independent fisheries research conducted by industry such as Oil Sands and Pulp and Paper mill operators.
- Fisheries assessments for baseline studies and EIAs by Oil Sands operators for planned developments.
- Reports prepared by consultants working for resource agencies or industry.
- Reports prepared for the Northern River Basins Study (NRBS). This program examined the relationship between industrial, municipal, agricultural and other development in the Peace, Athabasca and Slave river basins.

4 THE DATABASE

A Microsoft Access database was designed to store, sort and query the historical information. Based on information from the studies reviewed, the database retains specific information based on watercourse location, water quality, habitat description, habitat use, fish community and population structure.

Watercourse Location

References to both the stream location and the location of study sites are stored in this section of the database. The distinction between site specific surveys (i.e., point study sites) and reach surveys (i.e., study sections) was made when possible and location details reflect this distinction. Season and approximate time and length of sampling in months and years are contained in this database section. Bibliographic details are also provided here.

Water Quality

If sampling for basic water quality was conducted in the historical information, the results were tabulated in this database section. Information stored in the database includes water temperature, dissolved oxygen (DO) concentration, pH, conductivity and sample date. A comment window was also installed to allow for descriptive comments such as water colour.

Habitat Description

Habitat was described in text-based comment windows. A distinction was made between habitat descriptive (i.e., physical conditions) and habitat potential (i.e., potential to support spawning, rearing, adult feeding or overwintering activities by specific fish species or groups) comments.

Habitat Use

Actual habitat use by fish species were documented in tabular form that included species and life stage present during the studies, the season in which the species was present in the watercourse and the presumed activities of the fish at the time of the survey. Fish species activities included overwintering, spawning, nursery, rearing and adult feeding and were ranked on a nil, low, moderate and high scale.

Fish Summary

The fish summary was organized in tabular form. Species encountered, life stage, site location and season of capture were documented. In addition, information for calculation of catch-per-unit-effort (CPUE) (i.e. duration of sampling effort, area of sampling effort and technique) was included when available. Several comment windows were installed to allow for text-based notes that could be divided into categories that included growth, health and population analysis of the fish community as well as equipment and CPUE information.

Following review of the reports, the data was entered into the database and queries were designed to provide information on each watercourse and its tributaries. The query sorted the data by WID# and provided fish community and habitat information as well as the bibliographic references for the data. From these queries, the summary was constructed.

5 SUMMARY OF HISTORICAL INFORMATION BY TRIBUTARY WATERSHED

The following sections summarize the existing fisheries information for each of the 32 tributary watersheds in the Oil Sands Region for which historical information is available. This summary includes information that precedes RAMP, as well as current information collected outside the RAMP program.

The common and scientific names of the fish species discussed in this report are provided in Table 3.

Table 3 Common and Scientific Names of Fish Species

Species	
Common Name	**Scientific Name**
Arctic grayling	*Thymallus arcticus*
brassy minnow	*Hybognathus hankinsoni*
brook stickleback	*Culaea inconstans*
bull trout	*Salvelinus confluentus*
burbot	*Lota lota*
emerald shiner	*Notropis atherinoides*
fathead minnow	*Pimephales promelas*
finescale dace	*Phoxinus neogaeus*
flathead chub	*Platygobio gracilis*
goldeye	*Hiodon alosoides*
Iowa darter	*Etheostoma exile*
lake chub	*Couesius plumbeus*
lake cisco	*Coregonus artedi*
lake whitefish	*Coregonus clupeaformis*
longnose dace	*Rhinichthys cataractae*
longnose sucker	*Catostomus catostomus*
mountain whitefish	*Prosopium williamsoni*
ninespine stickleback	*Pungitius pungitius*
northern pike	*Esox lucius*
northern redbelly dace	*Phoxinus eos*
pearl dace	*Margariscus margarita*
slimy sculpin	*Cottus cognatus*
spoonhead sculpin	*Cottus ricei*
spottail shiner	*Notropis hudsonius*
trout-perch	*Percopsis omiscomaycus*
walleye	*Stizostedion vitreum*
white sucker	*Catostomus commersoni*
yellow perch	*Perca flavescens*

5.1 TRIBUTARY WATERSHED #1 – HORSE RIVER

Six reports provided fisheries information for the Horse River watershed (Griffiths 1973; Tripp and Tsui 1980a, 1980b; Stanislawski 1998; Golder 1999a; RL&L n.d.). Information for the Horse River mainstem was available from all six reports. Griffiths (1973) and RL&L (n.d.) also provided information on Horse Creek, the largest tributary in the watershed, and Tripp and Tsui (1980a, 1980b) examined the lower portion of Cameron Creek. The portions of the Horse River watershed included in these reports are shown in Figure 3.

5.1.1 Fish Community

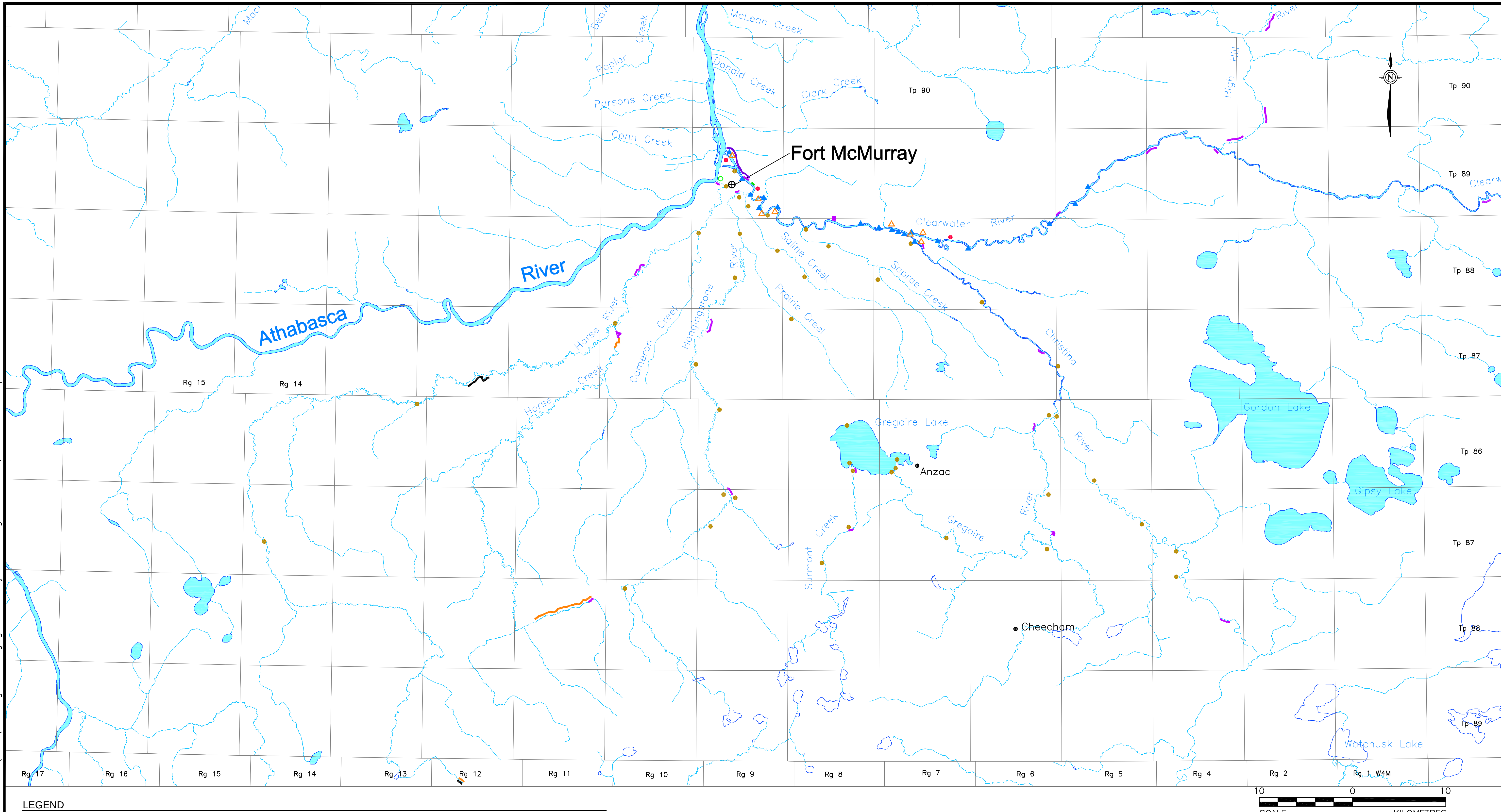
Fish species collected in the Horse River watershed are listed in Table 4. Twenty one fish species have been captured in this watershed, including eight sport fish species, two sucker species and eleven small-bodied forage fish species.

Table 4 Fish Species and Life Stages in Tributary Watershed #1 (Horse River)

Species	Life Stage
Arctic grayling[(a)]	fry, juvenile, adult
brook stickleback[(a)]	unspecified
burbot	unspecified
emerald shiner	unspecified
fathead minnow[(a)]	unspecified
flathead chub	unspecified
goldeye	unspecified
lake chub[(a)]	unspecified
lake whitefish	unspecified
longnose dace[(a)]	unspecified
longnose sucker[(a)]	fry, juvenile, adult
mountain whitefish	unspecified
northern pike	unspecified
pearl dace[(a)]	unspecified
slimy sculpin[(a)(b)]	unspecified
spoonhead sculpin	unspecified
spottail shiner	unspecified
trout-perch[(a)]	unspecified
walleye	juvenile, adult
white sucker[(a)]	fry, juvenile, adult
yellow perch	unspecified

(a) Species documented in Horse Creek.

(b) Species documented in Cameron Creek.



LEGEND

- GRIFFITHS 1973
- JACOBSON AND BOAG 1995
- RL&L 1994
- RL&L n.d.
- STANISLAWSKI 1998
- BIOLOGICAL CONSULTANTS 1977
- GOLDER 1999a
- JONES ET AL. 1978a&b
- KLAVERKAMP AND BARON 1996
- TRIPP AND MCCART 1979a&b
- TRIPP AND TSUI 1980a&b

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

HISTORICAL STUDY LOCATIONS
TRIBUTARY WATERSHEDS #1 AND #2

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No. Hangingstone Survey
DESIGN	CS	08/07/02	SCALE AS SHOWN REV. 0
CADD	JAM	23/02/04	
CHECK	CB	23/02/04	FIGURE: 3
REVIEW	CB	23/02/04	

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: Hangingstone Surveyed River.dwg Feb 26, 2004 - 12:38pm

Data was available from Tripp and Tsui (1980a) and Stanislawski (1998) to evaluate relative abundance of fish in the Horse River. CPUE from Tripp and Tsui (1980a) are provided in Table 5 and CPUE from Stanislawski (1998) are in Table 6.

Table 5 CPUE for Fish Species Captured in Tributary Watershed #1 (Horse River) – 1978[a]

Species	Number of Fish	Sampling Season	Gill Net		Seine Net	
			Effort (hr)	CPUE (#/100 hr)	Effort (m of shoreline)	CPUE (#/100 m)
Arctic grayling	6	summer	-	-	62	9.7
	4	fall	19.5	5.1	36	5.6
fathead minnow	87	summer	-	-	32	271.9
flathead chub	5	summer	23.0	21.7	-	-
goldeye	19	summer	23.0	82.6	-	-
	2	fall	24.0	8.3	-	-
lake chub	160	summer	-	-	205	78.0
	3	fall	-	-	36	8.3
longnose dace	25	summer	-	-	92	27.1
longnose sucker	2	spring	4.0	50.0	-	-
	98	summer	47.0	6.4	229	41.5
	1	fall	19.5	5.1	-	-
northern pike	2	summer	47.0	4.2	-	-
	1	fall	19.5	5.1	-	-
slimy sculpin	83	summer	-	-	100	83.0
	1	fall	-	-	36	2.8
spottail shiner	1	summer	-	-	38	2.6
trout-perch	34	summer	-	-	205	16.6
	1	fall	-	-	36	2.8
walleye	2	spring	4.0	50.0	-	-
	11	summer	23.0	43.5	38	2.6
	2	fall	24.0	8.3	-	-
white sucker	2	summer	24.0	4.2	60	1.7
	2	fall	-	-	36	5.6
yellow perch	23	summer	-	-	38	60.5

[a] Tripp and Tsui 1980a.

Table 6 CPUE for Fish Species Captured in Tributary Watershed #1 (Horse River) – 1997[a]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
white sucker	1	summer	380	0.3
brook stickleback	3	summer	380	0.8
longnose dace	2	summer	380	0.5
pearl dace	18	summer	380	4.7
trout-perch	3	summer	380	0.8

(a) Stanislawski 1998.

The variety of sampling techniques in past studies provides a good indication of the species present and their relative abundance in the Horse River. The most abundant species captured by seine netting were fathead minnow, slimy sculpin, lake chub, yellow perch and longnose sucker. The most abundant species captured by backpack electrofishing was pearl dace. Gill netting indicated that the most abundant large-bodied species were goldeye, walleye and longnose sucker.

Twenty one fish species occur in the Horse River watershed and all species were found in the mainstem Horse River. Ten of the twenty one species were collected in Horse Creek and one species was captured in lower Cameron Creek (Table 4).

5.1.2 Habitat

Griffiths (1973) examined the lower 189 km of the 213 km length of the Horse River and described the river as having limited potential to support sport fish over most of its length. Approximately 25-30% of the river had suitable pool riffle ratios, spawning gravel and flow rates for sport fish, while the remainder had low flow, low gradient and consisted mostly of pool habitat. The lower river had good pool:riffle ratios with rocky substrates and good fish refugia and Griffiths (1973) rated this section as having good fisheries potential. Similarly, Tripp and Tsui (1980a) described the upper 155 km of the Horse River as primarily slow flowing, placid and meandering with substrate composed of silt and sand except for occasional stretches of rubble and boulder. Moving downstream, the gradient changed through a transition area and habitat conditions were said to improve in the lower portion of the river as the gradient increased and substrate material changed to gravel and rubble. The lower 25 km of the river was considered to provide the best habitat.

Researchers have described habitat conditions from various locations in the lower 140 km of the mainstem Horse River. Immediately upstream of the confluence with the Athabasca River, the Horse River consists of slow, placid run habitat in excess of 2 m in depth (Golder 1999a). A little farther upstream, away from the influence of the Athabasca River, the channel was shallow (<0.75 m deep) and was dominated by fast flowing water with riffle and run sequences over cobble substrate.

Approximately 1 km upstream from the confluence with the Athabasca River, the Horse River exhibited an irregular meander pattern (Tripp and Tsui 1980a). The substrate was dominated by rubble, with boulder, gravel, sand and silt also present. The channel was shallow (<0.5m deep), the gradient was moderate (0.38 m/km) and the pool to riffle ratio was 1:1 (Tripp and Tsui, 1980a). Approximately 28 km upstream from the junction with the Athabasca River, the Horse River became occasionally unconfined. The pool to riffle ratio increased from 1:1 in the lower reaches to 3:1.

Stanislawski (1998) studied the Horse River farther upstream in the transition area between the low and high gradient sections. It was suggested that this area provided good habitat for forage fish. In the same area, potential spawning and rearing habitat for Arctic grayling was rated as moderate. Suitable overwintering conditions did not exist for Arctic grayling in this section of the watercourse.

In the upstream low gradient area, approximately 88 km from the mouth, the watercourse was tortuously meandering and completely unconfined. No riffles were present and the substrate was mostly sand and silt. The uppermost reach of this study was 140 km upstream from the confluence. Here, the river meandered and was unconfined. The substrate was comprised of rubble and gravel with some organic materials present. Only a few riffles were present and the pool to riffle ratio was 10:1.

Habitat conditions were limited over much of the length of the Horse River. However, fast flowing riffles and runs over cobble substrate that occur in some reaches could provide spawning, nursery and juvenile rearing habitat for sport fish species and suckers that spawn in swift flowing habitats with rocky substrate (Golder 1999a).

5.1.3 Habitat Use

Seasonal habitat use was illustrated by Tripp and Tsui (1980a) during their multi-season investigation. Fish species diversity was highest during the summer with 14 species present (Tripp and Tsui 1980a). These fish species included Arctic grayling, fathead minnow, flathead chub, goldeye, lake chub, longnose dace, longnose sucker, northern pike, slimy sculpin, spoonhead sculpin, trout-perch, walleye, white sucker and yellow perch. Seven species were present in the fall, including Arctic grayling, lake chub, longnose sucker, northern pike, slimy sculpin, trout-perch and white sucker. Only two species, longnose sucker and walleye, were captured in Horse River in the spring.

CPUE indicated that most species that were present in more than one season in the Horse River were present in highest abundance in the summer. Based on fish species seasonal presence and abundance, it is inferred that small and large bodied fish species utilize the Horse River in summer for feeding activities. Habitat with the potential for spawning by Arctic grayling, walleye, longnose sucker and white sucker was found; however, only walleye and longnose sucker were in the watercourse in the spring and no spawning has been documented for either species.

Life stages were specified for captured fish in only a few studies, making it difficult to determine habitat use. However, it is known that all life stages of Arctic grayling, longnose sucker and white sucker were recorded in the watershed. Arctic grayling fry, juvenile and adult were recorded in the lower portion of the river and in some headwater locations in the Horse River and Horse Creek, but this species was not found in the middle portion of the watershed. This suggests use of portions of the watershed for spawning, nursery, rearing and feeding, and indicates suitable habitats for this species are likely limited to the higher gradient sections and do not generally occur throughout the river. The various life stages of longnose and white sucker were much more widely distributed, indicating a wider use of the watershed for spawning, nursery, rearing and feeding, although adult fish were generally only recorded in the lower portion of the river. Both juvenile and adult walleye have been recorded at the Horse River mouth, indicating use of the lower-most portion of the river as rearing and feeding habitat.

The potential for fish to overwinter in the Horse River has been estimated to range from poor to high (Tripp and Tsui 1980a), depending on location, however no winter survey was conducted.

5.1.4 Data Gaps

Associations between habitat and fish life stages were not studied in the Horse River, nor was life stage generally determined for captured fish. Therefore, inferences regarding habitat use were based on seasonal presence of fish species. Further studies would be required to determine if Arctic grayling, walleye and sucker spawn and whether their progeny remain in the Horse River.

Investigation of habitat and fish species presence during the winter would be required to assess the potential for fish to overwinter in the Horse River.

5.2 TRIBUTARY WATERSHED #2 – CLEARWATER RIVER

Seventeen reports that contained fisheries information for the Clearwater River watershed (AENV n.d; Griffiths 1973; Biological Consultants 1977; Jones et al. 1978a, 1978b; Tripp and McCart 1979a, 1979b; Tripp and Tsui 1980a, 1980b; RL&L 1994; Jacobson and Boag 1995; Brown et al. 1996; Klaverkamp and Baron 1996; Lockhart and Metner 1996; Pastershank and Muir 1996; Mill et al. 1997; TERA 2000) were reviewed. Information was available for the mainstem Clearwater River and some tributary streams, including the Hangingstone River, Christina River and High Hill River. Data was also available for one small tributary (Saprae Creek) as well as tributaries in the Hangingstone River basin (i.e., Saline and Prairie creeks) and in the Christian River basin (i.e., the Gregoire River and Surmont Creek). Figure 3 shows the portions of the Clearwater River watershed included in these studies.

5.2.1 Fish Community

Fish species captured in the Clearwater River are summarized in Table 7. Twenty two fish species have been reported from this watershed, including eight sport species, two sucker species and twelve small-bodied forage species. All of the 22 documented fish species have been reported from the mainstem Clearwater River. The number of species reported from larger tributaries of the Clearwater River include nine species in the High Hill River basin, twelve species in the Hangingstone River basin and twenty one species in the Christina River basin (Table 7).

Table 7 Fish Species and Life Stages in Tributary Watershed #2 (Clearwater River)

Species	Life Stage
Arctic grayling[(a)(b)(c)(d)(e)]	fry, juvenile, adult, spawning
brook stickleback[(a)(b)]	unspecified
burbot[(b)]	juvenile, adult, unspecified
emerald shiner	unspecified
fathead minnow[(b)]	unspecified
finescale dace[(b)]	unspecified
flathead chub[(b)]	unspecified
goldeye[(b)]	juvenile, unspecified
lake chub[(a)(b)(c)(d)]	unspecified
lake whitefish[(b)]	fry, juvenile, adult
longnose dace[(a)(b)(c)(d)]	unspecified
longnose sucker[(a)(b)(c)(d)]	fry, juvenile, adult, spawning
mountain whitefish[(a)(b)(d)]	fry, juvenile, adult
northern pike[(a)(b)(c)(d)]	fry, juvenile, adult, spawning
pearl dace[(a)(b)(c)]	unspecified
slimy sculpin[(a)(b)(c)(e)]	unspecified
spoonhead sculpin[(b)]	unspecified
spottail shiner[(c)(d)(e)]	unspecified
trout-perch[(a)(b)(c)(d)]	unspecified
walleye[(a)(b)]	fry, juvenile, adult
white sucker[(a)(b)(c)(d)(e)]	fry, juvenile, adult, spawning
yellow perch[(b)]	juvenile, unspecified

(a) Species documented in Hangingstone River.
(b) Species documented in Christina River.
(c) Species documented in Gregoire River.
(d) Species documented in High Hill River.
(e) Species documented in Surmont Creek.

Sufficient data was available from two of the studies to evaluate relative abundance using CPUE calculations. CPUE from Jones et al. (1978a) are summarized in Table 8.

Table 8 CPUE for Fish Species Captured in Tributary Watershed #2 (Clearwater River) – 1978[a]

Species	Number of Fish	Sampling Season	Gill Net		Seine Net	
			Effort (hr)	CPUE (#/100 hr)	Effort (hauls)	CPUE (#/haul)
Arctic grayling	2	fall	45.0	4.44	-	-
burbot	1		21.5	4.65	-	-
flathead chub	1		-	-	11	0.09
goldeye	26		65.5	38.17	11	0.09
lake whitefish	53		54.5	23.85	17	2.40
longnose sucker	25		140.5	6.41	8	2.00
northern pike	11		110.0	6.36	14	0.29
trout-perch	46		-	-	2	2.30
walleye	17		88.0	14.77	17	0.24
white sucker	31		234.5	6.82	13	1.15
yellow perch	3		-	-	2	1.50

[a] Jones et al. 1978a.

Jones et al. (1978a) estimated that the average seine net CPUE for fish in the Clearwater River study was 5.4 fish/haul, while the average gill net CPUE was 16 fish/100 hours, all species combined. Jacobson and Boag (1995) also provided sufficient information to calculate CPUE (Table 9) by a different capture method.

Table 9 CPUE for Fish Species Captured in Tributary Watershed #2 (Clearwater River) – 1994[a]

Species	Number of Fish	Sampling Season	Set Line	
			Effort (hook-hr)	CPUE (#/100 hook-hr)
northern pike	1	fall	100	1.0
burbot	5		125	4.0

[a] Jacobson and Boag 1995.

5.2.2 Habitat

The Clearwater River has very uniform habitat throughout the lower 78 km, consisting of long pools with sand and rubble substrate that were rated as excellent habitat for northern pike and walleye (Griffiths 1973). Tripp and McCart (1979a) described the Clearwater River upstream of the confluence with the Hangingstone River as predominantly sand substrate with heavy siltation.

Numerous large backwaters occurred and an abundance of aquatic macrophytes was identified in some areas. The upper river has pool habitat with silt/sand substrate and riffles with sand, gravel and rubble and was rated as providing excellent fish refugia (Griffiths 1973).

A later study (Tripp and Tsui 1980a), described habitat in the Clearwater River from the confluence with the Athabasca River to a location 27 km upstream. The lower 20 km of the river was sinuous to meandering and the substrate was predominantly rubble with boulder, although gravel and sand were also present. Pools were abundant at the time of survey. Approximately 27 km upstream from the confluence the river became confined and faster flowing and the pool to riffle ratio became 1:3. The substrate was predominantly boulder and rubble, with sand, silt and gravel also found at this location.

The Christina River is a large tributary to the Clearwater River that has homogenous habitat and a moderate gradient and flow rate (Tripp and Tsui 1980a). The substrate is primarily rocky, consisting of boulder, rubble and gravel, and has gravel, sand and silt in the pools. The Christina River has high potential to provide habitat for sport fish, with excellent refugia, excellent spawning potential, many deep pools and a 1:1 pool:riffle ratio (Griffiths 1973).

The Gregoire River and Surmont Creek are located in the Christina River basin. The Gregoire River is the outlet channel of Gregoire Lake and is a tributary to the Christina River. The Gregoire River was rated as providing limited habitat for sport fish because of extensive beaver activity. Much of the river has placid flow, sand substrate, prolific weed growth and high temperatures (Griffiths 1973; Tripp and Tsui 1980a). However, the lower Gregoire River has a higher gradient, a 2:1 pool:riffle ratio, riffles with rubble and gravel substrate and pools with gravel and sand. The habitat in the lower river was rated as providing excellent fish refugia (Griffiths 1973). Surmont Creek is an inflow tributary of Gregoire Lake. It is a small, swift stream dominated by gravel and rubble substrate with some boulder (Tripp and Tsui 1980a). Surmont Creek was rated as providing good fish habitat due to a favourable pool:riffle ratio and spawning gravels in riffle areas (Griffiths 1973).

The Hangingstone River is a small to medium sized tributary of the Christine River. The upper portion of the watercourse has a moderate gradient, numerous riffles and substrate composed of rubble, boulder and gravel (Tripp and Tsui 1980a). The middle section is wider, slower, placid and meandering with sand substrate and beaver activity. The gradient increases again in the lower portion of the watercourse. The Hangingstone River was rated as providing excellent spawning habitat in some areas (Griffiths 1973).

The High Hill River is a tributary of the Clearwater River. The upper High Hill River has a low gradient and consists of approximately 95% pool habitat (Griffiths 1973). The gradient and the quality of fish habitat increases moving downstream. The lower river has a 1:1 pool:riffle ratio, riffles with gravel and rubble substrate and pools with sand, silt and gravel. The lower river has excellent fish refugia and good habitat for sport fish (Griffiths 1973).

5.2.3 Habitat Use

Seasonal use of Clearwater River has been well documented. In the spring, young goldeye were present and use the river for rearing to a moderate degree. Arctic grayling, longnose sucker, northern pike, walleye and white sucker were also present in the spring (RL&L 1994). Arctic grayling appear to spawn throughout the Clearwater River watershed, with the Hangingstone River, Surmont Creek and the High Hill River specifically identified as hatchery streams (Griffiths 1973). Longnose and white sucker were widely distributed throughout the watershed and spawning areas were identified in the Christina River basin (Tripp and Tsui 1980a). Northern pike occur in much of the Clearwater River watershed and spawn to some extent in the Clearwater River (Tripp and Tsui 1980a). Walleye occur mainly in the Clearwater and Christina Rivers and, based on the presence of fry, may spawn in the watershed.

Walleye and northern pike fry were suspected to use the Clearwater River for summer nursery and rearing habitat (Mill et al. 1997), although RL&L (1994) suggested that the extent these species rear in this watercourse was limited. Arctic grayling, longnose sucker, mountain whitefish and white sucker also use the watershed as nursery, rearing and feeding habitat.

Burbot, including adults, and northern pike were present in the Clearwater River in the fall (Klaverkamp and Baron 1996). Arctic grayling, goldeye, northern pike, walleye and white sucker were present in the fall as far upstream as 2.5 km past the Christina River (Jones et al. 1978a). Burbot were in the Clearwater River during the fall as far upstream as 1.5 km below the Christina River confluence (Jones et al. 1978a).

Jones et al. (1978a, 1978b) examined the Clearwater River in the fall to investigate spawning activity by lake whitefish. No lake whitefish spawning was observed and no fish in spawning condition were captured in this watershed.

Sufficient depths were present in the Clearwater River for overwintering fish (RL&L 1994), but overwintering investigations were not conducted.

5.2.4 Data Gaps

Additional studies are required to determine the extent to which walleye and northern pike fry inhabit the Clearwater River watershed. A spring spawning survey would be needed to determine the extent of spawning in this river. Winter studies of habitat conditions and fish use would be necessary to determine the overwintering capacity of this watershed.

5.3 TRIBUTARY WATERSHED #3 – CONN CREEK

Two reports reviewed included information on the Conn Creek watershed (Griffiths 1973; Golder 1999a). The portions of the Conn Creek watershed examined in these reports are in Figure 4.

5.3.1 Fish Community

Fish species collected in Conn Creek are in Table 10. Only one fish species, juvenile Arctic grayling, has been captured in this watershed.

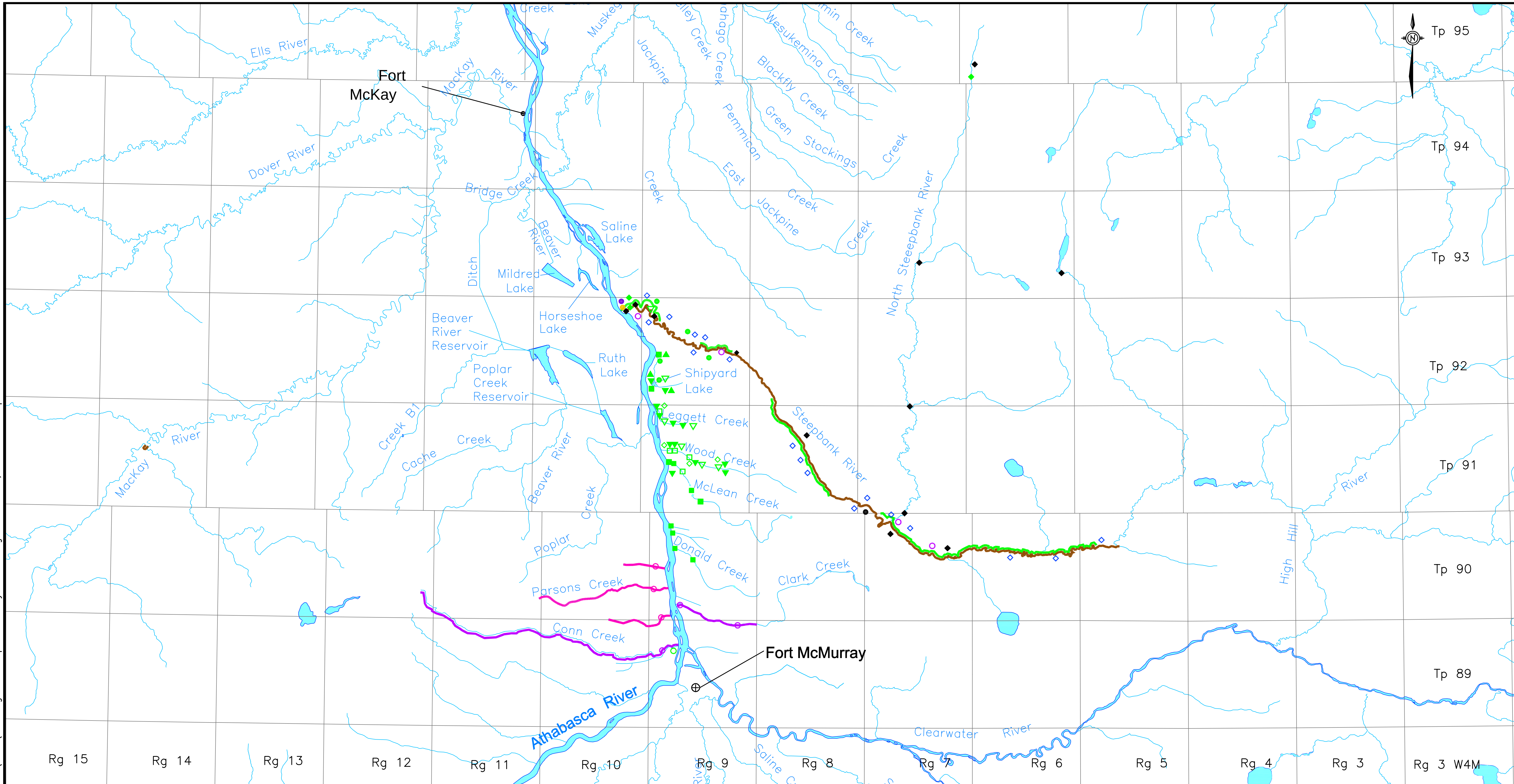
Table 10 Fish Species and Life Stages in Tributary Watershed #3 (Conn Creek)

Species	Life Stage
Arctic grayling	juvenile

The data were insufficient to allow calculation of CPUE for fish relative abundance in this watershed.

5.3.2 Habitat

Griffiths (1973) examined the entire 30 km length of Conn Creek and rated the watercourse as having low to moderate potential to support sport fish; fish habitat was considered limited due to the small size of the watercourse. During a spring survey, Golder (1999a) described Conn Creek as a small stream with water depths ranging from 0.4 to 0.7 m. The habitat consisted of shallow Class 3 runs with shallow Class 3 pools at some meander bends and occasional riffles. The substrate was mainly rocky, with cobble, boulder and gravel-sized particles, providing some possible spawning habitat. The abundant submerged woody debris present in run habitats was considered to provide excellent cover for fish. The debris piles in slower moving areas could provide spawning habitat for northern pike (Golder 1999a) if they were present. Portions of the creek with good cover were considered to provide good rearing habitat potential. Small channel size and shallow depths provided limited space for adult fishes.



LEGEND

GOLDER 1996a	GOLDER 1996a	PISCES 1998
GRIFFITHS 1973	GOLDER 1996b	RL & L 1994
RL & L 1999a	GOLDER 1996c	WALDER ET AL. 1980
SEKERAK AND WALDER 1980	GOLDER 1997 & 1998a	
	GOLDER 1997c	
	GOLDER 1998b	
	GOLDER 1998c	
	GOLDER 1999a	
	GOLDER 2001a	
	GRIFFITHS 1973	
	MACHNIAK AND BOND 1979	
	McCART ET AL. 1977	

5 0 5
SCALE KILOMETRES

REFERENCE
ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT
RAMP

TITLE
HISTORICAL STUDY LOCATIONS-TRIBUTARY WATERSHEDS #3 TO #13 AND #15 TO #18

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000	FILE No.	Steepbank Surveyed
DESIGN	CS	08/07/02	SCALE AS SHOWN REV. 0
CADD	JAM	24/02/04	
CHECK	CB	24/02/04	
REVIEW	CB	24/02/04	

FIGURE: 4

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: Steepbank Surveyed River.dwg Feb 26, 2004 - 1:19pm

It was considered unlikely that Conn Creek would provide any habitat for overwintering by fish because of shallow depths and lack of deep pools (Golder 1999a).

5.3.3 Habitat Use

Fisheries inventory data for Conn Creek was only collected by Griffiths (1973) at one location. Arctic grayling juvenile was the only species and life stage captured in this watercourse. Therefore, the only known use of Conn Creek was as rearing habitat for Arctic grayling.

5.3.4 Data Gaps

Due to the limited amount of sampling effort, additional fisheries inventory data collected on a seasonal basis would be required to determine the fish community and life stages present in this watershed as well as relative abundance of the species present. Spring spawning surveys would be necessary to determine if Arctic grayling spawn in Conn Creek. Overwintering surveys are not recommended because the habitat that allows overwintering of fish was limited.

5.4 TRIBUTARY WATERSHED #4 – UNNAMED WATERCOURSE

Tributary Watershed #4 is a small, unnamed watercourse (Figure 2). One report provided information on this watercourse (RL&L 1999a) and Figure 4 shows the sections of the watercourse studied in this report.

5.4.1 Fish Community

Although fisheries surveys were conducted during the one investigation for Unnamed Watercourse #4, no fish were captured.

5.4.2 Habitat

The 12.0 km length of Unnamed Watercourse #4 was divided into three reaches, based on the gradient profile (RL&L 1999a). Reach 1 (lower-most reach) was on the Athabasca River floodplain and was a low gradient, marshy reach lacking a defined channel. Reach 2 was on the Athabasca valley escarpment and had a steep gradient. Reach 3 included the headwater region and was low gradient with a predominance of bogs and beaver ponds.

A section of Unnamed Watercourse #4 in the vicinity of the Highway 63 crossing was examined in detail by RL&L (1999a). Near the highway crossing, the stream had a well-defined channel and was surrounded by a mixed stand of deciduous and coniferous trees with ample undergrowth. The aquatic habitat was characterized as shallow riffle and run sequences over gravel and cobble substrates that were heavily embedded with sand and silt. Instream cover was provided primarily by woody debris. The potential of the watercourse to support fish was severely limited by low flows and a lack of deeper water.

5.4.3 Habitat Use

No fish have been captured in Unnamed Watercourse #4.

5.4.4 Data Gaps

Further fish and fish habitat inventory studies are required to determine if this watercourse supports fish, particularly in the lower reaches below the highway crossing. Seasonal sampling that determines the species and life stages present, would establish habitat and fish associations. However, because of low flow and an intermittent channel, such studies are probably not warranted.

5.5 TRIBUTARY WATERSHED #5 – CLARKE CREEK

One report (Griffiths 1973) contained fisheries information for the Clarke Creek watershed. The portions of the Clarke Creek watershed studied are provided in Figure 4.

5.5.1 Fish Community

Fish species collected in Clarke Creek during the above study are presented in Table 11. One species, a sport fish, Arctic grayling, has been captured in this watershed.

Table 11 Fish Species and Life Stages in Tributary Watershed #5 (Clarke Creek)

Species	Life Stage
Arctic grayling	juvenile

CPUE results were not provided and could not be calculated due to insufficient data.

5.5.2 Habitat

Griffiths (1973) examined a 4.8 km section of Clarke Creek. The Creek was rated as having poor to moderate habitat for sport fish because of its small size. At the time of the survey, Clarke Creek was 2.4 m wide with an average depth of 0.3 m or less and had very low flow.

5.5.3 Habitat Use

Only immature Arctic grayling were captured in Clarke Creek. Therefore, documented habitat use was limited to rearing activity by this species.

5.5.4 Data Gaps

Further study of this watershed is required, including a detailed fish and fish habitat inventory, to determine the fish community, life stages present and species relative abundance. Spawning surveys would be required to determine if Arctic grayling spawn in the stream.

5.6 TRIBUTARY WATERSHED #7 – PARSONS CREEK

One report provided information for Parsons Creek (RL&L 1999a). The sections of the Parsons Creek watershed studied in this report are in Figure 4.

5.6.1 Fish Community

One species, brook stickleback, was captured in this watershed (Table 12).

Table 12 Fish Species and Life Stages in Tributary Watershed #7 (Parsons Creek)

Species	Life Stage
brook stickleback	unspecified

Electrofishing resulted in the capture of one brook stickleback from the mouth of Parsons Creek. CPUE for brook stickleback was 0.23 fish/100 seconds of electrofishing.

5.6.2 Habitat

The 13.5 km length of Parsons Creek was divided into three reaches, based on gradient profile (RL&L 1999a). Reach 1 (lower-most reach) was in the Athabasca River floodplain and was described as low gradient, marshy and lacked a defined channel. Reach 2 was on the Athabasca valley escarpment and had a steep gradient. Reach 3 included the headwater region and was low gradient with a preponderance of bogs and beaver ponds.

A section of Parsons Creek in the vicinity of the Highway 63 crossing was examined in detail by RL&L (1999a), as was a section at the creek mouth. Near the Highway 63 crossing, the stream had a well-defined channel surrounded by a mixed stand of deciduous and coniferous trees with ample undergrowth (RL&L 1999a). The aquatic habitat was characterized by shallow riffle and run sequences over gravel and cobble substrates that were heavily embedded with sand and silt. Instream cover was provided primarily by woody debris. The section of Parsons Creek near the creek mouth (i.e., within 200 m of the Athabasca River) was very shallow and narrow, with intermittent flow. The potential of Parsons Creek to support fish was considered to be severely limited by low flows, a lack of deeper areas (maximum depth of 0.3 m) and access by fish from the Athabasca River was limited.

5.6.3 Habitat Use

The only documented use of Parsons Creek was for brook stickleback, a small-bodied forage species. One brook stickleback was captured within a few meters of the Athabasca River.

5.6.4 Data Gaps

Further fish and fish habitat inventories would be required to determine if the Parsons Creek watershed supports sport fish, particularly in the lower reaches below the highway crossing. Seasonal sampling of fish by life stage would reveal associations with habitat type by species. However, because of low flows, such studies do not appear to be warranted.

5.7 TRIBUTARY WATERSHED #8 – UNNAMED WATERCOURSE

One report provided information on Unnamed Watercourse #8 (RL&L 1999a). Figure 4 shows the sections of the watercourse studied in this report.

5.7.1 Fish Community

Fish sampling was conducted during the one investigation for Unnamed Watercourse #8, but no fish were captured.

5.7.2 Habitat

The 9.7 km length of Unnamed Watercourse #8 was divided into three reaches, based on the gradient profile (RL&L 1999a). Reach 1 (lower-most reach) was on the Athabasca River floodplain and was described as low gradient, marshy and lacked a defined channel. Reach 2 was on the Athabasca valley escarpment and had a steep gradient. Reach 3 included the headwater region and was low gradient with a predominance of bogs and beaver ponds.

A section of Unnamed Watercourse #8 in the vicinity of the Highway 63 crossing was examined in detail by RL&L (1999a). Near the Highway 63 crossing, the stream had a well-defined channel surrounded by a mixed stand of deciduous and coniferous trees with ample undergrowth (RL&L 1999a). The aquatic habitat was characterized by shallow riffle and run sequences over gravel and cobble substrates that were heavily embedded with sand and silt. Instream cover was provided primarily by woody debris. The potential of the watercourse to support fish was considered to be severely limited by low flows and a lack of deeper areas.

5.7.3 Habitat Use

No fish were captured in Unnamed Watercourse #8.

5.7.4 Data Gaps

Further fish and fish habitat inventory studies would be required to determine if this watercourse supports sport fish, particularly in the lower reaches below the highway crossing. Seasonal sampling of fish by life stage would determine fish presence and habitat use. However, due to habitat limitations and low flows, such studies are not warranted.

5.8 TRIBUTARY WATERSHED #9 – DONALD CREEK

One report (Golder 1998a) and one file document (Golder 1997a) contained fisheries information on the Donald Creek watershed. Both documents pertained to the same study (Golder 1998a) and contained the same fish capture information. The portion of the Donald Creek watershed studied is in Figure 4.

5.8.1 Fish Community

One juvenile longnose sucker, was captured in this watercourse (Table 13).

Table 13 Fish Species and Life Stages in Tributary Watershed #9 (Donald Creek)

Species	Life Stage
longnose sucker	juvenile

Electrofishing CPUE for the juvenile longnose sucker taken from Donald Creek was 0.16 fish/100 seconds (Golder 1998a).

5.8.2 Habitat

The lower reaches of Donald Creek had a steep gradient and the watercourse consisted primarily of riffles and shallow, low quality (i.e. Class 3) run habitats (Golder 1998a). The substrate in this segment was large cobble and small boulders with some bedrock. The upper reaches were similar to the lower reaches in that riffle habitat was predominant. Numerous backwater areas and chutes were present in the upper segment of the creek.

Habitat potential for fish rearing was considered excellent in the upper reaches of Donald Creek due to the presence of riffles habitats and undercut banks providing cover for fish (Golder 1998a); however, chutes located downstream of this segment would likely prevent fish migration upstream to this area from the Athabasca River.

5.8.3 Habitat Use

Habitat use was reported only for longnose sucker rearing. Few fish were captured and these were captured near the confluence with the Athabasca River.

5.8.4 Data Gaps

A seasonal fisheries inventory would be required to determine the fish species and life stages present in Donald Creek, and to determine if the upper reaches of the watercourse are accessible to fish. The presence of rocky substrates probably justifies a spring spawning survey.

5.9 TRIBUTARY WATERSHED #10 – UNNAMED WATERCOURSE

One report (Golder 1998a) and one file document (Golder 1997a) contained fisheries information on Unnamed Watercourse #10. Both documents pertain to the same study (Golder 1998a) and contained the same fish capture information. The portion of Watershed #10 that was examined is in Figure 4.

5.9.1 Fish Community

Fish captured in this watercourse include two sport fish species (Table 14).

Table 14 Fish Species and Life Stages in Tributary Watershed #10 (Unnamed Watercourse)

Species	Life Stage
Arctic grayling	juvenile
burbot	juvenile

CPUE, given as #fish/100 electrofishing seconds, was 0.21 for Arctic grayling and 0.21 for burbot (Golder 1998a).

5.9.2 Habitat

This watercourse had a moderate to high stream gradient (Golder 1998a). The habitat consisted primarily of riffles and boulder garden areas. The occasional low quality (i.e. Class 3) pool was present. Boulder was the predominant substrate, with cobble and gravel also present. Overhead cover was provided by undercut banks, overhanging vegetation and woody debris. Instream cover was provided by boulders and woody debris.

The habitat was considered to provide excellent potential for rearing fish, although gradient and vertical drops over large substrate materials probably formed barriers to fish movement that would likely have limited their upstream migration (Golder 1998a).

5.9.3 Habitat Use

This watercourse was documented to be used in the fall to a minor extent as rearing habitat by juvenile Arctic grayling and burbot.

5.9.4 Data Gaps

A seasonal inventory of fish would be required to document the species and life stages that utilize this watercourse and determine the extent to which upstream fish movements may be limited by habitat conditions. As the available habitats include swift flowing water over rocky substrate, spring spawning surveys would be warranted to determine if the watercourse is used for spawning.

5.10 TRIBUTARY WATERSHED #11 – UNNAMED WATERCOURSE

One report (Golder 1998a) and one file document (Golder 1997a) contained fisheries information on Unnamed Watercourse #11. Both documents pertained to the same fisheries study (Golder 1998a) and contained the same fish capture information. The portion of Watershed #11 that was examined is in Figure 4.

5.10.1 Fish Community

One sport fish species, burbot, was captured in this watercourse (Table 15).

Table 15 Fish Species and Life Stages in Tributary Watershed #11 (Unnamed)

Species	Life Stage
burbot	juvenile

CPUE for burbot was 0.26 fish/100 electrofishing seconds (Golder 1998a).

5.10.2 Habitat

This watercourse had a high gradient and thus the stream consisted almost entirely of riffles and shallow, low quality (i.e. Class 3) runs (Golder 1998a). Boulder gardens were present in association with some of the riffles in the upper portion of the surveyed watercourse. Small pools and occasional backwaters were also present. The substrate varied from fines in areas of low water velocity to cobble and boulder in areas of faster moving water. Boulders dominated the substrate in upstream sections. Overhanging vegetation, woody debris and undercut banks provided overhead cover for fish and numerous boulder gardens and instream debris provided instream cover. Potential rearing habitat was present for fish able to access the various sections of the watercourse.

5.10.3 Habitat Use

Documented fish use was limited to burbot rearing activity, with juvenile burbot were present in the lower reach (Golder 1998a).

5.10.4 Data Gaps

Due to the limited amount of sampling that has been conducted, a seasonal fisheries inventory is required to determine the fish species and life stages present in this watercourse. The presence of habitats with swift flowing water over rocky substrates warrants a spring spawning survey.

5.11 TRIBUTARY WATERSHED #12 – MCLEAN CREEK

Four reports provide fisheries information on the McLean Creek watershed (Golder 1996a, 1998a, 1998b, 1998c). The portions of the McLean Creek watershed studied are provided in Figure 4.

5.11.1 Fish Community

The fish species collected from McLean Creek are provided in Table 16. In total, five fish species have been reported from this watershed including two sport fish species, one sucker species and two small-bodied forage species.

Table 16 Fish Species and Life Stages in Tributary Watershed #12 (McLean Creek)

Species	Life Stage
Arctic grayling	fry, juvenile, adult
burbot	juvenile
emerald shiner	unspecified
longnose sucker	juvenile
spoonhead sculpin	unspecified

CPUE for Arctic grayling fry was calculated based on the number of fish captured during the 1997 fall study (Golder 1998a) (Table 17).

Table 17 CPUE for Arctic Grayling Captured in Tributary Watershed #12 (McLean Creek) – 1997[a]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
Arctic grayling	3	fall	545	0.55

(a) Golder 1998a.

CPUE was also calculated for all species captured in the spring and fall sampling, 1998 (Table 18).

Table 18 CPUE for Fish Species Captured in Tributary Watershed #12 (McLean Creek) – 1998[a]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
Arctic grayling (juvenile)	8	spring	n/a	1.35
Arctic grayling (juvenile)	11	fall		1.30
Arctic grayling (adult)	2			0.33
burbot (juvenile)	1	spring		0.12
emerald shiner	1	fall		0.16
longnose sucker (juvenile)	20			3.26
spoonhead sculpin (juvenile)	12	spring		1.48
spoonhead sculpin (adult)	1			0.12
spoonhead sculpin (adult)	5	fall		0.82

(a) Golder 1998b.

n/a = Not available.

The most abundant species and life stage captured in McLean Creek was juvenile longnose sucker (fall only), followed by juvenile Arctic grayling and spoonhead sculpin.

5.11.2 Habitat

Golder (1998a) described the habitat in lower McLean Creek as having a moderate to high gradient with a series of riffle, run and pool sequences. Channel morphology was similar throughout the lower reach with a mean wetted width of 2.1 m and a mean depth of 0.12 m at the time of survey. The maximum water depth was 0.6 m. Although cobble and gravel substrates were present in the lower-most portion of the channel, approximately 200 m upstream from the creek mouth the cobble and gravel was heavily embedded with fines. Fish cover was provided by instream woody debris, overhanging vegetation and undercut banks. During a spring survey in 1995, the discharge and water levels in the creek were considered sufficiently low to limit fish passage into McLean Creek from the Athabasca River (Golder 1996a), indicating that access to this tributary may be limited by discharge. Upper McLean Creek (above the Athabasca River escarpment) had a low stream gradient and a poorly defined channel (Golder 1998c). Flooded beaver ponds occurred in the upper creek and woody debris and aquatic plants provided overhead and instream cover. Beaver dams, debris piles and chutes were considered to be potential barriers to fish movement.

As part of Oil Sands development, McLean Creek receives waters diverted from the upper catchment of Wood Creek, resulting in increased flows in McLean Creek (Golder 1998c). As part of a habitat monitoring program associated with the diversion, Golder (1998b) determined the habitat and channel morphology in McLean Creek in the fall of 1998 was similar to that observed in 1997.

5.11.3 Habitat Use

Arctic grayling and spoonhead sculpin were captured in lower McLean Creek during both the spring and fall surveys by Golder (1998b). Burbot were present only during the spring and emerald shiner and longnose sucker were present during the fall. All life stages of Arctic grayling were present, indicating use of this watercourse for nursery, rearing and feeding habitat by this species. The presence of Arctic grayling fry indicates that the lower reaches of McLean Creek may provide spring spawning habitat for adults (Golder 1998a). Young burbot and longnose sucker are also present in McLean Creek.

5.11.4 Data Gaps

Further seasonal studies are required to determine the fish community present in the McLean Creek watershed, including species and life stages. Fish populations and habitat in McLean Creek are being investigated as part of the monitoring program associated with the diversion from Wood Creek.

5.12 TRIBUTARY WATERSHED #13 – WOOD CREEK

Four reports contain fisheries information on the Wood Creek watershed (Golder 1996a, 1996b, 1998b, 1998c). The portions of the Wood Creek watershed studied in these reports are in Figure 4.

5.12.1 Fish Community

A total of eight species were captured in Wood Creek including three sport fish species, one sucker species and four small-bodied forage species (Table 19).

Table 19 Fish Species and Life Stages in Tributary Watershed #13 (Wood Creek)

Species	Life Stage
Arctic grayling	juvenile, adult
brook stickleback	unspecified
burbot	juvenile
lake chub	unspecified
longnose sucker	juvenile, unspecified
mountain whitefish	juvenile, unspecified
spoonhead sculpin	unspecified
trout-perch	unspecified

CPUE was calculated for the spring survey, 1995, (Golder 1996a, Table 20) and for the spring and fall sampling, 1998 (Golder 1998b, Table 21).

Table 20 CPUE for Fish Species Captured in Tributary Watershed #13 (Wood Creek) – 1995[(a)]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
brook stickleback	1	spring	1,222	0.08
longnose sucker	1			0.08
mountain whitefish	1			0.08
spoonhead sculpin	3			0.25

(a) Golder 1996a.

Table 21 CPUE for Fish Species Captured in Tributary Watershed #13 (Wood Creek) – 1998[a]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
Arctic grayling	7	spring	1,050	0.70
burbot	2			0.19
longnose sucker	5			0.48
mountain whitefish	1			0.10
spoonhead sculpin	19			1.81
Arctic grayling	7	fall	1,000	0.70
burbot	2			0.20
lake chub	10			1.00
longnose sucker	39			3.90
spoonhead sculpin	8			0.80
trout-perch	1			0.10

[a] Golder 1998b.

Spoonhead sculpin were also captured in minnow traps; the CPUE for this species was 0.23 fish/minnow trap hour. The most abundant species in both the spring and fall were Arctic grayling, longnose sucker and spoonhead sculpin. Lake chub were also relatively abundant in the fall.

5.12.2 Habitat

Wood Creek is a small watercourse with an average flow estimated to be 0.17 m^3/s during the open-water period (Golder 1998b). The average wetted width of Wood Creek was 3.15 m and the mean depth was 0.28 m at a measured discharge of 0.18 m^3/s (Golder 1998b). At a higher discharge of 0.54 m^3/s, the average wetted width was 5.5 m (Golder 1998c). The lower segment of Wood Creek was moderately steep with both riffle and run habitats present (Golder 1996a), with the exception of the lower 250 m that has a low gradient where it flows through the flood plain of the Athabasca River (Golder 1998b). The substrate in the lower reaches was predominantly cobble and gravel with some bedrock intrusions and some areas that were embedded in fines (Golder 1996a). The lower creek had abundant cover for fish from numerous debris piles, with the exception of the lower 100 m of the watercourse, which provided minimal overhead and instream cover (Golder 1998b).

Farther upstream, in the middle reaches of Wood Creek, the channel remained relatively steep with riffle and run habitats present (Golder 1996b). Boulder gardens were present in some of the riffle areas, which provided ample instream cover for fish. In the middle reaches, the substrate in areas other than riffles was cobble and gravel. Undercut banks, debris and overhanging vegetation were present in moderate amounts to provide overhead cover for fish (Golder 1996b). The upper reaches of Wood Creek contain numerous beaver dams, forming a series of ponds, wetlands, fens, bogs and swamps, although both runs and riffles were also located throughout these reaches (Golder 1996b, 1998b). Sedimentation had occurred in this area of the creek and the dominant substrate type was fines. Coarser materials such as cobble and gravel were present only in the centre of the channel in riffle areas. There was ample overhead cover mostly from instream debris, with some overhanging vegetation and undercut banks present (Golder 1996b).

Because of its small size and shallow depths, Wood Creek had limited potential for adults or to provide overwintering conditions; however, portions of the creek could provide rearing habitat for juvenile fish of various species from the Athabasca River. In addition, swift flowing habitats with rocky substrates were present throughout the lower and middle reaches, providing potential spawning and nursery habitat.

Under the development plan for the Millennium Mine, the upper catchment of Wood Creek is being diverted to the McLean Creek watershed (Golder 1998c), eliminating flow in Wood Creek. The diversion of the Wood Creek catchment is proposed to continue in the future.

5.12.3 Habitat Use

Arctic grayling, spoonhead sculpin, burbot and longnose sucker were all found in Wood Creek during both spring and fall studies (Golder 1998b). Mountain whitefish were captured during the spring survey only and trout-perch and lake chub were present during the fall survey only. Fish were only present in the lower reaches of the creek (Golder 1998c).

Arctic grayling, burbot, longnose sucker and mountain whitefish were the large-bodied species reported for the Wood Creek watershed. All four species were present as juveniles and used the watershed for rearing activities. Adult Arctic grayling were also captured in Wood Creek in the spring of 1998 (Golder 1998b), which indicates that spawning may occur in this watercourse. However, spawning by Arctic grayling has not been documented and no fry have been reported in Wood Creek.

Overwintering in this watershed is unlikely because there are no deep pools and flow is low.

5.12.4 Data Gaps

The Wood Creek diversion plan affects the value of additional study.

5.13 TRIBUTARY WATERSHED #14 – POPLAR CREEK

Twelve reports or documents provide fisheries information pertaining to the Poplar Creek watershed (Griffiths 1973; Syncrude 1975; Noton and Chymko 1977a, 1977b, 1978; O'Neil 1979, 1982; Syncrude 1985; Boerger 1986; Golder 1996a, 1997b, 1999a). Figure 5 shows the portions of the Poplar Creek watershed included in these reports.

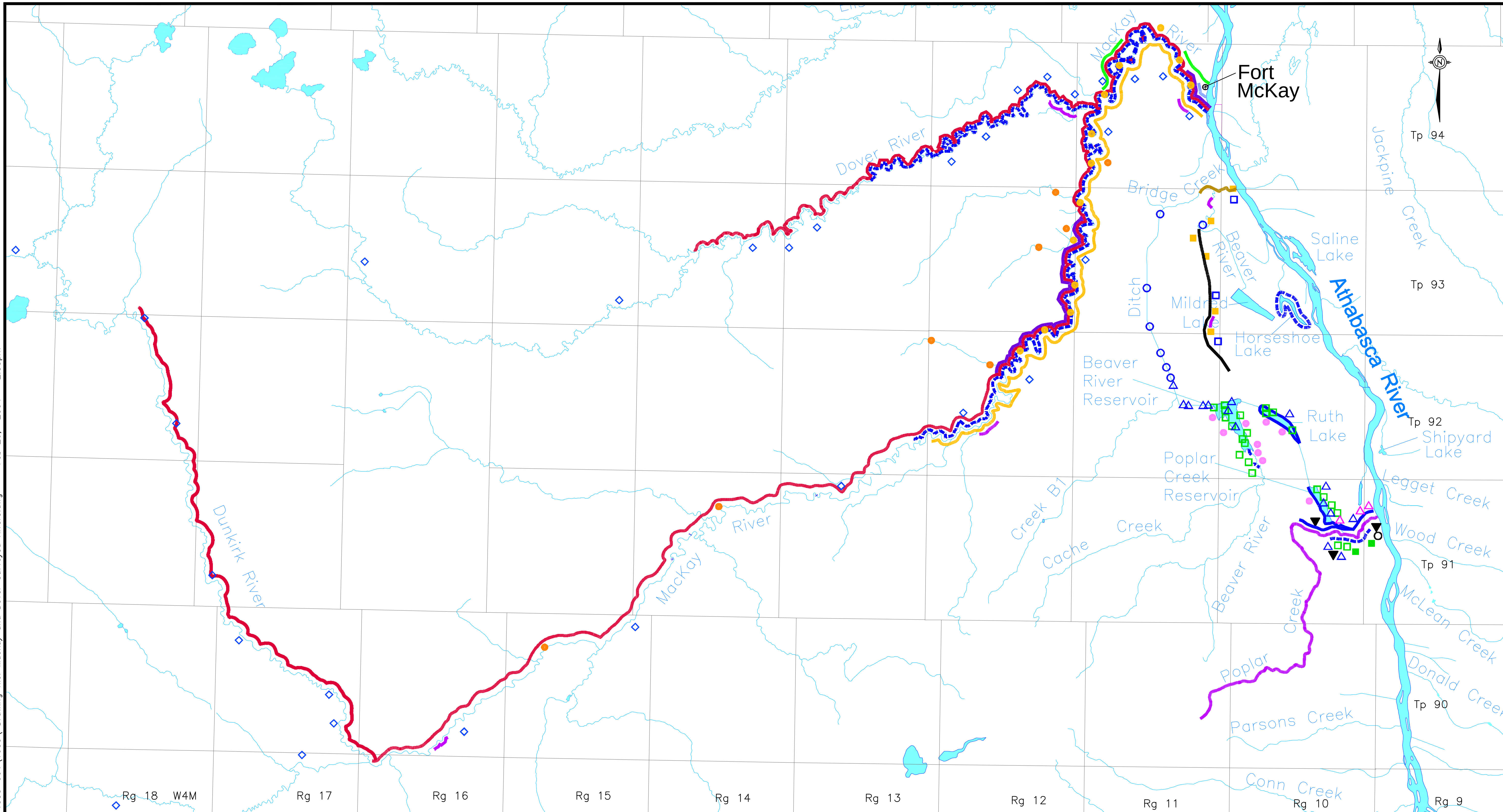
5.13.1 Fish Community

The fish species and life stages that occur in the Poplar Creek watershed in the above reports are summarized in Table 22. In total, 17 fish species have been captured, including seven sport species, two sucker species and eight small-bodied forage species.

Table 22 Fish Species and Life Stages in Tributary Watershed #14 (Poplar Creek)

Species	Life Stage
Arctic grayling	fry, juvenile, adult, spawning
brook stickleback	unspecified
burbot	juvenile, adult
emerald shiner	unspecified
fathead minnow	unspecified
finescale dace	unspecified
flathead chub	unspecified
goldeye	unspecified
lake chub	unspecified
lake whitefish	juvenile, unspecified
longnose sucker	juvenile, adult, unspecified
mountain whitefish	unspecified
northern pike	fry, juvenile, adult
northern redbelly dace	unspecified
trout-perch	unspecified
white sucker	fry, juvenile, adult, spawning
yellow perch	unspecified

CPUE is presented in Tables 23 and 24 for the reports for which the data was available. The most abundant species appeared to be brook stickleback, fathead minnow, lake chub and white sucker.



LEGEND

- GOLDER 2002a
- GRIFFITHS 1973
- MACHNIAK ET AL. 1980
- RL & L 1994
- RL & L 1999b
- ROBERTSON 1970
- SEKERAK AND WALDER 1980
- SYNCRUDE 1975
- SYNCRUDE 1985
- VANMEER 1990
- VANMEER 1993
- AXYS 1998
- BOERGER 1986
- GOLDER 1996a
- GOLDER 1999a
- MCCART ET AL. 1978
- NOTON AND CHYMKO 1977a & b
- NOTON AND CHYMCO 1978
- O'NEIL 1979
- O'NEIL 1982
- RRCS 1973
- SYNCRUDE 1973
- SYNCRUDE 1977
- SYNCRUDE 1985
- WALDER ET AL. 1980

5 0 5
SCALE KILOMETRES

REFERENCE
ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT
RAMP

TITLE
HISTORICAL STUDY LOCATIONS- TRIBUTARY WATERSHEDS #14, #19 TO #26, AND #28 TO #31

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Mackay and Dover
DESIGN	CS	08/07/02	SCALE AS SHOWN	REV. 0
CADD	JAM	23/02/04		
CHECK	CB	23/02/04		
REVIEW	CB	23/02/04		

FIGURE: 5

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Table 23 CPUE for Fish Species Captured in Tributary Watershed #14 (Poplar Creek) – 1978[a]

Species	Number of Fish	Sampling Season	Gill Net		Seine Net	
			Effort (hr)	CPUE (#/100 hr)	Effort (m)	CPUE (#/100 m)
brook stickleback	n/a	spring	-	-	1,025	<0.1
		summer	-	-	2,200	17.5
		fall	-	-	3,75	0.2
fathead minnow		spring	-	-	2,200	0.7
		summer	-	-	2,200	156.6
		fall	-	-	1,150	11.9
lake chub		summer	-	-	562	<0.1
white sucker		spring	34.0	8.4	1,025	0.1
		summer	16.0	32.3	2,937	1.3
		fall	17.0	2.1	-	-

[a] O'Neil 1979.

n/a = Not available.

Table 24 CPUE for Fish Species Captured in Tributary Watershed #14 (Poplar Creek) – 1997[a]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
Arctic grayling	n/a	fall	25.1	0.4
		spring	8.6	0.1
		summer	40.4	1.6
brook stickleback		fall	20.2	7.1
		summer	11.2	0.4
burbot		fall	4.0	0.5
		summer	10.0	0.2
fathead minnow		fall	9.4	16.2
		summer	23.7	3.6
lake chub		fall	34.5	26.8
		spring	7.9	0.5
		summer	46.4	15.0
longnose sucker		spring	13.9	0.7
		summer	16.7	1.7
northern pike		fall	9.4	0.1
		spring	12.2	0.7
		summer	12.7	0.4
white sucker		fall	38.5	29.1
		spring	37.1	25.1
		summer	46.4	39.5

[a] Golder 1997b.

n/a = Not available.

5.13.2 Habitat

Griffiths (1973) conducted a synoptic aerial survey of the entire length of Poplar Creek and rated the potential of the watercourse to support sport fish as poor; however, those habitat limitations were not provided. Later surveys (O'Neil 1979, 1982; Syncrude 1985; Boerger 1986) provided descriptions of habitat in the mainstem Poplar Creek as well as habitat alterations that occurred within development in the area. Poplar Creek was integrated into the Beaver River diversion system in 1976 following completion of the Poplar Creek spillway. The diversion moves water from the upper Beaver River to Poplar Creek via the Beaver River Reservoir, Ruth Lake and the Poplar Creek Reservoir, with flow from the Poplar Creek spillway entering Poplar Creek a short distance upstream of the Highway 63 crossing. [Note: Information for the Beaver River Reservoir, Ruth Lake and the Poplar Creek Reservoir is provided in the Beaver River Section]. Eleven drop structures have been incorporated into the Poplar Creek channel between the spillway and just below Highway 63. A 1.8 km section of the creek below the spillway was channelized to accommodate increased flows from the diversion system (Syncrude 1985).

Following channel modifications in Poplar Creek, the watercourse was divided into three reaches that included the original channel extending from 200 m downstream of highway 63 to the mouth, the channelized section between the diversion spillway and just below the highway, and the original channel upstream of the diversion spillway (Noton and Chymko 1978). Syncrude (1985) later delineated five reaches for Poplar Creek, but provided habitat descriptions for only the lower three reaches. The lower two reaches were the same as presented by Noton and Chymko (1978), but a longer section of the upper creek was examined and divided into reaches.

Reach 1 (0.0 to 2.1 km upstream of the creek mouth) had a low gradient with few riffles and was characterized by flat habitat with sand and silt substrate and abundant deadfalls (Syncrude 1975; 1985; Golder 1996a). Reach 2 (2.1 to 3.9 km upstream of the mouth) included the channelized portion of the creek. In this reach, riffle, run and flat habitat types were present in association with each of the 11 drop structures. The substrate here varied from boulders to sand and silt, with coarser substrates occurring in the swifter habitat types. Reach 3 (3.9 to 11.5 km upstream of the mouth) was a high gradient reach. There was an increase in riffle frequency in this reach and the substrate consisted of cobble and gravel (Syncrude 1975). Habitat diversity was high in Reach 3, with riffles, runs, flats and pools present. Overall, the substrate was dominated by coarse textured material (gravel and cobble), but sand was common. Reach 4 and 5 extended from 11.5 to 24.0 km and 24.0 to 31.0 km upstream of the mouth, respectively.

Habitat in Poplar Creek was limited for feeding and overwintering activities by large-bodied fish due to small channel size and shallow depths, although dissolved oxygen levels were high throughout the year (Noton and Chymko 1977b). The creek would provide potential rearing habitat for fish from the Athabasca River, as well as potential spawning habitat in the middle and upper reaches where swift flowing water over rocky substrate occurs.

5.13.3 Habitat Use

The lower reach of Poplar Creek was not used to an appreciable extent by sport fish (Syncrude 1975) and, in general, fish populations in the creek were small (Noton and Chymko 1977b). Arctic grayling, white sucker and longnose sucker were present in summer (Syncrude 1975). A multi-season study indicated that Arctic grayling, brook stickleback, fathead minnow, lake chub, northern pike and white sucker were present in spring, summer and fall (O'Neil 1979). In addition, burbot were present in summer and fall and longnose sucker were present in spring and summer. Species diversity in Poplar Creek decreased upstream, with increasing distance from the Athabasca River, and it was suggested that fish may enter the lower reaches of the creek to forage (Syncrude 1985).

With respect to sport fish, Arctic grayling were shown by past studies to use Poplar Creek primarily for rearing and feeding activities. Arctic grayling were present in some surveys and not in others (Syncrude 1975, 1985, O'Neil 1979, 1982), indicating that the presence of Arctic grayling in Poplar Creek was variable on a seasonal and yearly basis. Syncrude (1985) compared Arctic grayling abundance to flow levels and determined that their occurrence was related to periods of higher discharge in the creek and concluded that this species was primarily a seasonal migrant from the Athabasca River using the creek for foraging. Based on the presence of adult female fish in spawning condition and fry, Noton and Chymko (1977b) suggested that spawning by Arctic grayling may have occurred to some extent in Poplar Creek prior to watershed modifications. Recently, evidence of limited Arctic grayling spawning activity was documented at one site in the vicinity of the spillway confluence (Golder 1996a). Northern pike were not common in Poplar Creek, although adults in spawning condition were found in the spring. However, based on the limited amount of suitable spawning habitat for this species and the absence of fry in summer catches, significant use of the creek for spawning by northern pike was considered unlikely (O'Neil 1982; Syncrude 1985). Other sport species occur in low abundance and/or only in the lower creek, in association with the Athabasca River, and use Poplar Creek for rearing or feeding.

All life stages of white sucker were captured in Poplar Creek, indicating use as nursery, rearing and feeding habitat by this species. Pre-spawning concentrations of white sucker adults were found in lower Poplar Creek in the spring and large numbers of white sucker fry were reported during the summer (Syncrude 1985), probably indicating successful spawning by this species. Previously, Noton and Chymko (1977) captured post-emergent sucker fry in drift nets in Poplar Creek, also indicating successful spawning, but not identifying the species involved. Overall, longnose sucker were substantially less abundant than white suckers and were mainly present as juveniles, although a few adults were also reported. One sucker spawning site was documented in Poplar Creek, but the species spawning was not identified (Golder 1996a). From the available data, it would seem most likely that the spawning site would have belonged to white sucker.

5.13.4 Data Gaps

The use of Polar Creek for spawning activity is uncertain for some species, such as northern pike. Although one Arctic grayling spawning site was reported, the extent of spawning by this species is unknown. Spawning surveys would be required to identify the species that utilize Poplar Creek for spawning and the locations of spawning sites.

5.14 TRIBUTARY WATERSHED #15 – LEGGETT CREEK

Four reports provided information pertaining to the Leggett Creek watershed (Golder 1996a, 1996b, 1998b, 1998c). Figure 4 shows the portions of the Leggett Creek watershed included in these reports.

5.14.1 Fish Community

Fish species collected in the Leggett Creek watershed have been summarized and are listed in Table 25. Five species, four of which were small-bodied forage species, were captured. Unidentified sucker fry (i.e., white sucker and/or longnose sucker) were also captured.

Table 25 Fish Species and Life Stages in Tributary Watershed #15 (Leggett Creek)

Species	Life Stage
emerald shiner	unspecified
lake chub	unspecified
pearl dace	unspecified
spottail shiner	unspecified
sucker spp. (unidentified)	fry

CPUE was calculated for the 1995 and 1996 surveys (Golder 1996a, 1996b). CPUE, given as #fish/100 electrofishing seconds, were: emerald shiner 0.22, lake chub 1.2, pearl dace 0.22 and spottail shiner 0.12. During 1998 (Golder 1998b), no fish were captured by electrofishing in the lower section of Leggett Creek during the spring survey; however, schools of unidentified fry were seen along the margins of the creek. Some fry were collected and later identified as sucker spp.

5.14.2 Habitat

Golder (1996b) examined three separate portions of Leggett Creek representing the lower, middle and upper reaches of the watercourse. The lower segment of Leggett Creek had a moderate gradient and possessed medium quality (i.e., Class 2) pools and run habitats. The substrate in the lower creek was composed primarily of fine sediments. This reach had good overhead cover provided by instream debris, undercut banks and overhanging vegetation. Farther upstream, the gradient increased with the middle reach of the creek having a moderately high gradient. Riffle was the dominant habitat type in the middle reach and the substrate was coarse with cobble and gravel dominating. Ample overhead cover was provided by instream debris. The upper reach of Leggett Creek also had a moderately high gradient. The habitat was predominantly riffles and runs with a few pools. The substrate consisted of fines lining pool areas and coarser cobble and gravel present in riffles. In the headwaters of Leggett Creek, the channel was poorly defined and the substrate consisted of fines and peat.

Habitat in Leggett Creek was limited by the small size of the channel and lack of deep-water habitats. Habitat was considered suitable for forage fish but of limited utility for sport species (Golder 1998c). The potential of the stream to provide adequate feeding, holding and overwintering habitat for large-bodied fish was considered to be limited. The creek would provide potential nursery and rearing habitat for fish from the Athabasca River, at least in the lower, more accessible reaches. The middle and upper portions of Leggett Creek consisted of a small channel with beaver activity, instream debris and low discharge levels that were considered to limit fish passage. Habitat for spawning was present in some reaches for species that spawn in swift flowing water over rocky substrates.

Since the completion of the studies summarized above, Leggett Creek has been altered as a result of Oil Sands development. Upper Leggett Creek will be altered by development of the Millennium Mine and the lower creek is to be dewatered as part of the diversion plan for the Mine.

5.14.3 Habitat Use

No sport fish have been reported in Leggett Creek (Golder 1998c). Use has been documented for small-bodied forage fish and for sucker nursery activity. Fish have been limited to the lower-most portion of the creek only; no fish were captured in the middle or upper reaches. Spring spawning surveys were conducted in each of the three study sections but no spawning activity was found (Golder 1996b).

5.14.4 Data Gaps

The flow alterations associated with the Millennium Mine diversion plan precludes further study.

5.15 TRIBUTARY WATERSHED #17 – UNNAMED WATERCOURSE (SHIPYARD LAKE OUTLET)

Five reports provided fisheries information on the unnamed watercourse that connects Shipyard Lake to the Athabasca River (Golder 1996a, 1996b, 1996c, 1997c, 1998c). Information is available for the Shipyard Lake outlet channel, Shipyard Lake and two unnamed watercourses flowing into Shipyard Lake. Figure 4 shows the portions of this watershed included in the reports.

5.15.1 Fish Community

Fish species reported for the Shipyard Lake watershed are summarized in Table 26. In total, seven fish species were reported in this watershed including two sport species and five small-bodied forage species. All fish were captured in the Shipyard Lake outlet channel, with the exception of northern pike, which were captured only in Shipyard Lake. Brook stickleback was the only species recorded in the watershed upstream of Shipyard Lake.

Table 26 Fish Species and Life Stages in Tributary Watershed #17 (Shipyard Lake Outlet)

Species	Life Stage
brook stickleback	unspecified
emerald shiner	unspecified
lake chub	unspecified
northern pike	adult
spottail shiner	unspecified
trout-perch	unspecified
yellow perch	unspecified

Data were insufficient to calculate relative abundance (CPUE), however, all fish species were captured in low numbers.

5.15.2 Habitat

Fish habitat in this watershed was found to be limited. The Shipyard Lake outlet channel was entirely composed of shallow, low quality (i.e., Class 3) run habitat with silt/sand substrate (Golder 1996b). Some instream cover was available from woody debris and breached beaver dams. The Shipyard Lake outlet channel would generally be available for seasonal use by forage fish species, with some potential for rearing activities by large-bodied species from the Athabasca River. The potential for overwintering here by fish would be limited.

Shipyard Lake was a small, shallow marsh on the Athabasca River floodplain. Floating aquatic vegetation bordered the open-water area and emergent vegetation (primarily cattail) occurred along the perimeter of the wetland. Water depths ranged from 1.5 to 2.3 m in the summer (Golder 1996c). The habitat present in Shipyard Lake were considered to provide spawning habitat for sport species such as northern pike and yellow perch that utilize areas with aquatic vegetation for spawning (Golder 1998c). The lake was low in dissolved oxygen and shallow in winter (Golder 1997c), indicating poor overwintering conditions.

Two small watercourses that flow into Shipyard Lake were studied by Golder (1996b). One of these watercourses consisted primarily of fens and ponded areas with a well-defined channel only over the lower 2 km. This lower area was composed mainly of run habitats with some riffles and pools. The substrate was primarily silt. Several beaver dams were present throughout the watercourse, potentially affecting fish passage. The second watercourse also had a defined channel near where it enters Shipyard Lake, consisting almost entirely of shallow, low quality runs. The substrate in this lower section was composed of fines. Farther upstream, the watercourse flows down the escarpment where it has a steeper gradient, faster flowing run habitats and gravel substrate. Above the escarpment the watercourse had no defined channel. Habitat potential for these two watercourses would be mainly limited to forage species.

5.15.3 Habitat Use

Fish in the Shipyard Lake outlet channel were mainly small-bodied forage fish species. A small number of yellow perch were captured in the lower-most portion of this watercourse. Adult northern pike were present in Shipyard Lake in the spring of 1996 (Golder 1996b). It was considered that northern pike from the Athabasca River probably used this lake for spawning when flow and passage conditions in the outlet channel permitted. Yellow perch in the outlet channel indicates that this species may also spawn here when conditions permit (Golder 1998c).

Brook stickleback was the only species captured upstream of Shipyard Lake and was present only in the lower-most portion of one of the two tributary watercourses examined.

Fish passage into the watercourse from the Athabasca River was affected by both flow levels and beaver activity. During the spring 1995 survey (Golder 1996a), there was no water in the lower reaches of the Shipyard Lake outlet channel and fish passage into the watershed was not possible. In spring 1996, fish could move up the channel for the lower 2 km where passage was blocked by a large beaver dam (Golder 1996b). Later in 1996, water levels in the watercourse were elevated above the dam. It was concluded that fish species and their abundance in this watershed likely varied with flow conditions (Golder 1998c).

One overwintering study was conducted for Shipyard Lake, but no fish were captured (Golder 1997c).

5.15.4 Data Gaps

Further studies are required to determine the discharge levels at which northern pike could access Shipyard Lake and to determine if yellow perch spawn in the lake and if either species use the lake for nursery and rearing habitat.

5.16 TRIBUTARY WATERSHED #18 – STEEPBANK RIVER

Thirteen reports provided fisheries information for the Steepbank River watershed (Griffiths 1973; McCart et al. 1977; Machniak and Bond 1979; Sekerak and Walder 1980; Walder et al. 1980; RL&L 1994; Golder 1996a, 1997c, 1998c, 2001a; Mill et al. 1997; Pisces 1998; TERA 2000). Information is available for the mainstem Steepbank River and three of its tributaries. The three tributaries include the North Steepbank River (the main tributary to the Steepbank River) and two small, unnamed watercourses. Figure 4 shows the portions of the Steepbank River watershed that have been examined by these studies.

5.16.1 Fish Community

Fish species reported in the Steepbank River from the above reports are summarized in Table 27. Twenty four fish species were captured in this watershed, including ten sport species, two sucker species and twelve small-bodied forage species.

Table 27 Fish Species and Life Stages in Tributary Watershed #18 (Steepbank River)

Species	Life Stage
Arctic grayling[a]	fry, juvenile, adult, spawning
brassy minnow	unspecified
brook stickleback[a]	unspecified
bull trout	juvenile, unspecified
burbot	juvenile, unspecified
fathead minnow	unspecified
flathead chub	unspecified
goldeye	juvenile, unspecified
lake chub[a]	unspecified
lake cisco	unspecified
lake whitefish	adult, unspecified
longnose dace[a]	unspecified
longnose sucker[a]	fry, juvenile, adult, spawning
mountain whitefish	fry, juvenile, adult
northern pike	juvenile, adult, unspecified
northern redbelly dace	unspecified
pearl dace[a]	unspecified
slimy sculpin[a]	unspecified
spoonhead sculpin	unspecified
spottail shiner	unspecified
trout-perch[a]	unspecified
walleye	fry, juvenile, adult
white sucker[a]	fry, juvenile, adult, spawning
yellow perch	fry, unspecified

(a) Species also occurs in the North Steepbank River.

All of the above species were captured in the mainstem Steepbank River. Nine species were found in the North Steepbank River, including Arctic grayling, brook stickleback, lake chub, longnose sucker, longnose dace, pearl dace, slimy sculpin, trout-perch and white sucker (Table 27). No fish were captured in the two unnamed tributaries that were sampled.

A counting fence deployed near the mouth of the Steepbank River documented the species and numbers of fish moving in and out of the river in the spring and fall of 1977 (Machniak and Bond 1979). This study provided the most comprehensive evaluation of the large-bodied fish populations in this watershed, including length frequency distributions, length-weight relationships, growth, age at maturity, egg size, gonad weight and fecundity. Other information provides fisheries data for specific locations in the watershed (Griffiths 1973; Machniak and Bond 1979; Pisces 1998; TERA 2000; Golder 2001a) or for specific sections of the river (Golder 1996a). Additional fish measurements and population metrics were provided in Golder (1996a).

A summary of fish captured by Machniak and Bond (1979) in the counting fence, spring and fall, at the mouth of the Steepbank River is presented in Table 28. Other information that describes fish species relative abundance is the CPUE data calculated for the fisheries inventory conducted for the lower 26 km of the Steepbank River in 1995 (Golder 1996a, Table 29). CPUE data was not reported for any of the other reports.

Table 28 Summary of Fish Counting Fence Results for Tributary Watershed #18 (Steepbank River) – 1977[a]

Species	Spring		Fall	
	Upstream	Downstream	Upstream	Downstream
Arctic grayling	1,447	26	5	1,789
bull trout	4	0	1	4
burbot	2	7	3	43
flathead chub	2	0	0	0
goldeye	7	1	0	0
lake chub	1	0	0	1
lake cisco	1	0	0	0
lake whitefish	39	4	0	0
longnose dace	1	0	0	0
longnose sucker	3,811	1,665	0	121
mountain whitefish	503	55	3	6
northern pike	237	32	6	42
slimy sculpin	1	0	0	0
trout-perch	2	1	0	0
walleye	222	85	6	3
white sucker	992	134	7	256
total	7,272	2,010	31	2,265

[a] Machniak and Bond 1979.

Table 29 CPUE for Fish Captured in Tributary Watershed #18 (Steepbank River) – 1995[(a)]

Species	Sampling Season	Number of Fish	Boat Electrofishing	
			Effort (s)	CPUE (#/100 seconds)
Arctic grayling	spring	104	8,956	1.16
	summer	33	10,556	0.31
	fall	93	14,273	0.65
burbot	spring	1	3,019	0.03
goldeye	summer	3	578	5.19
lake chub	spring	25	8,956	0.28
	summer	13	17,056	0.07
	fall	2	2,921	0.07
lake whitefish	spring	3	578	0.52
	summer	8	6,500	0.12
longnose dace	spring	4	5,801	0.07
	summer	35	17,056	0.21
	fall	16	7,400	0.22
longnose sucker	spring	73	8,956	0.82
	summer	110	17,056	0.64
	fall	21	14,273	0.15
mountain whitefish	spring	110	8,956	1.23
	summer	83	17,056	0.49
	fall	104	14,273	0.73
northern pike	spring	1	3,019	0.03
	summer	3	7,078	0.04
spoonhead sculpin	spring	28	8,956	0.31
	summer	73	17,056	0.43
	fall	197	14,273	1.38
trout-perch	spring	2	6,174	0.03
	summer	1	3,436	0.03
walleye	spring	2	3,019	0.07
	summer	4	17,056	0.02
white sucker	spring	5	8,956	0.06
	summer	5	3,436	0.15
	fall	5	9,794	0.05

(a) Golder 1996a.

Of the 24 fish species captured in the Steepbank River, 10 were described by Sekerak and Walder (1980) as common and widespread, including Arctic grayling, northern pike, longnose sucker, white sucker, brook stickleback, lake chub, longnose dace, pearl dace, slimy sculpin and trout-perch. Golder (1996a) reported similar abundance and distribution patterns for most species but, in contrast, found mountain whitefish to be common throughout the lower 26 km of the river, northern pike to be only in the lower-most river and spoonhead sculpin to be more abundant than in the earlier study. Walleye were reported as moderately abundant by Machniak and Bond (1979) but were found to occur in low abundance by Golder (1996a). The remaining fish species were reported as rare and/or occurring only in the vicinity of the Steepbank River mouth and included brassy minnow, bull trout, burbot, fathead minnow, flathead chub, goldeye, lake cisco, lake whitefish, redbelly dace, spottail shiner and yellow perch (Machniak and Bond 1979; Golder 1996a).

5.16.2 Habitat

Mainstem Steepbank River

Griffiths (1973) examined the entire 130 km length of the mainstem Steepbank River. The fisheries potential of the upper drainage was found to be limited. The headwaters are in a low gradient area of muskeg bogs and there was extensive beaver activity, resulting in the impoundment of 90 to 95% of the river channel. Substrates were composed of fine sediments. The lower portions of the river had a steeper gradient with a more favourable pool to riffle ratio and more gravel for spawning, as well as cobbles and boulders. The potential of the lower Steepbank River to support a fisheries was rated fairly high by Griffiths (1973), based on consideration of flow, summer water temperature, depth of pools, refugia, bank cover and substrate conditions. The point at which the habitat potential changed moving from the upper to the lower river was identified by Griffiths (1973) as occurring upstream of the North Steepbank River confluence. Machniak and Bond (1979) provided a similar habitat description, and also described the lower few kilometres of the river as having an increasing amount of tar sands in the substrate. Sekerak and Walder (1980) examined the lower 75 km of the Steepbank River and provide a delineation of five reaches for this portion of the river. Sekerak and Walder (1980) show the break between the upper portion of the river (low gradient and habitat potential) and the lower portion (higher gradient and habitat potential) as occurring 47 km upstream of the river mouth (i.e., 5 km upstream of the North Steepbank River confluence).

Golder (1996a) provided a detailed habitat map of the Steepbank River channel for the lower 26 km. Habitat in this section consisted of 54% run, 40% riffle and 6% pool areas. Run habitats were primarily moderate depth Class 2 runs with some shallow Class 3 runs and deep Class 1 runs. Pools were infrequent, occurring on sharp meander bends and consisted of deep Class 1 and moderately deep Class 2 habitats.

It was concluded that the lower 47 km of the Steepbank River was an excellent stream with favourable pool to riffle frequency throughout. Fish refugia was rated as excellent with many overhanging banks, logs and brush. The substrate was primarily boulders and rubble in the riffles with boulders, sand and silt in the pools (Griffiths, 1973; Machniak and Bond 1979). Among the combined studies, the lower river has been described as containing a variety of excellent fish habitats, providing potential for spawning, rearing, feeding and resting for several fish species. The section of Steepbank River near the confluence with the Athabasca River has slightly lower habitat potential due to increasing amounts of tar sands in the substrate (Machniak and Bond 1979; RL&L 1994; Golder 1996a). In the upper portion of the Steepbank River (47 to 130 km upstream of the mouth), the habitat changes substantially because of beaver activity, low habitat heterogeneity and the predominance of fine substrates. This section was considered to provide potential northern pike spawning habitat (Sekerak and Walder 1980).

Golder (1997c) conducted a study to examine the deepest pools in the lower 26 km of the Steepbank River during winter. The winter sampling indicated that some pools were of sufficient depth and had oxygen concentrations high enough to provide overwintering habitat for adults of larger fish species. However, the extent of potential winter habitat was limited and only two pools were considered suitable for overwintering.

Steepbank River Tributaries

The North Steepbank River is the only significant tributary in the Steepbank River watershed. Griffiths (1973) rated the lower 16 km of the North Steepbank River as similar to the lower Steepbank River (i.e., fairly high habitat potential for spawning, rearing and feeding), with a pool to riffle ratio of 1:1, boulder and rubble substrate in riffle areas and boulder and fine sediment in the pool habitats. Machniak and Bond (1979) considered the lower 10 km of the North Steepbank River to provide possible spawning habitat for Arctic grayling, longnose sucker and white sucker. The habitat potential was found to decrease to a low rating moving upstream from this point, due to a continual decrease in gradient and increase in beaver activity. Habitat in the upper portion of this watercourse included low gradient, lack of habitat heterogeneity, substrate composed of fine sediments and detritus, stagnant flow and low dissolved oxygen levels (Machniak and Bond 1979; Golder 2001a). The upper river was considered to provide some habitat for rearing and feeding due to sufficient overhead cover provided by overhanging grasses and instream cover provided by aquatic macrophytes and deep pools (Golder 2001a).

One of the unnamed tributary watercourses had a regular meander pattern that was occasionally confined (Golder 2001a). The substrate was composed primarily of cobble and sand with small amounts of gravel and boulder present. There was a variety of habitat types present, including riffle, run, cascade and pool habitats. However, the maximum water depth was only 0.25 m. This small watercourse could provide habitat for small-bodied fish, but the high gradient and the presence of natural drop-offs were considered barriers to fish accessing this watercourse from the Steepbank River (Golder 2001a).

5.16.3 Habitat Use

Mainstem Steepbank River

Substantial numbers of longnose sucker, white sucker, Arctic grayling, walleye, mountain whitefish and northern pike have been reported to inhabit the Steepbank River during the open-water season (Sekerak and Walder 1980). Machniak and Bond (1979) documented large spawning runs of longnose and white suckers in the spring, with smaller numbers of the above sport fish entering the river to spawn or feed. Comparison of spring and fall counting fence results from Machniak and Bond (1979) indicated that Arctic grayling remained in the river during the summer but exited the watershed in the fall. Approximately one-third of the longnose sucker left the watershed to return to the Athabasca River in the spring following spawning, and most of the remainder left the watershed prior to the fall, indicating that only a few longnose suckers remained in the river for summer feeding. Adult white sucker from the spring run returned downstream following spawning, whereas juvenile fish remained in the river for a longer period of time and were recorded exiting the watershed in the fall. Northern pike appeared to use the Steepbank River for the spring and summer as did walleye. However, many of the walleye returned downstream in the spring and only a few appeared to remain in the watershed until the fall. The northern pike and walleye in the spring run were mainly juvenile or post-spawning fish and no evidence of spawning in the watershed has been reported for these two species. Mountain whitefish moved upstream into the Steepbank River in the spring but few were observed leaving the watershed in the fall (Machniak and Bond 1979) indicating mountain whitefish may leave the Steepbank River during the summer.

The capture of widely distributed fry has been reported for Arctic grayling, mountain whitefish, longnose sucker and white sucker (Machniak and Bond 1979; Golder 1996a), indicating that adults probably spawned in the Steepbank River. Golder (1996a) conducted spring spawning surveys of the lower 26 km of the Steepbank River and documented spawning sites for Arctic grayling, longnose sucker and white sucker.

No fall spawning survey has been conducted; therefore, spawning activity for mountain whitefish in the Steepbank River has not been investigated. Machniak and Bond (1979) thought that mountain whitefish used the river for rearing and feeding habitat, exiting the Steepbank River in the summer. In contrast, Golder (1996a) found that the mountain whitefish catch in the lower 26 km of the river was as high in the fall (October) as in the spring or summer, indicating that mountain whitefish were still present in the fall. As this is a fall spawning species, and the Steepbank River could provide suitable spawning habitat, mountain whitefish may remain in the river to spawn. However, the fall catch of mountain whitefish consisted of fry and juvenile fish (Golder 1996a) with no adult fish recorded. This information indicates that either the adult fish had left the Steepbank River, or had moved upstream to spawn in the Steepbank River above the Golder (1996a) study area. The availability of suitable spawning areas in the Steepbank River and the number and distribution of mountain whitefish fry in the summer and fall indicates that it is likely that this species is spawning here.

Walleye and yellow perch fry were captured in the mouth of the Steepbank River (McCart et al. 1977), but this was not considered an indication of spawning activity within the Steepbank River watershed. The mouth of the Steepbank River likely provides nursery habitat suitable for fry of several species from the Athabasca River. Rearing by juvenile fish has also been reported for several species at the river mouth.

The Steepbank River provides habitat for spawning and/or summer rearing and feeding for a number of fish species, but the river was not believed to be heavily utilized for overwintering by sport fish. Arctic grayling fry may overwinter in the river (Machniak and Bond 1979) and northern pike may overwinter in the reach immediately upstream of the North Steepbank River confluence (Sekerak and Walder 1980), but there is no direct evidence. Walleye and northern pike may overwinter in the Steepbank River (Mill et al. 1997), and RL&L (1994) described suitable areas for overwintering by adult walleye and northern pike in the vicinity of the Steepbank River mouth. Golder (1997c) investigated the largest and deepest pools in the lower 26 km of river and found suitable under-ice depths and dissolved oxygen in the two deepest pools, but found no fish. Overwintering is suspected for several forage fish species that were considered to have permanent resident populations; including brook stickleback, lake chub, longnose dace, pearl dace, slimy sculpin and trout-perch (Machniak and Bond 1979).

Steepbank River Tributaries

Arctic grayling occupy the North Steepbank River up to approximately 16 km upstream of the confluence with the Steepbank River. Other fish reported include longnose and white sucker as well as six small-bodied forage species. The forage species occur throughout the lower and upper portions of this watercourse. Although habitat with the potential for spawning is present in the lower portion of the North Steepbank River, spawning is unknown.

No fish have been captured in either of the two small, unnamed tributaries that were surveyed.

5.16.4 Data Gaps

Recent evidence indicates that mountain whitefish may spawn in the Steepbank River (Golder 1996a), but this has not been confirmed and spawning locations are unknown. A fall spawning survey of the lower 47 km of the river (i.e., the section with habitat that appears suitable for spawning) would be needed to confirm spawning and determine the location of spawning.

Updated inventory data would be useful in order to assess the current status and relative abundance of fish populations including Arctic grayling particularly in light of the apparent decline in Arctic grayling abundance in other Athabasca River tributaries in the Oil Sands Region (i.e., the Muskeg River).

5.17 TRIBUTARY WATERSHED # 21 – UNNAMED WATERCOURSE (HORSESHOE LAKE OUTLET)

One report provided fisheries information for the Horseshoe Lake watershed (Syncrude 1985). This report focused on Horseshoe Lake, but provides incidental information on the outlet channel that connects the lake to the Athabasca River. Figure 5 presents the portions of the watershed that have been examined.

5.17.1 Fish Community

The fish species and life stages reported from the Horseshoe Lake watershed are in Table 30. One fish species was captured in this watershed; northern pike were in Horseshoe Lake. Sampling occurred only in Horseshoe Lake and the fish present in the outlet channel are unknown.

Table 30 Fish Species and Life Stages in Tributary Watershed #21 (Horseshoe Lake Outlet)

Species	Life Stages Present
northern pike	juvenile

CPUE data is not available for this watershed.

5.17.2 Habitat

Horseshoe Lake has two outlet channels. One is a natural channel that originates in the northwest tip of the lake and follows an irregular course to the Athabasca River; the other is a man-made channel that drains from the northeast end of the lake to the Athabasca River. During the 1984 survey (Syncrude 1985), the natural channel did not have continuous flow and terminated near the Athabasca River in a series of stagnant pools, while the constructed channel was blocked by three large beaver dams. Habitat in these two channels was severely limited by low flow.

Horseshoe Lake is a small waterbody within the floodplain of the Athabasca River. The outlet channel, during periods of high discharge in the Athabasca River, may be temporarily inundated such that reverse flow occurs and the water level in the lake is increased (Syncrude 1985). The majority of the surface of Horseshoe Lake was covered with abundant growths of emergent and floating aquatic vegetation. Habitat is limited except for the possibility of seasonal use by small-bodied forage fish and spawning, nursery and rearing activities by northern pike and yellow perch during periods when conditions in either of the outlet channels provided access to the lake from the Athabasca River.

5.17.3 Habitat Use

The only sampling for this watershed was one survey of Horseshoe Lake. Although no fish were captured, three juvenile northern pike were observed by sampling crews (Syncrude 1985), indicating use for rearing by this species. Horseshoe Lake may provide spawning habitat for northern pike, but spawning was not investigated. The presence of northern pike and yellow perch would depend on access through one of the outlet channels, which would be dependant on flow in the watershed and/or the Athabasca River.

5.17.4 Data Gaps

A spring inventory and spawning survey during a year of high flows would be necessary to determine if this watershed is used for spawning by northern pike and/or yellow perch.

5.18 TRIBUTARY WATERSHED #26 – BEAVER RIVER

Thirteen reports provided information pertaining to the Beaver River watershed (Robertson 1970; Griffiths 1973; RRCS 1973; Syncrude 1973, 1975, 1977; Noton and Chymko 1977a, 1977b, 1978; O'Neil 1979, 1982; Syncrude 1985; Boerger 1986; Van Meer 1990). Combined, these reports examine the mainstem Beaver River, Bridge Creek and a few unnamed Beaver River tributaries. In addition, information was also available for the Beaver River Reservoir, Ruth Lake, Poplar Creek Reservoir, and man-made ditches that now form part of this watershed. Figure 5 shows the portions of the Beaver River watershed included in these reports.

The Beaver River was referred to as both the Beaver River and Beaver Creek during past investigations. The 1:50,000 scale National Topographic Service map delineates this watercourse as the Beaver River and this name is used in this report.

5.18.1 Fish Community

Fish species in the Beaver River watershed from all studies are summarized and presented in Table 31. Fourteen fish species were captured in the Beaver River watershed, including five sport species, two sucker species and seven small-bodied forage species. In addition, walleye have been reported as present in the watershed (Wallace and McCart 1984), but the only capture of walleye (RRCS 1973) was at the confluence with the Athabasca River, not in the Beaver River itself.

Table 31 Fish Species and Life Stages in Tributary Watershed #26 (Beaver River)

Species	Life Stage
Arctic grayling	fry, juvenile, adult, spawning
brook stickleback	unspecified
burbot	juvenile, adult
fathead minnow	unspecified
lake chub	unspecified
lake whitefish	adult
longnose sucker	fry, juvenile, adult, spawning
mountain whitefish	unspecified
northern pike	juvenile, adult, spawning
slimy sculpin	unspecified
spoonhead sculpin	unspecified
spottail shiner	unspecified
trout-perch	unspecified
white sucker	fry, juvenile, adult, spawning

In 1973, a two-way fish counting fence operated during spring in the lower Beaver River, a short distance upstream of the confluence with the Athabasca River (RRCS 1973). A summary of the counting fence results is provided in Table 32.

Table 32 Summary of Fish Counting Fence Results, Tributary Watershed #26 (Beaver River) – Spring 1973[(a)]

Species	Upstream Trap		Downstream Trap
	Juvenile	Adult	
Arctic grayling	1	5	0
burbot	0	1	0
lake whitefish	0	4	0
longnose sucker	0	86	0
northern pike	1	63	0
white sucker	0	433	0
total	594		0

(a) RRCS 1973.

The CPUE from the available reports is in Tables 33 and 34. The most abundant species were brook stickleback, fathead minnow, lake chub and white sucker.

Table 33 CPUE for Fish Captured in Tributary Watershed #26 (Beaver River) – 1978[(a)]

Species	Number of Fish	Sampling Season	Gill Net		Seine Net	
			Effort (hr)	CPUE (#/100 hr)	Effort (m)	CPUE (#/100 m)
brook stickleback	n/a	spring	-	-	2,575.0	1.2
		summer	-	-	2,062.5	175.2
		fall	-	-	1,675.0	20.5
fathead minnow		spring	-	-	2,250.0	1.9
		summer	-	-	2,062.5	445.6
		fall	-	-	1,675.0	156.7
lake chub		spring	-	-	575.0	0.3
		summer	-	-	1,525.0	7.8
		fall	15.0	4.0	1,262.5	0.9
longnose sucker		spring	30.5	5.6	-	-
		summer	13.0	9.2	-	-
white sucker		spring	30.5	136.1	2,250.0	0.4
		summer	13.0	95.1	2,075.0	6.3
		fall	15.0	141.6	525.0	<0.1

[(a)] O'Neil 1979.

n/a = Not available.

Table 34 CPUE for Fish Captured in Tributary Watershed #26 (Beaver River) – 1978[(a)]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
brook stickleback	n/a	summer	1,280	1.2
		fall	400	0.5
fathead minnow		summer	1,280	2.4
		fall	400	0.7
lake chub		summer	1,280	4.4
		fall	680	0.7
longnose sucker		spring	450	0.2
spoonhead sculpin		fall	400	0.3
white sucker		spring	850	2.8
		summer	1,280	3.4
		fall	1,170	1.3

[(a)] O'Neil 1979.

n/a = Not available.

5.18.2 Habitat

Griffiths (1973) conducted a synoptic aerial survey of the entire 77 km length of the Beaver River and described three separate reaches of the river; however, the boundaries between the reaches were not identified. Based on the stream profile provided by Robertson (1970), the reach divisions would probably occur at approximately 16 km and 60 km upstream of the river mouth (i.e., Reach 1 – 0 to 16 km; Reach 2 – 16 to 60 km; Reach 3 – 60 to 77 km). According to Griffiths (1973), the upper portion of the Beaver River had a high percentage of impounded water and was rated as having poor fish habitat. Downstream, the gradient steepened, providing improved habitat that was rated as moderate. However, Robertson (1970) rated the Beaver River as having excellent habitat for salmonids based on calculations involving pool measure, pool structure, stream bottom and stream environment. Syncrude (1973) identified the gradient break between the upper and lower river as occurring 16 km upstream of the river mouth. In the lower 16 km of the river, the gradient was steeper which resulted in alternating riffles and long pool sections. The upper portion of the river was comprised almost entirely of slack water flowing over heavily silted substrate. While the predominant substrate type was silt, approximately 6% of the substrate was considered ideal Arctic grayling spawning habitat (Syncrude 1973). Fisheries habitat in the Beaver River was considered marginal for sport fish, Arctic grayling in particular (Syncrude 1973).

Following these studies, watershed modifications occurred in the Beaver River basin as a result of a diversion system for the Syncrude Canada Ltd. mine site. Modifications included construction of a reservoir on the upper river, diversion of flows from the upper Beaver River basin to Poplar Creek via Ruth Lake and the Poplar Creek Reservoir/spillway, and construction of interception ditches diverting tributary flows in the lower Beaver River basin to Bridge Creek (a Beaver River tributary near the River mouth).

The upper Beaver River watershed currently includes the Beaver River Reservoir, a 32 km section of the mainstem river plus the tributary watercourses upstream of the reservoir, as well as an unnamed tributary (referred to as Creek B1) that has been diverted to the reservoir (Syncrude 1985). Drainage from the Beaver River Reservoir now flows to the Poplar Creek basin via Ruth Lake and the Poplar Creek Reservoir. The upper mainstem river was described as low gradient, meandering and characterized by low velocity, sand/silt substrate and predominantly flat habitat type (Noton and Chymko 1978; Syncrude 1985). Syncrude (1985) divided the upper river into three reaches. The lower of the three reaches was examined and had low habitat diversity and poor fish habitat. It was believed that the upstream reaches would have more suitable habitat because of higher gradient. The tributary watercourses in the upper Beaver River watershed were described as having low habitat diversity and extensive beaver activity and had poor fish habitat. Creek B1 was documented to provide spawning habitat for suckers and forage fish in the lower-most portion of the creek, where it has been channelized.

The Beaver River Reservoir was formed by impoundment of the upper Beaver River in 1975 (Syncrude 1985). The reservoir collects drainage from the upper Beaver River watershed and from Creek B1 and discharges to Ruth Lake. The Beaver River Reservoir is moderately shallow (mean depth 2.2 m, maximum depth 10.0 m) with gently sloping shorelines (Noton and Chymko 1978). Substrates in the reservoir are variable due to the terrain that was flooded. Aquatic macrophytes were abundant along the periphery of the basin.

Ruth Lake was originally a closed drainage basin but now receives diversion water from the Beaver River Reservoir and discharges to Poplar Creek Reservoir. Ruth Lake is a shallow, alkaline waterbody (mean depth 1.2 m, maximum depth 3.0 m) with gently sloped shorelines and substrates composed of mud and organic material (Noton and Chymko 1977b, 1978). Aquatic macrophytes are abundant in the lake basin. Oxygen depletion occurred in Ruth Lake during periods of hot summer weather (Noton and Chymko 1977b).

Poplar Creek Reservoir was formed in 1975 and receives diversion water from Ruth Lake and discharges to Poplar Creek via a spillway structure. This reservoir is moderately deep (mean depth 3.5 m, maximum depth 19.0 m) and is divided into two basins by a causeway (Noton and Chymko 1978). The north basin was shallower with gently sloping shorelines, compared to the deeper and more steeply sloped south basin. Aquatic macrophytes form a narrow fringe around the periphery of both basins.

The lower Beaver River drainage includes the 13 km long west interception ditch, Bridge Creek, a number of unnamed tributaries and an 8 km remnant of the original lower Beaver River channel. The west interceptor ditch drains to Bridge Creek, which in turn drains to the lower Beaver River channel.

The west interceptor ditch was a shallow, slow moving stream of variable width. The substrate was predominantly fine sediment, except where gravel had been placed for streambed protection. Syncrude (1985) divided the ditch into three habitat reaches. The upper 10.8 km was a low gradient section and was followed by a 1.2 km moderate gradient section and a 1 km section of higher gradient at the ditch mouth. The majority of the ditch was slow flowing, with fine sediments, but the lower-most reach had riffles, runs, and pools with substrates ranging in size from gravel to boulder.

Bridge Creek was also divided into three habitat reaches on the basis of stream gradient (Syncrude 1985). The lower reach (0.0 to 0.5 km upstream of mouth) had a steep gradient, high habitat diversity (riffle, run, pool habitats) and a substantial portion of both fine (sand) and coarse (gravel, cobble, boulder, bedrock) substrates. The middle reach (0.5 to 4.5 km) had a high gradient, but was not as steep as the lower reach. Habitat in this reach was moderately diverse and substrates were dominated by coarse material below the inflow of the west interceptor ditch and by sand above the ditch inflow. The upper reach (4.5 to 6.5 km) was lower gradient and was assumed to have low habitat diversity; substrates were dominated by fines and low fisheries potential.

The lower Beaver River mainstem was investigated upstream of the confluence with Bridge Creek (Syncrude 1985). The creek had a moderate gradient, low habitat diversity, with low proportions of run and pool habitats. The substrate was dominated by fines, but a good proportion of gravel and cobble was also present. The low habitat diversity was a result of the extremely low discharge occurring in this portion of the river because of diversions. Habitat quality was assumed to be higher downstream of the Bridge Creek confluence because of the higher flow regime.

5.18.3 Habitat Use

Prior to drainage modifications of the Beaver River watershed, nine fish species were captured in this watercourse, including Arctic grayling, burbot, lake chub, lake whitefish, longnose sucker, mountain whitefish, northern pike, slimy sculpin and white sucker (Robertson 1970; Griffiths 1973; RRCS 1973; Syncrude 1973). Arctic grayling fry, juveniles and adults were present, indicating use of the river for rearing and feeding by this species. The presence of Arctic grayling fry in the Beaver River in the fall indicated that grayling probably spawned in the river, possibly in the upper river (Robertson 1970). The counting fence (RRCS 1973) confirmed that there was a spring spawning run of Arctic grayling in the Beaver River, but with only five adult fish captured (Table 32), spawning was likely limited. Overall, the Arctic grayling population was not large, but the species was distributed throughout the river. With juvenile fish the predominant life stage, the Beaver River was used primarily as rearing habitat for this species.

Northern pike were captured in sufficient numbers for Robertson (1970) to suggest that a fishery could exist for this species. RRCS (1973) recorded a small spawning run of northern pike into the Beaver River during the spring (Table 32), indicating use of the river for spawning as well as rearing and feeding by this species. The low numbers of lake whitefish, burbot and mountain whitefish captured indicated that these fish likely were part of the Athabasca River population and that a small amount of feeding activity occurred in the Beaver River for these species.

Spawning runs of longnose and white suckers were recorded for the Beaver River (Table 32), with white sucker being most abundant (RRCS 1973). Rearing was also reported for juveniles of both sucker species.

RRCS (1973) recorded walleye in pre-spawning condition at the confluence of the Beaver and Athabasca rivers, but did not capture any fish moving upstream in the counting fence. They concluded that walleye did not spawn in the Beaver River, rather that the confluence was used as a resting and feeding area. As no fish apparently entered the Beaver River, walleye are not on the species list for the watershed (Table 31).

Additional fisheries surveys conducted since the onset of drainage modifications identified eleven fish species in this watershed, including six of the nine species reported prior to watershed modifications, and five new species. Burbot, lake whitefish and mountain whitefish were reported only prior to construction of the diversion. These three species may either no longer be present in the Beaver River watershed, or were not captured in the later sampling that occurred primarily in the upper river. Following diversion construction, eight fish species were captured in the upper Beaver River drainage (i.e., upper Beaver River and tributaries, Beaver River Reservoir, Ruth lake and Poplar Creek Reservoir) and nine species were captured in the lower Beaver River drainage (i.e., lower Beaver River, lower tributaries and west interceptor ditch).

Of the eight species of fish reported from the upper Beaver River watershed following completion of the diversion, all were present in riverine habitats. These species included Arctic grayling, brook stickleback, fathead minnow, lake chub, longnose sucker, northern pike, spoonhead sculpin and white sucker. Brook stickleback, fathead minnow, lake chub and white sucker were also present in all of the lakes in this portion of the watershed. In the lakes, longnose sucker were in the Beaver River Reservoir and Ruth Lake, but not Poplar Creek Reservoir, and northern pike were only in the Beaver River Reservoir.

With regard to riverine habitats in the upper watershed, small numbers of Arctic grayling and northern pike were reported shortly after completion of the diversion system by Noton and Chymko (1977b), but not in more recent studies (O'Neil 1979; Syncrude 1985). It may be that these species are no longer present in this portion of the watershed. Spoonhead sculpin was reported by O'Neil (1979), but appeared to occur in low abundance with limited distribution. The most common and widespread species, in order of relative abundance, were lake chub, fathead minnow, brook stickleback and white sucker. White sucker adults in spawning condition were captured in the spring in the upper Beaver River and in Creek B1. All white sucker captured in the fall were fry, indicating that spawning may occur in the upper river and Creek B1 (Syncrude 1985). Spawning was presumed to occur in the upstream reaches of the watercourse because suitable habitat was not available in the lower reaches. White sucker were observed spawning in the channelized portion of Creek B1 (Syncrude 1985). Spawning white suckers were identified as originating from a resident population in the Beaver River Reservoir, and possibly from Ruth Lake and Poplar Creek Reservoir. Lake chub spawning was also recorded in the channelized portion of Creek B1 (Syncrude 1985).

Six fish species have been reported for the Beaver River Reservoir and include brook stickleback, fathead minnow, lake chub, longnose sucker, northern pike and white sucker. In the more recent studies, fathead minnow was the most abundant species, followed by roughly equal numbers of brook stickleback and white sucker, and lower numbers of lake chub (Syncrude 1985). Longnose sucker, although present in 1978 (O'Neil 1979), were not subsequently captured and were considered to no longer be present in the reservoir (Syncrude 1985). Similarly, northern pike were captured only in 1977 (Noton and Chymko 1977b).

Five fish species have been reported from Ruth Lake, including brook stickleback, fathead minnow, lake chub, longnose sucker and white sucker. In earlier studies, large-bodied species were not captured and only brook stickleback and fathead minnow were recorded, which were reported to have abundant, reproducing populations (Noton and Chymko 1977b). In more recent studies, the order of abundance was fathead minnow, brook stickleback and white sucker (Syncrude 1985). Longnose sucker were captured in 1977 and 1978 (Noton and Chymko 1978; O'Neil 1979) but have not been found subsequently. As with the Beaver River Reservoir, longnose sucker appear to no longer be present in Ruth Lake. Declining catch rates for white sucker fry and juveniles over time have occurred and may indicate a decline in abundance of early life stages for this species because of limited spawning success in the lake. Nonetheless, Ruth Lake was considered to be heavily used as rearing and feeding habitat by white sucker.

Four fish species were reported from Poplar Creek Reservoir. In order of abundance, the species were brook stickleback, white sucker, fathead minnow and lake chub (O'Neil 1979; Syncrude 1985). Capture rates for the small-bodied forage fish declined over time, although the cause of the decline was unknown. White sucker abundance was low in this reservoir in comparison to the Beaver River Reservoir and Ruth Lake. No white sucker fry were present in the Poplar Creek Reservoir in 1984 (Syncrude 1985), suggesting that Poplar Creek Reservoir was used primarily for rearing and feeding by fish originated from upstream waterbodies within the diversion system. More recently, yellow perch have been introduced to the waterbody.

Nine fish species have been reported from the lower Beaver River watershed since completion of the diversion (Syncrude 1977, 1985; Boerger 1986, Van Meer 1990). These species included brook stickleback, fathead minnow, lake chub, longnose sucker, northern pike, slimy sculpin, spottail shiner, trout-perch and white sucker. Small-bodied forage fish were the most common species present, with brook stickleback the most abundant and widely distributed species. Longnose sucker spawning was observed in the lower Beaver River and fry longnose and white sucker use the area as nursery habitats (Syncrude 1977). A small number of northern pike were recorded during one survey (Van Meer 1990), indicating very limited use of the lower Beaver River by this species. Brook stickleback and fathead minnow were captured in the west interceptor ditch and unnamed tributaries in the summer. Fathead minnow and brook stickleback were captured in Bridge Creek as well as fewer lake chub, white sucker and longnose sucker. Small numbers of juvenile longnose and white sucker, probably originating from the Athabasca River, used the lower-most portion of Bridge Creek as rearing habitat. The lower Beaver River was used by resident species (brook stickleback) as well as, on a seasonal basis, by species from the Athabasca River. Spawning and nursery activity was recorded for longnose and white suckers, both before and after completion of the diversion. However, the absence of sucker fry in 1984 (Syncrude 1985) indicated that spawning did not occur that year.

5.18.4 Data Gaps

Further seasonal fish inventories, throughout the upper and lower portions of the Beaver River watershed, would be necessary to monitor apparent changes in species composition, fish populations and habitat use that have occurred over time following completion of the diversion. Habitat has not been investigated during winter, but the potential of this watershed to support fish in winter is limited and probably would not warrant an overwintering study.

5.19 TRIBUTARY WATERSHED #27 – MUSKEG RIVER

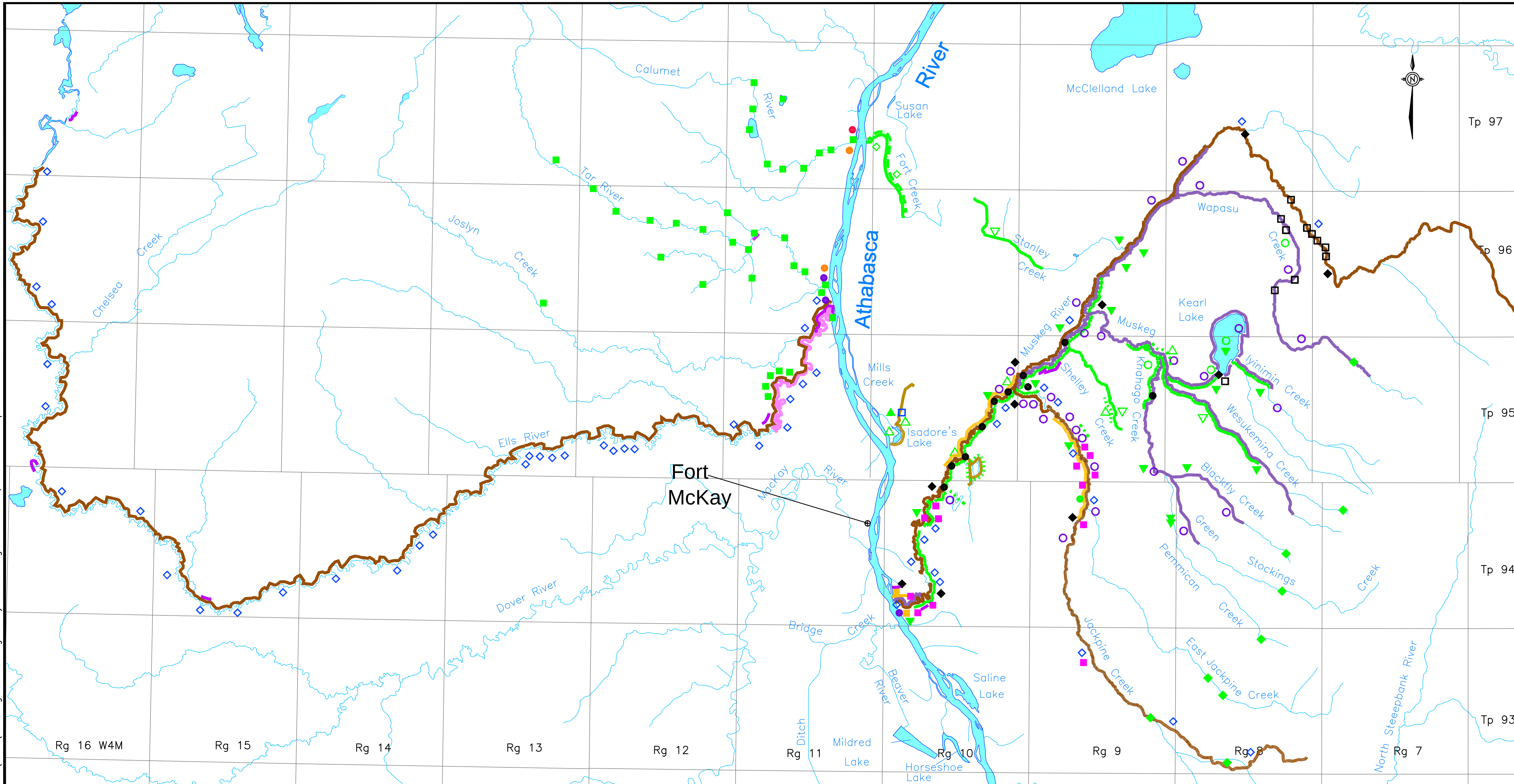
The Muskeg River watershed has been much studied because it is a significant tributary to the Athabasca River and in close proximity to Oil Sands development. Twenty eight reports contained information pertaining to the fishery in the Muskeg River watershed (Fedoruk 1973; Griffiths 1973; RRCS 1974; Bond and Machniak 1977, 1979; McCart et al. 1977; Sekerak and Walder 1980; Walder et al. 1980; Webb 1980; O'Neil et al. 1982; Wallace and McCart 1984; Louma and Shelast 1986; Louma et al. 1986; RL&L 1988, 1989, 1994; Golder 1996a, 1996d, 1997c, 1997d, 1997e, 1999b, 1999c, 2001a, 2002b; Komex 1997; Mill et al. 1997; TERA 2000). Information is available for the mainstem Muskeg River as well as the following tributary basins (see Figure 2):

- an unnamed tributary containing three small waterbodies;
- Jackpine Creek (formerly Hartley Creek), including East Jackpine Creek;
- Shelly Creek;
- Muskeg Creek (formerly Kearl Creek), including Khahago Creek, Pemmican Creek, Green Stockings Creek, Blackfly Creek, Wesukemina Creek, Iyinimin Creek and Kearl Lake;
- Stanley Creek; and
- Wapasu Creek.

Figure 6 shows the portions of the Muskeg River watershed that have been examined by the 27 studies.

5.19.1 Fish Community

Fish species in the Muskeg River watershed have been summarized by species and life stage in Table 35. In total, 25 species have been reported from this watershed, including 9 sport species, 2 sucker species and 14 small-bodied forage fish species. Table 36 provides the distribution of fish species among the 15 different watercourses/waterbodies surveyed in the Muskeg River watershed. Of the 25 species reported for the watershed, 21 were in the mainstem Muskeg River. Four small-bodied species have been reported only from tributary streams. Two species, emerald shiner and flathead chub, were captured in the Jackpine Creek drainage only. Finescale dace were captured in one of the small waterbodies in the unnamed tributary in 1979 and were not captured since. Spoonhead sculpin were found in a few tributaries, but not in the mainstem Muskeg River. It is considered likely that since these four species are present in the watershed, they may also occur to some extent in the mainstem Muskeg River.



LEGEND

GOLDER 1996d
GOLDER 1997d
GOLDER 2001b
GOLDER 2002b
GRIFFITHS 1973
LUOMA and SHELAST 1986
PSUTKA 1979
RRCS 1974
SEKERAK and WALDER 1980
WEBB 1980

ASRD n.d.
BOND AND MACHNIAK 1977&1979
EBA 2001
FEDORUK 1973
GOLDER 1996a
GOLDER 1996d
GOLDER 1996e
GOLDER 1997c
GOLDER 1997e
GOLDER 1999b
GOLDER 2000

GOLDER 2001a
GOLDER 2002a
HERBERT 1979
KOMEX 1997
MCCART ET AL. 1977
O'NEIL ET AL. 1982
RL & L 1988 & 1999
RL & L 1994
WALDER ET AL. 1980

5 0 5
SCALE KILOMETRES

REFERENCE
ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT
RAMP

TITLE
HISTORICAL STUDY LOCATIONS-TRIBUTARY WATERSHEDS #27 and #32 TO #41

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Muskeg Surveyed	
DESIGN	CS	08/07/02	SCALE AS SHOWN	REV.	0
CADD	JAM	24/02/04			
CHECK	CB	24/02/04			
REVIEW	CB	24/02/04			

FIGURE: 6

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: Muskeg Surveyed River.dwg Feb 26, 2004 - 3:31pm

Table 35 Fish Species and Life Stages in Tributary Watershed #27 (Muskeg River)

Species	Life Stage
Arctic grayling	fry, juvenile, adult, spawning
brook stickleback	unspecified
bull trout	juvenile, unspecified
burbot	fry, juvenile, unspecified
emerald shiner	unspecified
fathead minnow	unspecified
finescale dace	unspecified
flathead chub	unspecified
lake chub	unspecified
lake cisco	unspecified
lake whitefish	fry, adult, unspecified
longnose dace	unspecified
longnose sucker	fry, juvenile, adult, spawning
mountain whitefish	fry, juvenile, adult
ninespine stickleback	unspecified
northern pike	fry, juvenile, adult, spawning
northern redbelly dace	unspecified
pearl dace	unspecified
slimy sculpin	unspecified
spoonhead sculpin	unspecified
spottail shiner	unspecified
trout-perch	unspecified
walleye	juvenile, adult, unspecified
white sucker	fry, juvenile, adult, spawning
yellow perch	fry, unspecified

Table 36 Fish Species Distribution in Watercourses in Tributary Watershed #27 (Muskeg River Basin)

Species	Watercourse Drainage Basin[a]														
	Mainstem Muskeg River	Unnamed Tributary	Jackpine Creek	East Jackpine Creek	Shelly Creek	Muskeg Creek	Khahago Creek	Pemmican Creek	Green Stockings Creek	Blackfly Creek	Wesukemina Creek	Iyinimin Creek	Kearl Lake	Stanley Creek	Wapasu Creek
Arctic grayling	x		x												
brook stickleback	x	x	x	x	x	x	x	x	x	x	x	X	x	x	x
bull trout	x														
burbot	x														
emerald shiner			x												
fathead minnow	x	x	x	x		x							x		
finescale dace		x													
flathead chub			x												
lake cisco	x														
lake chub	x	x	x	x	x	x	x			x	x		x		x
lake whitefish	x														
longnose dace	x		x												
longnose sucker	x	x	x	x	x	x		x					x		x
mountain whitefish	x		x												
ninespine stickleback	x														
northern pike	x		x										x		
northern redbelly dace	x		x												
pearl dace	x	x	x	x		x	x	x	x	x	x	X	x		x
slimy sculpin	x		x			x	x								
spoonhead sculpin			x			x	x								
spottail shiner	x					x									
trout-perch	x														
walleye	x														
white sucker	x	x	x			x	x						x		x
yellow perch	x														
number of species	21	7	15	5	3	9	6	3	2	3	3	2	7	1	5

[a] See Figure 2 for Watercourse Locations.

[Note: errors in reported fish presence and distribution were discovered during this review, including:

- White sucker and lake chub were reported as present in Iyinimin Creek and the Khahago Creek drainage and slimy sculpin was reported as present in Blackfly Creek in 1988 as a result of typographical errors (RL&L 1989);
- Fathead minnow were reported to be present in Khahago Creek and in Wapasu Creek as a result of data transcription errors (Golder 1996a, Golder 2002b); and
- Lake whitefish were reported as present in Jackpine Creek as a result of a reporting error (Golder 2002b), the fish were mountain whitefish.

Table 36 indicates that the mainstem Muskeg River and the Jackpine Creek drainage support most of the fish community in the watershed, with 21 and 15 species documented in these watercourses, respectively. All nine sport fish species occur in the Muskeg River mainstem and three of these species occur in Jackpine Creek. Muskeg Creek drains Kearl Lake, as well as several small tributaries, to the Muskeg River and this portion of the watershed provides habitat for ten fish species including suckers, small-bodied forage fish and northern pike. The remaining watercourses in the watershed support from one to seven sucker and small-bodied forage species.

Brook stickleback was the most ubiquitous species and was present in all 15 of the studied watercourses/waterbodies (Table 36). Other species widely distributed in the watershed were pearl dace, lake chub, longnose sucker, white sucker and fathead minnow.

Several counting fence studies have been conducted on the Muskeg River, and to a lesser extent on Jackpine Creek. The results of these studies provide the best relative abundance estimates of large-bodied fish species in the watershed (Table 37 and 38).

Table 37 Summary of Fish Counting Fence Results for Large-Bodied Species for Tributary Watershed #27 – Mainstem Muskeg River

Species	Spring 1973[a]	Spring/Summer 1976[b]		Spring 1977[c]		Spring 1995[d]		Fall 1995[d]	
	Upstream	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream	Upstream	Downstream
Arctic grayling	11	305	78	161	11	14	49	2	74
bull trout	0	0	0	3	0	0	0	0	0
burbot	0	1	2	1	0	0	0	0	0
lake cisco	0	0	0	1	0	0	0	0	0
lake whitefish	0	3	14	7	6	0	0	0	0
longnose sucker	45	2,837	2,191	1,641	1,004	308	36	0	21
mountain whitefish	0	33	101	50	17	0	0	0	0
northern pike	4	131	155	433	59	126	3	0	117
walleye	0	4	3	8	5	1	0	0	0
white sucker	29	2,839	1,669	2,970	1,385	299	1	0	89
total	89	6,153	4,213	5,275	2,487	748	89	2	301
overall total	89	10,366		7,762		837		303	

(a) Fedoruk 1973 – hoop net operated 17.5 km upstream of the river mouth from April 29 to May 13, 1973.

(b) Bond and Machniak 1977 – fish fence operated near the river mouth from April 28 to July 30, 1976.

(c) Bond and Machniak 1979 – fish fence operated near the river mouth from April 28 to June 15, 1977.

(d) Golder 1996a – fish fence operated 16.5 km upstream of the river mouth from May 6-31 and from September 19 to October 28, 1995.

Table 38 Summary of Upstream Fish Trap Results in Tributary Watershed #27 – Jackpine Creek

Species	1973[(a)]	1981[(b)]	
	Near Creek Mouth	5.5 km Above Creek Mouth	14.2 km Above Creek Mouth
Arctic grayling	6	904	82
longnose sucker	1	583	1
northern pike	0	1	0
white sucker	1	814	41
Total	8	2,302	124

(a) Fedoruk 1973 – hoop net operated from April 29 to May 13, 1973.

(b) O'Neil et al. 1982 – hoop trap/fence operated from May 2-18 (Km 5.5) and May 5-19 (km 14.2), 1981.

Data to estimate relative abundance were limited for most studies which usually reported percent of catch. However, counting fence studies provide an indication of the relative abundance of large-bodied species utilizing the watershed. Table 39 presents percent composition data for the main fish fence studies in the watershed; data from Fedoruk (1973) was not included as the 1973 catches in the Muskeg River and Jackpine Creek were small. For the Muskeg River, Fedoruk (1973) did not report if the hoop net provided complete channel blockage or captured a sub-sample of fish migrating upstream, and in Jackpine Creek, the hoop net was set immediately upstream of a beaver dam that was believed to be a barrier to upstream migration. Percent catch for other capture techniques are presented in Tables 40 through 43.

Table 39 Percent of Catch for Large-Bodied Species Captured in Tributary Watershed #27 – Muskeg River

Species	Mainstem Muskeg River			Jackpine Creek[(d)]	
	1976[(a)]	1977[(b)]	1995[(c)]	km 5.5	km 14.2
Arctic grayling	3.7	2.2	12.2	39.2	66.1
bull trout	0.0	<0.1	0.0	0.0	0.0
burbot	<0.1	<0.1	0.0	0.0	0.0
lake cisco	0.0	<0.1	0.0	0.0	0.0
lake whitefish	0.2	0.2	0.0	0.0	0.0
longnose sucker	48.5	34.1	32.0	25.3	0.8
mountain whitefish	1.3	0.9	0.0	0.0	0.0
northern pike	2.8	6.3	21.5	<0.1	0.0
walleye	<0.1	0.2	<0.1	0.0	0.0
white sucker	43.5	56.1	34.1	35.4	33.1

(a) Bond and Machniak 1977 – spring/summer counting fence

(b) Bond and Machniak 1979 – spring counting fence

(c) Golder 1996a – spring and fall counting fence

(d) O'Neil et al. 1982 – spring hoop trap/fence

Table 40 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1976[a]

Species	Watercourse		
	Mainstem Muskeg River	Jackpine Creek	Muskeg Creek
Arctic grayling	1.7	20.2	0.0
brook stickleback	4.9	13.1	5.9
burbot	0.1	0.0	0.0
lake chub	4.1	32.3	3.9
longnose dace	2.6	0.2	0.0
longnose sucker	0.4	1.4	5.3
pearl dace	0.1	0.0	0.0
slimy sculpin	8.6	4.4	0.0
spottail shiner	<0.1	0.0	0.0
trout-perch	1.5	0.0	0.0
walleye	0.1	0.0	0.0
white sucker	16.2	5.9	84.9
unidentified sucker fry	59.7	22.5	0.0

[a] Bond and Machniak 1977 – sampling by seine net, minnow trap and backpack electrofishing.

Table 41 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1977[a]

Species	Watercourse		
	Mainstem Muskeg River	Jackpine Creek	Muskeg Creek
Arctic grayling	0.8	1.2	0.0
brook stickleback	7.1	37.0	94.6
burbot	0.1	0.0	0.0
fathead minnow	<0.1	0.0	0.0
lake chub	6.0	22.2	0.9
lake whitefish	0.7	0.0	0.0
longnose dace	1.1	1.3	0.0
longnose sucker	0.2	2.5	0.0
mountain whitefish	0.1	0.0	0.0
ninespine stickleback	<0.1	0.0	0.0
northern pike	0.3	0.0	0.0
pearl dace	0.4	0.0	0.9
slimy sculpin	1.4	8.6	0.0
trout-perch	0.3	0.0	0.0
white sucker	1.1	27.2	3.6
yellow perch	1.4	0.0	0.0
unidentified sucker fry	78.9	0.0	0.0

[a] Bond and Machniak 1979 – sampling by seine net, minnow trap, drift net and dip net.

Table 42 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1985[(a)]

Species	Watercourse							
	Mainstem Muskeg River	Muskeg Creek	Khahago Creek	Blackfly Creek	Green Stockings Creek	Iyinimin Creek	Wapasu Creek	Kearl Lake
brook stickleback	40.5	50.6	98.4	100	100	100	96.4	59.1
lake chub	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
northern pike	23.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
pearl dace	23.8	31.2	0.6	0.0	0.0	0.0	1.8	1.1
slimy sculpin	0	8.8	0.0	0.0	0.0	0.0	0.0	0.0
white sucker	9.5	9.4	0.0	0.0	00.	0.0	1.8	39.8

(a) Louma et al. 1986 – sampling by seine net, gill net and backpack electrofishing.

Table 43 Percent of Catch for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1988[(a)]

Species	Watercourse								
	Mainstem Muskeg River	Jackpine Creek	Muskeg Creek	Khahago Creek	Blackfly Creek	Green Stockings Creek	Iyinimin Creek	Wapasu Creek	Kearl Lake
brook stickleback	28.1	15.4	20.0	66.7	94.4	85.5	91.2	76.6	30.8
fathead minnow	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
lake chub	0.0	0.0	0.3	6.1	0.0	0.0	0.0	0.0	0.3
longnose sucker	9.4	3.1	1.4	0.0	0.0	0.0	0.0	0.0	2.2
northern pike	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
pearl dace	21.9	38.1	41.0	27.2	5.6	14.5	8.8	9.8	1.8
slimy sculpin	21.9	23.8	5.6	0.0	0.0	0.0	0.0	0.0	0.0
white sucker	10.4	19.6	31.7	0.0	0.0	0.0	0.0	13.6	64.6

(a) RL&L 1989 – sampling by backpack electrofishing and gill net.

CPUE from various sampling techniques are provided in some of the more recent studies and are listed in Golder (1999c). CPUE for studies with sufficient sampling effort to provide an indication of species relative abundance are summarized in Table 44 through 47.

Table 44 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1985[(a)]

Watercourse	CPUE by Sampling Technique	Species					
		Brook Stickleback	Lake Chub	Northern Pike	Pearl Dace	Slimy Sculpin	White Sucker
Muskeg River	electrofishing (#/hr)	7.6	0.5	0.0	4.8	0.0	1.4
	electrofishing (#/m^{2}x100)	0.30	0.02	0.00	0.20	0.00	0.06
	gill net (#/hr)	0.00	0.00	0.09	0.00	0.00	0.01
Muskeg Creek	electrofishing (#/hr)	24.5	0.0	0.0	15.2	4.2	4.5
	electrofishing (#/m^{2}x100)	1.20	0.00	0.00	0.80	0.20	0.20
Khahago Creek	electrofishing (#/hr)	54.8	0.0	0.0	0.9	0.0	0.0
	electrofishing (#/m^{2}x100)	2.90	0.00	0.00	0.05	0.00	0.00
Blackfly Creek	electrofishing (#/hr)	110.5	0.0	0.0	0.0	0.0	0.0
	electrofishing (#/m^{2}x100)	3.9	0.0	0.0	0.0	0.0	0.0
Green Stockings Creek	electrofishing (#/hr)	95.6	0.0	0.0	0.0	0.0	0.0
	electrofishing (#/m^{2}x100)	6.0	0.0	0.0	0.0	0.0	0.0
Iyinimin Creek	electrofishing (#/hr)	54.5	0.0	0.0	0.0	0.0	0.0
	electrofishing (#/m^{2}x100)	2.5	0.0	0.0	0.0	0.0	0.0
Wapasu Creek	electrofishing (#/hr)	76.5	0.0	0.0	1.5	0.0	0.7
	electrofishing (#/m^{2}x100)	3.90	0.00	0.00	0.07	0.00	0.04
Kearl Lake	gill net (#/hr)	0.0	0.0	0.0	0.0	0.0	0.1
	minnow trap (#/hr)	0.37	0.00	0.00	0.01	0.00	0.00

(a) Louma et al. 1986.

Table 45 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1988[(a)]

Watercourse	CPUE by Sampling Technique	Species							
		Brook Stickleback	Fathead Minnow	Lake Chub	Longnose Sucker	Northern Pike	Pearl Dace	Slimy Sculpin	White Sucker
Muskeg River	electrofishing (#/hr)	13.0	0.0	0.0	4.3	3.9	10.1	10.1	4.8
	electrofishing (#/m^{2}x100)	1.6	0.0	0.0	0.5	0.5	1.2	1.2	0.6
Jackpine Creek	electrofishing (#/hr)	94.6	0.0	0.0	1.8	0.0	48.2	*	23.2
	electrofishing (#/m^{2}x100)	10.4	0.0	0.0	0.2	0.0	5.3	*	2.6
Muskeg Creek	electrofishing (#/hr)	78.9	0.0	0.9	5.6	0.0	161.9	22.1	125.4
	electrofishing (#/m^{2}x100)	7.0	0.0	0.1	0.5	0.0	14.4	2.0	11.2
Khahago Creek	electrofishing (#/hr)	70.9	0.0	6.5	0.0	0.0	29.0	0.0	0.0
	electrofishing (#/m^{2}x100)	16.1	0.0	1.5	0.0	0.0	6.6	0.0	0.0
Blackfly Creek	electrofishing (#/hr)	66.7	0.0	0.0	0.0	0.0	3.9	0.0	0.0
	electrofishing (#/m^{2}x100)	5.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Green Stockings Creek	electrofishing (#/hr)	87.0	0.0	0.0	0.0	0.0	14.8	0.0	0.0
	electrofishing (#/m^{2}x100)	11.5	0.0	0.0	0.0	0.0	1.9	0.0	0.0
Iyinimin Creek	electrofishing (#/hr)	106.8	0.0	0.0	0.0	0.0	10.3	0.0	0.0
	electrofishing (#/m^{2}x100)	9.8	0.0	0.0	0.0	0.0	0.9	0.0	0.0
Wapasu Creek	electrofishing (#/hr)	148.5	0.0	0.0	0.0	0.0	19.1	0.0	26.5
	electrofishing (#/m^{2}x100)	15.9	0.0	0.0	0.0	0.0	2.0	0.0	2.8
Kearl Lake	gill net (#/hr)	0.0	0.0	<0.1	0.1	0.0	0.0	0.0	2.2
	minnow trap (#/hr)	0.4	<0.1	0.0	0.0	0.0	<0.1	0.0	0.0

(a) RL&L 1989.

* Species captured but data not available to calculate CPUE.

Table 46 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1995[(a)]

Watercourse	CPUE by Sampling Technique	Species										
		Arctic Grayling	Brook Stickleback	Burbot	Fathead Minnow	Lake Chub	Longnose Sucker	Northern Pike	Pearl Dace	Slimy Sculpin	Trout-perch	White Sucker
Muskeg River	electrofishing (#/m^{2}x100)	<0.01	0.00	<0.01	0.10	0.06	0.07	0.01	0.00	0.04	0.02	0.04
Jackpine Creek	electrofishing (#/m^{2}x100)	0.00	0.00	0.00	0.40	0.00	0.06	0.00	0.00	0.30	0.00	0.00
Muskeg Creek	electrofishing (#/m^{2}x100)	0.00	2.00	0.00	0.70	0.00	0.10	0.00	0.20	0.60	0.00	0.00
Khahago Creek	electrofishing (#/m^{2}x100)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blackfly Creek	electrofishing (#/m^{2}x100)	0.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iyinimin Creek	electrofishing (#/m^{2}x100)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kearl Lake	electrofishing (#/hr)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.10
	minnow trap (#/hr)	0.00	3.90	0.00	12.60	0.00	0.00	0.00	1.26	0.00	0.00	0.00

(a) Golder 1996a.

Table 47 CPUE for Fish Species Captured in Tributary Watershed #27 (Muskeg River) – 1997[a]

Watercourse	CPUE by Sampling Technique	Species			
		Brook Stickleback	Longnose Sucker	Pearl Dace	White Sucker
Upper Muskeg River[a]	electrofishing (#/hr)	38.4	0.0	47.8	7.3
	minnow trap (#/hr)	0.5	2.0	<0.1	<0.1
Wapasu Creek	electrofishing (#/hr)	8.6	0.0	6.6	0.7
	minnow trap (#/hr)	0.8	0.0	0.8	0.2

[a] Komex 1997 – Study limited to upper Muskeg River (upstream of Wapasu Creek confluence).

5.19.2 Habitat

Mainstem Muskeg River

The Muskeg River is one of the larger tributaries to the Athabasca River in the Oil Sands Region. Historical fisheries investigations have determined that the Muskeg River provides important habitat for some fish species and life stages, but habitat conditions and fish species composition were variable along the length of the watercourse.

Griffiths (1973) suggested that the lower 8 km section of the river had excellent potential for sport fish production due to the favourable gradient, flow rate, pool/riffle sequences and availability of spawning gravels. The remainder of the watercourse was rated as having poor fisheries potential because the gradient was low and habitat was dominated by slow moving pools with silt substrate.

Since the study by Griffiths (1973), several habitat assessments have been conducted for the Muskeg River, encompassing varying lengths of the watercourse. These assessments have divided the river into reaches, with gradient being used as the primary criteria for reach designation. As such, they confirm Griffiths' (1973) separation of the lower few km by gradient, but provide a more detailed longitudinal assessment. Different numbers of reaches have been identified for the Muskeg River by different researchers. In general, reach boundaries and reach descriptions have been in agreement over the common portions of the watercourse examined. The following reach designations and descriptions have been synthesized from the early descriptions provided by RRCS (1974), Bond and Machniak (1979), Sekerak and Walder (1980) and O'Neil et al. (1982). Later studies confirmed these reach designations (RL&L 1989; Golder 1996a). In total, 112 km of the mainstem Muskeg River have been included in the reach analysis.

Reach 1 of the Muskeg River was a short section that extends from 0.0 to 0.5 km upstream of the river mouth. This section basically encompasses the portion of the river in the Athabasca River floodplain. Reach 1 has a moderate gradient with shallow runs, but also has some pool and riffle areas. The substrate was gravel and cobble, with some boulder and fine sediment. This reach was considered to have low spawning potential for sport fish but to provide excellent rearing habitat for young fish originating from spawning areas farther upstream or from the Athabasca River, as well as providing resting areas for Athabasca River migrants (Bond and Machniak 1979).

Reach 2 extended from 0.5 to 9.0 km upstream of the river mouth and has been called the canyon section because of the highly incised valley walls. This reach has a high gradient with a diversity of habitats, including pools, riffles, runs and rapids. The substrate was predominately coarse, with gravel, cobble and boulder sized particles, as well as exposed bedrock. In general, the substrate size increased from the bottom to the top of this reach. Reach 2 was considered by all researchers to provide excellent spawning potential for sport fish, suckers and forage fish that use swift flowing rocky habitat. The diversity of habitat types in Reach 2 was also considered to provide potential rearing and adult feeding habitat for most fish species, although RRCS (1974) felt that the shallow pool depths would limit adult fish of large-bodied species. Side sloughs occurred in this reach that were considered to provide potential spawning, rearing and feeding areas for northern pike (Bond and Machniak 1979).

Reach 3 of the Muskeg River extended from 9.0 to 16.5 km upstream of the mouth. The reach has a moderate to low gradient reach, transitional in nature between the higher gradient zone in Reach 2 and the low gradient areas farther upstream. Although riffle, run and pool habitats occur in this reach, pool habitat was predominant and the run habitats were deep and slow (Sekerak and Walder 1980; Golder 1996a). The pools were considered high quality (RRCS 1974) and were regularly interrupted by riffle areas through the length of the reach. The substrate was variable, depending on habitat type, with fine sediment, gravel, cobble and boulder all present. Fine sediments were common in low velocity habitats, but there was still rocky substrate throughout the reach, with gravel and cobble dominating in the riffle areas. Overall, Reach 3 was thought to provide opportunity for spawning, rearing and feeding for most fish species. The potential for spawning by sport fish, suckers and forage fish that utilize swift rocky habitat, although limited to the localized riffle areas, was rated as excellent (RRCS 1974; Bond and Machniak 1979). Rearing and feeding habitat in this reach was considered to be good for most fish species.

Reach 4 was the longest section of the Muskeg River and the primary habitat type. Extending from 16.5 to 80.0 km upstream of the river mouth, this reach comprised 57% of the length of river examined. Reach 4 had a low gradient consisting primarily (i.e., 95%) of deep slow pool and run habitats. Riffles were also present but occurred infrequently (Golder 1996a). The substrate was dominated by fine sediment. Some reports list the substrate as 100% fines and organic material (Sekerak and Walder 1980) while others indicate that a small amount of gravel, cobble and boulder substrate occurs, located in the rare riffle areas (Bond and Machniak 1979; RL&L 1989; Golder 1996a). Beaver dams and impoundment pools were common in Reach 4, further reducing flow velocity and increasing water depth and sediment deposition. Some habitat degradation appears to have occurred over time in Reach 4 due to beaver activity. One study site examined in 1988 (RL&L 1989) and in 1995 (Golder 1996a) was found to have changed from a pool to riffle ratio of 3:2 to 5:1 in the later study. The change in habitat was attributed to increased beaver impoundments in the local area.

Some distinction has been made between the portion of Reach 4 downstream of the Jackpine Creek confluence (i.e. the lower 16.5 km of the reach) and the upper 47.0 km of the reach above Jackpine Creek. Downstream of Jackpine Creek, the habitat and substrate in Reach 4 was more variable than in upstream areas. The lower portion of the reach had occasional but regular riffle habitats that had cobble/boulder substrate interspersed among the dominant deep, slow run and pool habitats that had silt/sand/organic substrate (Fedoruk 1973; RL&L 1989). The upper portion of Reach 4 lacked riffle areas and had substrate dominated by sand and organic substrates with areas of gravel, cobble and boulder being rare (Fedoruk 1973; Louma et al. 1986; RL&L 1989). Beaver activity and the frequency of impoundment pools was higher in the upper portion of the reach, resulting in extremely low water velocities (Golder 1996a).

Studies rated habitat in Reach 4 from poor for all species and life stages to good for some species and/or life stages. Habitat limitations noted for Reach 4 (and areas farther upstream) have been the main reason that the Muskeg River has been considered to provide limited potential for fisheries. In general, Reach 4 has been described as having low habitat diversity, fine substrates, a lack of spawning areas for most species and limited potential for food production. Northern pike was the one sport species for which Reach 4 would likely provide suitable spawning, rearing and feeding habitat (Fedoruk 1973; Sekerak and Walder 1980; RL&L 1989; Golder 1996a). In addition, the occasional riffle habitats that occur in the lower portion of Reach 4 were considered to provide spawning habitat of limited suitability for Arctic grayling, longnose sucker and white sucker (Bond and Machniak 1979; RL&L 1989). The lower portion of Reach 4 was also considered to provide some potential rearing and feeding habitat for most species, with the habitat capability rated as good in some areas (Bond and Machniak 1979; RL&L 1989). The most severely limited habitat occurred in the portion of Reach 4 upstream of Jackpine Creek where habitat diversity, poor substrate conditions, lack of cover for fish and potential blockages to fish movements were caused by extensive beaver activity. Louma et al. (1986) rated upper Reach 4 as poor for all fish species and stated that suitable spawning habitat for northern pike was not found. This contrasts with the RL&L (1989) report, which considered the upper reach to provide low quality spawning and rearing habitat for northern pike and small-bodied forage fish.

Reach 5 of the Muskeg River extended from 8.0 to 93.0 km upstream of the river mouth. This reach had a moderate to high gradient. Despite the increased gradient relative to Reach 4, habitats remained primarily limited to slow moving pools with occasional riffle areas because beaver impoundments reduced flow. The substrate material was predominately fine sediments (i.e., 80% silt/sand), with small amounts of gravel, cobble and boulder located in the riffle areas. Reach 5 was considered to provide low productivity for sport species due to the limited amount of suitable habitat and limited potential for fish movement (Komex 1997). Habitat may be suitable for northern pike and forage fish, when accessible.

Reach 6 encompasses the headwater regions of the Muskeg River, extending from 92.0 to 112.0 km upstream of the river mouth. As in Reach 5, the gradient was relatively high but beaver impoundments and debris piles resulted in habitats limited to slow pools with fine sediment and organic material for substrate. The habitat in Reach 6 was considered to be limited due to habitat conditions and because fish movement was restricted.

Habitat that would provide overwinter conditions for fish in the mainstem Muskeg River was not investigated in most studies. However, potential for the river to provide overwintering habitat was speculated in several reports, although there was disagreement. RRCS (1974) believed that there was no habitat for overwintering in the upper river, but that overwintering may be possible in the lower river. Other researchers speculated that overwintering habitat may be present in deep pools in reaches 2, 3 and 4, but may be limited to small-bodied species or young life stages of large-bodied species. Louma et al. (1986) investigating habitat conditions in Reach 4 in the early winter (December) of 1985 found water depths suitable for overwintering, but no measurable flow and low dissolved oxygen levels. Golder (1997e) in its late winter (March) investigation in 1997 at the boundary of reaches 3 and 4 also found water depths sufficient for overwintering, low flow and low dissolved oxygen levels. It may be that the potential of the habitat to provide overwintering conditions was variable or poor and may be limited to fish tolerant of low dissolved oxygen concentrations.

Tributary Drainages of the Muskeg River

Unnamed Tributary and Waterbodies

An unnamed tributary enters the Muskeg River from the south, partway between the river mouth and the Jackpine Creek confluence. Connected to this drainage are three small, unnamed waterbodies. This drainage was investigated in 1979 (Webb 1980) and in 2001 (Golder 2002b). The watercourse had sustained flow in the lower-most portion and was intermittent farther upstream. The substrate was variable ranging from all silt in some areas to part silt and part rocky (gravel, cobble, boulder) substrates in other areas. The watercourse is small and beaver occupy its length. The best habitat for fish occurs in the lower-most portion of the watercourse, downstream of where it drains the waterbodies, where the flow is sustained and the substrate includes some gravel and boulder.

The three unnamed waterbodies have maximum depths ranging from 11 to 15 m. The lake substrates are primarily fines and organic muck, with small, local areas of rock (gravel, cobble, boulder). There is habitat in these waterbodies for forage fish and large-bodied fish; however, use is somewhat limited by the poor habitat and poor fish passage in the watercourse that connects them to the Muskeg River, which would limit fish presence and access. Webb (1980) found one waterbody to have sufficient dissolved oxygen to sustain fish in winter while the other two did not.

Jackpine Creek (Formerly Hartley Creek)

Jackpine Creek is the largest tributary in the Muskeg River watershed and has been described as having the highest fisheries potential of all tributaries in the watershed. As with the Muskeg River mainstem, reach analysis has been conducted for Jackpine Creek by several studies, with reach designations based on stream gradient as it affects habitat and substrate. Several studies examined the lower portion of the watercourse (up to 27.5 km upstream of the creek mouth) and consistently divided it into five reaches (RRCS 1974; Bond and Machniak 1979; O'Neil et al 1982; RL&L 1989; Golder 1996a). Sekerak and Walder (1980) examined the full 69.0 km length of Jackpine Creek and provided a total of only five reaches, amalgamating three of the reaches proposed by others into a single reach. The following reach designations and descriptions have been generated from all reports combined and include the five reaches designated for the lower portion of the creek by the majority of reports, as well as the upper reaches designated by Sekerak and Walder (1980). This provides a total of seven reaches that have been recognized for Jackpine Creek.

Reach 1 of Jackpine Creek extended from 0.0 to 3.0 km upstream of the creek mouth. This reach had a low gradient and low habitat diversity, consisting almost entirely of slow runs and pools dominated by sand/silt substrate with a few isolated areas of gravel/cobble. Beaver dams were common. Reach 1 was considered to have a low potential to support fish, with spawning habitat for species requiring swift flow over rocky substrate limited (Bond and Machniak 1979; O'Neil et al. 1982). Spawning habitat for species such as northern pike or brook stickleback requiring aquatic vegetation and instream debris was thought to be higher (O'Neil et al. 1982; RL&L 1989). Rearing habitat was considered most suitable for suckers and small-bodied fish species and adult feeding potential was considered low for all but small forage species.

Reach 2 extended from 3.0 to 6.7 km upstream of the creek mouth. The gradient was moderate, resulting in an increase in habitat diversity. The habitats included riffle, run and pool areas. Beaver dams were common and, as a result, approximately half of the reach consisted of slow runs or beaver impoundments, but these habitats were regularly interspersed with riffle-run-pool sequences (O'Neil et al. 1982; Golder 1996a). Overall, the dominant (i.e. 70%) substrate material was fine sediment, but coarse material comprised a significant portion of the substrate in the reach (O'Neil et al. 1982; RL&L 1989). Sand was present in slow moving habitats and gravel/cobble was present in the swifter riffle and run areas, with occasional boulders throughout the reach. The potential in Reach 2 for spawning by species such as Arctic grayling, mountain whitefish and suckers was rated as excellent in the rocky riffle areas, and the rearing potential was rated as good for the same species (RRCS 1974; Bond and Machniak 1979; O'Neil et al. 1982). Feeding habitat for adults of large-bodied species was considered to be dependant on flow level, with only marginal habitat during low flow periods.

Reach 3 was a short section of Jackpine Creek extending from 6.7 to 8.2 km upstream from the mouth. This was a high gradient section with high habitat diversity and increased occurrence of riffle and run habitats with coarse substrate. Rocky substrates were dominant throughout the reach, with cobble and boulder common and gravel occurring in patches. Reach 3 may provide habitat for spawning, rearing and feeding by Arctic grayling (Bond and Machniak 1989). O'Neil et al. (1982) described the reach as providing habitat for spawning by Arctic grayling and sucker, but felt that the suitability was limited due to the large substrate size. O'Neil et al. (1982) rated the reach as having significant rearing capability based on the available habitat types and the high degree of cover provided by large substrate particles, but considered high velocities in the reach as a potential limitation to rearing suitability. Adult feeding conditions were described as limited due to the lack of deep pools.

Reach 4 of Jackpine Creek extended from 8.2 to 21.0 km upstream of the mouth. This reach had a moderate gradient with habitat similar to Reach 2. The reach consisted mainly of slow pool habitats interspersed with regular riffle and run areas. Beaver dams were common throughout the reach. The substrates were primarily fine sediments and organic material, particularly in impounded areas, but there was still a significant amount of coarse substrate in the form of gravel, cobble and boulder in the riffle habitats. The potential for spawning by Arctic grayling, mountain whitefish and suckers was rated as excellent in the rocky riffle areas (RRCS 1974; Bond and Machniak 1979; O'Neil et al. 1982). Reach 4 was considered to provide suitable rearing habitat for most species, particularly Arctic grayling. Adult feeding habitat was considered to be suitable for Arctic grayling at moderate to high discharges, but limited at low flows due to lack of good quality pools (O'Neil et al. 1982).

Reach 5 extended from 21.0 to 49.0 km upstream of the Jackpine Creek mouth. This reach had a low gradient and poor habitat diversity. This reach consisted primarily (i.e., 95%) of slow run and pool habitats. Beaver activity was extensive resulting in numerous impoundment pools. Substrate materials were dominated by fine sediment and organic debris, with very small amounts of gravel. It was concluded that habitat conditions in Reach 5 were best suited to small-bodied forage fish, although sporadic spawning sites for suckers might be present in the isolated scour areas where gravel occurred (O'Neil et al. 1982; RL&L 1989). Habitats were largely unsuitable for rearing and feeding by large-bodied fish due to the restricted occurrence of riffles, runs and good quality pools (O'Neil et al. 1982).

Reach 6 included the section of creek from 49.0 to 61.5 km upstream of the mouth. This reach had a high gradient, but low habitat diversity because of beaver dams. Habitat consisted almost entirely of slow pool areas and impoundments. As a result, substrates consisted mainly of fine sediment and organic material, with small amounts of gravel located in isolated scour areas. Habitat potential was not rated for this reach, but from the description appears to be extremely limited due to habitat limitations and poor potential for fish movement.

Reach 7 encompasses the headwaters of Jackpine Creek, extending from 61.5 to 69.0 km upstream of the creek mouth. This reach was similar to Reach 6 and had a high gradient and low habitat diversity. Beaver activity was extensive in this section and the reach consisted entirely of slow pool habitat with fine sediment for substrate. As in Reach 6, habitat potential was not rated for this reach, but appears to be extremely limited.

Habitat in which fish could overwinter in Jackpine Creek was examined in only a few instances but most reports speculated about the overwintering potential of the creek based on habitat observations. In general, overwintering habitat was considered limited throughout the creek because low water and low dissolved oxygen levels during low flow periods would affect survival in winter (Fedoruk

1973; RL&L 1989). Some opportunity for overwintering by small-bodied species or young fish of larger species may exist, but conditions for overwintering by large fish would be marginal at low discharge in reaches 1 to 4 and poor in the upper reaches (Bond and Machniak 1979; O'Neil et al. 1982). These conclusions were verified by later winter studies. Examination of Jackpine Creek in Reach 5 determined that at low discharge, dissolved oxygen and water levels were sufficient to sustain small fish, but depths were too shallow for large fish (Golder 1997c). Near the creek mouth (Reach 1) in March of 1997, water depths and dissolved oxygen was adequate to sustain sport fish (Golder 1997e).

East Jackpine Creek is the major tributary to Jackpine Creek. Limited information was available for this watercourse. East Jackpine Creek had a low gradient and low habitat diversity, with numerous beaver dams throughout the watercourse (O'Neil et al. 1982; RL&L 1989; Golder 2001a). The habitat consisted mainly of slow runs, pools and impoundments. The substrate was comprised almost entirely of fine sediment and organic material with occasional boulder. Because of beavers, the discharge in the upper portion of the creek was low in the summer and fall, and undetectable in the winter (O'Neil et al. 1982).

Shelly Creek

Shelly Creek is a small tributary to the Muskeg River. The channel was narrow and meandering. Beaver activity was extensive, with beaver dams and impoundment pools common throughout the watercourse. In 1996, in the vicinity of the Canterra Road crossing, the tributary consisted of 30% low grade pools (i.e., Class 3) and 70% low (Class 3) to moderate (Class 2) grade run habitat (Golder 1996d). In 2001, also in the vicinity of the Canterra Road crossing, the habitat present included impoundment pools, scour pools, runs and some isolated riffle areas (Golder 2002b). Substrate in the section near the road crossing was primarily silt and sand, with small amounts of cobble and boulder in the riffle areas. Aquatic vegetation was present in the ponded areas and overhanging vegetation (shrubs) provided overhead cover.

Habitat was investigated in the winter of 1997 (Golder 1997e). The creek had standing water with no measurable discharge and a low dissolved oxygen concentration, making it unsuitable as overwintering habitat.

Muskeg Creek (Formerly Kearl Creek)

The Muskeg Creek watershed includes a number of small watercourses as well as Kearl Lake, the main waterbody in the Muskeg River watershed. The other watercourses in the Muskeg Creek basin include Khahago Creek, Pemmican Creek, Green Stockings Creek, Blackfly Creek, Wesukemina Creek and Iyinimin Creek (Figure 2).

Muskeg Creek drains Kearl Lake to the Muskeg River and receives inflow from Khahago and Wesukemina creeks. Muskeg Creek was divided longitudinally into four reaches (RL&L 1989). Reach 1 was short and consisted of the lowermost portion of the creek that occurs within the Muskeg River floodplain. This section of the watercourse had a low gradient, deep, slow pool habitats and substrates composed of fine sediments. Reach 2 had a relatively high gradient with a pool:run:riffle ratio of 2:4:1. Substrates consisted of gravel and cobble in the run and riffle habitats and sand and silt in the pools. Reach 3 had a relatively high gradient, but riffles were absent and the stream consisted primarily of deep, fast runs with occasional pools. Sand and silt were the dominant substrates, occurring in the slow runs and pools. Cobble and boulder were present in the faster run habitats. Beaver dams were common throughout all three lower reaches of Muskeg Creek. The potential of the habitat to support fish in the lower three reaches of the creek was rated as fair to good for some fish species, including suckers and small-bodied forage fish. Spawning habitat was present for suckers and forage species that use swift flowing, rocky habitats. Habitat for spawning was limited in extent to the localized gravel riffle areas, but was rated as good relative to the other small streams in the Muskeg River watershed. The lower three reaches were also considered to provide rearing habitat for suckers and habitat for small-bodied species. Beaver dams created potential barriers, limiting fish movement in the watercourse.

Reach 4 was the uppermost section of Muskeg Creek (extending from the Khahago Creek confluence up to Kearl Lake) and contained the outflow from Kearl Lake. Descriptions of Reach 4 vary between 1985 (Louma et al. 1986) and when the creek was re-examined in 1988 (RL&L 1989). Differences in habitat were probably the result of beaver activity. In 1985, Reach 4 had a mix of pool, run and riffle habitats in a ratio of 2:4:1. This section was generally shallow and dominated by cobble substrate with some gravel, which provided limited potential for spawning by suckers and forage fish. In 1988, the same reach had extensive beaver activity and consisted of run habitat only, with predominately sand substrate and small amounts of cobble and gravel. In 1995, Golder (1996a) noted an increase in beaver activity since the previous studies and described the habitat as consisting of impoundment pools with very slow flow, resulting in substrate change due to sedimentation and a reduction or elimination of the spawning potential of the reach.

An assessment of beaver activity in Muskeg Creek was conducted during an overflight in 1996 (Golder 1996d). At that time, the creek had a well-defined meandering channel from its confluence with the Muskeg River upstream to the Canterra Road bridge crossing in Reach 3, with little beaver activity in this section. However, upstream of the bridge, beaver activity was common, with dams and impoundment pools comprising much of the upper portion of the creek (i.e. Reach 4).

RL&L (1989) suggested that Muskeg Creek had some potential to provide overwintering habitat due to stabilizing flows from the Kearl Lake outlet. In December 1985, Louma et al. (1986) recorded a small amount of flow in Kearl Creek with dissolved oxygen concentrations suitable for supporting fish. In winter 1997 (Golder 1997e), the creek was also found to be flowing with suitable dissolved oxygen levels for fish; however, the discharge was very low and the water depths were considered too shallow to provide suitable overwintering habitat (Golder 1997e, 1999b).

Kearl Lake is the largest waterbody in the Muskeg River watershed. The lake has consistently been described as a small (i.e., 5.3 km^2 surface area), shallow waterbody with a shoreline dominated by floating sedge fen, a mean depth of 1.4 m, a maximum depth of 2.5 m, abundant submergent, emergent and floating-leaved vegetation, and substrates composed entirely of silt, sand and organic material (Griffiths 1973; O'Neil et al. 1982; Louma et al. 1986; RL&L 1989; Golder 1996a). Kearl Lake was considered to provide marginal habitat for some fish species and life stages, including suckers and small-bodied fish. Habitat for spawning was limited to species that require vegetation, such as brook stickleback. Rearing and feeding habitat was limited and use of the lake was considered to be seasonal, due to the limited potential of the lake to provide suitable overwintering conditions. Louma et al. (1986) believed the capability of Kearl Lake to provide overwintering habitat was severely limited by shallow depths and high organic load and considered overwintering likely limited to species tolerant to low dissolved oxygen levels, such as brook stickleback. RL&L (1989) suggested that the lake may provide overwintering habitat for suckers and small-bodied species in some years, but that winter kill would occur in other years. In the early winter (December) of 1998, Golder (1999b) found the maximum under-ice depth of the lake to be 1.75 m, with good dissolved oxygen levels. However, in the late winter of 1989, RL&L (1989) found that Kearl Lake was anoxic, with hydrogen sulphide gas present. Although the lake may provide seasonal habitat for northern pike, use of Kearl Lake by sport fish appeared to be blocked by beaver dams in both the Muskeg River and Kearl Creek.

Khahago Creek is the main tributary to Kearl Creek and collects flow from Pemmican, Green Stockings and Blackfly creeks. Khahago Creek has been described as low gradient, consisting primarily of deep, slow runs with few pools or riffles. The substrates were mainly silt, sand and organic material, with few gravel areas. Beaver dams were present on the creek and instream vegetation was abundant. The potential of habitat to support large-bodied species was considered to be poor, but suitable for forage fish such as brook stickleback

(O'Neil et al. 1982; Louma et al. 1986; RL&L 1989; Golder 1996a). Beaver dams likely impeded movements of fish, particularly in the upper reaches of the creek. The overwintering potential of Khahago Creek was determined to be extremely poor. O'Neil et al. (1982) found the creek to be frozen to the bottom in the winter. Other studies found water to be present in the winter, but the creek had no measurable flow and critically low dissolved oxygen levels (Louma et al 1986; RL&L 1989).

The three watercourses in the Khahago Creek drainage also had limited habitat potential. Pemmican Creek was a small, narrow channel with shallow runs and moderately shallow pools in a ratio of 2:1, with substrates composed of fine sediments (Golder 1996d). Green Stockings Creek was a small, shallow watercourse with a low to moderate gradient and low flow volume (O'Neil et al. 1982; Louma et al. 1986; RL&L 1989). The creek consisted primarily of low quality run and pool habitats, with occasional riffles. The substrates were mainly composed of silt and sand, with small gravel/cobble deposits in the few riffle areas. Beaver dams were common. The habitat was rated with a low potential to support most fish species, but may be suitable for small-bodied fish such as brook stickleback because of the availability of abundant instream vegetation (Louma et al. 1986; RL&L 1989; Golder 2001a). Studies during winter in Green Stockings Creek found no measurable discharge, but water was present in the stream and had suitable dissolved oxygen concentrations for fish. The lack of discharge and shallow depths would limit the overwintering habitat to small-bodied tolerant species. Blackfly Creek had a higher gradient than Khahago Creek and consisted primarily of pools and runs, with occasional riffle areas. The run habitats were swift and shallow. The creek substrate was primarily silt and sand, with gravel and cobble in the few riffle areas. Blackfly Creek probably provided poor habitat for most fish species, but suitable habitat for small-bodied species such as brook stickleback (Louma et al. 1986; RL&L 1989; Golder 1996a).

Wesukemina Creek is a small tributary of Muskeg Creek. Wesukemina Creek was dominated by shallow pools with no measurable discharge during a 1996 study (Golder 1996d). The substrate was entirely fine sediment (i.e., silt and sand). Habitat potential was extremely limited.

Iyinimin Creek is the main inflow into Kearl Lake; it was divided longitudinally into two reaches by RL&L (1989). The lower portion of the creek was designated Reach 1 and was characterized by a low gradient with marsh/muskeg conditions. The remainder of the creek was designated as Reach 2 and had an increased gradient with pools, runs and riffles occurring at a ratio of 1:3:1 (Louma et al. 1986; RL&L 1989; Golder 1996a). The creek was shallow with a low flow and numerous beaver dams. The substrate was mainly silt, sand and organic material, with gravel/cobble patches and occasional boulder in the riffle areas. The habitat potential of Iyinimin Creek was rated as poor to fair for forage fish species. During winter, flow was thought to be absent in some years (RL&L 1989). During one winter study, water was present in the creek with dissolved oxygen concentrations suitable for fish, but there was no measurable discharge (Louma et al. 1986).

Stanley Creek

Stanley Creek is one of the few tributaries that enters the Muskeg River from the north. The creek was a small, low gradient watercourse with intermittent flow and had a low potential to support fish (Golder 1996a, 1996d). The lower-most portion of Stanley Creek lacked a defined channel. In this section, the creek flowed through a muskeg area in a system of shallow braided channels with substrate composed of fine sediment and organic material. Farther upstream, the middle portion of the creek had flooded areas and braided channels dominated by run habitats, with some pool and riffle areas. The substrate was primarily sand with some cobble and boulder in the riffle areas. The headwater segment of Stanley Creek, where it exits the Fort Hills, had a small (2.0 m) but defined channel dominated by low quality run habitat (92%), with some riffles (4%) and shallow pools (4%). The substrate was primarily sand with some boulder/cobble that could provide good instream cover. Cover was also available from instream woody debris and overhanging vegetation. Stanley Creek had standing water with no discharge during some periods of the open water season and probably provided poor habitat for all fish species.

Wapasu Creek

Wapasu Creek is a tributary of the Muskeg River in the upper portion of the watershed. The creek has been divided longitudinally into four reaches (Louma et al. 1986; RL&L 1989). Reach 1 and 2 comprise the lower portion of the watercourse and had low gradient sections with extensive beaver activity resulting in deep, slow runs and impoundment pools. The substrate in these two reaches was mainly fine sediment and organic material with some gravel. Reaches 3 and 4 comprise the majority of the creek. These upper reaches had an increased gradient and slightly greater habitat diversity relative to the lower reaches. Reaches 3 and 4 consisted of runs and pools interspersed with occasional riffle areas. The substrates in reaches 3 and 4 were mainly silt and sand, with deposits of gravel and cobble in scour areas and riffle habitats.

Wapasu Creek had a limited potential to support sport species because fish movement was restricted by numerous beaver dams (Komex 1997). Conditions for suckers and small-bodied forage fish were rated as poor in the lower two reaches of the creek and fair in the upper two reaches for spawning, rearing and feeding (Louma et al. 1986; RL&L 1989). Examination of Wapasu Creek in the winter showed suitable dissolved oxygen levels for fish in the early winter (RL&L 1989), although Golder (1999b) found no measurable flow in the early winter. Dissolved oxygen concentrations were low in the lower portion of the creek but suitable for fish in the upper portion of the creek (Louma et al. 1986). Overall, Wapasu Creek was considered to have no potential to support fish in winter because of low dissolved oxygen levels, lack of deep pools and lack of measurable discharge (Louma et al. 1986).

5.19.3 Habitat Use

Mainstem Muskeg River

Fish in the Muskeg River watershed have been classed into three categories:

- resident species using the watershed for most or all life history stages;
- species using the watershed irregularly, in small numbers, or to a limited geographical extent; and
- migrant species using the watershed for one or more life stages.

Based on available reports, resident species were six small-bodied forage fish with wide distribution in the watershed. Originally, five resident species were reported, including brook stickleback, lake chub, longnose dace, pearl dace and slimy sculpin (Bond and Machniak 1979). Recently, fathead minnow have been shown to be common and widely distributed. These species all may overwinter in the watershed.

Fourteen of the twenty five fish species in the Muskeg River watershed would be considered as restricted species. These species occur in small numbers and/or with limited distribution. The large-bodied species are bull trout, burbot, lake cisco, lake whitefish, walleye and yellow perch. These species were typically restricted to the lower three reaches of the river and were most often present near the river mouth, in association with the Athabasca River. These large-bodied species have been determined to use the Muskeg River to a limited extent for seasonal rearing and feeding or as a resting area during migration. Of these six species, walleye appears to be consistently present in the watershed particularly upstream of the river mouth and has been recorded as far upstream as the boundary between reaches 3 and 4 (Golder 1996a). The forage fish in this category are emerald shiner, finescale dace, flathead chub, ninespine stickleback, northern redbelly dace, spoonhead sculpin, spottail shiner and trout-perch. These species were restricted to the lower Muskeg River or occur irregularly in small numbers in one or more tributary streams.

Regular migrants into the Muskeg River watershed include five large-bodied species: Arctic grayling, longnose sucker, mountain whitefish, northern pike and white sucker. Mountain whitefish was originally included in the restricted species category by Bond and Machniak (1979). However, mountain whitefish have been shown to occur upstream of Reach 3 into Reach 4, and from Reach 4 into Jackpine Creek and should be considered a regular migrant. The other four species in this category use the Muskeg River watershed to varying degrees as spawning, rearing and feeding habitat. Possible overwintering use of the watershed has been speculated for young-of-the-year for some of these species.

Species diversity varies throughout the length of the mainstem Muskeg River because of longitudinal habitat changes and distance from the Athabasca River. The highest diversity occurs in the three lower reaches where 21 species have been documented. Species diversity declines in Reach 4, where 12 species occur. There are four species that have been recorded only in tributary streams. Three species, emerald shiner, flathead chub and spoonhead sculpin, that have been recorded in Jackpine Creek, and finescale dace have been recorded in the unnamed tributary. Spoonhead sculpin has also been captured in Muskeg Creek.

Species diversity declines further within Reach 4 in relation to the location of the Jackpine Creek confluence, which occurs in the lower portion of Reach 4 (i.e., approximately one third of the way from the bottom of the reach). All 12 species reported from Reach 4 occur as far as the Jackpine Creek confluence, and also occur in Jackpine Creek. Four species, including Arctic grayling, longnose dace, mountain whitefish and northern redbelly dace, reach the limit of their distribution at Jackpine Creek. Only 8 species occur in Reach 4 of the Muskeg River upstream of the Jackpine Creek confluence, including one sport fish (northern pike), two suckers (longnose and white sucker) and five small-bodied forage fish (brook stickleback, fathead minnow, lake chub, pearl dace and slimy sculpin). Fathead minnow and slimy sculpin reach the limit of their distribution in Reach 4 at the Muskeg Creek drainage. Northern pike also reach their distribution limit in Reach 4, with fry and juvenile fish recorded in the mainstem Muskeg River up to the Wapasu Creek confluence.

Five fish species have been recorded in reach five, including brook stickleback, lake chub, longnose sucker, pearl dace and white sucker. Although habitat assessments were made in Reach 6, no fish inventory surveys have been conducted. Because brook stickleback, pearl dace and white sucker have been captured at the Reach 5/6 boundary (Komex 1997), it is likely that their distribution continues into Reach 6.

The data from past counting fence studies indicate that spring runs of large-bodied fish species occurred in the Muskeg River watershed from the Athabasca

River (Table 37 and 38). In order of abundance, the main species comprising the spring migration included white sucker, longnose sucker, northern pike, Arctic grayling and mountain whitefish. The spring migration included a spawning run for Arctic grayling, longnose sucker and white sucker. For northern pike, Bond and Machniak (1979) found most of the fish ascending the Muskeg River to be immature or maturing fish and concluded the main use of the river by this species was as feeding habitat. However, some northern pike spawning occurred in the watershed, as evidenced by the presence and distribution of gravid and ripe adults and young-of-the-year fish. Based on the presence of young-of-the-year northern pike as far upstream as the Wapasu Creek confluence, RL&L (1989) suspected that spawning occurred near there. The presence of young northern pike in Reach 4, combined with poor access to this upstream area due to large numbers of beaver dams indicated that a small resident population of northern pike may occur in Reach 4 that could be supplemented in high water years by fish from the lower Muskeg River (RL&L 1989). The mountain whitefish run in the watershed was considered to be a feeding run and spawning by this species was not considered to occur in the Muskeg River (Bond and Machniak 1979). However, based on habitat descriptions, suitable spawning habitat for mountain whitefish is present in the lower Muskeg River and in Jackpine Creek. Young-of-the-year mountain whitefish were captured in the Muskeg River and in Jackpine Creek, indicating that spawning may occur.

The counting fence showed that, at times, small numbers of walleye, lake whitefish, lake cisco, burbot and bull trout move into the watershed in the spring. Walleye, although a spring spawning species, has not been documented to spawn in the watershed; walleye captured in the spring were juvenile fish or spent adults. The other four species spawn in the fall. Yellow perch, although not captured during the spring run, were captured occasionally in the lower Muskeg River. Although young-of-the-year burbot, lake whitefish and yellow perch have been found in the vicinity of the Muskeg River mouth, these fish probably originate from the Athabasca River and spawning activity is not suspected for any of these species in the Muskeg River.

Spawning locations for each of the four large-bodied species determined to spawn in the Muskeg River watershed (white sucker, longnose sucker, northern pike, Arctic grayling) have not been confirmed. However, possible spawning areas have been identified based on the habitat characteristics of the watershed (described in the previous section) in combination with known fish movements, the distribution of adult fish during the spawning season and the distribution of young-of-the-year. Likely spawning areas occur in reaches 1 through 4 of the mainstem Muskeg River for all four species, throughout much of Jackpine Creek for Arctic grayling, longnose sucker and white sucker, and in the lower-most portion of Jackpine Creek for northern pike. Spawning areas have also been identified for longnose and white suckers in Muskeg Creek. Longnose and white sucker have been observed spawning in the lower few kilometres of the Muskeg River (Bond and Machniak 1979).

The capability of the watershed to provide overwintering conditions has been speculated for some of these species, but has not been studied. Arctic grayling are in the watershed through the summer and fall and are present in the mainstem river into October, just prior to freeze-up (Bond and Machniak 1979, O'Neil et al. 1982). Although Arctic grayling were thought to move to the Athabasca River in the late fall, the presence of young-of-the-year fish well upstream of the river mouth in October led to speculation that they may overwinter in the Muskeg River. Some northern pike move downstream out of the watershed in the spring and summer but it was suspected that all northern pike leave the watershed prior to winter.

Based on tag return information, the longnose and white sucker in the spring run into the Muskeg River watershed are from Lake Athabasca (Bond and Machniak 1979). Young-of-the-year and juvenile suckers of both species occur in the Muskeg River. Young of both species are primarily in the lower 35 km of the river, but both, in particular white sucker, are present far upriver. Some summer feeding activity also occurs for adult fish, although a portion of the adult fish leave the river after spawning (Bond and Machniak 1979). Based on the presence of young-of-the-year and juvenile suckers in the Muskeg River in the fall, it was speculated that overwintering may occur for these life stages (O'Neil et al. 1982).

Tributary Drainages of the Muskeg River

Unnamed Tributary and Waterbodies

Seven fish species occur in the unnamed tributary drainage, including the watercourse and the three unnamed waterbodies combined. Brook stickleback were abundant in all three waterbodies and in the portion of the watercourse connecting the waterbodies. Other species present in one or more of the waterbodies were fathead minnow, finescale dace, lake chub, longnose sucker, pearl dace and white sucker. The suckers captured in the waterbodies were adults. Therefore, the waterbodies provided habitat for several forage fish species as well as feeding habitat for suckers. The portion of the watercourse connecting the waterbodies to the Muskeg River was sampled and fish were present only in the lower-most portion, between the Muskeg River and the first beaver dam. Species present in the lower channel included brook stickleback, lake chub and fry and juvenile longnose and white sucker. This portion of the creek provided forage fish habitat, sucker rearing habitat and possibly sucker spawning habitat. It was suggested (Webb 1980) that the waterbodies in the drainage could support northern pike but that fish passage was restricted at the time of the study.

Jackpine Creek (Formerly Hartley Creek)

Fifteen fish species were documented in Jackpine Creek, including three sport fish, two sucker species and ten small-bodied species. The upstream fish trap in Jackpine Creek from 1981 (Table 38) indicated spring runs occurred for Arctic grayling, longnose sucker and white sucker, with a few northern pike. The two trap locations used in the 1981 study (O'Neil et al. 1982) showed that most of the fish utilized the lower 14 km of Jackpine Creek, which corresponds to reaches 1, 2, 3 and the lower half of Reach 4. Mountain whitefish were captured in Jackpine Creek during inventory studies, but not in the counting fence.

The large-bodied fish captured migrating upstream in Jackpine Creek included spawning adult Arctic grayling, longnose sucker, white sucker and northern pike, as well as juvenile Arctic grayling and northern pike (Fedoruk 1973; O'Neil et al. 1982). Spawning in Jackpine Creek by Arctic grayling was documented in 1981 by O'Neil et al. (1982) at five locations in reaches 2, 3 and 4, and they suspected that spawning by this species occurred primarily between 5.5 and 14.2 km upstream of the creek mouth. Based mainly on the 1981 counting fence, O'Neil et al. (1982) suggested that spawning by longnose and white suckers occurred within the lower 14.2 km of the creek, with sucker (species unknown) spawning at two locations in Reach 4. Bond and Machniak (1979) speculated, based on the presence of a few adults in spawning condition, that northern pike may spawn in Reach 1 of Jackpine Creek.

Arctic grayling young-of-the-year, juveniles and adults were in reaches 2, 3 and 4 of Jackpine Creek in 1981, but this species left the creek in the fall (O'Neil et al. 1982). A small amount of rearing activity for young-of-the-year and juvenile suckers has been observed for Jackpine Creek, but summer/fall adult feeding activity was not recorded for longnose sucker and was minor for white sucker. Fish species in Jackpine Creek appears to have changed. The more recent investigations indicate that large-bodied species, particularly Arctic grayling, are fewer. For example, Arctic grayling were not captured in Jackpine Creek in 1985 (Louma et al 1986), 1988 (RL&L 1989), 1995 (Golder 1996a) or 2001 (Golder 2001a), despite being the primary species captured in previous years (RRCS 1974; O'Neil et al. 1982). Arctic grayling were captured in Jackpine Creek in 1997, but only one individual was recorded (Golder 1997d). Numbers of adult longnose and white sucker also appear to have declined in Jackpine Creek since the levels recorded in 1981, although some rearing activity has continued to occur. Northern pike were low in abundance in Jackpine Creek in the older studies and, although not always present, this species was low in abundance in recent years (Golder 1997d).

Overwintering by fish in Jackpine Creek has not been investigated, but it was suspected that overwintering could occur for young-of-the-year and yearling Arctic grayling, longnose sucker and white sucker in high water years (Bond and Machniak 1979; O'Neil et al. 1982).

Shelly Creek

Three fish species have been captured in Shelly Creek: brook stickleback, lake chub and juvenile longnose sucker (Golder 1996d, 2002b).

Muskeg Creek (Formerly Kearl Creek)

In total, ten fish species occurred in the Muskeg Creek watershed, which is comprised of Muskeg Creek, Khahago Creek, Pemmican Creek, Green Stockings Creek, Blackfly Creek, Wesukemina Creek, Iyinimin Creek and Kearl Lake. These species included one sport fish, two sucker species and seven small-bodied forage fish; their distribution in each of these watercourses/waterbodies is presented in Table 36. Nine species were found in Muskeg Creek and seven in Kearl Lake. The same species were in both waterbodies with the exception of slimy sculpin, spoonhead sculpin and spottail shiner (Muskeg Creek only) and northern pike (Kearl Lake only). It is likely that northern pike would also be in Muskeg Creek as it would provide a route between Kearl Lake and the Muskeg River. In addition, RL&L 1989 recorded an unconfirmed report by a local trapper of Arctic grayling in Muskeg Creek. The remaining watercourses in the drainage support a few small-bodied and/or sucker species.

The most abundant species in Muskeg Creek proper were brook stickleback, pearl dace and white sucker, although slimy sculpin were common in riffle habitats (Louma et al. 1986; RL&L 1989; Golder 1996a). Species diversity in the creek was highest in the higher gradient reaches 2 and 3. Pearl dace and white sucker spawning was reported in Muskeg Creek (Louma et al. 1986; RL&L 1989); large numbers of both species were documented to spawn in the section of creek 2 km downstream of the Kearl Lake outlet. Longnose and white sucker young-of-the-year and juveniles were captured in Muskeg Creek and longnose sucker may have spawned there, but this was not confirmed.

Kearl Lake supports abundant populations of small-bodied forage fish dominated by brook stickleback, fathead minnow and pearl dace (Louma et al. 1986; RL&L 1989; Golder 1996a). Louma et al. (1986) and RL&L (1989) found white sucker to be abundant in Kearl Lake, with the lake providing rearing and feeding habitat for this species. Spawning by white suckers was believed to occur in Muskeg Creek (Louma et al. 1986), as described above. However, recent investigations (Golder 1996a) indicate that the spawning potential of Muskeg Creek has been reduced because of habitat and substrate changes resulting from increased beaver impoundments. RL&L (1989) found large number of white sucker in the lake in the summer, but only a few in the fall, indicating that fish may leave the lake prior to the winter. A small number of juvenile longnose sucker were reported from the lake in 1988 (RL&L 1989), but not in 1985 (Louma et al. 1986) or 1996 (Golder 1996a), indicating a small amount of rearing activity occurs for this species. Movement of suckers between Kearl Lake and Muskeg Creek was considered likely but dependant on beaver activity (RL&L 1989). The one study reporting fisheries sampling of Kearl Lake in the winter (Golder 1999b) documented the presence of small numbers of brook stickleback, juvenile white sucker and juvenile and adult northern pike. This was the first record of northern pike in this waterbody and in the Muskeg Creek drainage.

For the six small watercourses in the Muskeg Creek drainage, only small-bodied forage fish or suckers were captured (Louma et al. 1986; RL&L 1989; Golder 1996a, 1996d, 2002b). Brook stickleback and pearl dace were in all six watercourses and were the dominant species in all streams. Juvenile and adult white sucker were captured in Khahago Creek near the confluence with Muskeg Creek and juvenile longnose sucker were captured in Pemmican Creek.

Stanley Creek

Brook stickleback is the only species found in Stanley Creek and occurs in low abundance. The limited sampling for this watercourse typically resulted in no fish captures (Golder 1996a, 1996d).

Wapasu Creek

Wapasu Creek supported brook stickleback, lake chub, longnose sucker, pearl dace and white sucker (Louma et al. 1986; RL&L 1989; Komex 1997). By all reports, brook stickleback was the dominant species and occurred in both the lower and upper portions of the watercourse. Small numbers of longnose sucker, pearl dace and white sucker were captured in the upper creek.

5.19.4 Data Gaps

Although a number of fisheries investigations have been conducted in the Muskeg River watershed, information is required concerning overwintering habitat conditions in the mainstem Muskeg River, spawning locations used in the mainstem river and tributary watercourses by Arctic grayling, longnose sucker, white sucker and northern pike, and the extent (if any) of fall spawning by mountain whitefish in the mainstem river and Jackpine Creek.

In addition, the available data indicates that fish abundance in Muskeg River watershed has changed, including reduced numbers of Arctic grayling, longnose sucker and white sucker. Habitat in some portions of the watershed has also changed as a result of beaver activity. Changes include more pools, decreased water velocity and increased sedimentation, particularly in Jackpine Creek and Muskeg Creek, resulting in reduced availability of swift-flowing rocky habitat. It is not known how these habitat changes, coupled with reduced fish passage, may have affected the fish populations in Jackpine Creek, Muskeg Creek and Kearl Lake.

5.20 TRIBUTARY WATERSHED #31 – MACKAY RIVER

Fourteen reports provided fisheries information for the MacKay River watershed (Griffiths 1973; McCart et al. 1978; Machniak et al. 1980; Sekerak and Walder 1980; Walder et al. 1980; Boerger 1986; Syncrude 1985; Van Meer 1993; RL&L 1994, 1999b; Golder 1996a, 2002a; Mill et al. 1997; AXYS 1998). Fisheries information is available for the MacKay River mainstem, two major tributaries (i.e., the Dover River and the Dunkirk River) and several small, unnamed tributaries. Figure 5 shows the portions of the MacKay River watershed that have been examined by these fourteen studies.

5.20.1 Fish Community

Fish collected in the MacKay River were summarized from the above reports and are listed in Table 48. Twenty three fish species were captured in the MacKay River watershed, including eight sport species, two sucker species and thirteen small-bodied forage species.

Table 48 Fish Species and Life Stages in Tributary Watershed #31 (MacKay River)

Species	Life Stage
Arctic grayling[(b)]	fry, juvenile, adult
brook stickleback[(a)(b)]	unspecified
burbot[(a)]	juvenile, adult, unspecified
emerald shiner	unspecified
fathead minnow	unspecified
finescale dace[(a)]	unspecified
flathead chub	unspecified
goldeye	juvenile, adult, unspecified
lake chub[(a)(b)]	unspecified
lake whitefish	fry, adult, unspecified
longnose dace[(a)]	unspecified
longnose sucker[(a)(b)]	fry, juvenile, adult, spawning
mountain whitefish	juvenile, adult, unspecified
northern pike[(a)(b)]	fry, juvenile, adult
northern redbelly dace[(a)]	unspecified
pearl dace[(a)(b)]	unspecified

Table 48 Fish Species and Life Stages in Tributary Watershed #31 (MacKay River) (continued)

Species	Life Stage
slimy sculpin[(a)(b)]	unspecified
spoonhead sculpin	unspecified
spottail shiner	unspecified
trout-perch[(a)(b)]	unspecified
walleye	fry, juvenile, adult
white sucker[(a)(b)]	fry, juvenile, adult, spawning
yellow perch[(a)]	fry, juvenile, unspecified

(a) Species documented in Dover River.

(b) Species documented in Dunkirk River.

All species were in the mainstem MacKay River. Thirteen fish species were in the Dover River, including three sport species, two sucker species and eight small-bodied forage species (Table 48). The known fish assemblage of the Dunkirk River is comprised of nine species, including two sport species, two sucker species and five small-bodied forage species (Table 48).

Studies of the fish community in the MacKay River included a counting fence operated in spring and fall, 1979 (Machniak et al. 1980) and inventories at specific locations or in sections of the watershed. CPUE and percent composition of catch by fish species are presented in Tables 49 through 53 for the reports for which the data was presented or could be calculated.

Table 49 CPUE for Fish Species Captured in Tributary Watershed #31 (MacKay River) – 1977[(a)]

Species	Number of Fish	Sampling Season	Gill Net		Seine Net	
			Effort (hr/std gang)	CPUE (#/1000 hr)	Effort # of Hauls	CPUE #/Haul
Arctic grayling	1	spring	26.0	39	10	0.1
	2	summer	-	-	3	0.3
brook stickleback	1	fall	-	-	10	0.1
burbot	2	summer	-	-	3	0.3
emerald shiner	1	spring	-	-	10	0.1
	9	summer	-	-	n/a	0.8
flathead chub	3	spring	17.5	171	-	-
goldeye	13	spring	43.5	299	-	-
	20	summer	93.5	214	-	-
lake chub	134	spring	-	-	19	7.1
	1349	summer	-	-	34	39.7
	983	fall	-	-	7	140.4
lake whitefish	3	spring	17.5	171	-	-
	1	summer	-	-	10	0.1
longnose dace	5	spring	-	-	17	0.3
	153	summer	-	-	13	11.8
	5	fall	-	-	4	1.3
longnose sucker	10	spring	50.5	198	-	-
	700	summer	64.0	359	11	61.5
	53	fall	23.5	85	4	12.8
mountain whitefish	1	summer	-	-	10	0.1
northern pike	8	spring	50.5	138	3	0.1
	7	summer	60.5	99	10	0.1
	9	fall	70.5	170	10	0.3
slimy sculpin	3	spring	-	-	3	1.0
	13	summer	-	-	13	1.0
	1	fall	-	-	3	0.3
spoonhead sculpin	1	summer	-	-	5	0.2
spottail shiner	9	spring	-	-	17	0.5
trout-perch	92	spring	-	-	13	7.1
	808	summer	-	-	35	23.1
	13	fall	-	-	9	1.4
walleye	38	spring	48.5	783	-	-
	35	summer	118.5	253	26	0.2
	2	fall	26.0	77		
white sucker	18	spring	50.5	337	3	0.3
	413	summer	115.5	69	11	36.8
	23	fall	73.0	205	4	2.0
yellow perch	63	summer	-	-	6	10.5
	11	fall	-	-	3	3.7

[(a)] McCart et al. 1978.

n/a = Not available.

Table 50 Summary of Fish Sampling for Tributary Watershed #31 (MacKay River) – 1978[(a)]

Species	Number of Fish	Sampling Season	Sampling Technique
Arctic grayling	45	spring	counting fence (located approximately 11 km upstream of the river mouth)
burbot	5		
flathead chub	43		
goldeye	21		
lake whitefish	5		
longnose sucker	1072		
northern pike	87		
trout-perch	1		
walleye	364		
white sucker	3,934		
arctic grayling	4	fall	
burbot	8		
flathead chub	11		
lake chub	2		
longnose sucker	56		
northern pike	15		
walleye	5		
white sucker	108		
Arctic grayling	4	spring	gill net
longnose sucker	164		
northern pike	3		
white sucker	27		
sucker spp.	19,703	summer	drift net
Arctic grayling	1	fall	gill net
burbot	1		
goldeye	1		
lake whitefish	2		
longnose sucker	15		
northern pike	23		
walleye	6		
white sucker	28		

(a) Machniak et al. 1980.

Table 51 Percent Composition for Fish Species Captured in Tributary Watershed #31 (MacKay River) – 1984[(a)]

Species	Sampling Season	Percent Composition by Sampling Technique		
		Boat Electrofishing	Backpack Electrofishing	Seine Netting
Arctic grayling	fall	-	0.3	-
burbot	spring	0.6	-	-
emerald shiner	spring	-	-	1.0
fathead minnow	summer	-	-	5.5
flathead chub	spring	2.9	-	-
	summer	5.3	-	-
goldeye	spring	8.7	-	-
	summer	40.9	-	-
lake chub	spring	11.0	-	65.2
	summer	-	-	71.2
	fall	-	55.5	52.9
lake whitefish	summer	1.5	-	-
longnose dace	spring	-	-	1.4
	summer	-	-	10.2
	fall	-	4.0	8.8
longnose sucker	spring	5.8	-	2.0
	summer	6.8	-	0.4
	fall	-	10.8	1.0
mountain whitefish	spring	1.7	-	-
	summer	4.6	-	-
northern pike	spring	1.7	-	0.3
	summer	3.8	-	0.1
northern redbelly dace	summer	-	-	0.1
	fall	-	8.4	5.9
pearl dace	fall	-	6.6	4.9
slimy sculpin	spring	-	-	0.5
	summer	-	-	0.5
	fall	-	-	2.0
trout-perch	spring	1.2	-	28.1
	summer	-	-	6.8
	fall	-	8.9	16.7
walleye	spring	16.2	-	0.3
	summer	6.8	-	-
white sucker	spring	50.3	-	0.9
	summer	30.3	-	5.2
	fall	-	5.5	5.9
yellow perch	spring	-	-	0.2
	summer	-	-	2.0

[(a)] Syncrude 1985.

Table 52 CPUE for Fish Species Captured in Tributary Watershed #31 (MacKay River) – 1992[(a)]

Species	Number of Fish	Boat Electrofishing CPUE (#/100 s)
Arctic grayling	9	0.53
emerald shiner	3	0.18
finescale dace	2	0.44
flathead chub	164	9.66
goldeye	8	0.47
lake chub	72	4.24
longnose dace	12	n/a
longnose sucker	73	4.3
mountain whitefish	7	0.41
northern pike	30	1.77
slimy sculpin	2	0.12
spoonhead sculpin	1	0.06
trout-perch	18	n/a
walleye	35	2.06
white sucker	88	n/a

(a) Van Meer 1993.

n/a = Not available.

Table 53 CPUE for Fish Captured in Tributary Watershed #31 (MacKay River) – 1997[(a)]

Species	Number of Fish	Sampling Season	Backpack Electrofishing	
			Effort (s)	CPUE (#/100 s)
brook stickleback	20	fall	1,699	1.2
finescale dace	49		1,788	2.7
lake chub	38		1,251	3.0
slimy sculpin	1		618	0.2
white sucker	1		328	0.3

(a) AXYS 1998.

5.20.2 Habitat

Griffiths (1973) surveyed all 214 km of the MacKay River, and suggested that the upper portion of the river (from the headwaters downstream to well below the Dunkirk River mouth) had a low potential to support sport fish. As the gradient gradually increased moving downstream, fish habitat became more favourable.

Griffiths (1973) listed infrequent riffles and lack of spawning gravels as limitations for fish in this watercourse. Bottom substrates were mostly boulders and rubble in the riffle areas and boulder, gravel and silt in pools, changing in the lower-most portion of the river to gravel and sand in the riffles and fine sediments in the pools.

Both Machniak et al. (1980) and Sekerak and Walder (1980) divided the MacKay River into reaches, based on channel characteristics such as size, gradient, flow, pool to riffle ratio, substrate and channel pattern. Machniak et al. (1980) examined 171 km of the river while Sekerak and Walder (1980) examined 197 km. The reach boundaries described in the two studies were somewhat different, but the general descriptions of longitudinal changes in habitat potential were similar. The lower-most section of the MacKay River (i.e., lower 5 km) lacked spawning habitat but provided rearing, feeding and resting areas. A major part of the substrate in this reach was formed by oil sands. RL&L (1994) indicated that the lower MacKay River had a low gradient, was a depositional area, was dominated by run habitat and sand/silt substrate and indicated that it did not provide suitable habitat for spawning by fish.

The middle section of the MacKay River, from approximately 5 to 112 km upstream of the mouth, had a moderate gradient, a good pool to riffle ratio and a variety of substrate types (Machniak et al. 1980; Sekerak and Walder 1980). The lower portions of this section of river had a substrate that was mainly fines but also contained gravel areas that were considered to provide spawning grounds for white and longnose sucker as well as some forage species. Rearing habitat was also present, as was feeding habitat for all fish species. Habitat suitable for spawning increased moving upstream in the middle section of the MacKay River, particularly upstream of the Dover River mouth (located 16 km upstream of the Athabasca River). Long riffles with gravel, cobble and boulder substrates were present in some sections, separated by small pools with sand, gravel and boulder. Potential spawning habitat was considered to exist for Arctic grayling, walleye, lake whitefish, white sucker, longnose sucker, and forage fish species. Overall, the middle reaches of the MacKay River, as described by Machniak et al. (1980) and Sekerak and Walder (1980) were considered to provide moderate to high fisheries potential.

The upper-most reaches of the MacKay River (i.e., farther than 112 km upstream of the river mouth) had a low gradient with placid flow, a predominance of fine sediments and an abundance of aquatic vegetation (AXYS 1998). These upper reaches accounted for slightly less than 50% of the length of the MacKay River. The substrates in the upper reaches were generally fines and pool habitats were common (Sekerak and Walder 1980), providing limited spawning habitat potential for all fish except northern pike and brook stickleback (Machniak et al. 1980).

Sekerak and Walder (1980) indicated that the combination of low winter flows and large amounts of fine sediments in the substrate were not conducive to overwintering by most sport species, but considered that the river could provide year-round habitat for forage fish and northern pike. Potential overwintering habitat was considered to exist in the MacKay River by McCart et al. (1978), who reported good dissolved oxygen concentrations and the capture of a few fish species in the lower and middle reaches of the river in the winter of 1977/1978. Beaver ponds in the upper portion of the river may also provide overwintering opportunities. RL&L (1994) suggested that the river mouth would provide overwintering habitat, based on an assessment during the open-water period. RL&L (1999b) investigated winter conditions at various locations in the MacKay River and concluded that winter discharge and water depths were too low to provide suitable overwintering conditions for most fish species. Golder (2002a) examined the overwintering potential of the MacKay River at one site immediately upstream of the river mouth and found the habitat to be poor due to low discharge, shallow depths and low dissolved oxygen levels (i.e., 3.1 mg/L). It appears that habitat for overwintering in the MacKay River is limited in most years by low winter flows.

MacKay River Tributaries

Griffiths (1973) described both the Dover and Dunkirk Rivers as typical, meandering muskeg streams with extensive beaver activity and rated them as having low sport fish potential. However, Griffiths (1973) suggested that habitat in the lower Dover River may be better suited for fish. The lower Dover River had a pool to riffle ratio of 3:1, with boulder, rubble and gravel substrate in the riffles, and rubble, gravel and silt in the pools. Some of the pools also had aquatic macrophytes along the edges. The pools were generally deep and fish refugia was considered to be good.

The Dover River has been divided into four reaches by Machniak et al. (1980) and into six reaches by Sekerak and Walder (1980). Although reach boundaries differ, both studies agree on the general habitat properties of various sections of the Dover River. The lower-most river consisted of steep gradients with gravel, cobble, boulder, and sand substrate. White sucker, longnose sucker and some small-bodied species could spawn in these habitat types. Habitat for overwintering was also considered to be present. The remaining upstream portion, comprising the majority of the river, had a low gradient and an irregular meander pattern with a confined channel form. Numerous beaver ponds were present and were considered to provide potential overwintering habitat but may also prevent migration by larger fish. Syncrude (1985) also found a high incidence of beaver dams and indicated that fish passage difficulties may occur at times. The substrate consisted of clay-silt and organic debris with occasional coarse gravel. Little spawning habitat was considered to be available, with the possible exception of habitat for spawning by northern pike. Overall, fish habitat in all but the lower-most section of the Dover River was considered to be poor.

The Dunkirk River was a low gradient watercourse and considered to be rather uniform over its length. Both Machniak et al. (1980) and Sekerak and Walder (1980) divided the river into three reaches. The lower reach consisted mainly of deep, placid pools, providing suitable spawning and rearing habitat for northern pike and brook stickleback. Riffle habitats were only present in the middle reach and could provide for spawning by Arctic grayling, suckers, and some forage fish species. Substrate in the riffle areas was gravel and boulder, but the remainder of the river bottom was composed of fine sediments. The upper reach in the headwaters of the Dunkirk River were marsh-like muskeg and provided poor spawning habitat for most fish species. Beaver dams were common.

Eleven minor, unnamed tributaries to the MacKay River were examined by Syncrude (1985) and six minor tributaries were examined by AXYS (1998). The small watercourses evaluated by Syncrude (1985) were generally considered to have numerous, severe limitations for fish and were considered to provide habitat only for coarse and forage species. All six of the tributary streams examined by AXYS (1998) were suitable for forage fish and four of the six streams had possible spawning habitat for Arctic grayling and northern pike.

5.20.3 Habitat Use

Sekerak and Walder (1980), based on the information available at the time, indicated that sport fish were relatively uncommon in the MacKay River. Sport fish in this river typically had a limited distribution or occurred in low abundance. Of the eight sport fish species documented to occur in the MacKay River, only three species have a fairly wide distribution: walleye, Arctic grayling and northern pike.

Machniak et al. (1980) reported a spring migration of walleye into the MacKay River, but the run consisted almost entirely of spent males, indicating use of the river as a post-spawning feeding area for this species. Syncrude (1985) also found the walleye population in the MacKay River to consist primarily of spent males, which occurred in low abundance and with a sporadic distribution in the lower river and near the Dover River mouth. The various studies have found that walleye numbers were highest in the river in the spring, with declining abundance over the summer and fall (McCart et al. 1978; Machniak et al. 1980;

Syncrude 1985), indicating that the river is used mainly as a post-spawning feeding area by adults (Mill 1997). In addition to adults, McCart et al. (1978) reported nursery activity by low numbers of walleye fry, and suggested that there was limited use of the MacKay River for spawning. Griffiths (1973) found walleye fry at the mouth of the MacKay River where they may have originated from the Athabasca River. Syncrude (1985) indicated that there was no evidence of spawning by this species in the MacKay River in 1984, but reported numerous areas of good potential spawning habitat.

Arctic grayling have been reported from the MacKay River in low abundance. A small upstream spring migration occurred for this river (McCart et al. 1978; Machniak et al. 1980). McCart et al. (1978) suggested that spawning by Arctic grayling might have occurred somewhere above the Dover River mouth; habitat that might support spawning occurs in the first 109 km upstream of the Dover River mouth. The capture of small numbers of Arctic grayling fry indicated a limited amount of spawning (McCart et al. 1978; Syncrude 1985). Arctic grayling have been shown to use the MacKay River in low abundance for rearing and feeding habitat.

Griffiths (1973) reported that northern pike were common throughout the MacKay River. Machniak et al. (1980) documented that a small upstream spring migration of northern pike occurred that consisted primarily of post-spawning adults. Northern pike were captured infrequently during a 1984 inventory (Syncrude 1985) with primary use by feeding adults. Habitat for spawning was reported to be limited and no fry and very few juveniles were captured. However, McCart et al. (1978) thought that a resident population of northern pike occurred in the upper portion of the river. Griffiths (1973) reported nursery and rearing activity by northern pike at the mouth of the MacKay River.

Five other sport fish species (burbot, goldeye, lake whitefish, mountain whitefish and yellow perch) were present in low abundance in the lower-most portion of the watershed. Juvenile and adult burbot and goldeye were reported in small numbers in the MacKay River (Griffiths 1973; McCart et al. 1978; Machniak et al. 1980; Syncrude 1985). Syncrude (1985) indicated that lake whitefish appeared to make short excursions into the lower MacKay River from the Athabasca River. Lake whitefish fry were also reported to be in the lower river but were thought to originate from the Athabasca River. Mountain whitefish were not captured in the spring migration into the MacKay River (Machniak et al. 1980) but were reported in the MacKay River in low abundance on a seasonal basis (Machniak et al. 1980). Juvenile and adult mountain whitefish were captured in small numbers in the lower portion of the river (Syncrude 1985), indicating use of this area for summer rearing and feeding habitat. Mountain whitefish fry have not been documented in the MacKay River and spawning by this species is not suspected. Yellow perch, particularly fry and juvenile fish, were in the lower river (Griffiths 1973; Machniak et al. 1980), typically within 3 km of the mouth (Syncrude 1985), and are believed to have originated from the Athabasca River (Sekerak and Walder 1980). This species has been shown to use the MacKay River mouth as nursery and rearing habitat.

Griffiths (1973) reported that longnose and white suckers were common throughout the MacKay River system. McCart et al. (1978) described the river as a major spawning, nursery, rearing and summer feeding area for these two species. Suckers dominated the fish captured at both the spring and fall counting fences, with white sucker being the most abundant (Machniak et al. 1980). Syncrude (1985) found juvenile and adult suckers in high abundance in the spring, with sucker fry occurring in high abundance in the summer. Although specific spawning locations have not been documented in the MacKay River for these two species, the distribution of fish and potential spawning habitats indicate that spawning may occur in the MacKay River upstream of the Dover River mouth, and in the lower Dover and Dunkirk rivers (Machniak et al. 1980; Syncrude 1985). Machniak et al. (1980) documented two out migrations of sucker fry, a large one in June and a smaller one in October. Both Griffiths (1973) and Syncrude (1985) reported nursery and rearing activity by suckers at the MacKay River mouth, with fish at this site believed to originate from the Athabasca River.

Although recent studies reported that the MacKay River offered poor conditions for overwintering by fish, (RL&L 1999b; Golder 2002a), McCart et al. (1978) sampled in December and January in the lower and middle reaches and found small numbers of Arctic grayling, northern pike, longnose sucker, white sucker and sculpins.

MacKay River Tributaries

Although three sport species were reported from the Dover River (burbot, northern pike, yellow perch), their abundance was low and the river was considered by Sekerak and Walder (1980) to have extremely little direct importance to sport fish. White sucker was the most abundant species and other common and widespread species were longnose sucker and small-bodied forage fish. The presence of both white and longnose sucker fry was considered to confirm spawning activity in this watercourse for these two species (Syncrude 1985). Only small-bodied species were likely to occur in the headwaters of the Dover River.

Two sport fish species, including Arctic grayling and northern pike, were in the Dunkirk River. While Arctic grayling occur rarely, northern pike were found in moderate to low numbers throughout the watercourse. The most abundant species were white sucker and small-bodied forage fish.

AXYS (1998) examined four small, unnamed tributaries to the MacKay River for fish presence. Species captured in the tributary streams included brook stickleback, finescale dace, lake chub, slimy sculpin and white sucker.

5.20.4 Data Gaps

Spring spawning surveys would be needed to identify spawning locations for fish species suspected to spawn in the MacKay River (e.g. Arctic grayling, longnose sucker and white sucker). Spawning surveys would also confirm if walleye and northern pike also spawn in the river.

The potential for the MacKay River to provide overwintering habitat has not been established. A study would be required to relate habitat to flow regime. Winter sampling could also determine the species and life stages of fish that overwinter in this watercourse.

5.21 TRIBUTARY WATERSHED #34 – UNNAMED WATERCOURSE (ISADORE’S LAKE OUTLET)

Four reports provided fisheries information for Tributary Watershed #34 (Webb 1980; Golder 1996e, 1997e; EBA 2001). This watershed includes Isadore’s Lake, Mills Creek (the inflow channel to Isadore’s Lake) and the unnamed outlet channel that connects Isadore’s Lake to the Athabasca River. Figure 6 shows the portions of the watershed that have been examined.

5.21.1 Fish Community

Fish species reported from Tributary Watershed #34 were from Webb (1980) and are summarized in Table 54. No fish were captured during any other study. One sport species and one small-bodied forage species were reported for this watershed. Northern pike were captured in Isadore’s Lake and trout-perch were captured at the mouth of the lake’s outlet channel.

Table 54 Fish Species and Life Stages in Tributary Watershed #34 (Isadore's Lake Outlet)

Species	Life Stage
northern pike	fry, juvenile, adult, spawning
trout-perch	unspecified

5.21.2 Habitat

Mills Creek, in the vicinity of the Highway 63 crossing, was described as consisting primarily of pools and riffles with some runs. The stream was shallow (<0.5 m deep) with a low gradient and much of the watercourse was influenced by beaver activity. The substrate was dominated by fines in most habitats, but cobble and gravel were present and dominant in riffles. Habitat in Mills Creek was affected by its small size and low gradient and habitat quality was rated as low (Golder 1996e; EBA 2001); however, some habitat for spawning was considered to occur in the riffles (EBA 2001). Barriers to fish migration as a result of beaver activity were common.

Isadore's Lake was considered to be an oxbow lake of the Athabasca River. The lake had a maximum depth of 4 m, substrate of organic muck with local areas of sand, cobble and boulder, and abundant aquatic macrophytes (Webb 1980). Based on this description, the lake would be expected to include habitat for small-bodied species and potential spawning, rearing and feeding habitat for northern pike and yellow perch.

The unnamed channel that connects Isadore's Lake to the Athabasca River was examined by Webb (1980). The channel was found to be a small, intermittent stream with a moderate gradient and several beaver dams located between the Athabasca River and the lake. In the spring of 1979, the beaver dams were overtopped and there was flow in the channel, with water depths of up to 2 m. However, in the following summer there was only a trickle of flow and the depths were <0.2 m. The stream substrate was entirely silt. The flows observed in 1979 indicated that access to the watershed by fish from the Athabasca River would be possible in some years.

The potential of Isadore's Lake and Mills Creek to overwinter fish was investigated in a late winter (March) study (Golder 1997e). Mills Creek was flowing at the time but had a low discharge (0.03 m^3/s). Although the dissolved oxygen in the creek was adequate to sustain sport fish, under-ice water depths were insufficient to provide suitable overwintering habitat. Isadore's Lake was deep enough to provide overwintering habitat but dissolved oxygen was low, allowing only tolerant species to survive. However, Webb (1980) found that Isadore's Lake had suitable dissolved oxygen to support fish in mid-winter. Data indicate that overwintering conditions in the lake are variable, with overwintering possible in some years, but not others.

5.21.3 Habitat Use

No fish species were captured by the limited sampling in Mills Creek.

All life stages of northern pike were recorded in Isadore's Lake and it was considered to provide spawning, rearing and feeding habitat for this species (Webb 1980). The fish population was considered to be resident with movement occurring between the lake and the Athabasca River in high water years. Based on reported poor overwintering conditions in some years (Golder 1997e), such movement would be necessary to perpetuate this population. No other fish species were captured in Isadore's Lake.

Only trout-perch were reported in the unnamed stream connecting Isadore's Lake to the Athabasca river. Fish were captured at the stream mouth only and were most likely associated with the Athabasca River. Fish use of the remainder of this watercourse has not been documented, but it would provide a migration route for northern pike to access Isadore's Lake.

5.21.4 Data Gaps

The viability of the northern pike population in Isadore's Lake should be investigated by additional study. The habitat conditions in the outlet channel and in Mills Creek are such that further investigation of fish use in these watercourses is not warranted.

5.22 TRIBUTARY WATERSHED #36 – ELLS RIVER

Nine reports provided information for the Ells River (Griffiths 1973; Herbert 1979; Psutka 1979; Bond and Berry 1980; Sekerak and Walder 1980; Walder et al. 1980; RL&L 1994; Noton 1999; Golder 2002a). Fisheries information is available for the Ells River and for the two largest tributary streams; Joslyn and Chelsea creeks. Figure 6 shows the portions of the Ells River watershed examined by these studies.

5.22.1 Fish Community

Fish species collected in Ells River have been summarized and are listed in the Table 55. Nineteen fish species have been documented in the Ells River watershed, including eight sport species, two sucker species and nine small-bodied forage species.

Table 55 Fish Species and Life Stages in Tributary Watershed #36 (Ells River)

Species	Life Stage
Arctic grayling	juvenile, adult, unspecified
brook stickleback	unspecified
burbot	fry, adult, unspecified
flathead chub[a]	unspecified
goldeye	juvenile, adult, unspecified
lake chub[a]	unspecified
lake whitefish	adult, unspecified
longnose dace	unspecified
longnose sucker	fry, juvenile, adult
mountain whitefish	juvenile, adult, unspecified
northern pike	juvenile, adult, unspecified
pearl dace	unspecified
slimy sculpin	unspecified
spoonhead sculpin	unspecified
spottail shiner	unspecified
trout-perch	unspecified
walleye	fry, juvenile, adult
white sucker[a]	fry, juvenile, adult
yellow perch	fry, unspecified

(a) Species documented in Joslyn Creek.

All the above species were captured in the mainstem Ells River. For Joslyn Creek, three species were reported from a single study site examined by Golder (2002a): white sucker (juvenile), lake chub and flathead chub. No information is available concerning the fish community in Chelsea Creek.

CPUE for fish in the Ells River were not reported, but Sekerak and Walder (1980) provided the relative percentage of the 17 species captured in that study (Table 56).

Table 56 Fish Species as Percentage of Total Catch, Tributary Watershed #36 (Ells River) – 1978[a]

Species	Number of Fish	Percentage of Total
Arctic grayling	42	1
brook stickleback	3	<1
burbot	1	<1
flathead chub	2	<1
goldeye	16	<1
lake chub	1,698	52
lake whitefish	6	<1
longnose dace	270	8
longnose sucker	313	10
mountain whitefish	2	<1
northern pike	13	<1
pearl dace	118	4
slimy sculpin	83	3
spoonhead sculpin	1	<1
trout-perch	208	6
walleye	12	<1
white sucker	420	13
sucker spp.	53	2

[a] Sekerak and Walder 1980.

The most abundant species in the Ells River were lake chub followed by suckers and several small-bodied forage fish species. Arctic grayling, walleye and northern pike were considered likely to occur throughout the watercourse (Sekerak and Walder 1980), with a significant fishery reported for these three species (Griffiths 1973). Based on known distribution, species such as burbot, yellow perch, lake whitefish, mountain whitefish and goldeye were thought to use only the lower reaches of the river.

5.22.2 Habitat

Griffiths (1973) evaluated the 184 km length of the Ells River and rated the habitat as having a high potential to support fish throughout the watercourse. Sekerak and Walder (1980) also described the Ells River as having high sport fish potential. Griffiths (1973) stated that the Ells River contained abundant pools and riffles (2:1 pool to riffle ratio), providing excellent fish refugia. Dominant substrates included boulder, cobble, and gravel, with some fines. Boulder, cobble and gravel were dominant in the swifter flowing riffle sections, and silt and boulder or silt and gravel were in the slower pool habitats. The substrate in the lower most portion of the river contained more fine sediments than farther upstream and tar sands formed part of the bed material. Griffiths (1973) described the pool and boulder habitats as providing excellent cover for fish.

Sekerak and Walder (1980) conducted a longitudinal evaluation of the Ells River and defined eight separate reaches, based on channel size, gradient, flow character, habitat composition, substrate and channel pattern. The upper six reaches of the river, comprising 97% of the river length, were described as providing excellent fish habitat. These reaches had good pool to riffle ratios, backwater habitats and a mixture of fines, gravels and rubble sized substrate, with small amounts of bedrock. The lower two reaches consisted mostly of fine substrates with few riffle habitats, and the habitat rating was considered to be somewhat lower. RL&L (1994) described the lower-most reach of the Ells River as low gradient, depositional, and consisting predominantly of run habitat with silt and sand substrate.

Both Griffiths (1973) and Walder et al. (1980) found good to high quality fish habitat in nearly all sections of the river. A variety of possible spawning habitats were found in all but the lower-most reaches near the river mouth. Sekerak and Walder (1980) described the winter flow in the Ells River from the headwater regions as relatively constant and suggested that most of the river could provide overwintering habitat. However, Golder (2002a) examined the Ells River near the river mouth late in the winter of 2000/2001 and found that, although the flow rate was 1.99 m^3/s, the dissolved oxygen levels (i.e., 1.0 mg/L) were low.

Based on cursory examination, Joslyn Creek and Chelsea Creek (the two largest Ells River tributaries) were described as small watercourses (Sekerak and Walder 1980) that primarily drained muskeg areas and had low potential to support fish (Griffiths 1973). Golder (2002a) conducted a seasonal sampling study at one site on Joslyn Creek and a winter study at one site on a first order feeder stream. Both the main creek and the feeder stream were frozen completely in the winter. During the open-water period, Joslyn Creek was described as having a mix of habitat types. Shallow Class 3 runs were predominant but deeper Class 2 runs and Class 1 and 2 pools were also present as were riffles. Substrates were primarily gravel, cobble and boulder but fine sediments were present in most habitat types. Cover was provided by woody debris and substrate roughness. This watercourse was small, with low flow and few deep-water habitats. Joslyn Creek was considered to provide habitat for spawning, rearing and feeding by forage fish and suckers, but would be less suitable for sport fish (Golder 2002a).

5.22.3 Habitat Use

Although eight sport species have been reported from the Ells River, only three species have been shown to be present throughout much of the watercourse. Arctic grayling, walleye and northern pike occurred in most sections of the river, including the upstream-most reaches (Griffiths 1973; Walder et al. 1980). Juvenile and adult life stages were present in the Ells River for each of these three species, indicating use of the river as rearing and feeding habitat. Bond and Berry (1980) studied the Ells River in the summer and captured walleye fry at two sites, demonstrating use of this watercourse as nursery habitat for this species. Most of the fish data for the Ells River did not distinguish between fry and juvenile fish, and it is not known if Arctic grayling or northern pike fry were captured. Given the proclivity of Arctic grayling in the Athabasca River basin to utilize tributary watersheds for spawning, and the abundance of suitable spawning habitat described for the Ells River, it is likely that Arctic grayling spawning and nursery activity occurred in this watershed. Northern pike may also spawn in the watershed, as Griffiths (1973) described lush growths of weeds in some of the pools in the Ells River, and the Gardiner-Namur lakes form the headwaters of the watershed (Sekerak and Walder 1980). Based on the presence of fry, spawning in the watershed by walleye is also possible; however, other studies that reported walleye fry from the lower portions of Athabasca River tributaries suggested that they originate from the Athabasca River.

Burbot, goldeye, lake whitefish, mountain whitefish, yellow perch captures were low and/or only in the lower-most reaches of the river, near the confluence with the Athabasca River. Based on the life stages present, most of these species are typically associated with the Athabasca River and probably use lower portions of tributary watercourses for development. Mountain whitefish use tributary watercourses for spawning activity; however, no direct evidence of spawning by mountain whitefish could be found in the historical reports.

Longnose and white sucker were present throughout the Ells River in the spring, summer and fall. Fry, juveniles and adults of both species were present. Although spawning was not observed, the abundant potential spawning habitat and wide distribution of fry indicates that these species may spawn in the Ells River.

A few, isolated spring spawning sites were documented for the Ells River in 1978 by kick sampling for eggs (Walder et al. 1980), but the fish species associated with the spawning sites were not identified.

Low dissolved oxygen was measured in winter at one site near the Ells River mouth. Since winter flows in the Ells River were fairly good (Golder 2002a), overwintering habitat may be better upstream where the flow is turbulent.

White suckers and small-bodied forage species were found in Joslyn Creek during the open water period by Golder (2002a). Winter investigations indicted Joslyn Creek did not provide overwintering habitat (Golder 2002a).

5.22.4 Data Gaps

The Ells River has been considered to provide some of the highest quality tributary habitat in the Oil Sands Region of the Athabasca River (Griffiths 1973; Sekerak and Walder 1980). However, fisheries investigations are limited for the Ells River and its fisheries resources are less well known than those of other major tributaries such as the Steepbank, Muskeg and MacKay rivers. The 19 fish species reported from the Ells River watershed is lower than the other tributaries, despite a higher rating for its fisheries potential. Fisheries inventories, including relative abundance and life stages present, would be needed to describe the fish community and habitat use for this watershed.

Spawning surveys of the Ells River in the spring and fall are required to confirm spawning activity by Arctic grayling, longnose sucker and white sucker, mountain whitefish, northern pike and walleye. The spawning surveys would also provide the location of those habitats used for spawning.

Data collected in winter is limited. Although preliminary data suggest overwintering potential may be poor, additional study would provide a more conclusive assessment.

5.23 TRIBUTARY WATERSHED #37 – TAR RIVER

Five reports included information on the Tar River watershed (Griffiths 1973; Herbert 1979; RL&L 1994; Mill et al. 1997; Golder 2002a). Information is available for the mainstem Tar River and for a few small, unnamed tributary watercourses. Figure 6 presents the portions of the Tar River watershed that have been examined.

5.23.1 Fish Community

Fish collected in Tar River were summarized and are listed in Table 57. Eleven fish species were captured in the Tar River watershed, including three sport species, two sucker species and six small-bodied forage species. All of these species occur in the Tar River mainstem. A fish inventory was conducted for one unnamed tributary of the Tar River; brook stickleback was the only species present.

Table 57 Fish Species and Life Stages in Tributary Watershed #37 (Tar River)

Species	Life Stage
Arctic grayling	juvenile
brook stickleback	unspecified
burbot	Juvenile, fry, unspecified
flathead chub	unspecified
lake chub	unspecified
longnose sucker	fry, juvenile, adult, spawning
pearl dace	unspecified
slimy sculpin	unspecified
trout-perch	unspecified
walleye	fry, juvenile
white sucker	fry, juvenile, unspecified

Of the reports reviewed, relative abundance information (CPUE) was available in Golder (2002a) and is presented in Table 58.

Table 58 CPUE for Fish Species Captured in Tributary Watershed #37 (Tar River) – 2001[(a)]

Species	Sampling Season	Number of Fish	Backpack Electrofishing		Minnow Trap	
			Effort (s)	CPUE (#/100 s)	Effort (hr)	CPUE (#/hr)
brook stickleback	combined	21	7,807	0.23	130.5	0.02
flathead chub		47		0.60		0.00
lake chub		29		0.37		0.00
longnose sucker		18		0.19		0.02
pearl dace		15		0.19		0.00
trout-perch		2		0.00		0.01
walleye		3		0.04		0.00

(a) Golder 2002a.

5.23.2 Habitat

Griffiths (1973) examined all 66 km of the mainstem Tar River and rated the fish habitat as poor in the upper and lower sections and poor to moderate in the middle reaches. The middle portion of the river was considered to contain the only suitable habitat for fish, with the upper tributary streams described as intermittent and the lower-most portion of the river described as a tangle of brush, logjams and windfall. The pool to riffle ratio in the middle portion of the river was 3:1. Pool depths were limited but there was overhanging vegetation to provide cover and fish refugia was rated as fair (Griffiths 1973). Substrate in the middle portion of the river was mainly boulder and gravel, with silt or sand in the pools. Nearer the river mouth, the habitat was nearly 100% pools (Griffiths 1973). RL&L (1994) described the mouth of the Tar River as low gradient and depositional, consisting predominantly of run habitat with silt and sand substrate.

Golder (2002a) conducted a longitudinal reach break analysis for the middle and lower portions of the Tar River, excluding the headwaters. They delineated four separate reaches for the mainstem Tar River based on channel characteristics such as gradient, pool to riffle ratio, flow volume, substrate and channel pattern. Reach 1, the lower-most reach, extended for only 0.4 km upstream from the Tar River mouth and had low habitat diversity and relatively homogeneous substrate (i.e., 90% sand). Reaches 2 through 4 comprised the remaining 34.5 km of the river that was examined by Golder (2002a) and had somewhat better habitat potential, with a mix of riffle, run and pool habitats and a mix of coarse and fine substrates.

Similar to Griffiths (1973), Golder (2002a) concluded that the potential of the Tar River to support fish was limited and that the potential varied somewhat between sections of the river. Overall, the river was considered to provide suitable habitat for small-bodied forage fish, moderate habitat for sucker spawning, rearing and feeding and poor habitat for sport fish spawning and rearing. Habitat quality decreased slightly moving upstream as deep water feeding and holding habitats were lacking and beaver dams were frequent, limiting fish access. Habitat with the potential for spawning by suckers and sport fish that use swift flowing areas with rocky substrates was present, but the habitat quality was low due to the high proportion of fine sediments present in these habitats. Although the lower-most section of the river did not provide suitable spawning habitat, Golder (2002a) considered it to provide potential nursery, rearing and feeding habitat, particularly for fish from the Athabasca River. RL&L (1994) considered the Tar River mouth suitable as feeding habitat for walleye and northern pike but stated spawning and rearing habitat was limited for sport fish.

Mill et al. (1997) suspected that the Tar River provided the potential for fish to overwinter. However (Golder 2002a) examined sites on the mainstem river as well as on some of the tributaries and found that all sites were completely frozen during the late winter, including the Tar River mouth. Golder (2002) examined the limited amount of historical flow data available, which showed the late winter discharges to be zero and concluded that this was likely a typical condition for this watershed in winter.

Examination of the small tributaries of the Tar River indicated that they had poor fish habitat due to low flow volumes, low habitat diversity, substrates composed of fine sediments and extensive beaver activity (Golder 2002a).

5.23.3 Habitat Use

Documented habitat use of the Tar River watershed included spawning, nursery and rearing by longnose sucker, rearing use by Arctic grayling and burbot, and nursery and rearing use by walleye and white sucker, (Griffiths 1973; Golder 2002a). Small-bodied forage species also use the river for life stage activities. One longnose sucker spawning location was recorded in the middle section of the Tar River (Golder 2002a). Walleye were only in the vicinity of the river mouth and were believed to originate from the Athabasca River. Fish in the upper portion of the Tar River was limited to small-bodied forage species.

Although it has been speculated that the Tar River could provide potential overwintering habitat, the one winter study indicated that there was no overwintering potential (Golder 2002a).

5.23.4 Data Gaps

Fisheries information for the Tar River is limited and studies would be required to determine the fish species that use the watershed. Only the oldest of the historical reports indicated the presence of Arctic grayling. Although spawning surveys were conducted, a comprehensive survey would be necessary to determine if species other than longnose sucker spawn in the Tar River.

5.24 TRIBUTARY WATERSHED #38 – FORT CREEK

Three reports included fisheries information for Fort Creek (Golder 1996d, 2000, 2001b). Figure 6 shows the portions of the Fort Creek watershed included in these reports.

5.24.1 Fish Community

Fish species collected in the Fort Creek watershed were summarized from the above reports and are listed in Table 59. Eight species were reported from the watershed, including one sport species, one sucker species and six small-bodied forage species.

Table 59 Fish Species and Life Stages Documented in Tributary Watershed #38 (Fort Creek)

Species	Life Stage
brook stickleback	unspecified
lake chub	unspecified
longnose sucker	juvenile
northern pike	juvenile
pearl dace	unspecified
slimy sculpin	unspecified
spoonhead sculpin	unspecified
trout-perch	unspecified

CPUE reflecting fish species abundance in Fort Creek is presented in Table 60.

Table 60 CPUE for Fish Species Captured in Tributary Watershed #38 (Fort Creek) – 2000[(a)]

Species	Number of Fish	Sampling Season	Sampling Technique			
			Backpack Electrofishing		Minnow Trapping	
			Effort (s)	CPUE (#/100 s)	Effort (hr)	CPUE (#/hr)
brook stickleback	1	spring	1,212	0.08	-	-
	8		-	-	-	n/a
	1	summer	-	-	-	n/a
lake chub	71	summer	-	-	-	n/a
longnose sucker	8	spring	1,212	0.66	-	-
	4		-	-	-	n/a
	31	summer	-	-	-	n/a
pearl dace	15	spring	1,212	1.24	-	-
	3		-	-	4.4	0.68
	8		-	-	-	n/a
	18	summer	-	-	-	n/a
spoonhead sculpin	1	spring	1,212	0.08	-	-
slimy sculpin	9	spring	-	-	-	n/a
	3	summer	-	-	-	n/a
northern pike	3	summer	-	n/a	-	n/a
trout-perch	68	summer	-	n/a	-	n/a

(a) Golder 2001b.

n/a = Not available.

The fish population consisted mostly of small-bodied forage fish; lake chub and trout-perch were the most abundant species.

5.24.2 Habitat

Fort Creek was described as a small watercourse with limited habitat potential. When examined in 1996 and 1999, the Fort Creek channel had continuous flow only over its lower 7 km, being ephemeral farther upstream (Golder 1996d, 2000, 2001b). Only the lower 250 m of this watercourse had a well defined channel, with the remainder of the creek consisting of a series of beaver dams/ponds interspersed with sections of defined channel. The ephemeral headwater area was a low-lying area with no defined channel. The habitat in the defined channel consisted primarily of shallow, low quality runs and pools, with some riffle sections in the middle reaches of the stream. Instream cover was sparse and consisted of woody debris. Overhead cover consisted of undercut banks, overhanging shrubs and deadfall.

Habitat with the potential for spawning in Fort Creek was limited in distribution and quality (Golder 2000). The lower-most segment of the creek was accessible to larger fish species from the Athabasca River but did not contain suitable spawning substrate, being composed primarily of fine sediments. The substrate in the middle section of the stream contained some rocky particle sizes, but they were imbedded in silt. Fish passage to the middle segment was thought to be unlikely due to the presence of numerous beaver dams.

Habitat in the Fort Creek watershed was considered suitable for some small-bodied forage fish species. The potential to support sport fish or other large bodied species was considered limited. Potential use by fish from the Athabasca River was believed to limited to the lower 250 m of the watercourse that was not affected by beaver dams.

The potential for fish to overwinter was investigated (Golder 2001b) and considered to be unlikely because of inadequate water depth (i.e., $\leq$0.2 m) and low discharge (i.e., 0.02 m^3/s).

5.24.3 Habitat Use

Although most fish were small-bodied species, three juvenile northern pike were captured in the lower-most section of the creek during summer (Golder 2001b). Longnose sucker juveniles were present in the lower-most section of the creek in the spring and summer. All eight fish species reported for the Fort Creek watershed occurred in the lower-most section of the watercourse that is accessible to fish from the Athabasca River and only brook stickleback and pearl dace were farther upstream in the impounded sections.

No spawning was recorded in areas of suitable substrate and flow during the spring spawning surveys (Golder 1996d, 2001b).

5.24.4 Data Gaps

Additional inventories for the lower section of Fort Creek would be needed to determine the fish species and the extent to which fish from the Athabasca River use this watercourse.

5.25 TRIBUTARY WATERSHED #39 – CALUMET RIVER

Five reports or file documents included information on the Calumet River watershed (ASRD n.d; Griffiths 1973; RRCS 1975; Herbert 1979; Golder 2002a). Fisheries information is available for the Calumet River and for Calumet Lake, which is situated on the mainstem Calumet River. Figure 6 shows the portions of the Calumet River watershed that have been studied.

5.25.1 Fish Community

Fish species collected in Calumet River were summarized from the above reports and are listed in Table 61. Fourteen fish species occurred in the Calumet River watershed, including six sport species, two sucker species and six small-bodied forage species.

Table 61 Fish Species and Life Stages in Tributary Watershed #39 (Calumet River)

Species	Life Stage
Arctic grayling	juvenile
brook stickleback	unspecified
burbot	juvenile
flathead chub	unspecified
lake chub	unspecified
longnose dace	unspecified
longnose sucker	fry, juvenile, adult
mountain whitefish	juvenile
northern pike	juvenile, adult, spawning
pearl dace	unspecified
trout-perch	unspecified
walleye	fry
white sucker	fry, juvenile, unspecified
yellow perch	adult

Few fish were captured in the Calumet River watershed during sampling (Table 62) and fish abundance in this watershed appears to be low. CPUE was reported only from the seasonal inventory conducted by Golder (2002a) (Table 63). From the limited sampling, the most abundant species were trout-perch, flathead chub, longnose sucker and northern pike.

Table 62 Summary of Fish Captured in Tributary Watershed #39 (Calumet River) – 1977[(a)] and 1982[(b)]

Species	Number of Fish	Sampling Season	Sampling Technique
Arctic grayling	1	spring	gill net
longnose sucker	3		
northern pike	11		
yellow perch	1		
brook stickleback	9		minnow trap
longnose sucker	1		
white sucker	1		
brook stickleback	1	summer	n/a
longnose sucker	4		
pearl dace	n/a		
white sucker	9		

(a) Herbert 1979.
(b) ARSD n.d.
n/a = Not available.

Table 63 CPUE for Fish Species Captured in Tributary Watershed #39 (Calumet River) – 2001[(a)]

Species	Sampling Season	Number of Fish	Backpack Electrofishing		Minnow Trap	
			Effort (s)	CPUE (#/100 s)	Effort (hr)	CPUE (#/hr)
burbot	combined	1	3,181	0.03	29.7	0.0
flathead chub		27		0.85		0.0
lake chub		16		0.50		0.0
longnose dace		1		0.03		0.0
longnose sucker		26		0.82		0.0
mountain whitefish		1		0.03		0.0
pearl dace		16		0.50		0.0
trout-perch		83		0.25		0.0
walleye		1		0.03		0.0
white sucker		3		0.09		0.0

(a) Golder 2002a.

5.25.2 Habitat

Griffiths (1973) conducted a synoptic overflight of the length of the Calumet River and found little or no habitat likely to support sport fish. At that time the river was rated as having low fisheries potential. Golder (2002a) completed a longitudinal reach break analysis for the middle and lower portions of the Calumet River, excluding the headwaters; they delineated five reaches for the mainstem river based on channel characteristics such as gradient, pool to riffle ratio, flow volume, substrate and channel pattern. Golder (2002a) considered the habitat in the Calumet River to have limited capacity to support fish, with similar limitations occurring in all reaches. Habitat limitations included low flow volume, lack of deep-water areas, low habitat diversity and substrates comprised mainly of fine sediments. Habitat with potential to support fish was highest in the vicinity of the river mouth. The lower river was shallow and included riffles and Class 3 runs and pools. The substrate was a mix of gravel and sand with occasional boulders. There was some habitat with potential for spawning by suckers and sport fish that require swift flowing areas with rocky substrates, but the quality was low because of the large amount of fine sediment present. Farther upstream in the Calumet River, beaver activity was extensive and numerous barriers to fish passage were observed. Impoundment pools (beaver ponds) and shallow runs with infrequent riffle areas were common. The substrate was predominately silt and detritus, with a few areas of sand, gravel and cobble sized material in riffles.

Based on the habitats observed in the Calumet River, Golder (2002a) considered that the watershed should provide suitable habitat for small-bodied forage species, moderate habitat for sucker rearing, poor habitat for sucker spawning and feeding, and poor habitat for sport fish spawning and rearing.

The potential of the Calumet River to overwinter fish was examined in 1981 (ASRD n.d.), 2001 and 2002 (Golder 2002a). In all three surveys, the mouth of the Calumet River was completely frozen. Lack of flow at the river mouth during the late winter period was considered typical for this watercourse.

Calumet Lake was a small (70 ha), shallow, highly eutrophic waterbody with abundant emergent and submergent vegetation (RRCS 1975; Golder 2002a). The lake inlet and outlet are formed by the mainstem Calumet River. The maximum depth was 2.5 m in the open-water period and 0.8 m under-ice. The lakebed consisted entirely of fine sediments and organic material. Calumet Lake was rated as having low potential to support fish (RRCS 1975; Golder 2002a). During the open-water period, the lake was considered to provide habitat for small-bodied forage fish and for northern pike spawning and rearing, although northern pike have not been reported from this waterbody. During winter, the lake was anoxic (Golder 2002a). Access to the lake for fish from the Calumet River was questionable because of beaver activity on the Calumet River downstream of the lake.

5.25.3 Habitat Use

To date, fish have been captured only in the lower-most portion of the Calumet River (i.e., within 2 km of the river mouth); however most studies have only sampled at the river mouth. Most large-bodied fish species occurred in low numbers and/or as fry or juvenile life stages, indicating the Calumet River provides nursery and rearing habitat for small numbers of fish. Yellow perch adults from the Athabasca River have been reported in the Calumet River mouth. Other adult fish reported from the Calumet River were northern pike and longnose sucker. A few adult northern pike in spawning condition (i.e., gravid or ripe) were captured in the lower Calumet River during the spring of 1982 (ASRD n.d.). It is considered likely that northern pike spawn in this watershed. A small number of adult longnose sucker were also captured in the lower river in the spring, although the sexual maturity of these fish was not recorded (ASRD n.d.). Spawning in the Calumet River is also a possibility for this species.

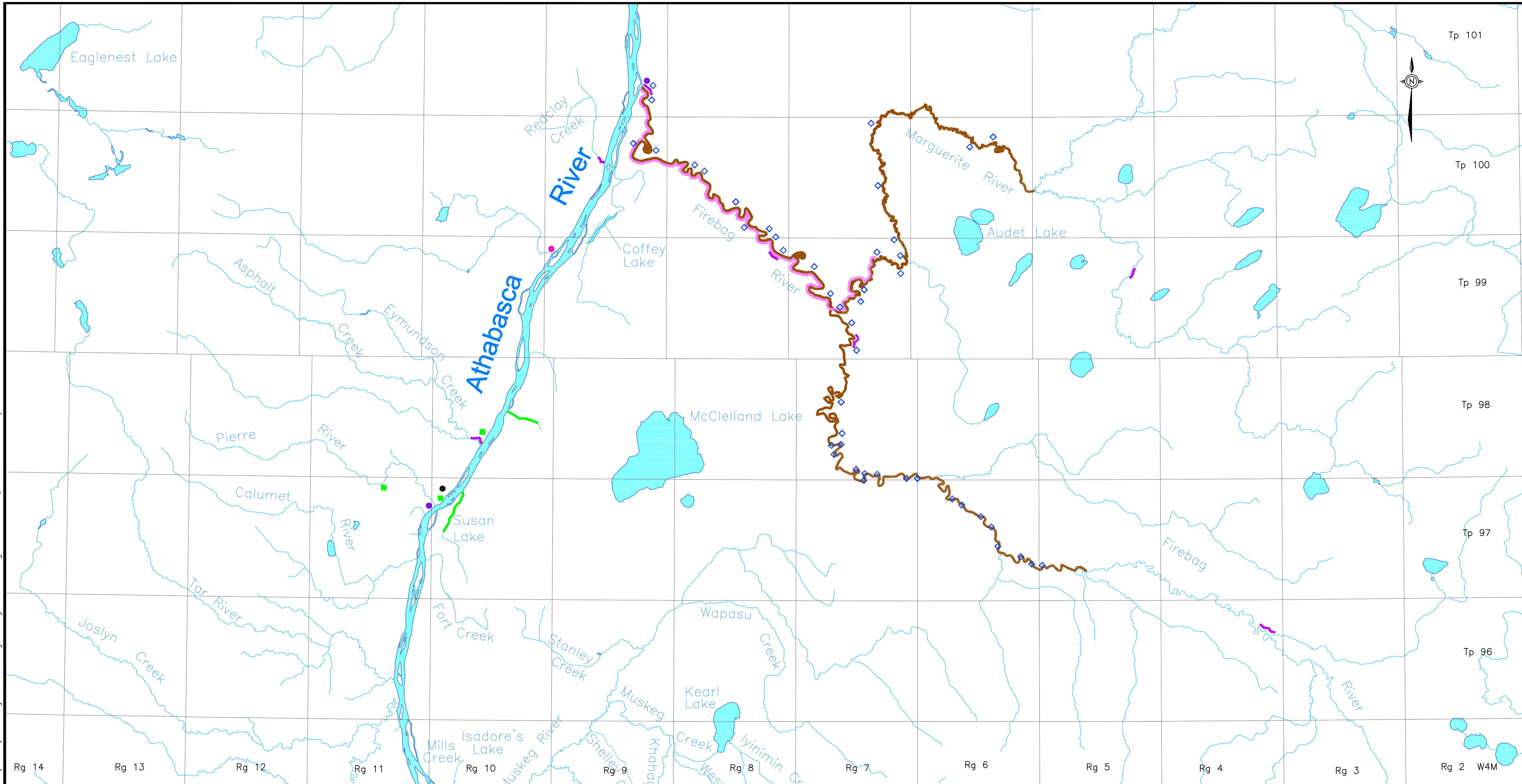
Calumet Lake has been sampled twice for fish and no small or large-bodied fish were captured (RRCS 1975; Golder 2002a).

5.25.4 Data Gaps

General inventory data is limited for the Calumet River. Further studies would be needed to determine fish species composition and relative abundance, seasonal use and the life stages present. Spring spawning surveys would be required to document the species that use this watercourse for spawning.

5.26 TRIBUTARY WATERSHED #42 – PIERRE RIVER

Five reports included fisheries information on the Pierre River (ASRD n.d; Griffiths 1973; Herbert 1979; RL&L 1994; Golder 2002a). Sampling occurred primarily in the vicinity of the Pierre River mouth, and to a lesser extent on the upper mainstem river. Figure 7 presents the portions of the Pierre River that have been included in past studies.



LEGEND

- GOLDER 2001b
- GRIFFITHS 1973
- SEKERAK AND WALDER 1980
- PSUTKA 1979
- ASRD n.d.
- GOLDER 2002a
- HERBERT 1979
- RL&L 1994
- WALDER ET AL. 1980

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: Firebag Surveyed River.dwg Feb 26, 2004 - 12:44pm

PROJECT

RAMP

TITLE

HISTORICAL STUDY LOCATIONS- TRIBUTARY WATERSHEDS #42 TO #50

PROJECT 04-1335-001.1000			FILE No.	Firebag Surveyed
DESIGN	CS	08/07/02	SCALE AS SHOWN	REV. 0
CADD	JAM	24/02/04		
CHECK	CB	24/02/04	FIGURE: 7	
REVIEW	CB	24/02/04		

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Calgary, Alberta

5.26.1 Fish Community

Fish species collected in the Pierre River watershed were summarized from the above reports and are listed in Table 64. Twelve fish species were collected in the Pierre River, including five sport species, two sucker species and five small-bodied forage species.

Table 64 Fish Species and Life Stages in Tributary Watershed #42 (Pierre River)

Species	Life Stage
Arctic grayling	fry, juvenile, adult
brook stickleback	unspecified
burbot	adult
flathead chub	unspecified
lake chub	unspecified
longnose sucker	juvenile, adult
mountain whitefish	juvenile, adult
northern pike	juvenile, adult
slimy sculpin	unspecified
trout-perch	unspecified
walleye	juvenile
white sucker	juvenile, adult

The limited sampling that occurred on the Pierre River is presented in Table 65. The most comprehensive sampling was by a counting fence in the spring of 1982 (ASRD n.d.). CPUE could not be calculated from the available information.

Table 65 Summary of Fish Captured in Tributary Watershed #42 (Pierre River)

Species	Number of Fish	Sampling Season	Sampling Technique
Arctic grayling	27	spring[a]	fish fence
burbot	1		
flathead chub	3		
longnose sucker	16		
mountain whitefish	3		
northern pike	59		
walleye	1		
white sucker	3		
brook stickleback	67		minnow trap
lake chub	17		
sculpin spp.	1		
trout-perch	1		
brook stickleback	21		seine net
lake chub	2		
longnose sucker	4		
Arctic grayling	19	summer[b]	n/a
lake chub	n/a		

[a] ASRD n.d.
[b] Herbert 1979.
n/a = Not available.

5.26.2 Habitat

Information regarding the habitat of the Pierre River was limited. Griffiths (1973) conducted a synoptic overflight of the Pierre River and reported that the river had little or no favourable sport fish habitat. However, the habitat in this watercourse was not described. RL&L (1994) examined the mouth of the Pierre River and described this area as low gradient, depositional and consisting of run habitat with silt and sand substrate. Golder (2002a) evaluated overwintering habitat at the Pierre River mouth and determined that the mouth was frozen to the bottom during the late winter.

5.26.3 Habitat Use

Since data were limited, inferences are drawn from the spring counting fence results (ASRD n.d.). Northern pike was the most numerous of the sport species captured in the spring run (52% of the total number of fish). Most fish were adults with a small number of juveniles. The adults were in spawning condition and gravid, ripe and spent fish were captured. Therefore, it is possible that northern pike use the Pierre River for spawning, nursery and rearing, and the adults may also use this watershed for summer feeding habitat. Arctic grayling was the second most numerous sport fish captured in the counting fence (24% of the total), with juvenile and adult fish recorded in roughly equal numbers. Arctic grayling fry were captured during summer in the lower portion of the river (Herbert 1979). Based on these results, Arctic grayling may use the Pierre River for spawning, nursery, rearing and feeding habitat. Burbot, mountain whitefish and walleye were captured in the Pierre River in very low numbers, indicating a small amount of use of this watershed for rearing and/or feeding by these species.

Longnose sucker was the third most numerous species captured in the spring counting fence (24% of the total) (ASRD n.d.). White sucker were present, but fewer (3% of the total). Juvenile and adults were captured for both sucker species and a portion of the adult longnose sucker were in spawning condition (i.e., ripe). Therefore, longnose sucker may use the Pierre River for spawning, nursery and rearing activities. If spawning habitat is available in the Pierre River for longnose sucker, it would also be present for white sucker.

Overwintering by fish in the Pierre River was assumed to be unlikely because there is no flow during the winter (Golder 2002a).

5.26.4 Data Gaps

A seasonal fish and habitat inventory examining the length of the Pierre River would be required to determine the habitat conditions, fish community structure, life stages present and abundance. Spawning surveys would be required to determine the species that use the river for spawning and the locations of spawning sites.

5.27 TRIBUTARY WATERSHED #43 – UNNAMED WATERCOURSE (SUSAN LAKE OUTLET)

One report provided fisheries information on the unnamed watercourse that forms the outlet of Susan Lake (Golder 2001b). Information was available on the outlet channel, Susan Lake and two small, unnamed tributaries that flow into Susan Lake. Figure 7 shows the portions of this watershed included in this report.

5.27.1 Fish Community

Fish species in the Susan Lake watershed are presented in Table 66. Seven fish species occurred in this watershed including one sport species, one sucker species and five small-bodied forage species.

Table 66 Fish Species and Life Stages in Tributary Watershed #43 (Susan Lake Outlet)

Species	Life Stage
brook stickleback	unspecified
lake chub	unspecified
longnose sucker	juvenile
northern pike	juvenile
pearl dace	unspecified
slimy sculpin	unspecified
trout-perch	unspecified

No CPUE data were available.

5.27.2 Habitat

The Susan Lake watershed contains three small watercourses and one small waterbody. The Susan Lake outlet channel was a small stream that was affected by beaver activity. Only the lower 300 m of the outlet channel was free flowing with no beaver dams. The habitat in this section was dominated by riffle areas and shallow, low quality (Class 3) runs. The substrate consisted of cobble, gravel and sand. Approximately 300 m upstream of the confluence with the Athabasca River, five beaver dams created a series of impoundments. Farther upstream, the channel became an alternating series of wetlands and beaver ponds with no defined channel. Access by fish from the Athabasca River was extremely limited. The Susan Lake outlet channel was frozen to the bottom at the time of the winter survey and would not provide overwintering habitat for fish (Golder 2001b).

Susan Lake was a small, shallow waterbody with an average depth <1.0 m and a maximum depth of 4.2 m (Golder 2001b). Substrate of the lake was entirely fine sediment and organic material, and there was extensive submergent macrophyte growth with isolated areas of emergent vegetation. The lake was considered to have the potential to provide seasonal habitat for forage fish as well as for northern pike spawning. However, access to the lake was limited due to conditions in the outlet channel. Movement between the lake and the Athabasca River would be necessary because the lake was anoxic during winter.

Two unnamed tributaries to Susan Lake were surveyed in a cursory manner and were described as shallow, marshy channels will little observable flow and it was concluded that they did not provide suitable fish habitat.

5.27.3 Habitat Use

All seven fish species in the Susan Lake watershed were present only in the lower 300 m of the Susan Lake outlet channel, where it was accessible form the Athabasca River. The two large-bodied species, northern pike and longnose sucker, were present as juveniles, indicating use of the lower-most portion of the outlet channel as rearing habitat. Only brook stickleback and lake chub were found farther upstream in the impounded section of the outlet channel. These two species were also present in Susan Lake, as was pearl dace. Potential spawning habitat (i.e. coarse substrate with riffle habitat) in the lower portion of the outlet channel was sampled for eggs but none were found.

5.27.4 Data Gaps

Although only one study has been conducted for the Susan Lake watershed, further study is not likely warranted. Access seems to be the primary factor limiting fish use.

5.28 TRIBUTARY WATERSHED #44 – EYMUNDSON CREEK

Two reports provided fisheries information for the Eymundson Creek watershed (Griffiths 1973; Golder 2002a). The portion of Eymundson Creek examined by these studies is presented in Figure 7.

5.28.1 Fish Community

Fish species collected in Eymundson Creek have been summarized and are listed in Table 67.

Table 67 Fish Species and Life Stages in Tributary Watershed #44 (Eymundson Creek)

Species	Life Stage
flathead chub	unspecified

Fish sampling was conducted by Griffiths (1973) and flathead chub was the only species captured. Fly fishing was the only sampling technique employed. The reported data was insufficient to allow CPUE calculation.

5.28.2 Habitat

Griffiths (1973) conducted a synoptic habitat survey of the length of Eymundson Creek. The watercourse was described as having poor fish habitat over most of its length, with a short middle section that had improved habitat conditions. Griffiths (1973) examined one section of the watercourse in detail and described the channel as 6m wide with an average depth of less than 0.3 m. Portions of the site had silt banks, sand bars and many windfalls. Other areas had higher gradient and exhibited riffles with boulder and rubble substrates.

Based on the description by Griffiths (1973), Eymundson Creek would provide habitat for forage fish and may provide seasonally available habitat for large-bodied species from the Athabasca River. Habitat consisting of swift flowing water over rocky substrates occurred in the middle section of the watercourse.

Golder (2002a) conducted an assessment of the overwintering potential of Eymundson Creek by examining the creek mouth during the late winter. The creek was frozen to the bottom with no discharge.

5.28.3 Habitat Use

Very limited fish sampling was conducted (fly fishing only), flathead chub was the only species captured, and the stream was frozen in winter indicating that Eymundson Creek provides conditions for this species in summer only.

5.28.4 Data Gaps

Because of limited data, seasonal fish and habitat assessments and spawning surveys would be needed to determine the fish community that uses this watercourse and its relation fish populations in the Athabasca River.

5.29 TRIBUTARY WATERSHED #45 – UNNAMED WATERCOURSE

One report provided fisheries information on Unnamed Watershed #45 (Golder 2001b). Figure 7 shows the portion of this watershed included in this report.

5.29.1 Fish Community

The fish species reported from tributary watershed #45 are summarized in Table 68. Four fish species have been reported in this watershed including one sport species, one sucker species and two small-bodied forage fish.

Table 68 Fish Species and Life Stages in Tributary Watershed #45 (Unnamed Watercourse)

Species	Life Stage
brook stickleback	unspecified
longnose sucker	juvenile
mountain whitefish	juvenile
pearl dace	unspecified

The reported data was insufficient to allow for the calculation of CPUE.

5.29.2 Habitat

This watercourse was described as having three distinct reaches (Golder 2001b). The first reach was short, consisting of the lower 100 m of the stream and was a shallow, low gradient reach dominated by low quality (Class 3) runs with fine sediment, and had abundant woody debris that provided cover for fish. The second reach began 100 m upstream of the confluence with the Athabasca River and comprised the majority of the channel that was examined. This reach was high gradient and had a narrow, incised channel composed mainly of riffles and shallow runs. Small step pools were also present. The substrates consisted of cobble and gravel in the riffles and sand in the slower runs and pools. The third reach occurred in the upper section of the watercourse where the gradient was lower and beaver activity was apparent. The stream was mainly shallow with low quality runs and impoundment pools behind beaver dams with a few short riffle sections. Some sections of subterranean flow were present where the watercourse travelled through spruce bogs. Substrates were mainly fine sediment.

The habitat in this unnamed watercourse was suitable for forage fish and for use by fish immigrating from the Athabasca River. Habitat for spawning in the form of swift flowing water over rocky substrates was present.

The stream was determined to remain open and free of ice during the winter, likely due to a high proportion of the flow as ground water.

5.29.3 Habitat Use

Fish numbers were low for all species captured (i.e., one individual captured), with the exception of longnose sucker, and all fish were captured in the lower reach (i.e., the first 100 m of the creek) in the late summer (Golder 2001b). The two large-bodied fish present, longnose sucker and mountain whitefish, were juveniles. It was evident that forage fish and rearing longnose sucker and mountain whitefish used the accessible low gradient reach at the watercourse mouth. It was considered likely that the high gradient farther upstream limited fish use of the upper watercourse.

5.29.4 Data Gaps

This watercourse has limited potential for fisheries and further investigation is not likely warranted.

5.30 TRIBUTARY WATERSHED #47 – UNNAMED WATERCOURSE

Two reports contained information on Unnamed Watercourse #47 (Griffiths 1973; Herbert 1979). Griffiths conducted a synoptic overflight to assess the fisheries potential of the watershed but did not conduct ground surveys. This watercourse, 35 km in length, is the largest of the unnamed tributary watersheds. Figure 7 shows the portion of the watercourse that was included in the available studies.

5.30.1 Fish Community

Fish species collected in this unnamed watercourse are listed in Table 69. Lake chub and unspecified sucker fry were captured. The sucker fry would have undoubtedly been one or both of the two indigenous species (i.e., longnose and/or white sucker).

Table 69 Fish Species and Life Stages in Tributary Watershed #47 (Unnamed Watercourse)

Species	Life Stage
lake chub	unspecified
sucker spp. (unidentified)	fry

The number of fish captured and the sampling effort was not reported.

5.30.2 Habitat

Based on an overflight, Griffiths (1973) concluded Watercourse #47 had low potential to support sport fish. A description or assessment of habitat was not provided by Herbert (1979).

5.30.3 Habitat Use

The presence of sucker fry and lake chub in the summer implies that the unnamed watercourse provides nursery habitat for sucker species and habitat for lake chub. The presence of fry suggests the possibility that spawning occurs in the watershed.

5.30.4 Data Gaps

Only cursory fisheries information from one season is available. Data gaps include an assessment of habitat, seasonal fisheries studies and spawning information. However, the small size of this watershed may not warrant further investigation.

5.31 TRIBUTARY WATERSHED #48 – REDCLAY CREEK

One report included fisheries information on Redclay Creek (Griffiths, W.E. 1973). Figure 7 shows the portions of the Redclay Creek watershed included in this report.

5.31.1 Fish Community

Fish species reported in the Redclay Creek watershed are listed in Table 70. Arctic grayling was the only species captured. Angling was the only capture technique employed.

Table 70 Fish Species and Life Stage in Tributary Watershed #48 (Redclay Creek)

Species	Life Stage
Arctic grayling	juvenile, adult

Data was not available from the study to calculate CPUE.

5.31.2 Habitat

Griffiths (1973) evaluated the habitat for the entire length of Redclay Creek using a synoptic overflight. The watercourse was described as having very little suitable fish habitat in the lower and upper reaches, with better habitat in the middle reach. The upper and lower sections were rated as having poor potential to support fish and the middle section was rated as fair.

Griffiths (1973) examined one site in the middle section of the creek and the site was described as low gradient with a substrate composed of fine sediment. Farther upstream, the gradient became steeper and the channel consisted of riffles and pools with rocky substrate. The mean depth of the creek was <0.3 m, with a maximum pool depth of 0.5 m and an average width of 6.1 m. Pool substrate consisted of sand and silt. Riffle substrate consisted of moss-covered boulders, and small amounts of gravel.

5.31.3 Habitat Use

Adult and juvenile Arctic grayling were captured in Redclay Creek in the summer, indicating that the creek provides summer rearing and feeding habitat for this species. Angling was the only sampling technique and the presence of other, small fish species not susceptible to angling was not determined.

5.31.4 Data Gaps

Only cursory fisheries information from one season was available for this watershed. Data gaps include a lack of habitat assessment, seasonal fisheries inventory and spawning study.

5.32 TRIBUTARY WATERSHED #50 – FIREBAG RIVER

Six reports provided information for the Firebag River watershed (Griffiths 1973; Psutka 1979; Sekerak and Walder 1980; Walder et al. 1980; RL&L 1994; Mill et al. 1997). Information was available for three tributaries to the Firebag River, including the Marguerite River. Figure 7 shows the portions of the Firebag River watershed included in these reports.

5.32.1 Fish Community

Fish species collected in the Firebag River watershed were summarized and are listed in Table 71. Eighteen fish species have been reported from this watershed, including six sport species, two sucker species and ten small-bodied forage species, with sixteen of these species occurring in the mainstem Firebag River. Table 71 also shows the eleven species reported from the Firebag River that have also been documented in the Marguerite River drainage. In total, thirteen fish species have been recorded in the Marguerite River, including two species not reported from the Firebag River: mountain whitefish and spoonhead sculpin. As these two species occur in the Firebag River basin, it is likely that they also occur in the mainstem Firebag River.

Table 71 Fish Species and Life Stages in Tributary Watershed #50 (Firebag River)

Species	Life Stage
Arctic grayling [(a)]	fry, juvenile, adult, spawning
brook stickleback [(a)]	unspecified
burbot [(a)]	unspecified
emerald shiner	unspecified
flathead chub	unspecified
lake chub [(a)]	unspecified
lake whitefish	juvenile, adult
longnose dace [(a)]	unspecified
longnose sucker [(a)]	fry, juvenile, adult, spawning
mountain whitefish [(b)]	fry, juvenile, unspecified
ninespine stickleback	unspecified
northern pike [(a)]	fry, juvenile, adult, spawning
pearl dace [(a)]	unspecified
slimy sculpin [(a)]	unspecified
spoonhead sculpin [(b)]	unspecified
trout-perch [(a)]	unspecified
walleye	juvenile, adult
white sucker [(a)]	fry, juvenile, adult, spawning

(a) Species documented in the Marguerite River.
(b) Species documented from Marguerite River only.

Some of the fish sampling of the Firebag River was conducted on the basis of longitudinal reaches. As a result, fish distribution is available for each river section (Table 72). Species present in all reaches of the river included lake chub, longnose sucker, northern pike and white sucker.

Table 72 Fish Species Distribution in Tributary Watershed #50 (Firebag River)

Species	Distance Upstream of the Athabasca River (km)					
	0-13	13-45	45-52	52-75	75-96	96-123+
Arctic grayling	-	x	x	x	x	x
brook stickleback	-	x	x	-	-	-
burbot	-	x	-	-	-	-
emerald shiner	-	-	x	-	-	-
flathead chub	-	-	-	-	x	-
lake chub	x	x	x	x	x	x
lake whitefish	x	x	x	-	-	-
longnose dace	-	x	x	x	x	x
longnose sucker	x	x	x	x	x	x
ninespine stickleback	-	-	-	x		x
northern pike	x	x	x	x	x	x
pearl dace	-	x	x	x	-	-
slimy sculpin	-	x	x	x	x	x
trout-perch	-	-	x	x	x	x
walleye	x	x	x	x	-	x
white sucker	x	x	x	x	x	x
total species	**6**	**12**	**13**	**11**	**9**	**10**

Average CPUE was calculated from the data provided by Psutka (1979) (Table 73). The most abundant species captured in gill nets were northern pike in the spring and lake whitefish in the fall. The most abundant species from seine net sampling, in relative order, were lake chub, white sucker, longnose sucker, pearl dace and trout-perch. Most of these species had a higher abundance in spring than fall, with the exception of pearl dace which was more abundant in the fall.

Table 73 CPUE Values for Fish Species Captured in Tributary Watershed #50 (Firebag River) – 1978[(a)]

Species	Number of Fish	Sampling Season	Sampling Technique	
			Gill Net (#/hr)	Seine Net ($\#/10m^2$)
Arctic grayling	10	spring	0.2	0.3
	40	fall	0.1	1.8
brook stickleback	1	spring	-	0.1
flathead chub	1	fall	-	0.1
lake chub	173	spring	-	68.7
	410	fall	-	42.0
lake whitefish	26	fall	0.8	-
longnose dace	31	spring	-	0.7
	78	fall	-	5.8
longnose sucker	69	spring	0.3	11.3
	40	fall	0.1	2.8
ninespine stickleback	4	fall	-	0.2
northern pike	5	spring	0.4	-
	68	fall	0.1	0.8
pearl dace	24	spring	-	6.8
	72	fall	-	15.7
slimy sculpin	14	spring	-	0.3
	10	fall	-	0.7
trout-perch	11	spring	-	11.0
	6	fall	-	0.2
walleye	4	spring	0.2	-
	7	fall	0.1	-
white sucker	329	spring	-	63.8
	58	fall	0.2	5.4

(a) Psutka 1979.

5.32.2 Habitat

Griffiths (1973) surveyed the lower 192 km of the 218 km long Firebag River and described it as a large watershed and an important fisheries area. Three longitudinal reaches for the watershed were detailed in this early study. The upper portion of the Firebag River was low gradient and nearly 100% pool habitat. The tributary streams in the upper portion of the watershed were rated as having low potential to support sport fish. Farther downstream, the river gradient became steeper and the middle portion of the river, extending to approximately

10 km below the Marguerite River confluence, was rated as having excellent potential for sport fish. Most of the tributary streams in this middle section of the Firebag River were considered important hatchery areas for Arctic grayling and were rated as having moderate fish habitat. The lower portion of the river lessened in gradient and became wider and deeper with extensive sand bars and large, deep pools on meander bends. RL&L (1994) characterized the lower Firebag River as run habitat with silt and sand substrate. The lower river provided excellent walleye and pike fishing (Griffiths 1973).

Sekerak and Walder (1980) examined the lower 123 km of the Firebag River and divided the watercourse into six reaches, which generally corresponded to stream gradient. Characteristics of these reaches were described by Sekerak and Walder (1980) and Psutka (1979). The first reach included the first 13 km of the watercourse upstream from the confluence with the Athabasca River. This lower-most reach was described by Psutka (1979) as low gradient and consisting mostly of long, wide pools, with pool to riffle ratios greater than 10:1, consistent with Sekerak and Walder (1980) who stated that the habitat in this reach was 90% pool. The substrate in this reach consisted primarily (95%) of fines with a small amount of gravel. Psutka (1979) suggested that mountain whitefish, arctic grayling, and burbot used the lower-most reach as a migration route to upstream habitats. Spawning potential for most forage and sport fish was considered poor in the lower reach due to unstable sand substrate (Psutka 1979). Sekerak and Walder (1980) considered that northern pike and forage fish could spawn in the occasional grassy shallows that occur along the banks. The reach contained slow water and cover suitable for forage fish, adult feeding and possibly overwintering (Psutka 1979; Sekerak and Walder 1980).

The next upstream reach extended to the mouth of the Marguerite River (i.e., 13 to 45 km upstream of the Athabasca River). This was also a low gradient section, although the gradient was slightly higher than the lower-most reach. The second reach was mostly pool habitat (i.e., 90%), interspersed with gravel bars and limestone outcrops and occasional riffles (Psutka 1979; Sekerak and Walder 1980). The overall substrate for this reach was primarily fines (70%) and gravel (25%), with small amounts of larger substrate particles. The potential for spawning by forage and sport fish was considered to be poor because of the dominance of sand substrate. Rearing habitat for fish was considered moderate due to low velocities and cover provided by debris. Feeding habitat was rated as high for forage and sport fish. Psutka (1979) considered that the deep pools at river bends could provide possible overwintering habitat for fish.

The third reach (extending from 45 to 52 km upstream of the Athabasca River) had a moderate gradient and had a pool:riffle ratio of 1:1 and occasional backwater areas (Psutka 1979; Sekerak and Walder 1980). The substrate consisted of cobble, boulder, and gravel with some sand. The potential for spawning for all fish was assumed to be good to excellent because of the diversity of substrate sizes, velocities and depths. Rearing habitat was considered to exist for most fish species in the occasional backwater areas and areas with overhanging vegetation and large substrates sizes that provided cover. Numerous pools were considered to provide good resting and feeding areas for larger fish. Psutka (1979) described the potential for Arctic grayling feeding habitat as high, but the potential for overwintering by Arctic grayling in this reach to be negligible. Sekerak and Walder (1980) also thought that overwintering potential was low due to relatively shallow water depths, despite the occurrence of many pool habitats.

The fourth reach (52 to 75 km upstream of the Athabasca River) had a low to moderate gradient and was described as mainly (85%) pool habitat, with a pool:riffle ratio of 6:1 (Psutka 1979; Sekerak and Walder 1980). The substrate was cobble, boulder, and gravel, with some sand and occasional bitumen deposits on the shoreline and banks. This reach provided good to excellent spawning habitat for sport and forage fish. This reach also provided good rearing habitat and forage fish habitat due to cover from backwaters, overhanging vegetation, debris and large substrate particles. The high number of pools provided good feeding and resting areas for larger fish and summer feeding habitat for adult northern pike and walleye. Overwintering habitat potential was considered limited to isolated deep pools along river bends.

The fifth reach (75 to 96 km upstream of the Athabasca River) had a moderate gradient and a higher occurrence of riffle habitats, with a pool:riffle ratio of 1:3 (Psutka 1979; Sekerak and Walder 1980). The substrate was predominantly gravel, cobble, and boulder with a small amount of fine sediment. This section of the Firebag River was described as providing habitat suitable for spawning by most species that occur in the river, based on the diversity of velocities, depths and substrate sizes. Grassy shallows with fine substrate were considered to provide potential spawning habitat for northern pike. Rearing habitat was rated as good for most species and excellent for fry and juvenile Arctic grayling due to the presence of sheltered backwaters, overhanging vegetation and large substrate particles that provided cover and refugia. Habitat for overwintering was limited to a few deep pools located at river bends.

The sixth reach (96 to 123+ km upstream of the Athabasca River) had a high gradient and was described as mostly riffle habitat, interspersed with occasional pools. The pool:riffle ratio was 1:5 with the substrate consisting of cobble, boulder, and gravel with a small amount of fines. Diverse substrate and depth profiles along with grassy side sloughs were considered to provide excellent spawning potential for sport and forage fish. Potential rearing habitat was also considered to be excellent in this reach. Potential feeding areas for adult fish were present in the gravel riffles for Arctic grayling and in back eddies and side sloughs for walleye and northern pike. Habitat in which fish could overwinter was found in a few deeper backwaters.

Firebag River Tributaries

The Marguerite River is the only major tributary of the Firebag River. The headwater regions of the Marguerite River were not examined in detail but were described by Sekerak and Walder (1980) as low gradient with a high percentage of pools, often formed by beaver dams or debris, providing slow moving water with fine sediment for substrate. The lower 75 km of the Marguerite River was examined in more detail (Sekerak and Walder 1980; Walder et al. 1980) and was divided into five reaches. The lowermost reach, extending for 3.0 km upstream from the river mouth, had a moderate gradient and was dominated by riffles and rapids with a low (10%) occurrence of pools. The substrate was dominated by boulder and gravel, with some cobble, bedrock and fines. The diversity of substrate types was considered to provide suitable spawning habitat for most of the sport and forage fish species that occur in the river. Potential rearing habitat was also present due to cover provided by rocky substrates, overhanging vegetation and moderate amounts of debris. Potential resting and feeding habitat for larger fish and overwintering habitat were considered to be low due to relatively high water velocities and low number of pools.

The second reach of the Marguerite River (extending from 3.0 to 18.5 km upstream of the mouth) was low gradient, composed predominately (90%) of pool habitat and with substrate dominated by fine sediments with some gravel. Spawning potential was considered to exist in this reach for a few forage fish species but was limited for other species. Rearing habitat was rated as poor to moderate, with cover provided by small amounts of debris and some overhanging vegetation. Resting and feeding habitat for larger fish as well as habitat with potential for overwintering was rated as good to excellent due to the many pools present and the generally deep waters.

The third reach of the Marguerite River (18.5 to 20.0 km upstream of the mouth) was a short, high gradient section with long sections of riffles and rapids and few pools (10%). The substrate in the third reach was mostly cobble, boulder and fines, with some gravel and bedrock. The diversity of substrates, velocities and depths was considered to provide good to excellent spawning habitat. Rearing habitat was rated as good due to the presence of rocky substrates, moderate amounts of debris and overhanging vegetation. High water velocities and low number of pools was considered to limit habitat for resting and feeding by larger fish and preclude overwintering.

The fourth reach of the Marguerite River (20.0 to 61.0 km upstream of the mouth) was low gradient with predominately pool habitat (90%); substrate was composed mostly of fine sediment. Spawning potential in this reach was unsuitable for most species, with the exception of forage fish that use sandy substrates. Rearing habitat was considered to be good to excellent due to an abundance of cover from low velocities. Overhanging vegetation and debris provided cover. Resting and feeding habitat for larger fish was rated as excellent due to numerous pools and areas sheltered by overhanging vegetation. Pool depths were generally considered too shallow to provide adequate conditions for overwintering.

The fifth reach of the Marguerite River (61.0 to 75.0 km upstream of the mouth) was moderately low gradient but had mainly riffle and rapids areas, low pool occurrence (10%) and substrates composed of a mix of particle sizes. Conditions in this reach were considered to provide excellent spawning potential, based on the diversity of depths, velocities and substrate sizes. Rearing potential was also considered excellent due to the abundance of cover from rocky substrates, overhanging vegetation and debris. Potential resting and feeding habitat for larger fish was rated as fair, with suitable habitats limited by the low number of pools present. Overwintering potential was considered to be low because there were few deep pools.

Overall, the majority of the Marguerite River was found to consist of slow moving pool habitat with fine sediment (Griffiths 1973; Sekerak and Walder 1980). Although sections of higher gradient with increased habitat diversity were present, they were limited in extent. Griffiths (1973) rated the Marguerite River as having low to moderate fisheries potential but rated the unnamed tributaries to the Marguerite River as having better habitat and higher potential to support fish, with the tributaries having stocks of Arctic grayling and mountain whitefish. Griffiths (1973) thought that the Marguerite River would primarily provide a route for movement and potential overwintering habitat for fish from its tributary streams.

Griffiths (1973) studied three of the unnamed tributaries to the Firebag River. The first unnamed tributary was found to be an important hatchery stream for the Firebag River. This stream had a pool to riffle ratio of 1:1, with 1.2 m deep pools. Riffle substrate consisted of boulder, cobble, and gravel, and pool substrate was boulders, gravel and sand. The second tributary also contained a pool to riffle ratio of 1:1. At the time of study, beaver activity had created 100% pool habitat upstream. Substrate consisted of gravel and cobble. The third tributary studied by Griffiths (1973) had a pool:riffle ratio of 2:1 and contained boulder and cobble substrate in the riffle sections and sand and gravel in the pools.

5.32.3 Habitat Use

Nursery, rearing and adult feeding activity has been documented to occur in the Firebag River for a number of sport and forage species. Spawning has not been investigated in detail, but has been inferred for a number of species based on habitat, the presence of adult fish during spawning periods and the presence of fry fish. Table 72 shows that several species are widely distributed in this watershed. Reported as the most common of these species were Arctic grayling, lake chub, northern pike and white sucker. Longnose dace, longnose sucker, slimy sculpin and walleye were also widespread but were less abundant. The other species reported in Table 72 either occurred in low abundance or with restricted distribution.

Arctic grayling were determined to use the Firebag River as nursery, rearing and feeding habitat. Based on reported use, it is also likely that grayling use the river for spawning. Adult fish in post-spawning (i.e., spent) condition have been recorded in areas where unidentified eggs were recovered during the spring (Walder et al. 1980). In addition, large numbers of young fish (including fry) have been reported from the upper reaches of the river. It appears that Arctic grayling use reaches 3 through 6 of the Firebag River as spawning and nursery areas. Northern pike also use the Firebag River as nursery, rearing and feeding habitat. Although rearing and feeding activity by juveniles and adults have been observed throughout the river, northern pike fry were found only upstream in Reach 6. The presence of northern pike fry so far from the Athabasca River indicates that spawning probably occurs for this species in the Firebag River, at least in the upper portions.

Other sport fish species reported in the Firebag River were less common. Walleye have been recorded in almost all reaches, but were low in abundance. Rearing and feeding activity has been reported for this species and the possibility of walleye spawning was suggested by Walder et al. (1990), based on the occurrence of suitable spawning habitat and the presence of adult, post-spawning fish during the spring. However, walleye spawning has not been documented in the Firebag River. In other tributaries (see section 5.14 – Steepbank River) post-spawning walleye entered the watershed in the spring probably to feed. Lake whitefish adults and juveniles were in the lower three reaches of the Firebag River in the fall. Spawning by this species may occur, based on the availability of suitable habitat (Walder et al. 1980), but no direct evidence of spawning has been found for lake whitefish in this watershed. Burbot were rare in the Firebag River.

Mountain whitefish have not been captured in the mainstem Firebag River, but are present, in low abundance, in the Marguerite River. It is likely that this species was in the Firebag River, even if it uses the Firebag River only as a route between the Athabasca River and the Marguerite River. However, the habitats in the mainstem Firebag River may provide suitable conditions for all mountain whitefish life stages.

Longnose sucker and white sucker were present throughout the studied reaches of the Firebag River. Fry, juvenile and adult fish of both were captured, indicating use of the river for nursery, rearing and feeding. Spent adult longnose sucker were captured in the spring in areas where unidentified eggs were found (Walder et al. 1980). This, in combination with the presence of fry, indicates that longnose sucker may spawn in the Firebag River. Spawning by white sucker is also likely for this watershed, based on the presence of ripe adult fish during spring and the occurrence of fry later.

Several researchers have suggested that the Firebag River could provide overwintering habitat for a variety of fish species, based on the presence of suitable pool habitats and the constant nature of the winter flow, particularly in the lower portion of the river. Mill et al. (1997) and RL&L (1994) suggested that walleye and northern pike might use the Firebag River for overwintering. However, no studies have been conducted and the species that spend the winter in the watershed are unknown.

Firebag River Tributaries

The Marguerite River supports thirteen species of fish, including four sport species, two sucker species and seven small-bodied forage species (Table 71). Fish in the Marguerite River were considered to be low in abundance by Griffiths (1973), who thought that fish stocks mainly used the tributary streams. However, Sekerak and Walder (1980) rated the fish use of the Marguerite River as high. Arctic grayling, lake chub, longnose dace, longnose sucker, northern pike, slimy sculpin, trout-perch and white sucker were common and widespread. Based on the number of fry and juvenile fish present, the Marguerite River was considered as providing spawning and rearing habitat for a variety of species. Eggs were recovered during the spring spawning season, unfortunately the eggs were not identified (Walder et al. 1980).

Arctic grayling were documented to use the Marguerite River as rearing and feeding habitat and were suspected to spawn in this watercourse, based on the presence of adult Arctic grayling in the spring in areas of suitable spawning habitat. Northern pike adult were found to use the Marguerite River for feeding. Use of the river by other life stages of northern pike was not specifically reported. Other sport species captured in the Marguerite River included mountain whitefish and burbot, both of which were rare. Mountain whitefish were mainly young fish using the river as rearing habitat. Burbot were present mainly in tributary streams.

Longnose and white suckers were present as young fish and adults. It was suggested that the Marguerite River was used for spawning and nursery activities, based on the presence adult fish in the spring and suitable spawning habitat.

The three Firebag River tributaries examined by Griffiths (1973) were found to provide nursery and rearing habitat for Arctic grayling, mountain whitefish, longnose sucker and white sucker. Spawning activity in these tributaries was suspected, but not documented, for these species. The tributaries were also used by a few small-bodied forage species.

5.32.4 Data Gaps

Additional fisheries inventory data would provide more information on the fish species and life stages present in the Firebag River watershed. In particular, previous studies reported the numbers of young fish captured but did not distinguish between fry and juvenile fish. As well, additional inventories would provide information on fish distribution, as it was speculated that walleye and lake whitefish occur in the Marguerite River. Spawning surveys in the spring and fall would document the species spawning in the watershed as well as the location. Studies during winter are needed to determine if the habitat described for the Firebag and Marguerite Rivers allow survival by the species are present during winter.

6 SPECIES DISTRIBUTION MAPS

Species distribution maps are provided in Appendix I for sport fish and suckers and in Appendix II for small-bodied forage fish. The maps are by species and show the portion of each tributary in which the species has been reported. The maps in Appendix I include the known distribution for each life stage (i.e., spawning, fry, juvenile, adult).

Twenty eight fish species have been documented to occur in the mainstem Athabasca River in the Oil Sands Region (Wallace and McCart 1984, Nelson and Paetz 1992, Golder 1996a). Of these 28 species, 27 occurred in one or more of the tributary watersheds (Table 74). Of the 32 tributary watersheds for which fisheries information was available, 30 had one or more fish species present. Species in the largest number of tributaries were Arctic grayling, brook stickleback, burbot, lake chub, longnose sucker, northern pike and trout-perch.

Table 74 Fish Species Reported from the Athabasca River Basin

Species	Present in Mainstem Athabasca River	Number of Tributaries Reported From
Arctic grayling	x	18
brassy minnow	x	1
brook stickleback	x	18
bull trout	x	2
burbot	x	16
emerald shiner	x	9
fathead minnow	x	7
finescale dace	x	4
flathead chub	x	12
goldeye	x	6
Iowa darter	x	0
lake chub	x	18
lake cisco	x	2
lake whitefish	x	9
longnose dace	x	8
longnose sucker	x	18
mountain whitefish	x	13
ninespine stickleback	x	2
northern pike	x	16
northern redbelly dace	x	4
pearl dace	x	13
slimy sculpin	x	12
spoonhead sculpin	x	11
spottail shiner	x	9
trout-perch	x	17
walleye	x	10
white sucker	x	12
yellow perch	x	9

7 CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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8 REFERENCES

AENV (Alberta Environment). No date. Alberta Fish Collection Permit Data Return for Permit No. 78-16. Fish and Wildlife Division, Fort McMurray, AB.

ASRD (Alberta Sustainable Resource Development). No Date. Unpublished Files. (Alberta Fish Collection Permit Data Return for Permit No. 82-09 and 82-09b). Fish and Wildlife Division, Fort McMurray, AB.

AXYS (AXYS Environmental Consulting Ltd.). 1998. MacKay River Project Environmental Impact Assessment, Volume 2: Baseline Environmental Studies. Prepared for Petro-Canada Oil and Gas.

Biological Consultants. 1977. Alberta Fish Collection Permit Data Return.

Boerger, H. 1986. Fish Survey of the Syncrude Development Area, 1985. Geology and Environmental Affairs, Syncrude Canada.

Bond, W.A., and D.K. Berry. 1980. Fishery Resources of the Athabasca River Downstream of Fort McMurray, Alberta: Volume II. Prepared for the Alberta Oil Sands Environmental Research Program. AOSERP Project AF 4.3.2.

Bond, W.A., and K. Machniak. 1977. Interim report on an Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta. Prepared by the Department of Fisheries for the Alberta Oil Sands Environmental Research Program. AOSERP Project AF 4.5.1.

Bond, W.A., and K. Machniak. 1979. An Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta. Prepared for Alberta Oil Sands Environmental Research Program by Environment Canada, Freshwater Institute. AOSERP Report 76.

Brown, S.B., R.E. Evans, and L. Vandenbyllaardt. 1996. Analyses for Circulating Gonadal Sex Steroids and Gonad Morphology in Fish Peace, Athabasca and Slave River Basins, September to December, 1994. Northern River Basins Study Project Report No. 89.

EBA (EBA Engineering Consultants Ltd.). 2001. Highway 63:14 Reconstruction Fish and Fish Habitat Assessments Mills Creek and Unnamed Creek North of Fort MacKay, Alberta. Prepared for Alberta Transportation.

Fedoruk, A.N. 1973. Supplementary Ecological Baseline Measurements of Tar Sands Lease C-13, Athabasca Tar Sands, Alberta, Canada. Prepared by Lombard North Group.

Golder (Golder Associates Ltd.). 1996a. Aquatic Baseline Report for the Athabasca, Steepbank and Muskeg Rivers in the Vicinity of the Steepbank and Aurora Mines. Prepared for Suncor Inc., Oil Sands Group.

Golder. 1996b. Addendum to Suncor Steepbank Mine Environmental Impact Assessment: Spring 1996 Fisheries Investigations. Prepared for Suncor Energy Ltd.

Golder. 1996c. Shipyard Lake Environmental Baseline Study. Prepared for Suncor Energy Inc., Oil Sands Group.

Golder. 1996d. Addendum to Syncrude Aurora Mine Environmental Baseline Program: Spring and Summer 1996 Fisheries Investigations. Prepared for Syncrude Canada.

Golder. 1996e. Addendum to Syncrude Aurora Mine Environmental Baseline Program: Autumn 1996 Fisheries Investigations: Draft Report. Prepared for Syncrude Canada.

Golder. 1997a. Alberta Fish Collection Permit Data Return for Permit No. 97-422.

Golder. 1997b. Alberta Fish Collection Permit Data Return for Permit No. 97-432.

Golder. 1997c. Steepbank Mine Winter Aquatic Baseline, February, 1997. Prepared for Suncor Energy Inc., Oil Sands Group.

Golder. 1997d. Aquatic Resources Baseline Study for the Muskeg River Mine Project. Prepared for Shell Canada Ltd.

Golder. 1997e. Shell Lease 13 Winter Aquatics Field Program. Prepared for Shell Canada Ltd.

Golder. 1998a. Suncor Project Millennium - 1997 Fall Fisheries Investigations. Prepared for Suncor Energy Ltd.

Golder. 1998b. Suncor Project Millennium - 1998 Spring and Fall Aquatic Investigations. Prepared for Suncor Energy Ltd.

Golder. 1998c. Project Millennium Conceptual Plan for "No Net Loss" of Fish Habitat. Prepared for Suncor Energy Inc.

Golder. 1999a. Fisheries Habitat Compensation Options for Project Millennium. Prepared for Suncor Energy Inc.

Golder. 1999b. Supplementary Aquatic Baseline Report for the Mobil Kearl Project. Prepared for Mobil Oil Canada Properties.

Golder. 1999c. Potential Key Indicator Resources (KIRs) for the Mobil Kearl Oil Sands Project. Prepared for Mobil Oil Canada Properties

Golder. 2000. Fall 1999 Aquatics Baseline Program for the Fort Hills Oil Sands Project. Prepared for Koch Exploration Canada Ltd.

Golder. 2001a. Application for Authorization of Works and Undertakings Affecting Fish Habitat, Firebag In-Situ Oil Sands Project Pipeline Crossings of Tributaries in the Utility Corridor. Prepared for Suncor Energy Inc.

Golder. 2001b. Fort Hills Oil Sands Project, Volume 2: Environmental Baseline Study – Fisheries and Fish Habitat Baseline Report. Prepared for TrueNorth Inc.

Golder. 2002a. Canadian Natural Resources Limited Horizon Project Environmental Impact Assessment: Volume 5, Section 6 – Fish and Fish Habitat. Prepared for Canadian Natural Resources Limited.

Golder. 2002b. Aquatic Resources Environmental Setting For Jackpine Mine – Phase 1. Prepared for Shell Canada Limited.

Griffiths, W.E. 1973. Preliminary Fisheries Survey of the Fort McMurray Tar Sands Area. Fish and Wildlife Division, Alberta Department of Lands and Forests.

Herbert, B.K. 1979. Supplemental Fisheries Life History Data for Selected Lakes and Streams in the AOSERP Study Area. Prepared for the Alberta Oil Sands Environmental Research Program by LGL Ltd. AOSERP Project WS 1.5.2.

Jacobson, T.L., and T.D. Boag. 1995. Fish Collections Peace, Athabasca and Slave River Basins September to December, 1994. Northern River Basins Study Project Report No. 61.

Jones, M.L., G.J. Mann, and P.J. McCart. 1978a. Fall Fisheries Investigations in the Athabasca and Clearwater Rivers Upstream of Fort McMurray Volume 1. AOSERP Report 36.

Jones, M.L., G.J. Mann, and P.J. McCart. 1978b. Fall Fisheries Investigations in the Athabasca and Clearwater Rivers Upstream of Fort McMurray Volume 2. AOSERP Report No. 4.8.1.

Klaverkamp, J.F., and C.L. Baron. 1996. Concentrations of Metallothionein in Fish, Peace, Athabasca and Slave River Basins, September to December, 1994. Northern River Basins Study Project Report No. 93.

Komex (Komex International Ltd.). 1997. Fisheries and Aquatics Component for the Mobil Lease 36 Baseline Environmental Assessment. Prepared for Mobil Oil Canada Ltd.

Lockhart, W.L., and D.A. Metner. 1996. Analysis for Liver Mixed Function Oxygenase in Fish, Peace, Athabasca and Slave River Basins, September to December, 1994. Northern River Basins Study Project Report No. 132.

Louma, M.E., and R.M. Shelast. 1986. Aquatic Baseline Survey for the Oslo Oil Sands Project, 1985, Stream Catalogue [Part 2]. Prepared by BEAK Associates Consulting Ltd. for Esso Resources Canada Ltd.

Louma, M.E., B.M. Shelast, and R.A. Crowther. 1986. Aquatic Baseline Survey for the Oslo Oil Sands Project, 1985 [Part 1]. Prepared by BEAK Associates Consulting Ltd. for Esso Resources Canada Ltd.

Machniak, K., and W.A. Bond. 1979. An intensive Study of the Fish Fauna of the Steepbank River Watershed of Northeastern Alberta. Prepared for the Oil Sands Environmental Research Program by Environment Canada, Freshwater Institute, Winnipeg, Manitoba. AOSERP Report 61.

Machniak, K. W.A. Bond, M.R. Orr, D. Rudy, and D. Miller. 1980. Fisheries and Aquatic Habitat Investigations in the MacKay River Watershed of Northeastern Alberta. Prepared by Department of Fisheries and Oceans.

McCart, P.J., P.T.P. Tsui, R. Green, and W, Grant. 1977. Baseline Studies of Aquatic Environments in the Athabasca River Near Lease 17, Vol. 1. Prepared for Syncrude Canada Ltd. by Aquatic Environments Ltd.

McCart, P., P. Tsui, W. Grant, R. Green, and D. Tripp. 1978. Baseline Study of the Water Quality and Aquatic Resources of the MacKay River, Alberta. Prepared by Aquatic Environments Ltd. for Syncrude Canada Ltd.

Mill, T.A., P. Sparrow-Clark, and R.S. Brown. 1997. Fish Distribution, Movement and Gross External Pathology Information for the Peace, Athabasca and Slave River Basins. Prepared for the Northern River Basins Study. NRBS Project Report No. 147.

Nelson, J.S., and M.J. Paetz. 1992. The Fishes of Alberta – second edition. The University of Alberta Press.

Noton, L. 1999. Unpublished Data.

Noton, L., and N. Chymko. 1977a. Alberta Fish Collection Permit Data Return for Permit No. 77-07. Fish and Wildlife Division, Fort McMurray.

Noton, L., and N. Chymko. 1977b. Aquatic Studies of Upper Beaver Creek, Ruth Lake, and Poplar Creek, 1975. Prepared by Renewable Resources Consulting Services Ltd. for Syncrude Canada Ltd.

Noton, L.R., and N.R. Chymko. 1978. Water Quality and Aquatic Resources of the Beaver Creek Diversion System, 1977. Prepared by Chemical and Geological Laboratories Ltd.

O'Neil, J.P. 1979. Fisheries Survey of the Beaver Creek Diversion System, 1978. Prepared by RL&L Environmental Services Ltd. for Syncrude Canada Ltd., Environmental Affairs Dept.

O'Neil, J.P. 1982. Fisheries Survey of the Beaver Creek Diversion System, 1981. Prepared by RL&L Environmental Services Ltd. for Syncrude Canada Ltd., Environmental Affairs Dept.

O'Neil, J., L. Noton, and T. Clayton. 1982. Aquatic Investigations in the Hartley Creek Area, 1981 (Sand Alta Project).

Pastershank, G.M. and D.C.G. Muir. 1996. Environmental Contaminants in Fish: Polychlorinated Biphenyls, Organochlorine Pesticides and Chlorinated Phenols, Peace, Athabasca and Slave River Basins, 1992 to 1994. Northern River Basins Study Project Report No. 101.

Pisces (Pisces Environmental Consulting Services Ltd.). 1998. Corridor Pipeline Limited Stream Crossing Assessment. Prepared for TERA Environmental Consultants Ltd.

Psutka, M.M. 1979. Biophysical Inventory of the Lower Mainstems of the Firebag River, Marguerite River, Ells River and Steepbank River - Draft. Prepared by LGL Ltd.

RL&L (R.L.&L. Environmental Services Ltd.). 1988. Fisheries and Aquatic Survey of the OSLO Oil Sands Minimum Size Demonstration Pilot (MSDP) Project Area. Prepared for DABBS Environmental Services.

RL&L. 1989. OSLO Project, Water Quality and Fisheries Resource Baseline Studies. Prepared for BOVAR Environmental Services.

RL&L. 1994. A General Fish and Riverine Habitat Inventory, Athabasca River, April to May, 1992. Prepared for the Northern River Basins Study. NRBS Project Report No. 32.

RL&L. 1999a. Fisheries and Habitat Assessments of Parsons Creek and Two Unnamed Streams Crossed by Highway 63 Near Fort McMurray, Alberta. Prepared for EXH Engineering Services Ltd.

RL&L. 1999b. Winter Fisheries and Habitat Assessment of the MacKay River. Prepared for Petro-Canada Oil and Gas, Oil Sands Development Group.

RL&L. No Date. Unpublished data.

Robertson, M.R. 1970. A Survey of the Beaver River With Respect to Fisheries Potential. Prepared by Regional Fisheries Biologist, St. Paul, Alberta.

RRCS (Renewable Resources Consulting Services Ltd.). 1973. An Investigation of Spring Spawning Migrations in Beaver Creek, Alberta, 1973. Prepared for Syncrude Canada Ltd.

RRCS. 1974. Fisheries Investigations of the Muskeg River and Hartley Creek, 1974. Prepared for Shell Canada Ltd.

RRCS. 1975. Northeast Alberta Regional Plan Project: Fisheries Resources. Prepared for Ekistics Design Consultants Ltd.

Sekerak, A.D., and G.L. Walder. 1980. Aquatic Biophysical Inventory of Major Tributaries in the AOSERP Study Area, Volume I: Summary Report. Prepared for the Oil Sands Environmental Research Program by LGL Limited, Environmental Research Associates. AOSERP Report 114.

Stanislawski, S. 1998. Stream Inventory of Alberta's Northeast Boreal Forest, 1997. Prepared by FRM Environmental Consulting Ltd.

Syncrude (Syncrude Canada Ltd.). 1973. Beaver Creek: An Ecological Baseline Survey. Prepared by Syncrude Canada Ltd.

Syncrude. 1975. Baseline Environmental Studies of Ruth Lake and Poplar Creek. Syncrude Canada Ltd., Research and Environmental Affairs. Environmental Research Monograph 1975-3.

Syncrude. 1977. A study of Biological Colonization of the West Interceptor Ditch and Lower Beaver Creek. Prepared by Aquatic Environments Ltd. for Syncrude Canada Ltd. Environmental Research Monograph 1978-6.

Syncrude. 1985. A Study of Aquatic Environments in the Syncrude Development Area, 1984. Prepared by R.L.&L. Environmental Services Ltd. and A.A. Aquatic Research Ltd. for Syncrude Canada Ltd. Environmental Research Monograph 1985-3.

TERA (TERA Environmental Consultants (Alta.) Ltd.). 2000. Fish Population and Riverine Habitat Inventories of Proposed Watercourse Crossings in the Green Area. Prepared for Colt Engineering Corp.

Tripp, D.B., and P.J. McCart. 1979a. Investigations of the Spring Spawning Fish Populations in the Athabasca and Clearwater Rivers Upstream from Fort

McMurray: Volume I. Prepared for the Oil Sands Environmental Research Program. AOSERP Report 84.

Tripp, D.B., and P.J. McCart. 1979b. Investigations of the Spring Spawning Fish Populations in the Athabasca and Clearwater Rivers Upstream of Fort McMurray: Volume II. Prepared for the Oil Sands Environmental Research Program. AOSERP Project WS 1.6.1.

Tripp, D.B., and P.T.P. Tsui. 1980a. Fisheries and Habitat Investigations of Tributary Streams in the Southern Portion of the AOSERP Study Area, Volume I: Summary and Conclusions. Prepared for the Oil Sands Environmental Research Program. AOSERP Report 92.

Tripp, D.B., and P.T.P. Tsui. 1980b. Fisheries and Habitat Investigations of Tributary Streams in the Southern Portion of the AOSERP Study Area, Volume II. Prepared for the Oil Sands Environmental Research Program. AOSERP Project WS 1.6.2.

Van Meer, T. 1990. Fisheries Impact Assessment Program; Lower Beaver and Bridge Creeks – 1990. Syncrude Canada Ltd. Environment Division.

Van Meer, T. 1993. Fisheries Monitoring and Assessment Program, MacKay River – 1992. Syncrude Canada Ltd., Environmental Division.

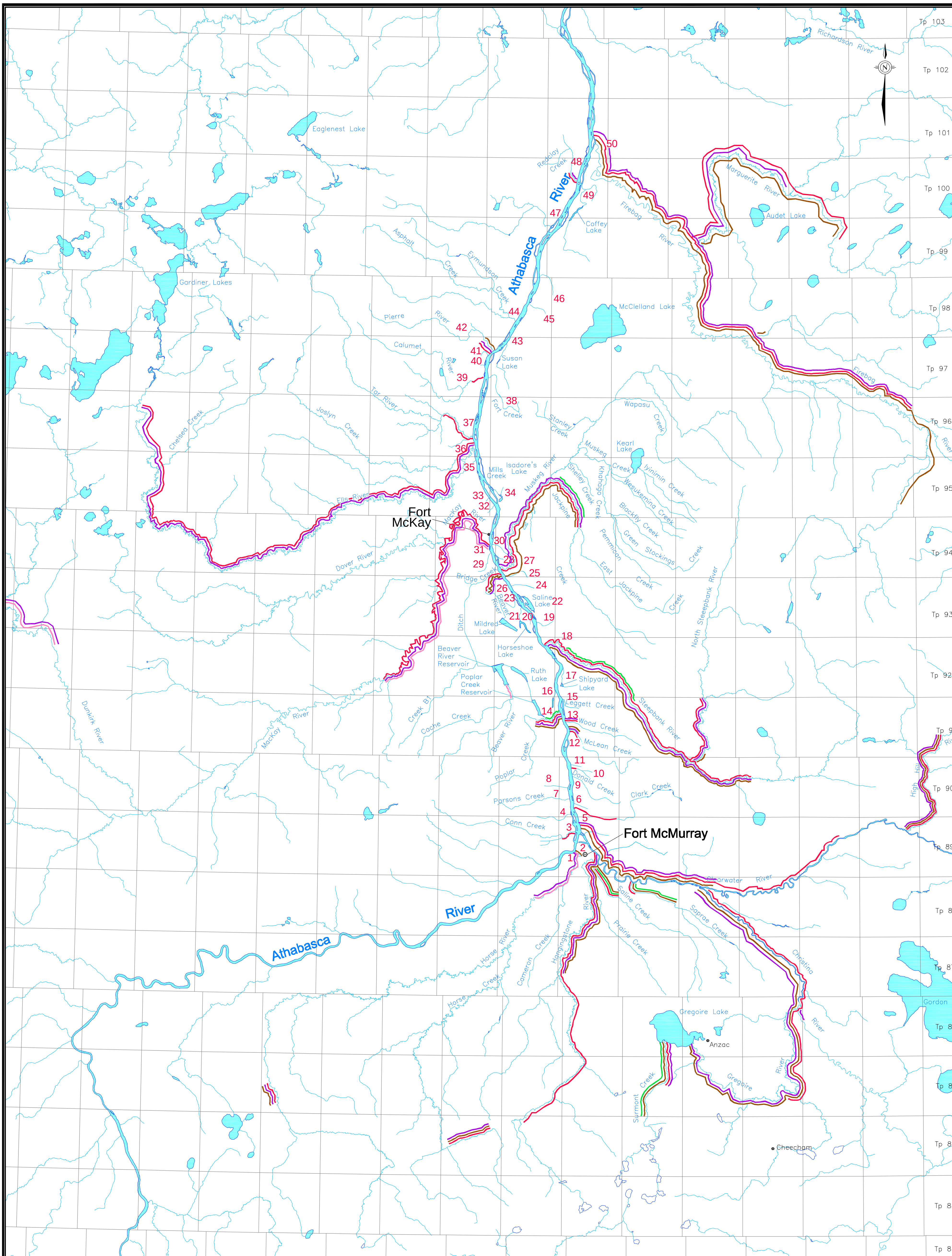
Walder, G.L., P.L. Strankman, E.B. Watton, and K.A. Bruce. 1980. Aquatic Biophysical Inventory of Major Tributaries in the AOSERP Study Area: Volume II, Atlas. Prepared for the Oil Sands Environmental Research Program by LGL Limited, Environmental Research Associates. AOSERP Project WS 3.4.

Wallace, R.R., and P.J. McCart. 1984. The Fish and Fisheries of the Athabasca River Basin – Their Status and Environmental Requirements. Prepared for Alberta Environment Planning Division.

Webb (R. Webb Environmental Services Ltd.). 1980. Lake and Pond Fisheries Survey, Alsands Project Area. Prepared for Alsands Project Group, Calgary.

APPENDIX I

FISH SPECIES DISTRIBUTION MAPS FOR TRIBUTARIES TO THE ATHABASCA RIVER – LARGE-BODIED SPECIES (BY LIFE STAGE)



ARCTIC GRAYLING DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15
SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT: RAMP

TITLE: **ARCTIC GRAYLING DISTRIBUTION MAP**

Golder Associates, Calgary, Alberta

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DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	18/02/04		
CHECK	CB	19/02/04	**FIGURE: I-1**	
REVIEW	CB	19/02/04		

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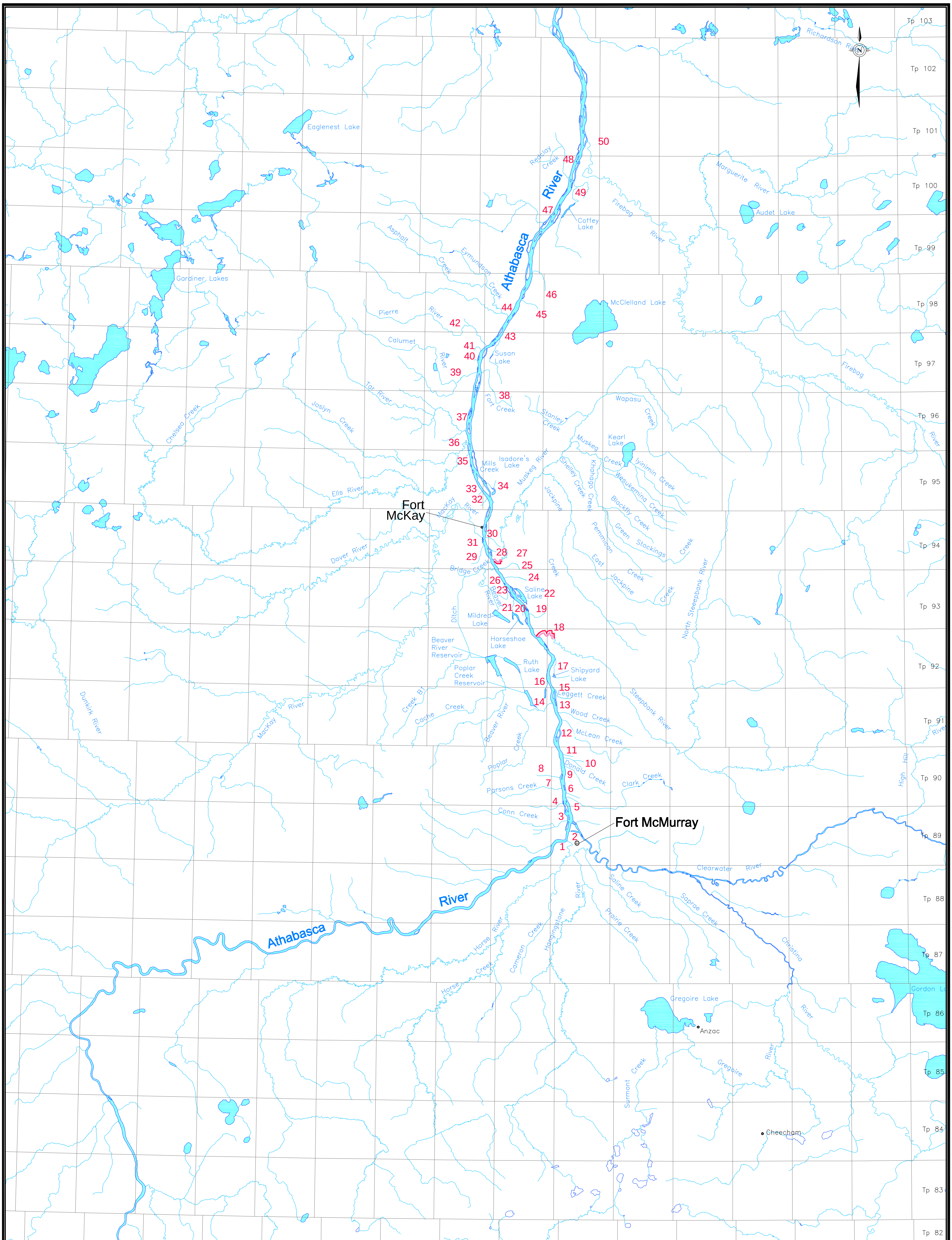

15 0 15
SCALE KILOMETRES

BULL TROUT DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

BULL TROUT DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	DLVR
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	**FIGURE: I-2**	
REVIEW	CB	19/02/04		

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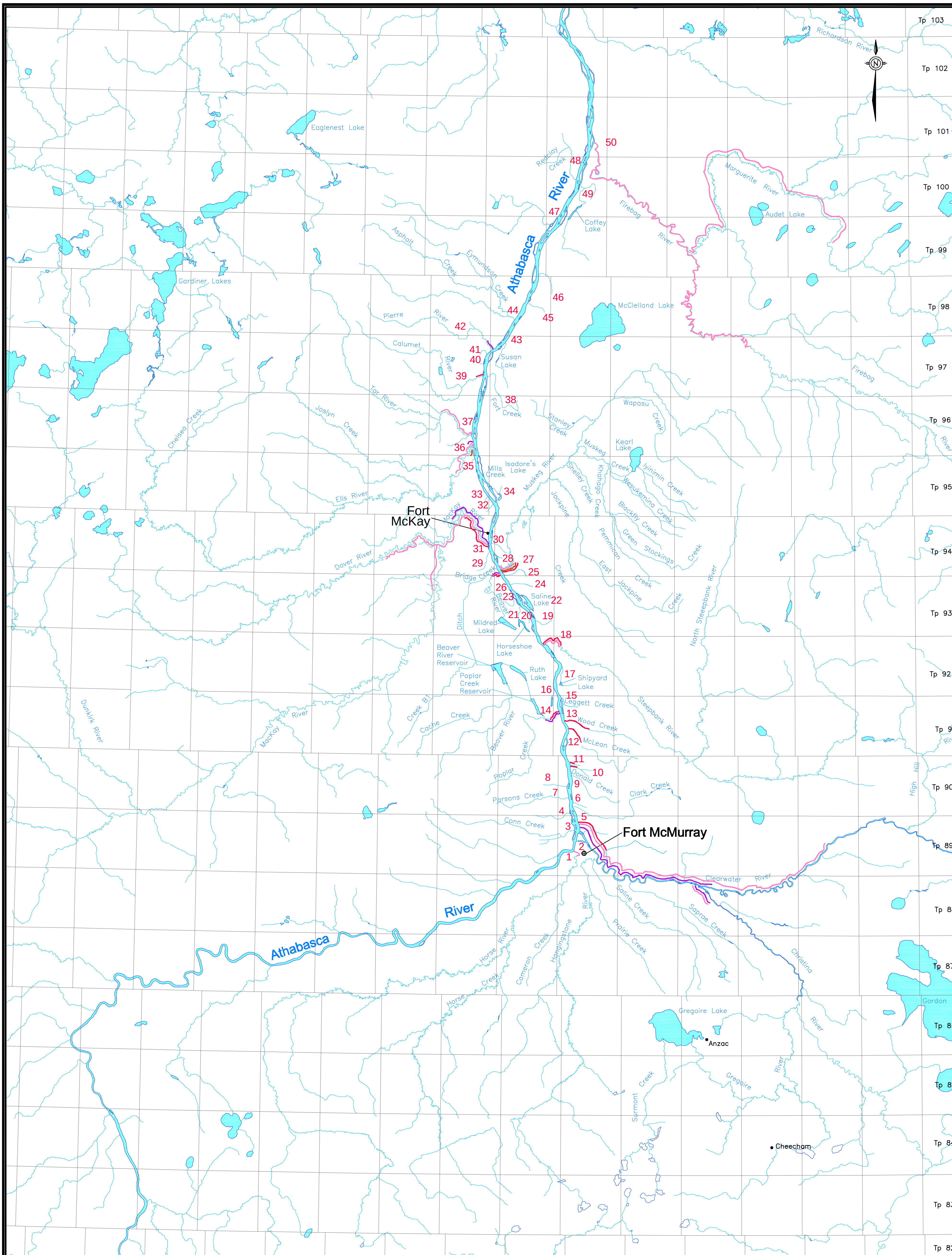


BURBOT DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

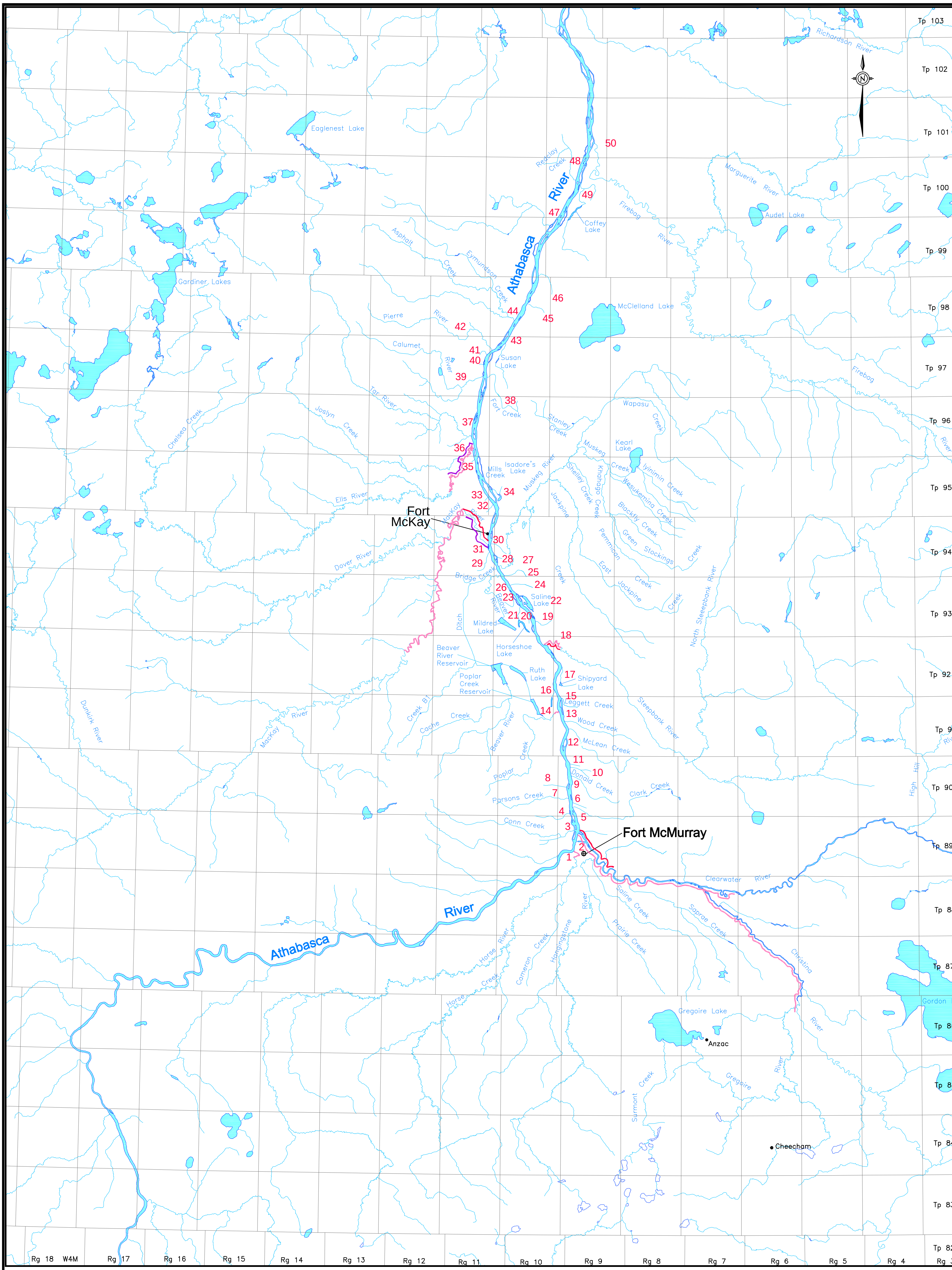
RAMP

TITLE

BURBOT DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Burbot
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	10/02/04	FIGURE: I-3	
REVIEW	CB	19/02/04		



GOLDEYE DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15
SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

GOLDEYE DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Goldeye
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: I-4	
REVIEW	CB	19/02/04		

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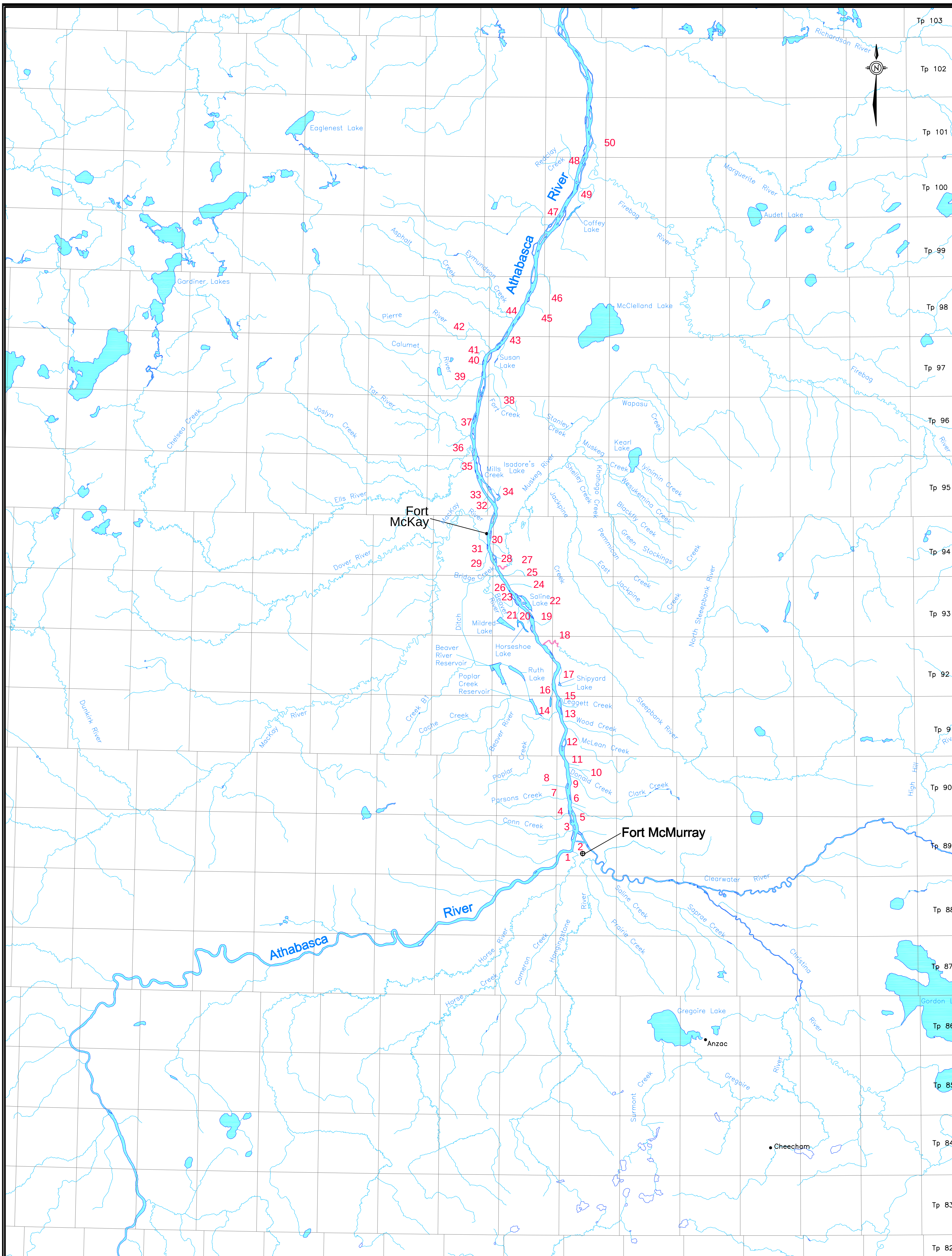


LAKE CISCOE DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15
SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

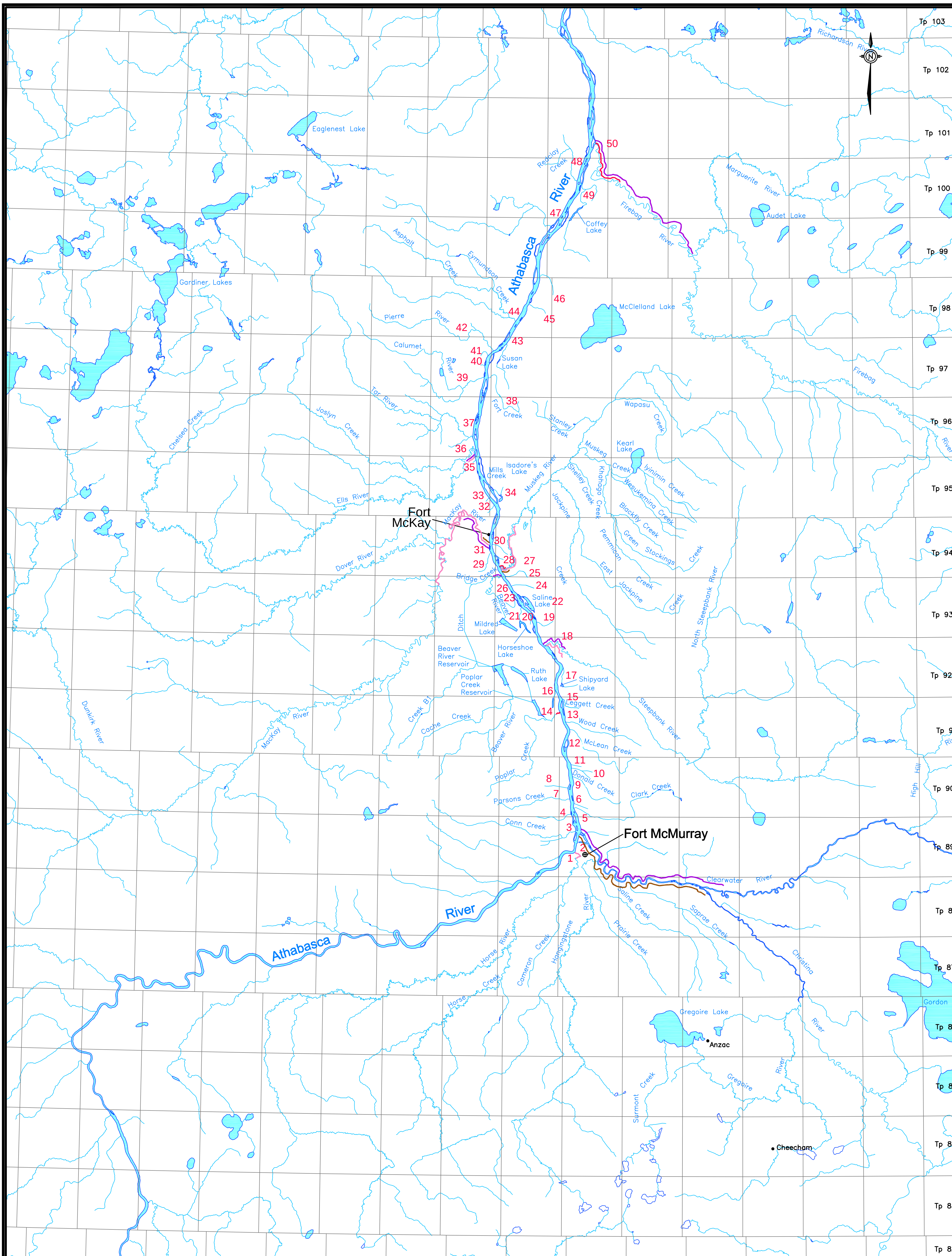
RAMP

TITLE

LAKE CISCOE DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Ciscoe
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	13/02/04		
CHECK	CB	19/02/04	FIGURE: I-5	
REVIEW	CB	19/02/04		



LAKE WHITEFISH

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

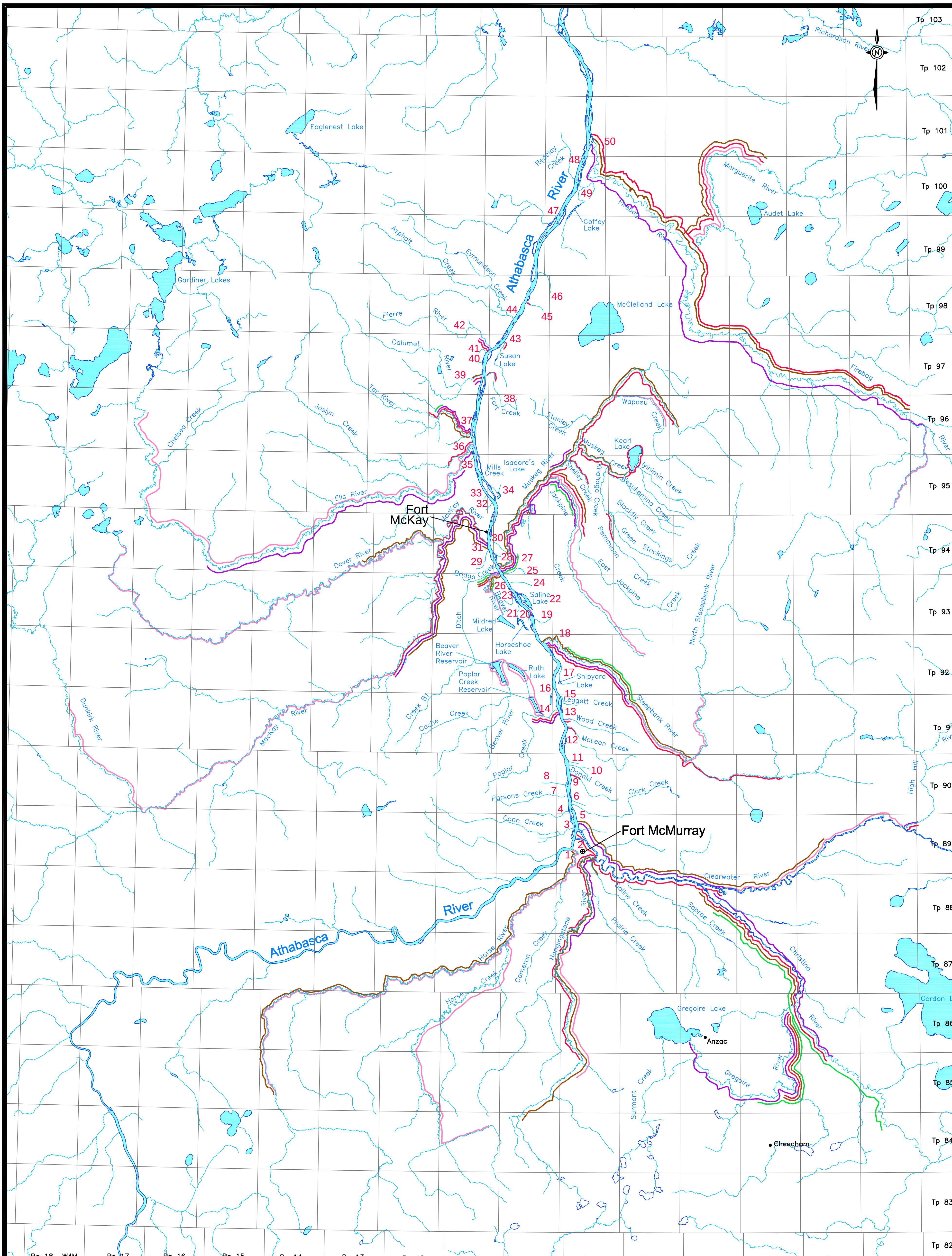
RAMP

TITLE

LAKE WHITEFISH DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Lake Whitefish
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	10/02/04	FIGURE: I-6	
REVIEW	CB	19/02/04		



LONGNOSE SUCKER DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

15 0 15
SCALE KILOMETRES

PROJECT

RAMP

TITLE

LONGNOSE SUCKER DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04–1335–001.1000	FILE No.	Longnose Sucker
DESIGN	CJS	01/01/02	SCALE AS SHOWN REV. 1
CADD	CJS	12/02/04	
CHECK	CB	23/02/04	FIGURE: I-7
REVIEW	CB	23/02/04	

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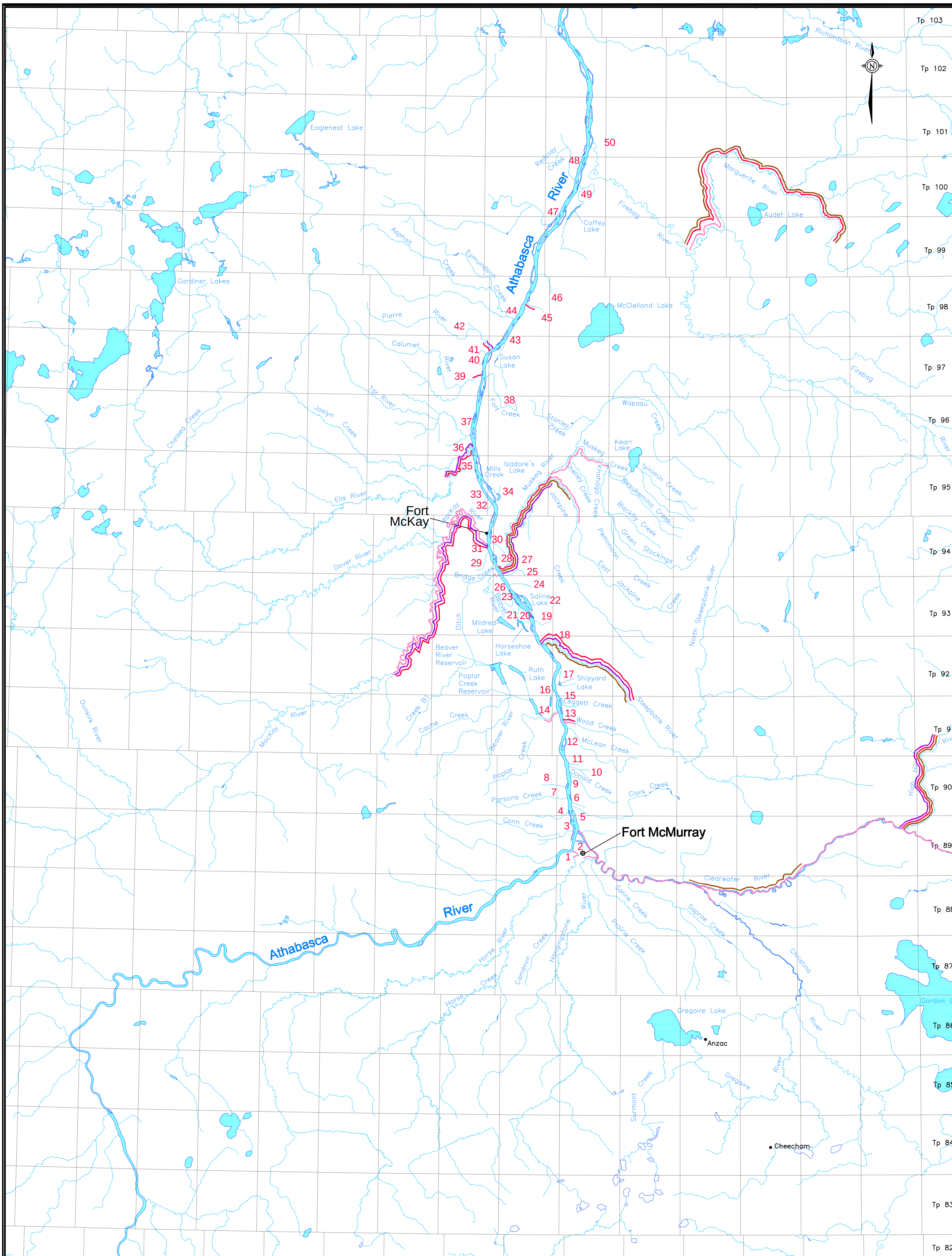

15 0 15
SCALE KILOMETRES

MOUNTAIN WHITEFISH DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

MOUNTAIN WHITEFISH DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000	
DESIGN	CJS	01/01/02
CADD	CJS	12/02/04
CHECK	CB	19/02/04
REVIEW	CB	19/02/04

FILE No. Mountain Whitefish
SCALE AS SHOWN REV. 1

FIGURE: I-8

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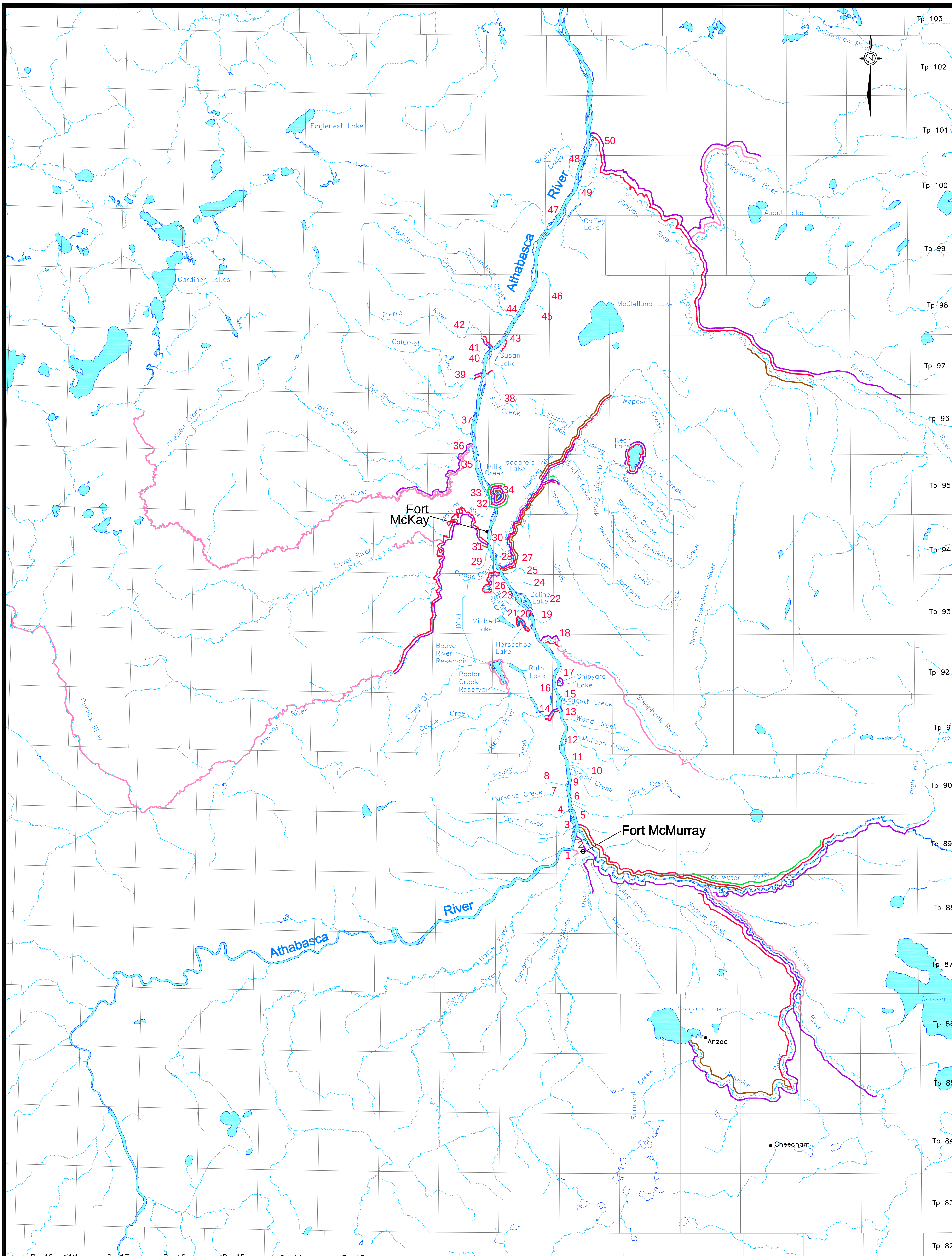


NORTHERN PIKE DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15
SCALE KILOMETRES

REFERENCE

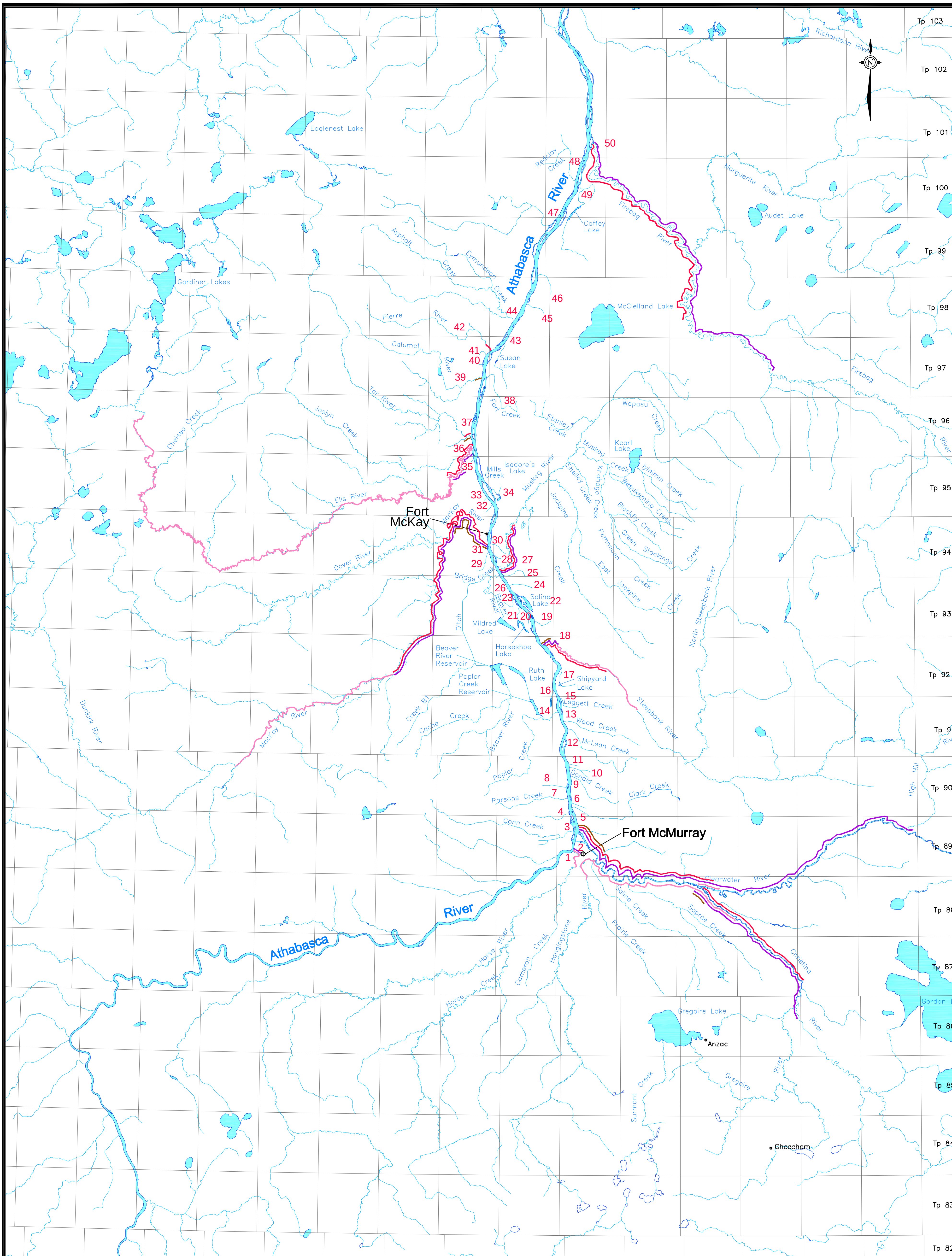
ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT: RAMP

TITLE: **NORTHERN PIKE DISTRIBUTION MAP**

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Northern Pike
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	02/12/04		
CHECK	CB	19/02/04	FIGURE: I-9	
REVIEW	CB	19/02/04		



WALLEYE DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

WALLEYE
DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Walleye
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	02/12/04	FIGURE: I-10	
CHECK	CB	19/02/04		
REVIEW	CB	19/02/04		

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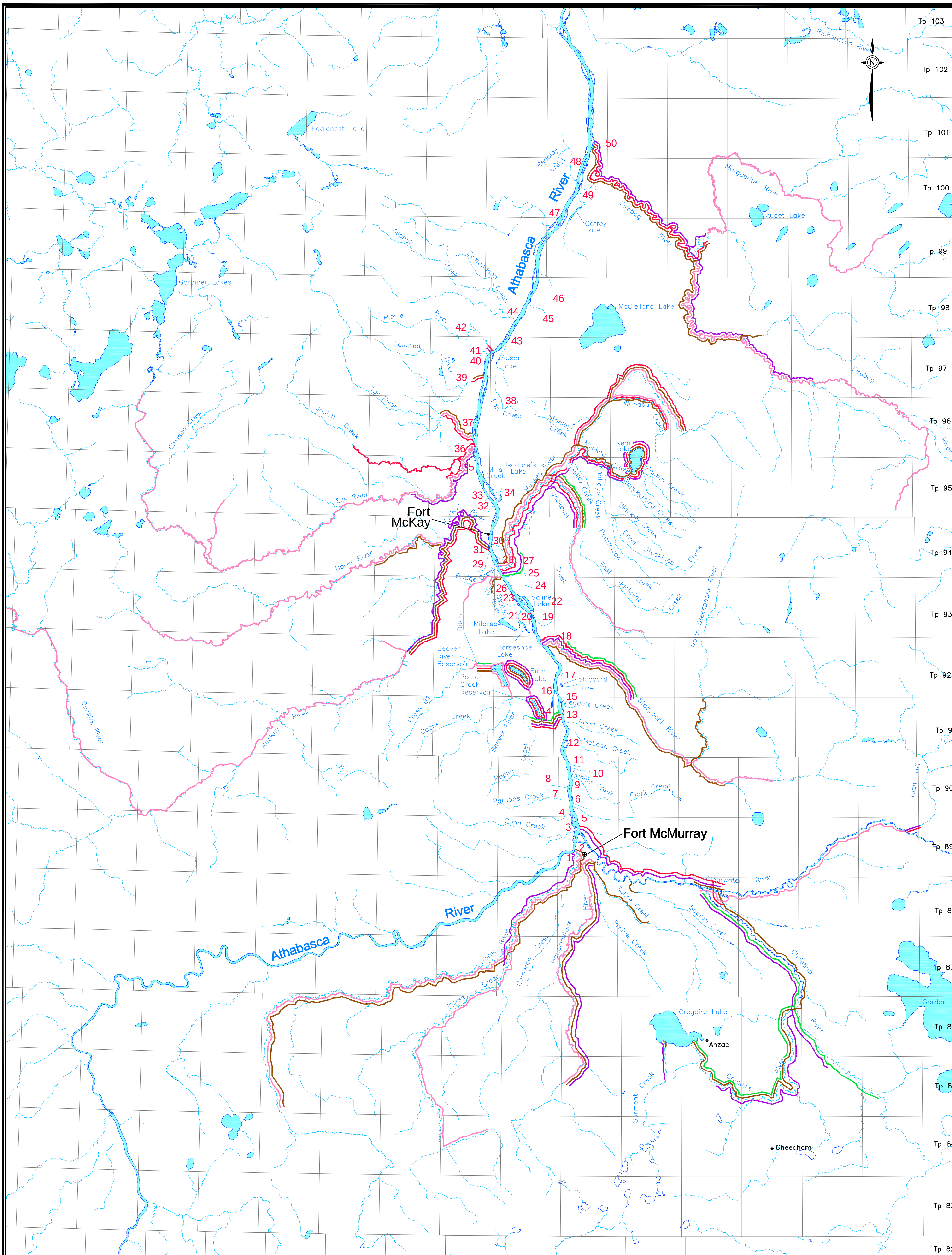

WHITE SUCKER DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15
SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

WHITE SUCKER DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	White Sucker
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	GMF	12/02/04	**FIGURE: I-11**	
CHECK	CB	23/02/04		
REVIEW	CB	23/02/04		

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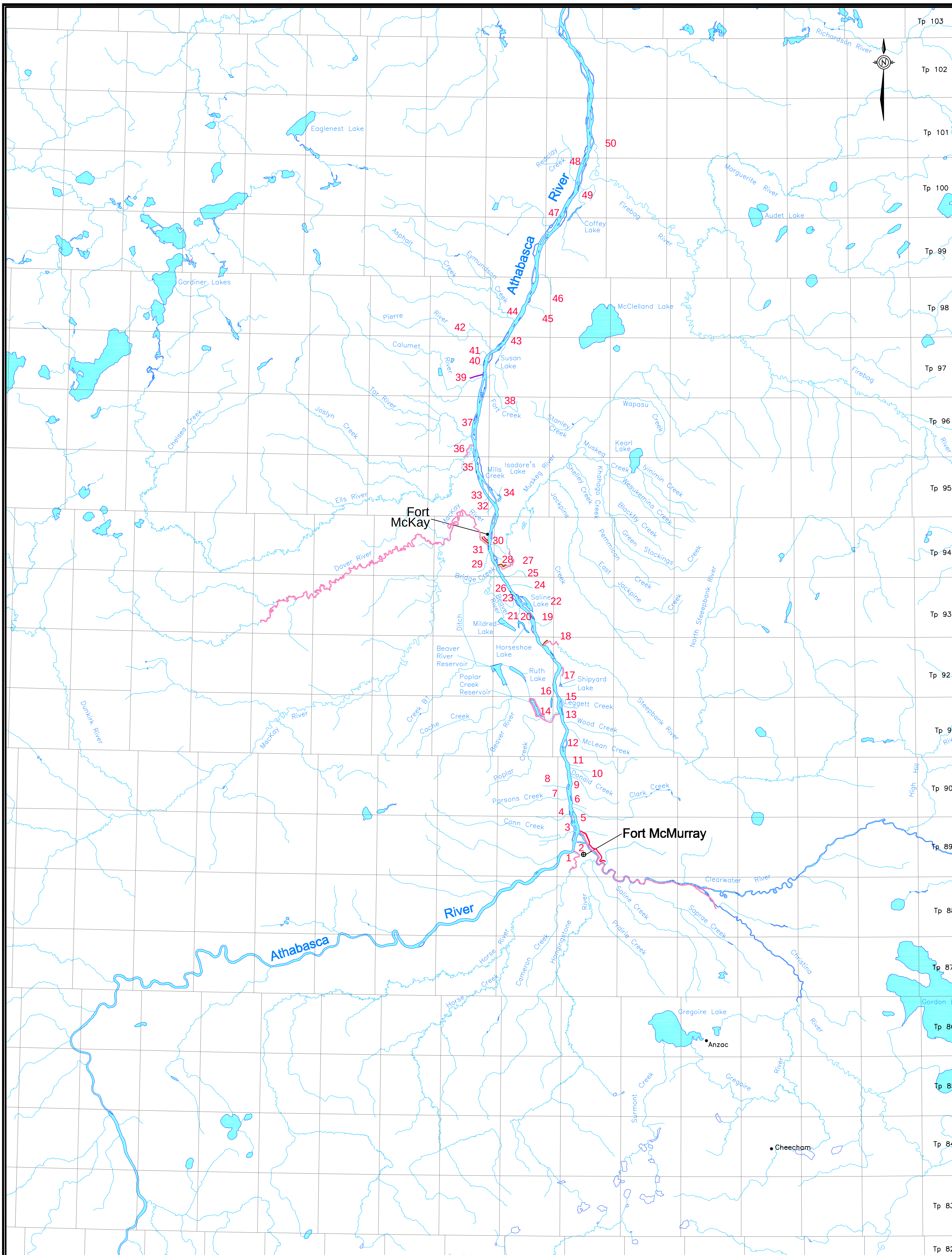

YELLOW PERCH DISTRIBUTION

- FRY
- JUVENILE
- ADULT
- SPAWNING
- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

YELLOW PERCH DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No. YLPR
DESIGN	CJS	01/01/02	SCALE AS SHOWN REV. 1
CADD	JAM	24/02/04	FIGURE: I-12
CHECK	CB	24/02/04	
REVIEW	CB	24/02/04	

APPENDIX II

FISH SPECIES DISTRIBUTION MAPS FOR TRIBUTARIES TO THE ATHABASCA RIVER – SMALL-BODIED SPECIES

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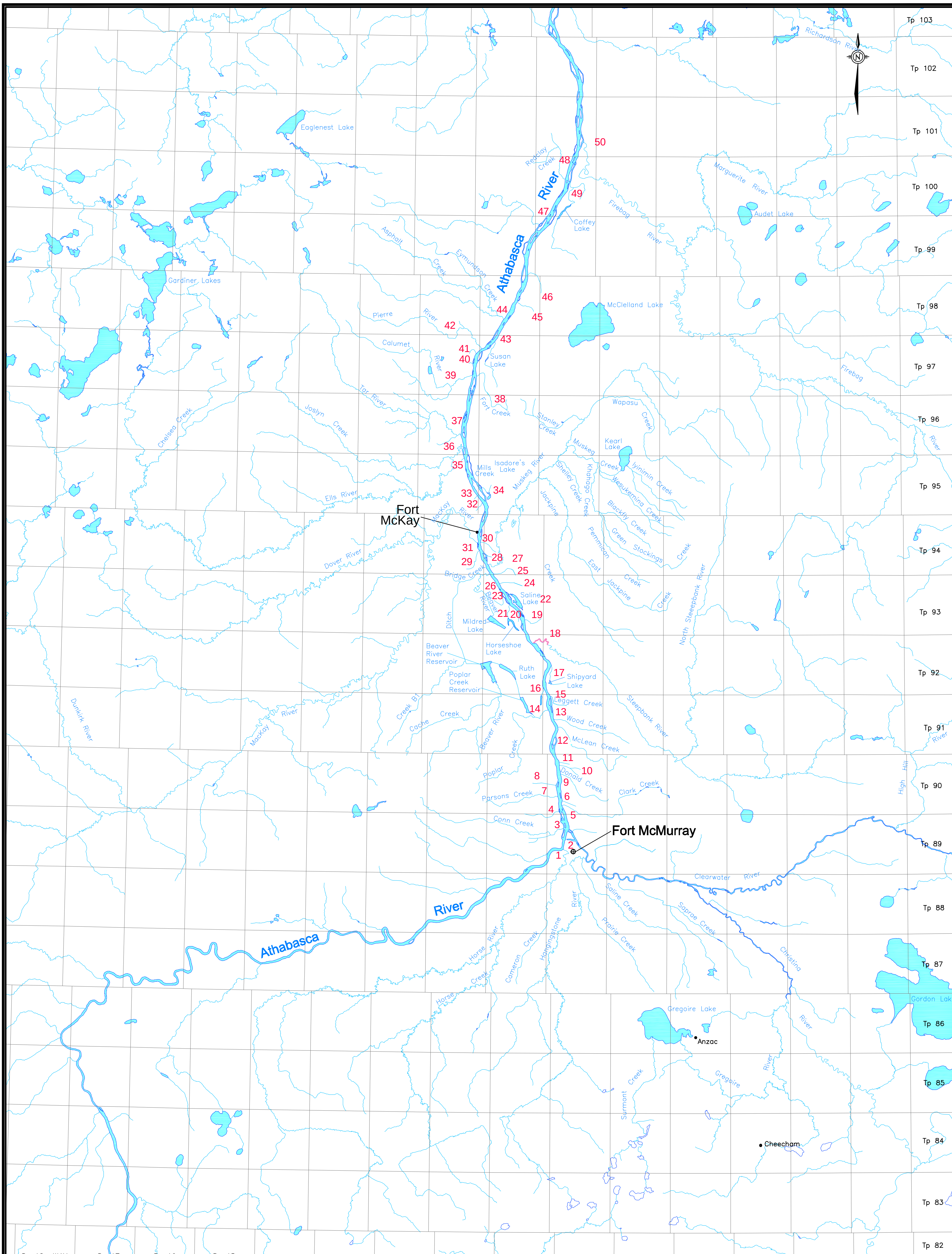

BRASSY MINNOW DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

PROJECT

RAMP

TITLE

BRASSY MINNOW DISTRIBUTION MAP

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	BRMN
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	02/12/04		
CHECK	CB	19/02/04	**FIGURE: II-1**	
REVIEW	CB	19/02/04		

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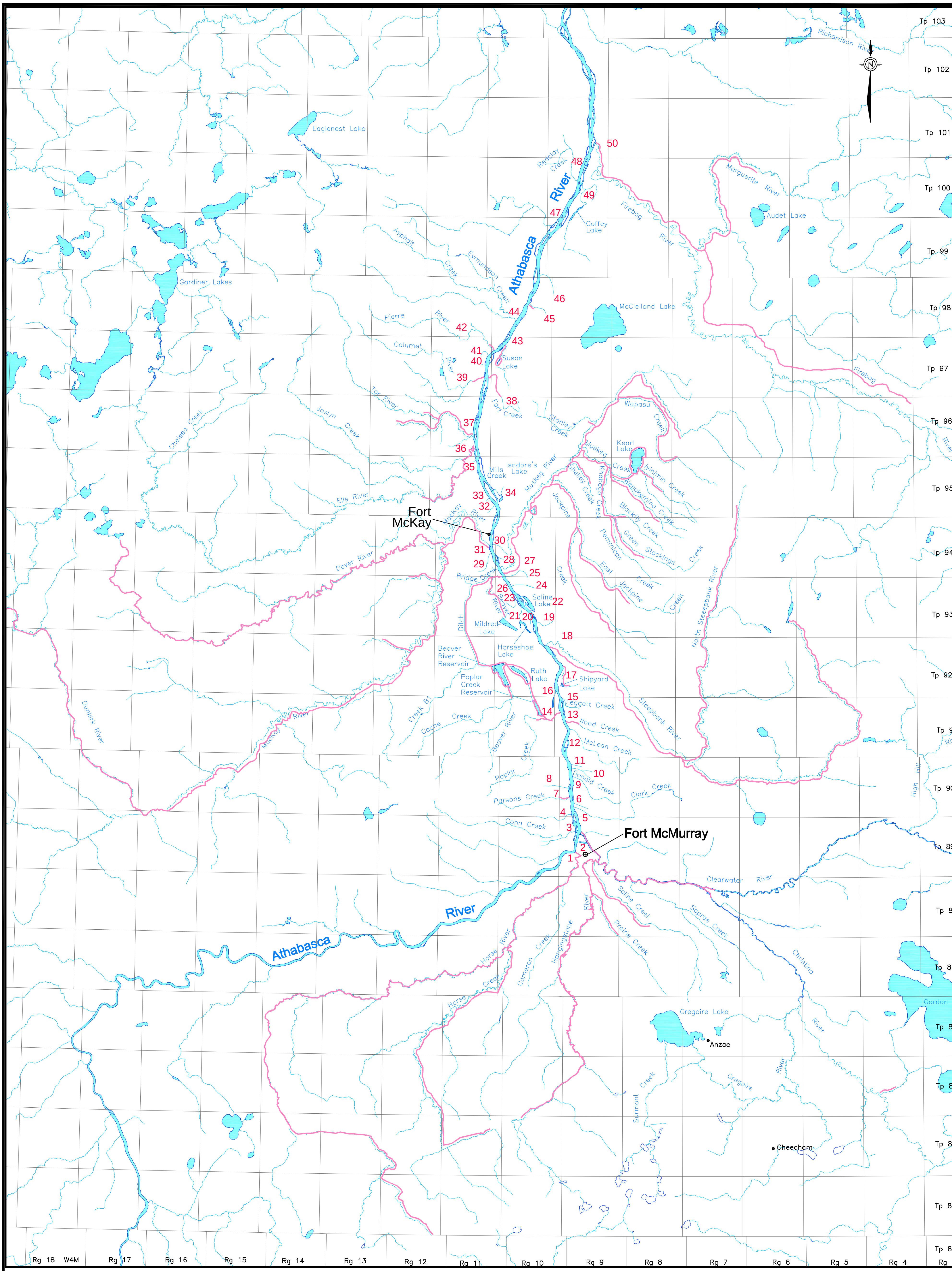


BROOK STICKLEBACK DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

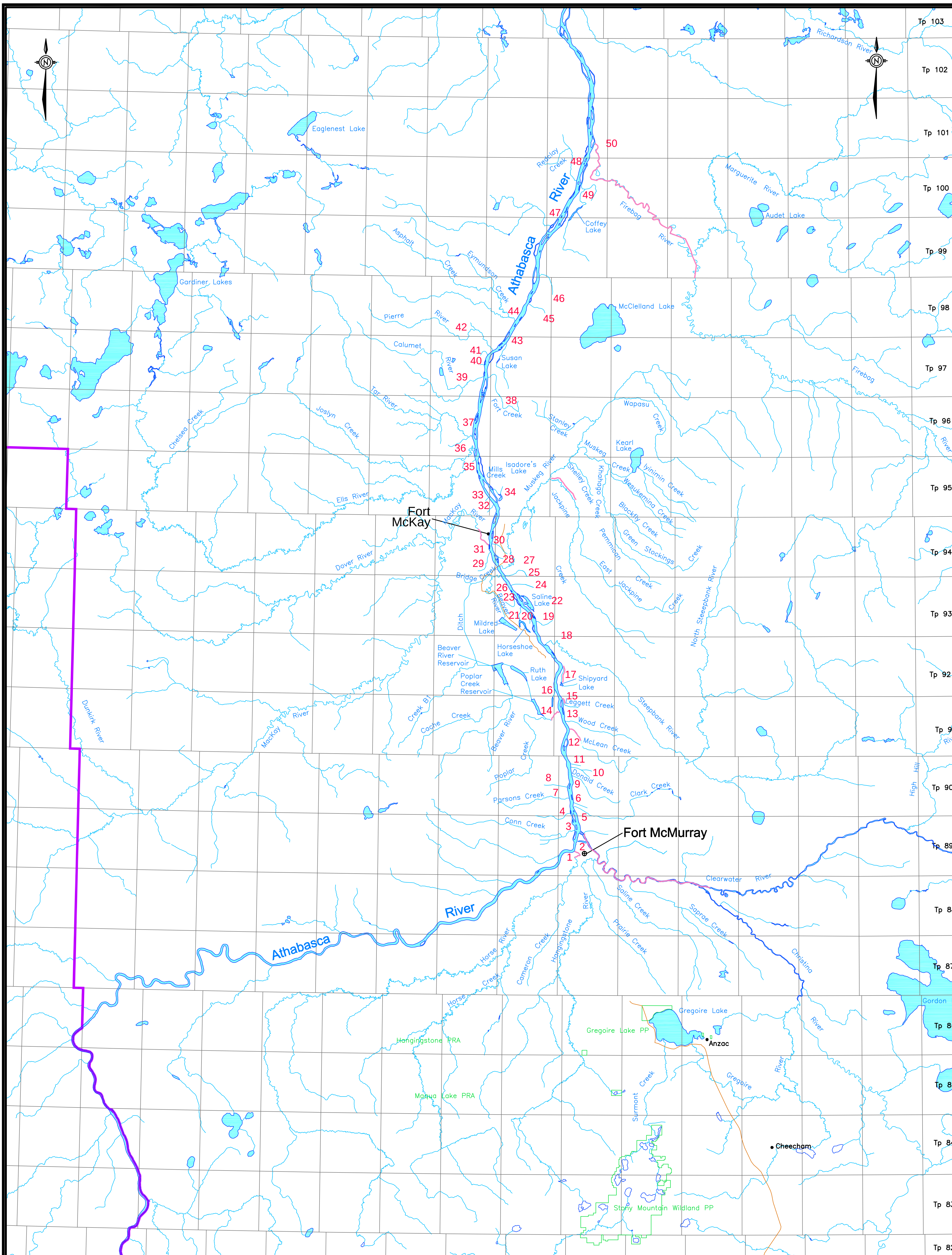
TITLE

BROOK STICKLEBACK DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000	FILE No.	Brook Stickleback	
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	02/12/04		
CHECK	CB	19/02/04	**FIGURE: II-2**	
REVIEW	CB	19/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: EMSH.dwg Feb 26, 2004 - 1:37pm



EMERALD SHINER DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

EMERALD SHINER DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	EMSH
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04		
REVIEW	CB	19/02/04		

FIGURE: II-3

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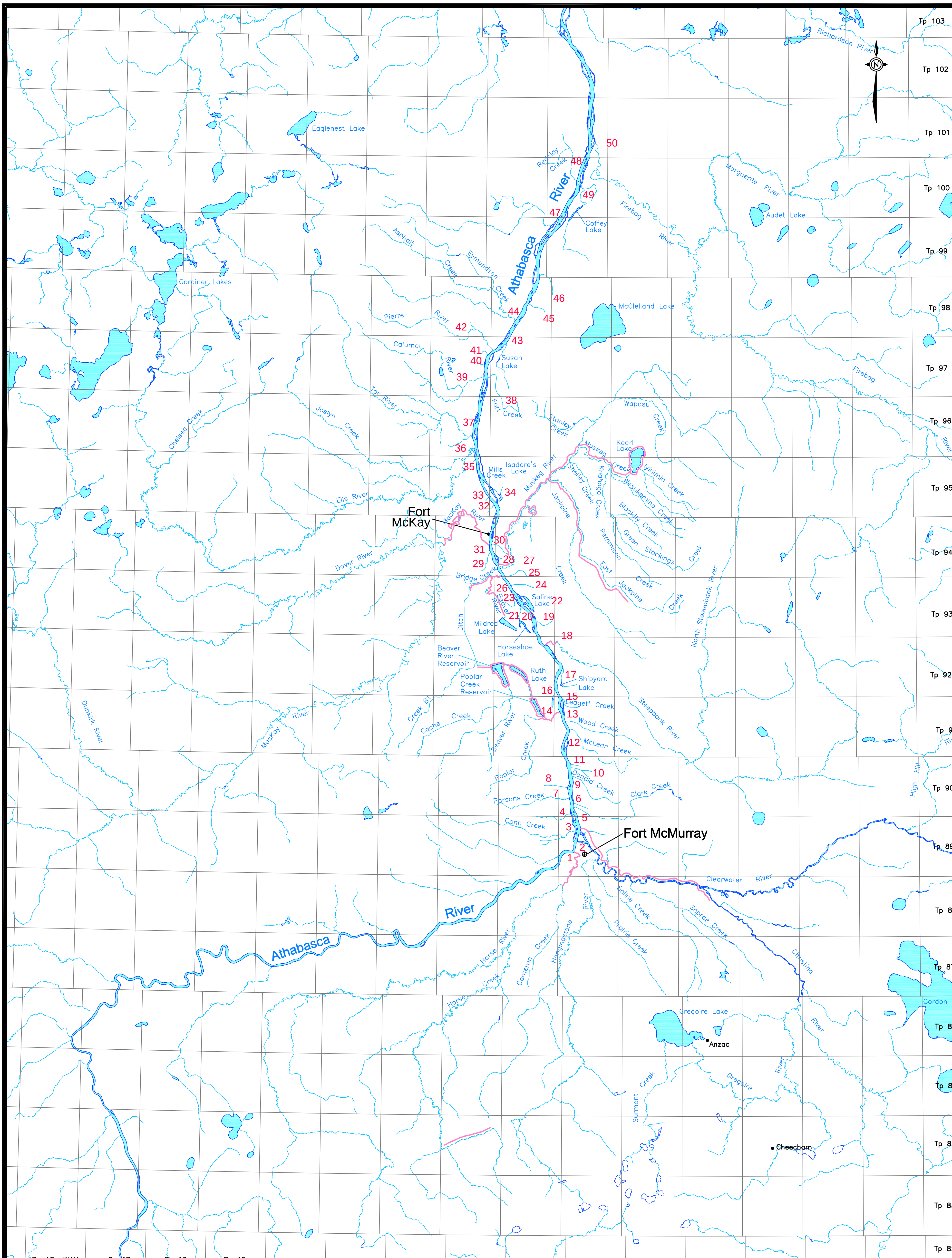

FATHEAD MINNOW DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

FATHEAD MINNOW DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04–1335–001.1000		FILE No.	FTMN
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-4	
REVIEW	CB	19/02/04		

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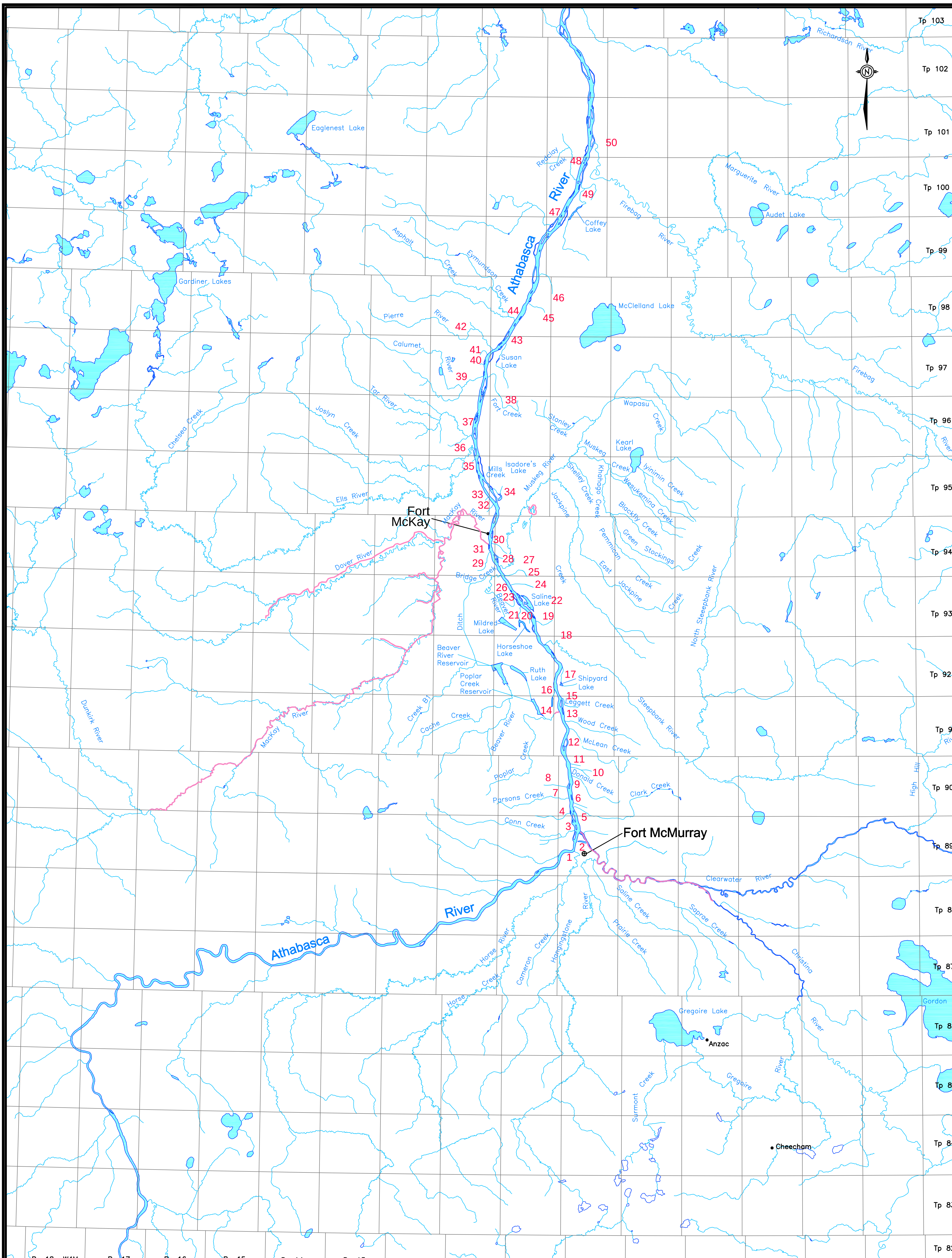


FINESCALE DACE DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

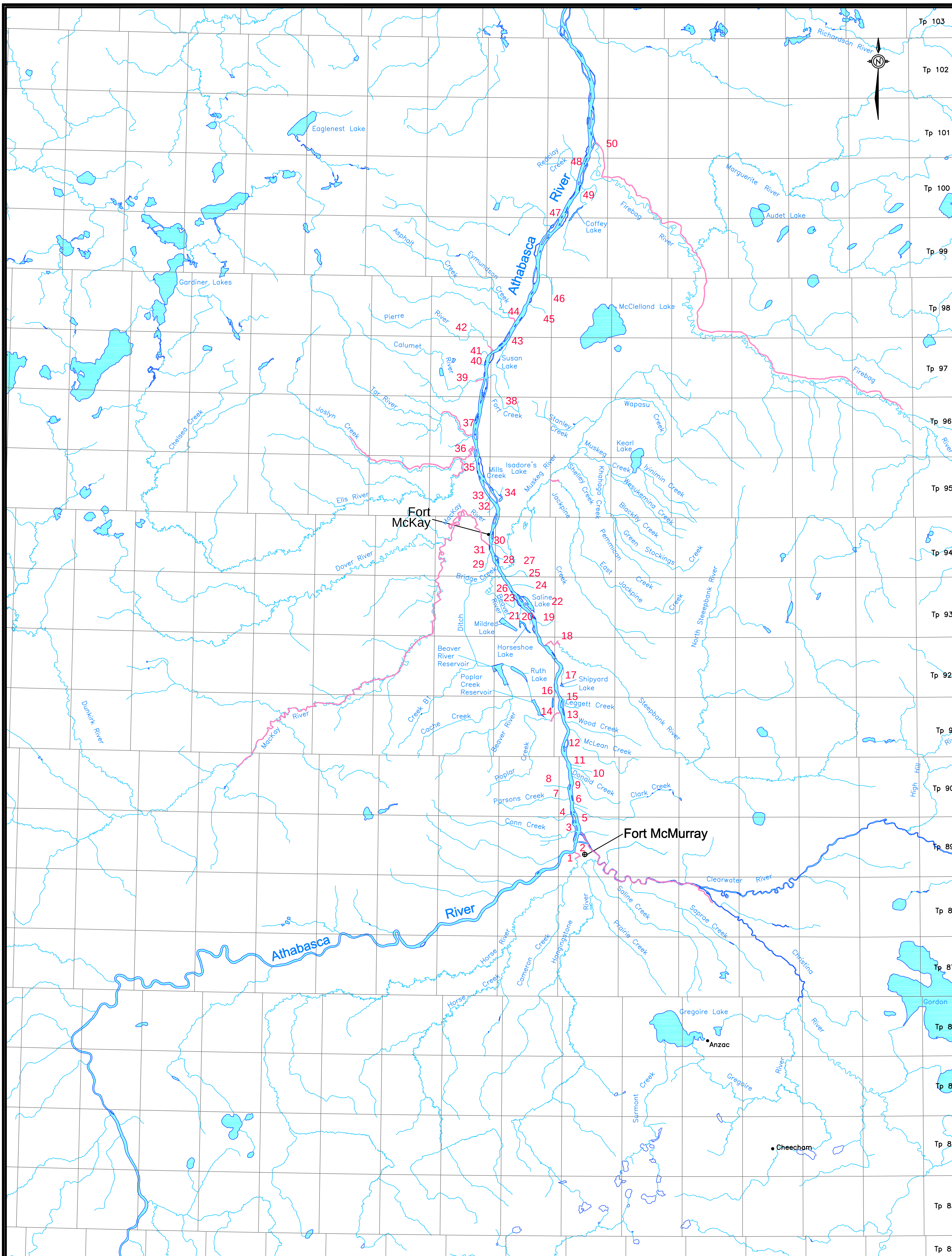
TITLE

FINESCALE DACE DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	FNDC
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-5	
REVIEW	CB	19/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: FLCH.dwg Feb 26, 2004 - 1:44pm



FLATHEAD CHUB DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

FLATHEAD CHUB DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	FLCH
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-6	
REVIEW	CB	19/02/04		

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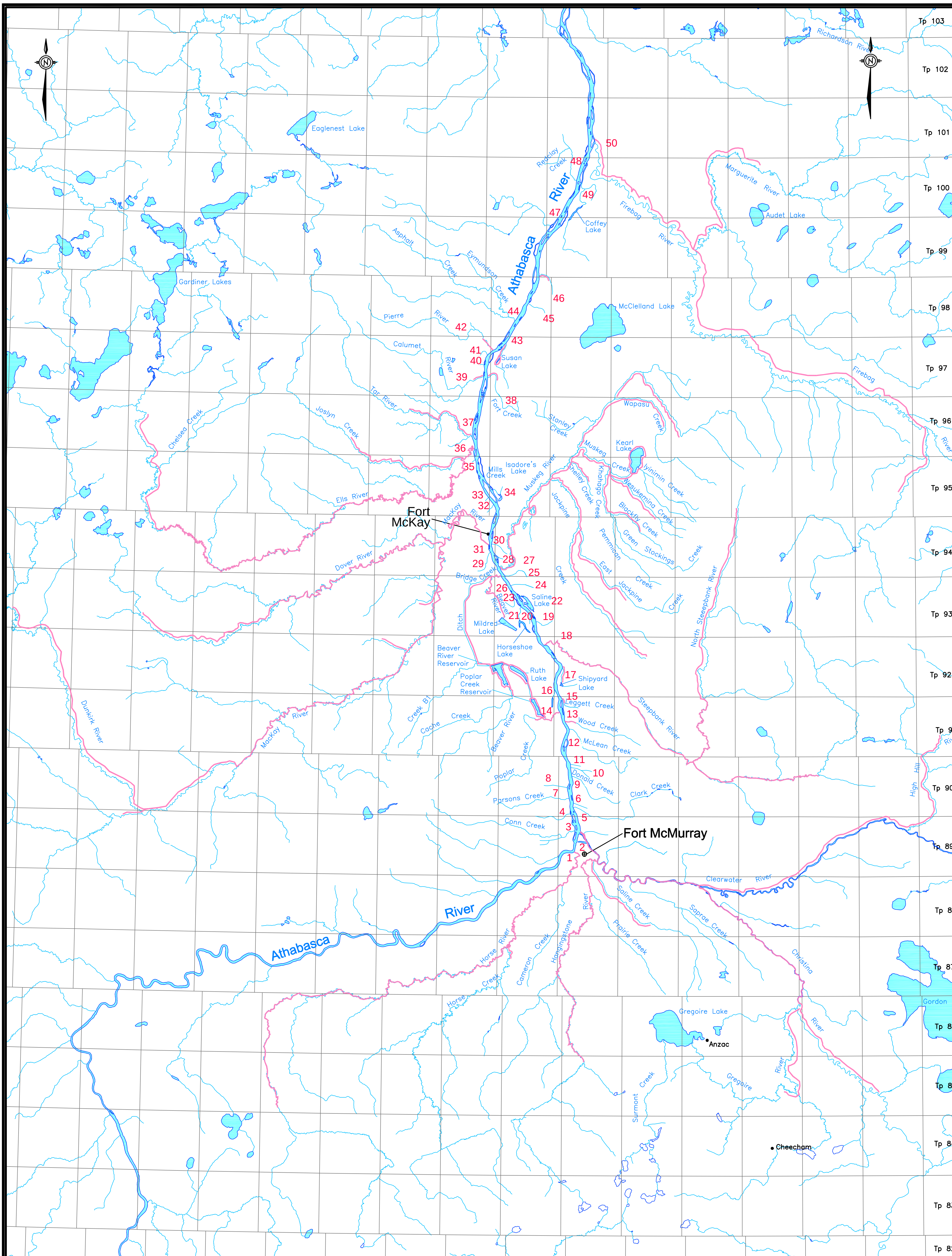

LAKE CHUB DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

LAKE CHUB DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Lake Chub
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-7	
REVIEW	CB	19/02/04		

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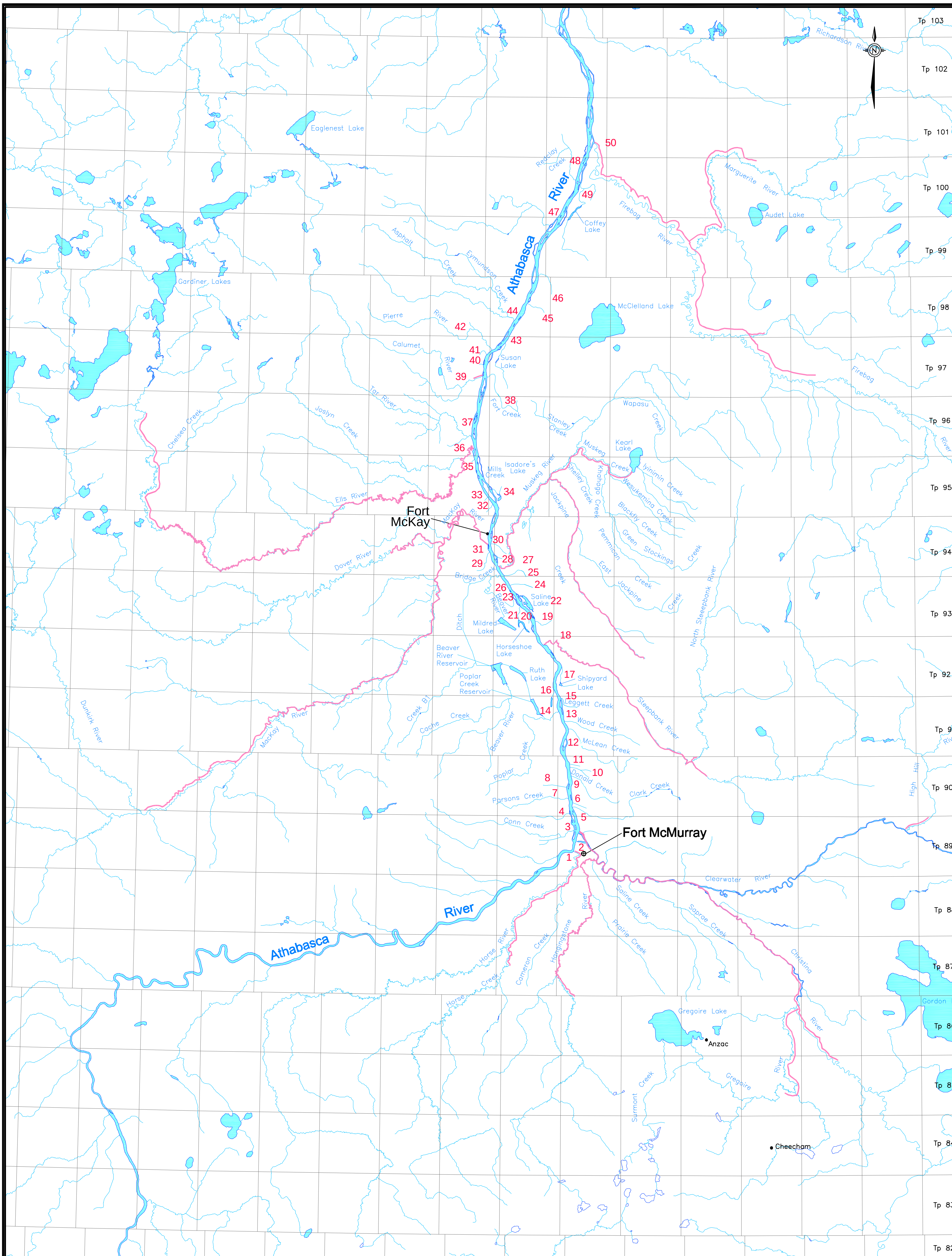

15 0 15

SCALE KILOMETRES

LONGNOSE DACE DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

LONGNOSE DACE DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	LNDC
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-8	
REVIEW	CB	19/02/04		

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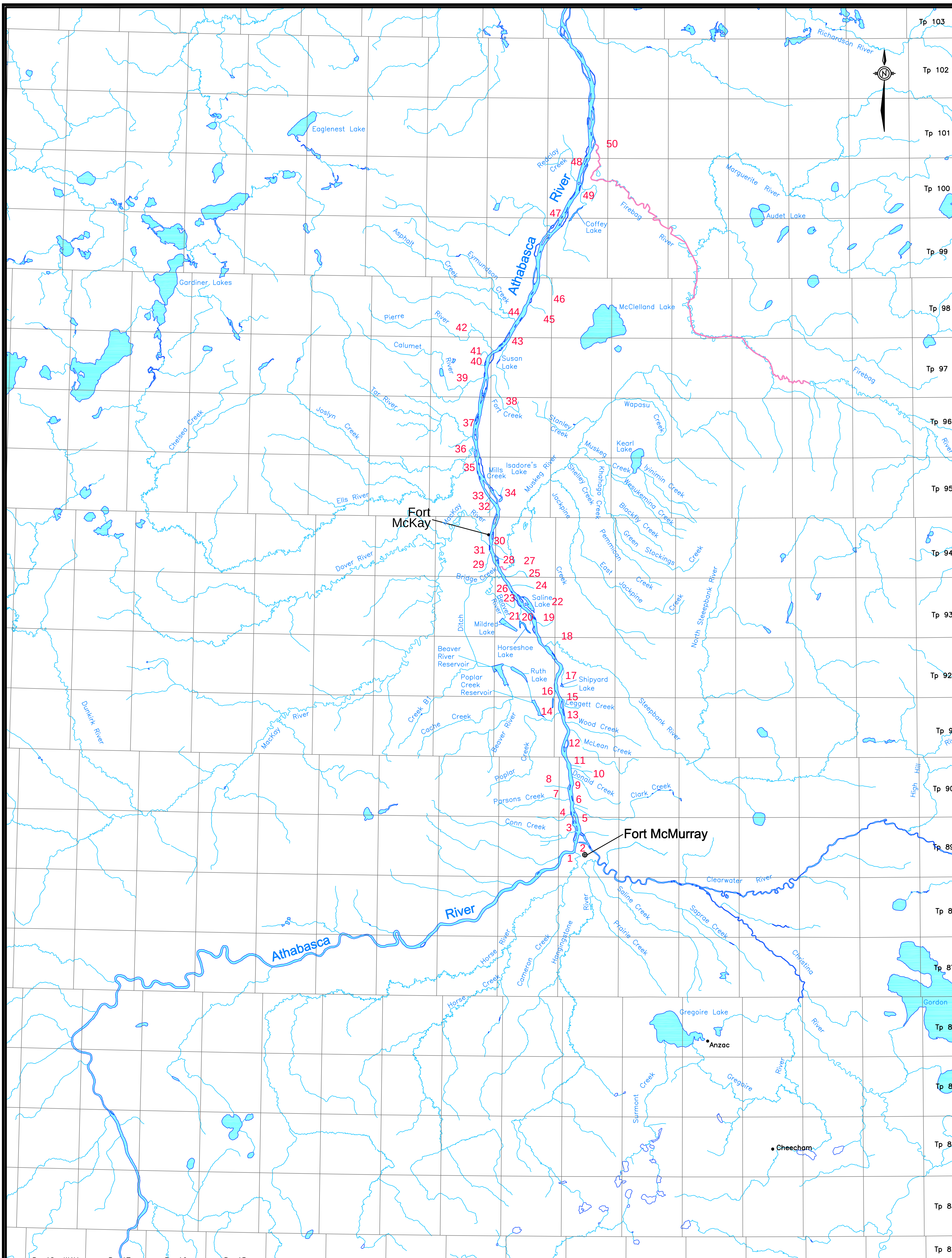


NINESPINE STICKLEBACK DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

PROJECT

RAMP

TITLE

NINESPINE STICKLEBACK DISTRIBUTION MAP

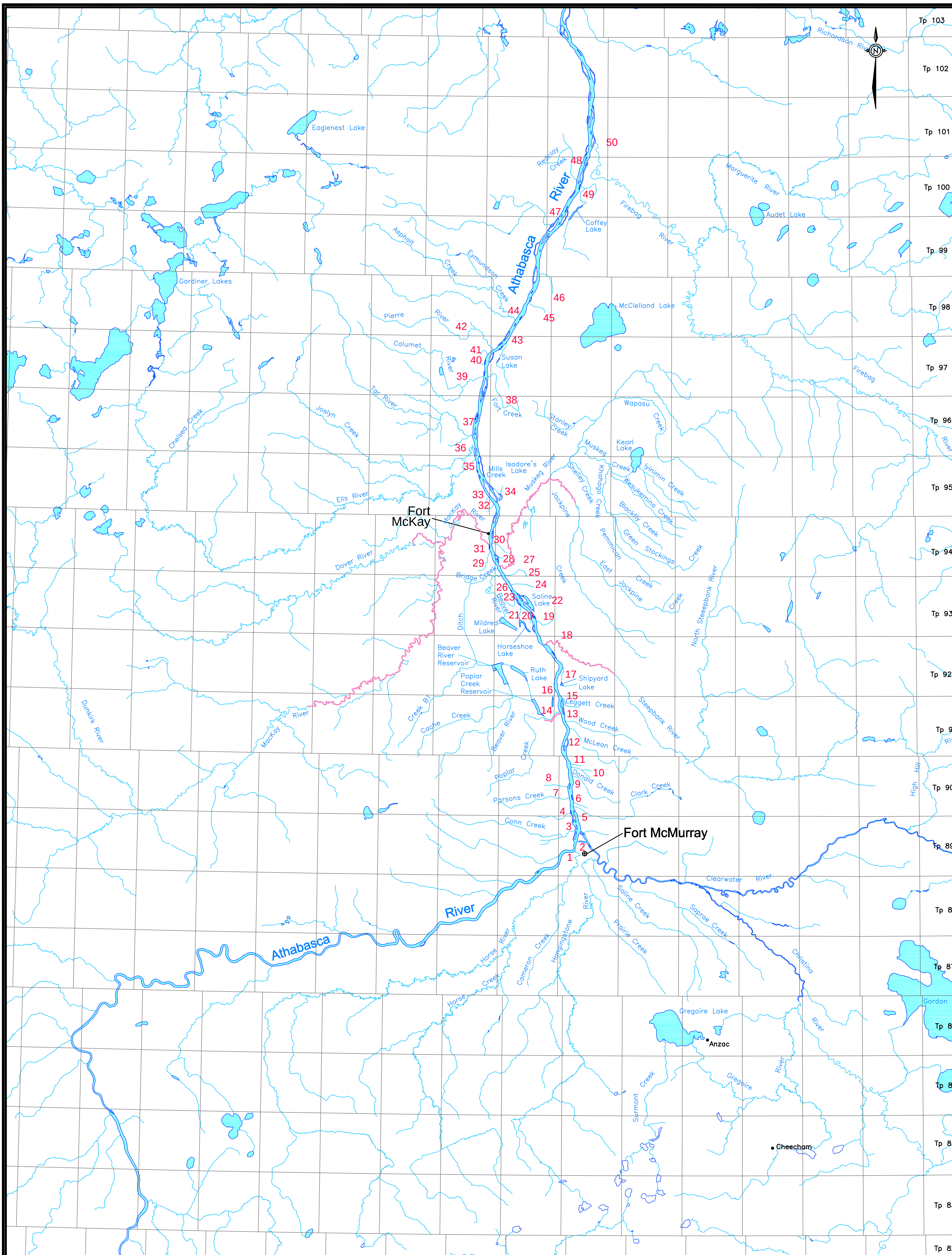
REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	NNST
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-9	
REVIEW	CB	19/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: NRDC.dwg Feb 26, 2004 - 2:00pm



NORTHERN REDBELLY DACE DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

PROJECT

RAMP

TITLE

NORTHERN REDBELLY DACE DISTRIBUTION MAP

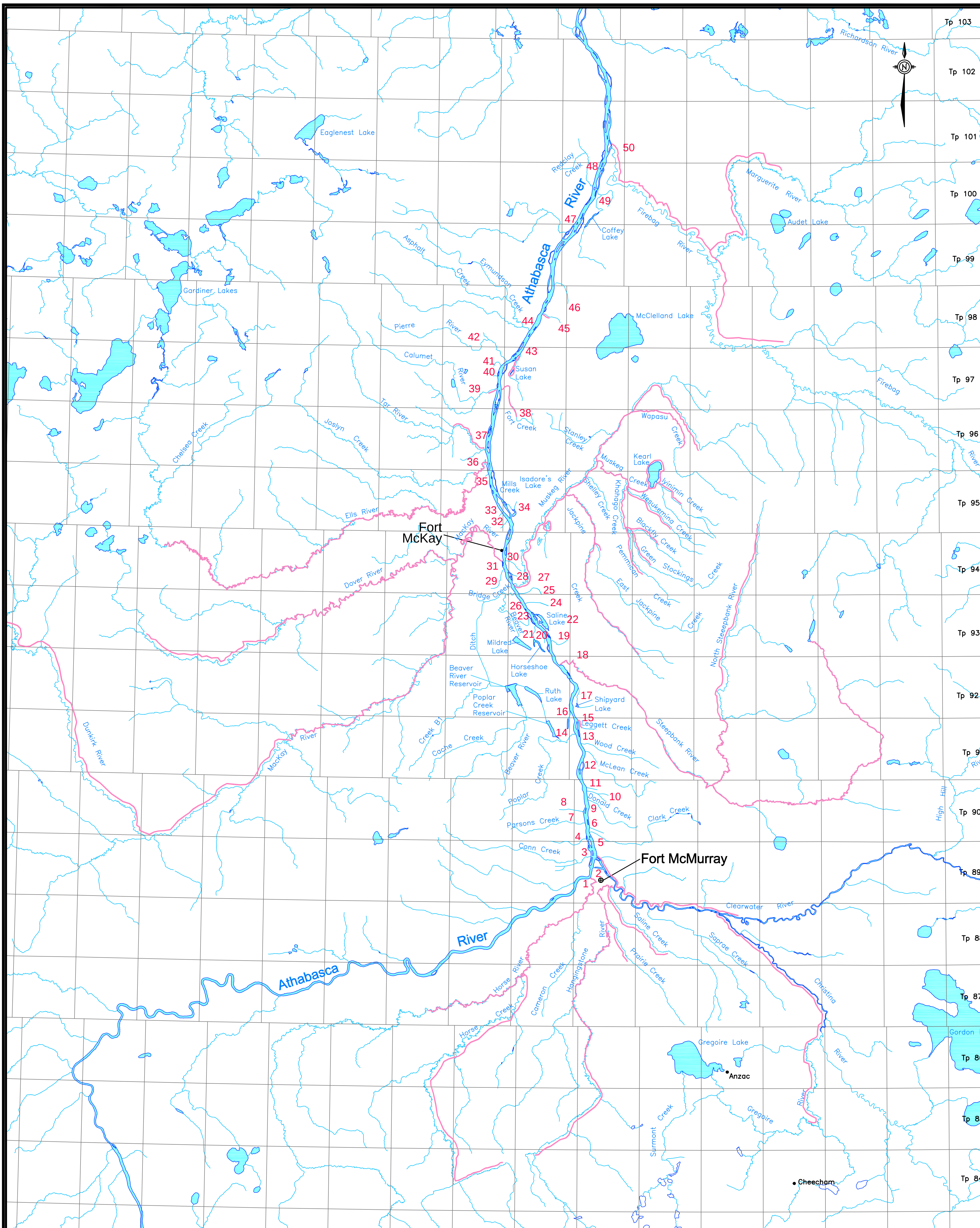
REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	NRDC
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-10	
REVIEW	CB	19/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: PRDC.dwg Feb 26, 2004 - 2:02pm



PEARL DACE DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

PROJECT

RAMP

TITLE

PEARL DACE DISTRIBUTION MAP

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	PRDC
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-11	
REVIEW	CB	19/02/04		

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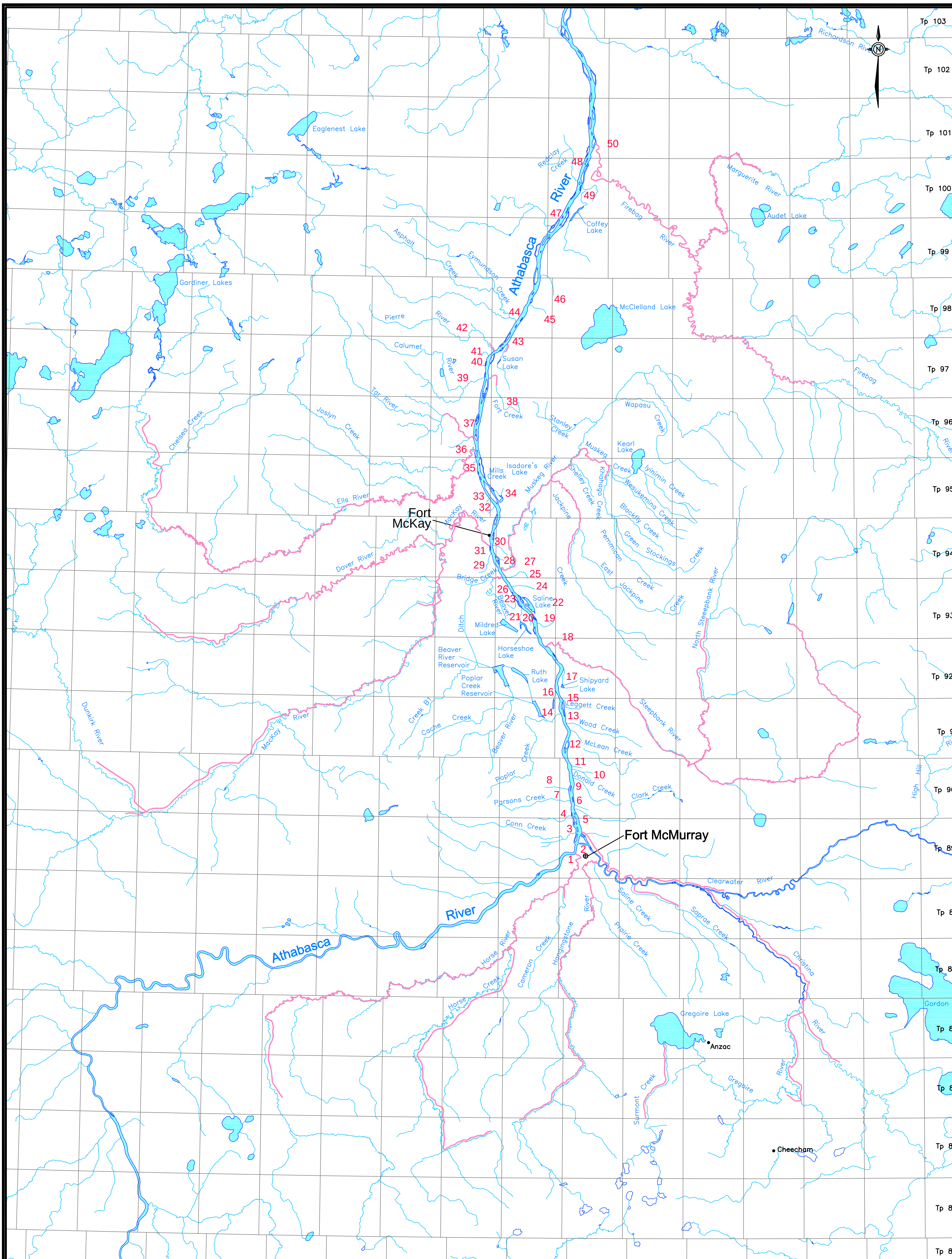


SLIMY SCULPIN DISTRIBUTION

- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

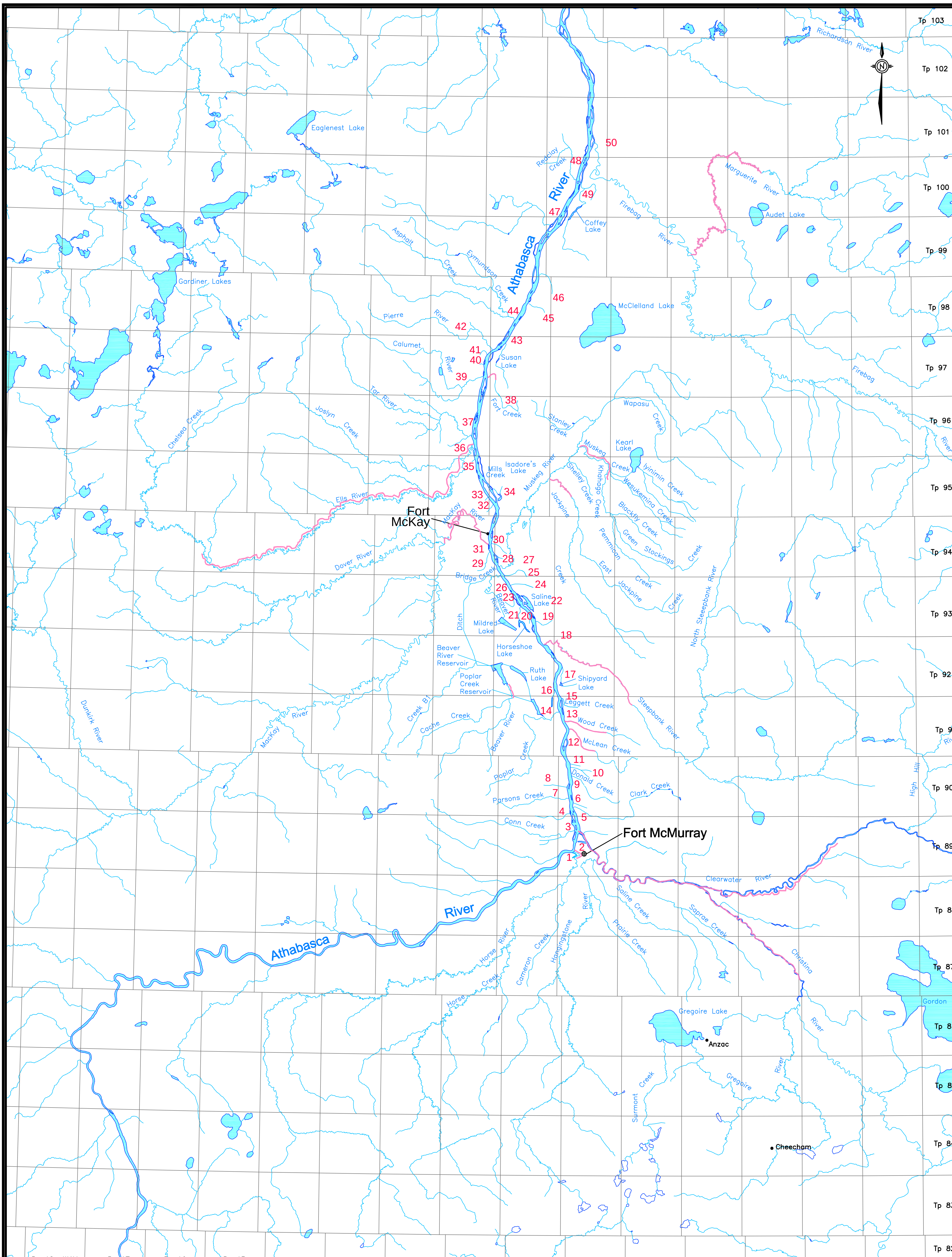
SLIMY SCULPIN DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	SLSC
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04		
REVIEW	CB	19/02/04		

FIGURE: II-12

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: SPSC.dwg Feb 26, 2004 - 2:09pm



SPOONHEAD SCULPIN DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

15 0 15

SCALE KILOMETRES

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

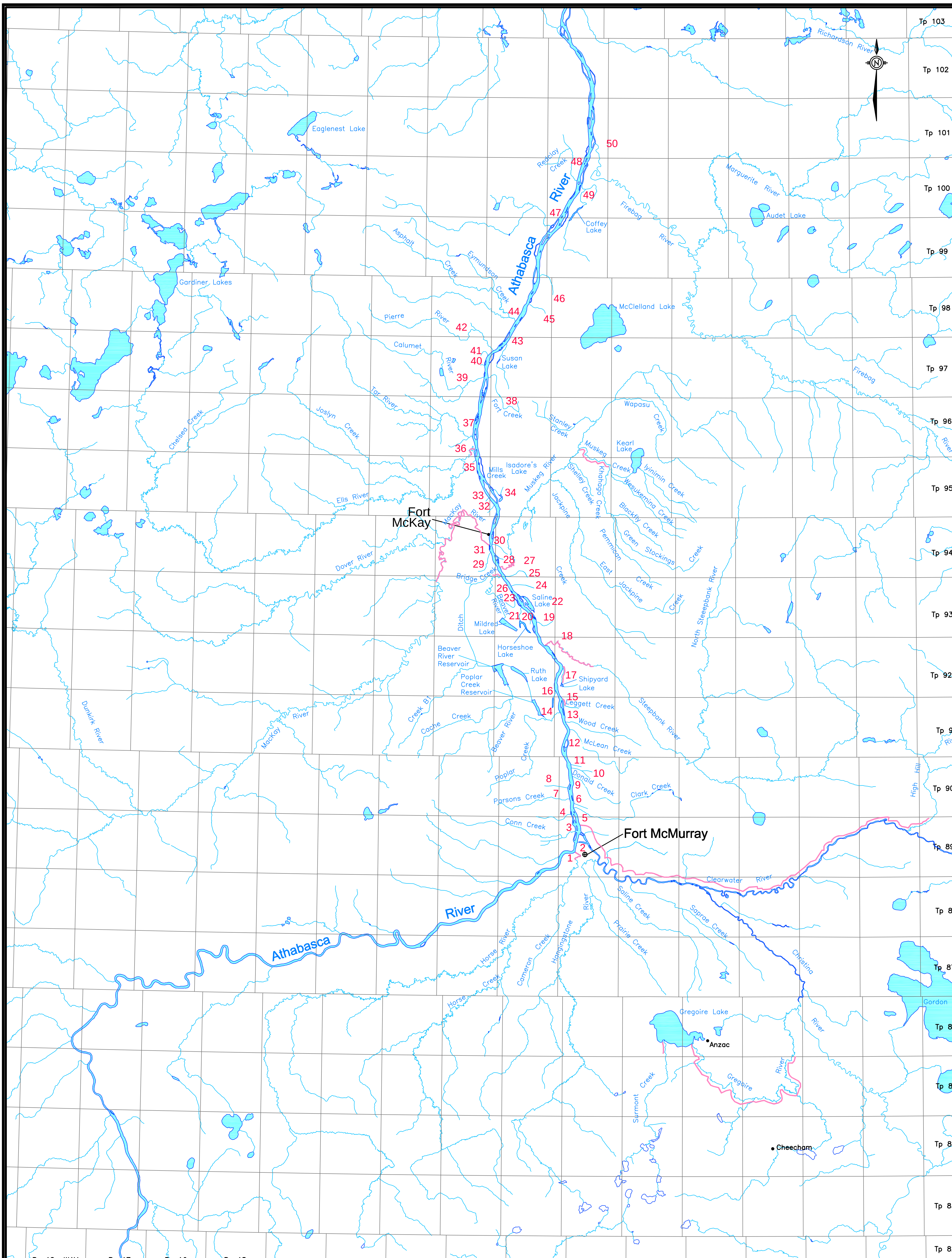
TITLE

SPOONHEAD SCULPIN DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	SPSC
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04	FIGURE: II-13	
CHECK	CB	19/02/04		
REVIEW	CB	19/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: SPSH.dwg Feb 26, 2004 - 2:12pm



15 0 15

SCALE KILOMETRES

SPOTTAIL SHINER DISTRIBUTION

- UNSPECIFIED LIFE STAGE
- 2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

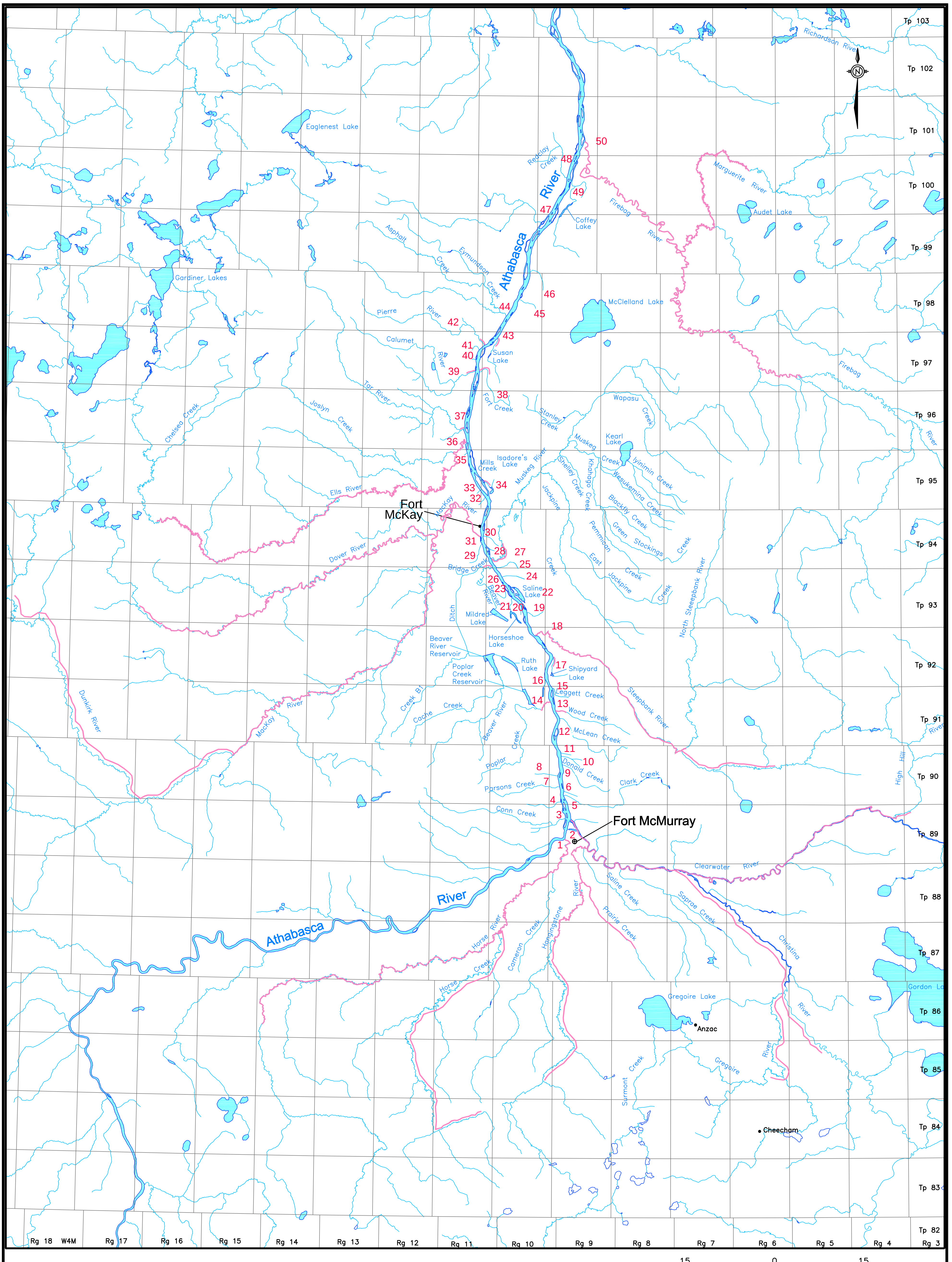
TITLE

SPOTTAIL SHINER DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	SPSH
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	**FIGURE: II-14**	
REVIEW	CB	19/02/04		

R:\CAD\2004\1323-Aquatics\1335\04-1335-001\1000\ Drawing file: Trout Perch.dwg Feb 26, 2004 - 2:14pm



15 0 15

SCALE KILOMETRES

TROUT-PERCH DISTRIBUTION

UNSPECIFIED LIFE STAGE

2 TRIBUTARY WATERSHED IDENTIFICATION NUMBER (WID #)

REFERENCE

ALBERTA NTDB DIGITAL DATA OBTAINED FROM GEOMATICS CANADA, AUGUST 2001.
DATUM: NAD 83 PROJECTION: UTM ZONE 12

PROJECT

RAMP

TITLE

TROUT-PERCH DISTRIBUTION MAP

Golder Associates
Calgary, Alberta

PROJ	04-1335-001.1000		FILE No.	Trout Perch
DESIGN	CJS	01/01/02	SCALE AS SHOWN	REV. 1
CADD	CJS	12/02/04		
CHECK	CB	19/02/04	FIGURE: II-15	
REVIEW	CB	19/02/04		