Executive Summary

This report presents the results of the Phase 3 and 4 investigations of the Lower Athabasca River Navigation Study completed by Dillon Consulting Limited on the behalf of Transport Canada. These study phases represent the continued examination of navigational constraints found along the lower stem of the Athabasca River and represent the next levels of investigation following the earlier Phase 1 and 2 studies completed by Golder Associates in 2015 and 2018. The Phase 1 and 2 studies were focused on examinations of the most recent and historical data related to channel bathymetry, dredging operations, and hydrology of the watershed, in addition to obtaining Indigenous community input from main stem river users to ascertain where navigation concerns were the greatest. This Phase 3 and 4 study has focussed on completing detailed surveys and river channel evaluations of a selection of the areas of navigation concern, and to provide a more thorough assessment of Lower Athabasca River flow discharges, water levels, and channel depths pertinent to maintaining a navigable channel during the Fall Navigational Season (August to October).

The study is to assist in addressing whether current navigational concerns are systemic to the lower Athabasca River and pertinent to an understanding of the impacts related to water withdrawals by oil sands developments, climate change, and natural flow variations in the river. The general study area location is described as the Lower Athabasca River between Fort McMurray and extending 200 km further downstream to near Embarras Portage. Within this stretch of river the investigation examined a total of 11 higher-ranked sites that were previously identified in a list of 35 sites of navigation concern noted in the Phase 2 report. The ranking of these sites was based on the compilation and assessment of information provided by the Indigenous people's consultation, details related to water intake withdrawals, and channel characteristics.

Surveys of the 11 study sites were undertaken during the period September 17th to 23rd, 2018 and were completed by a four-person crew who navigated the river by boat and helicopter. Assistance was provided by representatives of the ACFN Industrial Relations Corp. for survey activities in the downstream areas of the study area. An Acoustic Doppler Profiler (ADP) and a RTK GPS survey instrument were used to collect topographic, bathymetric, and river discharges data for each of the 11 survey sites. This information was used to develop contour base maps and to allow for correlation of measured river discharges with discharge information obtained from local Water Survey of Canada (WSC) and Alberta Environment and Parks (AEP) hydrometric flow monitoring stations.

Discharge estimates from WSC's Fort McMurray gauge were ultimately compared to the 2018 measured discharges to derive site discharge ratios that allowed for the estimation of prorated historical, statistical, and predicted future climate change discharge estimates for each site. Future climate change discharge estimates for the 2060's were enlisted from the Teck 2013 Frontier Project investigations which were available for the Fort McMurray gauge site. Notably, the Warm-Wet climate change scenario was selected as the more probable condition for the area's future climate outlook. This scenario suggests significant natural future discharge reductions in the river of 52.8%, 32.8% and 5.4%

predicted for the months of August, September and October respectively. Estimates of future climate change discharges have suggested that the mean monthly discharge in the month of August will reduce to 438 m^3/s, and the historical lowest monthly discharge would be reduced to 238 m^3/sec and would be expected to occur once every 20 to 50 years.

Water withdrawal information for the oil sands developments was provided by AEP, and the records have shown that maximum monthly, weekly, and daily withdrawals have historically been approximately 4 m^3/s, 6 m^3/s, and 8 m^3/s, respectively, which has been considerably less than the maximum permitted withdrawal rate of 29 m^3/s. Consequently, these current levels of withdrawal have been considerably less than 3% of the natural river discharge.

To assess the impact that water withdrawals and projected future climate change impacts can be expected to have on water level, channel velocity, and depth of water in the river, a calibrated HEC-RAS hydraulic model was developed. The model was used to simulate a wide range of discharge conditions (150 m^3/s to 1600 m^3/s) to investigate possible impacts. Notably, simulations included discharges associated to the current AXF threshold of 500 m^3/s, as well for 700 m^3/s, and 1600 m^3/s threshold, which is said to be an adequately deep channel (Candler, et al, 2010).

The results of the model simulations have illustrated the following:

Impacts due to Water Withdrawals:

- The impact of water withdrawals resulting in the reduction of water levels in the river is highly dependent on both the magnitude of the rate of withdrawal and the magnitude of the natural river discharge;
- For a natural river discharge of 500 m^3/sec (AXF threshold) as reported at the Fort McMurray gauge, the impacts can range from a reduction of 2 cm (0.02 m) assuming the current rate of maximum withdrawal, and up to 6 cm (0.06 m) should withdrawal rates increase to the maximum permitted rate of 29 m^3/sec; and
- For a natural river discharge of 273 m^3/sec (future lowest monthly discharge) as reported at the Fort McMurray gauge, the impacts can range from a reduction of 3 cm (0.03 m) assuming the current rate of maximum withdrawal, and up to 15 cm (0.15 m) should withdrawal rates increase to the maximum permitted rate of 29 m^3/sec.

Impacts due to Climate Change:

- The impact of future-predicted climate change discharges can see mean monthly water level reductions of approximately 20 cm (0.20 m) and the low monthly conditions will see reductions of approximately 11 cm (0.11 m); and
- While the general trend has been for the month of October to typically be the low month each year during the Fall Navigational Season, and discharges tend to decline throughout the three-month season, the ranging monthly impacts of climate change over the season are predicted to

see an overall prolonged and lower discharge period starting in August and extending into October In the future.

Impacts Due to Combined Effects of Withdrawals and Climate Change:

- The combined impact of both withdrawals and future climate change on mean monthly discharges is predicted to range from a water level reduction of 20 cm to 24 cm (0.20 m to 0.24 m) for a current rate of withdrawal and a maximum of 29 m^3/s respectively; and
- The combined impact of both withdrawals and future climate change on low monthly discharges is predicted to range from a water level reduction of 14 cm to 25 cm (0.14 m to 0.25 m) for a current rate of withdrawal and a maximum of 29 m^3/s respectively.

As the effects of both water withdrawals and climate change have been demonstrated to result in statistical water level reductions during the Fall Navigational Season, there will be future impacts on navigation in the Lower Athabasca River. The depths of water in the river system have been examined using a 7-level range of depths (0.3 m intervals) where Level 1 is the most severe rating with depths less than 0.3 m and Level 7 is for depths greater than 1.8 m. Level 3 is the condition by which depths are greater than 0.6 m and Level 5 depths are greater than 1. 2 m thresholds as noted below:

Impact Level	Minimum Water Depth
Level 1	< 0.30 m
Level 2	0.30 m- 0.60 m
Level 3	0.60m – 0.90 m
Level 4	0.90 m – 1.20 m
Level 5	1.2 m – 1.5 m
Level 6	1.5 m – 1.8 m
Level 7	>1.8 m

The results of the hydraulic model simulations and the surveyed river bathymetry were enlisted to identify minimum depths for the full range of discharge simulations up to 1600 m^3/s. The results show the following:

- 6 of the 11 sites will see depths below 0.3 m at a discharge of 300 m^3/s (Level 1)
- 0 of the 11 sites will see depths below 0.3 m at a discharge of 500 m^3/s (AXF) (Level 1)

- 7 of the 11 sites will see depths below 0.6 m at a discharge of 300 m^3/s (Level 1 & 2)
- 2 of the 11 sites will see depths below 0.6 m at a discharge of 500 m^3/s (AXF) (Level 1 & 2)
- 0 of the 11 sites will see depths below 0.6 m at a discharge of 700 m^3/s (Level 1 & 2)

- 10 of the 11 sites will see depths below 1.2 m at a discharge of 300 m^3/s (Level 1, 2, 3 & 4)
- 7 of the 11 sites will see depths below 1.2 m at a discharge of 500 m^3/s ((AXF) (Level 1, 2, 3 & 4)
- 4 of the 11 sites will see depths below 1.2 m at a discharge of 700 m^3/s (Level 1, 2, 3 & 4)
- 0 of the 11 sites will see depths below 1.2 m at a discharge of 1050 m^3/s (Level 1, 2, 3 & 4)

In summary, the future outlook will see water levels for both natural average and low monthly (drought) conditions decline. Average conditions will see flows decline from above the 500 m^3/s AXF condition at 535 m^3/s to below the AXF threshold to 439 m^3/s and consequently depths of water will be reduced by up to 18 cm (0.18 m) and see typical depths in the range 0.3 m to 0.9 m (Levels 2 & 3). During more extreme low monthly (drought) years described as in the order of a 20 to 50-year reoccurrence interval, both now and in the future, navigational challenges will be significant as many of the sites will experience water depths well less than 0.3 m (Level 1).

The impacts on navigation are of significant importance to the users of the river. The results of this assessment have shown that based on the channel geometry assessed in the September 2018 surveys, navigation issues brought on by lower water levels can inhibit the users of the river. As future climate change impacts on the flows and levels along the river become evident, the ability to navigate boats along the river will become more challenged. It is noted that climate change alone could see seasonal water level reductions as much as 20 cm (0.20 m). This suggests an increased frequency of challenging navigational conditions in the future. The impacts of withdrawals (up to 29 m^3/s) are more impactful during naturally lower flow conditions and can see the water levels decline an additional 15 cm (0.15 m) and potentially further limit navigation, however, maintaining withdrawal to existing levels will reduce the compounded impact significantly to be less than an additional 4 cm (0.04 m).