



Common Ground Drainage Channel Diversion Design Report



**Resource Management International Inc
Consulting Engineers
May 2017**

**COMMON GROUND DRAINAGE
CHANNEL DIVERSION**

**PREPARED FOR:
QUILL LAKES WATERSHED NO. 14**

**PREPARED BY:
RESOURCE MANAGEMENT INTERNATIONAL INC.
P.O. BOX 248
LASHBURN, SK, S0M 1H0**

MAY 2017

EXECUTIVE SUMMARY

The Quill Lakes area consists of Big Quill Lake, Mud Lake and Little Quill Lake. With the high rainfall and surface runoff in the since 2014, the water level has risen in the lakes to form a very large lake. Big Quill Lake has risen to levels where it has flooded many farmyards in the area. The Quill Lakes are saline lakes. The current lake level in Quill Lake is at an elevation of 520.9 m and the lake level at Pel Lake (south of the Ducks Unlimited Dam) is at 521.2m. At this point in time, it has a potential to overflow into the surrounding lake of Pel Lake, which is a lake which has inflows from rain water. This would cause a mixing of freshwater and saline water. This potential mixing is not likely cause any negative effects for wildlife or vegetation in the area or also downstream of Pel Lake, Kutawagan Lake and Peter Lake and then further downstream to Last Mountain Lake, but the potential should be well managed.

The construction of a drainage diversion channel will start at the Pel Lake Ducks Unlimited Dam and head south towards Kutawagan Lake and then towards Peter Lake. This will redirect surface runoff in the area and lower the water levels in Pel Lake and Kutawagan Lake. The drainage channel will be constructed at an elevation of 519.5 m. This elevation was determined for a possible drainage diversion from the areas north and west of the Big Quill Lakes. The drainage channel will consist of flow control structures of gated 900 mm culverts. The water levels to be lowered will be controlled by the gated culverts and will lakes elevations will be lowered by approximately 0.6 m. The total approximate amount of water to be drained from the area is 7,000,000 m³ of fresh water.

This drainage channel will drain water from Pel Lake and south. It will not be mixed with water from Big Quill Lake.

TABLE OF CONTENTS

1.0 Introduction.....1

 1.1 Background.....1

 1.2 Layout of Report.....1

 1.3 Scope of Work.....2

2.0 Design Analysis2

3.0 Utilities3

4.0 Cost Estimates Of Common Ground Drainage Design.....4

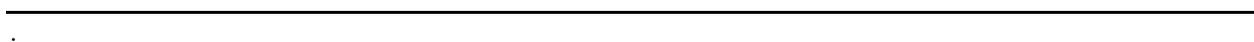
 4.1 Area 1: Channelization Section at Section NE 27-30-21-W34

 4.2 Area 2: Channelization Section from Pel Lakes Ducks Unlimited Dam to4

 4.3 Phase 1 Channelization Cost Estimate6

5.0 Channel Construction7

6.0 Summary And Conclusions7



LIST OF TABLES

Table 1: Phase 1 Channelization - Cost Estimate6

LIST OF FIGURES

Figure 1 - Plan View of Area 1 and Area 2 Channel Construction5

COMMON GROUND DRAINAGE DESIGN REPORT

1.0 INTRODUCTION

The Quill Lakes area (includes Big Quill Lake, Little Quill Lake and Mud Lake) are located in the Province of Saskatchewan, Canada. The lakes have been experiencing a number of wet years. Since 2004, the lakes have been rising and the seasons have been wetter than the normal. As such, the water elevation in Quill Lake has risen to levels never seen before. Big Quill Lake, Mud Lake and Little Quill Lake have each overflowed and the lakes have joined together to form one large lake. Each passing year that the surface water is larger than the evaporation rate, the lake continues to rise and grow larger.

1.1 Background

Quill Lakes is a saline lake that has inflows of surface water drainage from a large area. The Kutawagan Lake area naturally flows toward Big Quill Lake. This area has been managed by Ducks Unlimited as they have a areas for wildlife. The natural surface drainage flows into the Kutawagan Lake area. Once this has been filled, there are overflow culverts that flow to the north to Pel Lake. Ducks Unlimited has a 3 bay Stoplog concrete control structure. If Pel Lake fills up too high, this water is released into Big Quill Lake.

1.2 Layout of Report

Chapter one presents the introduction, objectives, scope, methodology, and layout of report. Chapter two presents the design analysis of the flow analysis. Chapter three talks about the utilities in the area. Chapter four has the cost estimate for the design channel. Chapter five talks about the channel construction and Chapter six has the summary and conclusions.

1.3 Scope of Work

Resource Management International was commissioned by the Quill Lakes Watershed Association No. 14 to design a diversion channel for the surface water at Pel Lake and Kutawagan Lake and to divert the water south towards Peter Lake. This would include diverting the water which is currently flowing north into Quill Lake and directing it to the south towards Peter Lake and then eventually towards Last Mountain Lake.

Aerial photos of the area were taken on April 20, 2017 to determine the extent of the flooding around the area.

A GPS survey was done on April 21-23, 2017 to determine the existing water elevations of the different bodies of water. The culvert inverts and sizes were also measured. Elevations of the bottom of the lakes were determined from previous surveys and some elevation data of the bottom of the lakes were estimated. The GPS coordinates were tied into the benchmarks close to Nokomis, SK. The benchmarks that were referenced are BM 91S170 and BM 91S172, from the Saskatchewan Geodetic Database.

2.0 DESIGN ANALYSIS

The design of the channel runs from the Pel Lake Ducks Unlimited Dam Structure (km 0+000) south to Grid 744 (km 25+000). The drainage channel will be constructed at an elevation of 519.5 m. This elevation was determined for a possible drainage diversion from the areas north and west of the Big Quill Lake. The water levels to be lowered will be controlled by the gated culverts and will lower the lakes by approximately 0.6 m. The total approximate amount of water to be drained from the area is 7,000,000 m³ of water. A plan view of the channel can be seen in Figure 1 below. *There will be no mixing of Quill Lake water with the Kutawagan Lake water.*

The existing water level at the Big Quill Lakes is at 520.9 m (North of the Ducks Unlimited Dam). The water level in Pel Lake and south is at 521.2 m (South of the Ducks Unlimited Dam).

There are a total of 8 culvert locations that need to be replaced and lowered to accommodate the drainage diversion channel. The drainage channel will consist of flow control structures of 2 gated 900 mm culverts located at km 9+700 and km 23+400. The culverts to be installed can be seen in Figure 1.

At the south end of the project at km 25+000 (Grid, 744), there is a 900 mm culvert that runs across the road. The existing culvert is sloped the wrong way with an elevation of 519.04 m on the north side of Grid 744 and 519.30 on the south side of the road. The natural flow of water is south towards Peter Lake. When the water level to the north fills up, it will overflow to the south of Grid 744 and then towards Peter Lake. With a 2m head through this culvert and the 900 mm culvert flowing full, the flow rate is approximately 1.0 - 1.4 m³/s. *The existing culvert through Grid 744 will be left the same as it is existing. No work will be done to Grid 744.*

The design of the drainage channel will consist of a 1 m channel bottom and 2.5:1 sideslopes. This will keep the flow rate to a minimum but still allow the overflow of water out of the regions.

Ducks Unlimited has some dams built on Kutawagan Lake. These dams hold water to a certain level and have overflow culverts that take water to the north towards Pel Lake when the lake fills up to the desired level.

The Ducks Unlimited Dams in Kutawagan Lake will be bypassed with the drainage channel to the south. *There will be no Ducks Unlimited structures that be changed or removed in the Kutawagan Lake area.*

3.0 UTILITIES

There is one Sasktel Line located at km 16+000 on Section SW 18-30-21-W3. The Sasktel Line should be located for depth. The line will likely have to be lowered to accommodate the channel.

SaskEnergy and SaskPower Lines should not be affected by any channel in the area, but these should be located and found also.

4.0 COST ESTIMATES OF COMMON GROUND DRAINAGE DESIGN

4.1 Area 1: Channelization Section at Section NE 27-30-21-W3 (See attached map)

Area 1 consists of constructing a channel at the south end of the quarter from km 23+400 to km 24+600 (NE 27-30-21-W3). This can be seen on Figure 1 below. This channel should be constructed at an elevation of 519.5m. This will drain to an existing low area and run through the culvert located at Grid 744. The excess earthwork material will be used to build up the access road on the R.M. right of way.

There will be two access roads for different land owner to access their land that will cross the drainage channel. The access road at km 23+400 will have a 900 mm culvert with a slide gate to stop the flow of water if it is required. The access road at km 24+200 will have a 900 mm culvert. Both culverts will have an elevation of 519.5 m.

Constructing this channel first will allow the water to slowly be lowered in the area north. This will also ease the construction of Area 2 if the water levels are lower in this area.

4.2 Area 2: Channelization Section from Pel Lakes Ducks Unlimited Dam to Area 1

Area 2 consists of constructing a channel from the Ducks Unlimited Dam down south through Pel Lake to Kutawagan Lake (km 0+000 to km 23+400). Area 2 can be seen on (Figure 1 below) and to Area 1 where the drainage channel was previously channeled. This will allow the water levels directly north of Grid 744 to drain out immediately and lower the levels of the lakes further north.

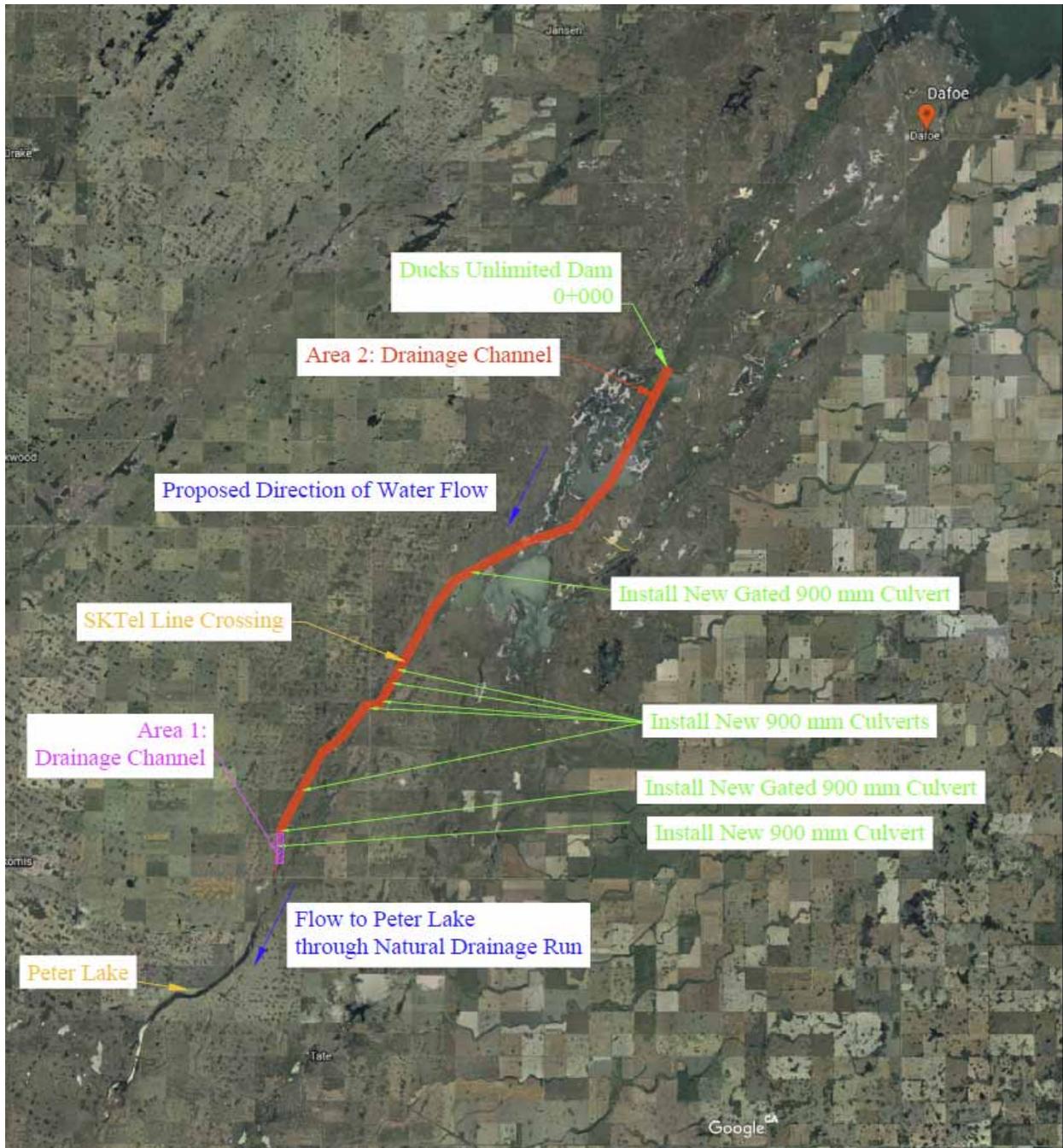


Figure 1 - Plan View of Area 1 and Area 2 Channel Construction

4.3 Phase 1 Channelization Cost Estimate

Table 1: Phase 1 Channelization - Cost Estimate

DESCRIPTION	UNITS	ESTIMATED QUANTITY	PRICE/UNIT	TOTAL
Mobilization	Lump Sum	1	\$ 10,000	\$ 10,000
Earthwork (Area 1 and Area 2)	m ³	200,000	\$10.00	\$ 2,000,000
Culverts (900 mm)	m	200	\$ 100.00	\$ 20,000
Culvert Installation	m	200	\$ 300.00	\$ 60,000
Fill Materials for Culverts	m ³	2,000	\$ 50.00	\$ 100,000
Gate for Culvert and Installation	each	2	\$ 6,000.00	\$ 12,000
Rip Rap Supply and Installation	m ³	2,000	\$ 50.00	\$ 100,000
SUBTOTAL				\$ 2,302,000
Engineering				\$ 150,000
Contingency	L.S.		30%	\$735,600
TOTAL				\$ 3,187,600

5.0 CHANNEL CONSTRUCTION

Channelization construction should be completed from the south to the north to allow the passage of water to drain towards the south during the construction phase. This will dry up some areas and also lower the water levels, so that construction of the newer areas will be easier.

Installation of the culverts will follow typical design standards for installing culverts from the Saskatchewan Department of Highways and Transportation.

The culverts located at Peter Lake should have the culverts open with gates should be open to allow overflow drainage to pass through the lake for water coming from the north to flow through the culverts.

Peter Lake should determine their high water level and have the gates set so that the overflow water can continue on downstream without affecting any operations in the park area.

6.0 SUMMARY AND CONCLUSIONS

The Quill Lakes water level is continuing to rise and will eventually will overflow to the south where the Ducks Unlimited Dam is located at Pel Lake. This will cause a mixing of salt water with fresh water and this will migrate south to other fresh water lakes. To mitigate this situation and by diverting fresh water flows from entering the Quill Lake System, there will be less water entering the Quill Lake system. *There will be no mixing of Quill Lake water with the Kutawagan Lake water.*

A drainage channel diversion to the south starting at the Pel Lake Ducks Unlimited Dam (km 0+000) towards Grid 744 (km 25+000) and then to Peter Lake will redirect surface runoff and lower the water elevations in Pel Lake and Kutawagan Lake. The drainage channel will be constructed at an elevation of 519.5 m. This elevation was determined for a possible drainage diversion from the areas north and west of the Big Quill Lakes. The drainage channel will

consists of flow control structures of 2 gated 900 mm culverts located at km 9+700 and at 23+400.

The water levels to be lowered will be controlled by the gated culverts and will lower the lakes by approximately 0.6 m. The total approximate amount of water to be drained from the area is 7,000,000 m³ of water.

Downstream at Peter Lake, the culverts at each crossing should be open to the fullest to allow water coming from the north to flow through the culverts.

Diverting the Kutawagan southbound and away from the Quill Lakes is one part of the larger solution to limiting the amount of surface water contributing to the rise of the Quill Lakes. There is still a large surface water area where water is still migrating towards Quill Lakes from the north, west and east of the lakes.

Common Ground Drainage Report:

Written by:

Bradford Li Pi Shan, P.Eng

Reviewed by:

Tom N Gehlen, P. Eng

APPENDIX A: DRAWINGS

APPENDIX B: PHOTOS



Figure A. 1 - Looking North - Section 18-30-20-W3



Figure A. 2 - Looking South - Section 18-30-20 - W3



Figure A. 3 - Grid 744 Culvert - South side of road



Figure A. 4 - Grid 744 Culvert - North Side of Road



Figure A. 5 Grid 744 Culvert - North Side of Road



Figure A. 6 Culverts located at 16-29-21-W2 - Peter Lake



Figure A. 7 Culverts located at 16-29-21-W2 - Peter Lake



Figure A. 8 - Peter Lake - 31-28-21- W2



Figure A. 9 Railroad Tracks at Big Quill Lake near Dafoe



Figure A. 10 - Ducks Unlimited Dam - Looking East



Figure A. 11 - Ducks Unlimited Dam - Looking North



Figure A 12 - Ducks Unlimited Dam - Looking North



Figure A. 13 - Ducks Unlimited Dam - Looking South



Figure A. 14 - Pel Lake - Looking South



Figure A. 15 Spillway heading north from Kutawagan Lake



Figure A. 16 Kutawagan Lake Channel on East Side - Looking South



Figure A. 17 Section 18-30-20-W2 Looking South



Figure A. 18 Section 18-30-20-W2 Looking SouthWest



Figure A. 19 Grid 744 Looking South



Figure A. 20 Peter Lake Looking South