



Advisian

WorleyParsons Group

Advisian
Suite 500, 151 Canada Olympic Rd SW
Calgary, AB T3B 6B7 CANADA
Phone: +1 403 247 0200
Toll-Free: 1 800 668 6772
Facsimile: +1 403 247 4811

A business of WorleyParsons Canada
Services Ltd.
www.advisian.com

17 July 2018

Proj. No.: 307011-00049

Municipal District of Foothills No. 31
309 MacLeod Trail SW
High River, AB
T1V 1M7

Attention: Robert Miller

Dear Mr. Miller:

RE: Modelling Support for Stage 1 of Phase 2, Little Bow River

1. Introduction

WorleyParsons Canada Services Ltd., operating as Advisian, was retained by the MD of Foothills No. 31 (MD) to complete additional modelling in support of the Phase 2 - Stage 1 program for the Scoping Study of the Little Bow River watershed within the MD's boundary.

Based on the results of the Town of High River (the Town) Flood Model, the Scoping Study completed in 2017 (Advisian & Amec Foster Wheeler 2017) and further discussion with the Town, Advisian was requested to:

- Improve model results accuracy in the area around legal quarter NE-32-19-28 W4 and to assess the impact at the only residence on legal quarter NE-30-19-28 W4 based on the updated model; and
- Model the effects of lowering a segment of 72 Street E, at the eastern limit of legal section 34-18-29 W4, on the Highwood River-Little Bow River flow split and specifically on the single landowner in the adjacent quarter NW-35-18-29 W4.

The simulation and outcomes of the above model interrogation are based on the assumption that the proposed South West Dike (SWD) in section 35-18-29 W4 will have the footprint of the commonly denominated "hockey-stick" alignment (i.e. model simulation Scenario 49A as described below), as shown in Figure A.

2. Model Improvements and Configurations

A number of scenarios were prepared to support the 2013 flood mitigation features design. Pertinent scenarios are summarized in the following Table A and described in this and the following sections.

Table A Model Scenarios Description

Scenario's Name	Description	Generation
2013 Landscape	The model of the conditions at the time of the 2013 flood, with a surface consistent with that apparent just after the 2013 inundation. The floodplain and active channel topography above the low water level are defined with LiDAR collected after the flood. Cross-section survey data collected after the flood were also used to define the low water channel through Town from just upstream of George Lane Park to just downstream of the Little Bow Canal Dike. The remaining low flow channel areas were estimated using pre-2013 flood information.	1 and 2
28A	Complete Mitigation Scenario: all mitigation features built after June 2013 flood event are included. On 12 Avenue SW and Centre Street the conceptual footage and cross-section of the dike denominated "Hockey Stick Alignment" was added as the more advanced option at the time of preparation.	1
28A	Generation 1 plus: the information obtained from the survey on three among railway and road corrugated steel pipes (CSP) located about 1.5 km and 2 km southeast of the Highway 2 crossing on the Highwood River, in section 32-19-28 W4, north of High River and south of Aldersyde (Figure A). Moreover, in legal section 35-18-29 W4, southern limit of High River Town limits, two important ridge lines (along 12 Avenue SW, 72 Street E and 88 Street E), previously modelled using the LiDAR information, were surveyed to improve their accuracy (Figure B).	2
37A	Existing Condition: represents the study area condition up to date, obtained from 28A Gen 2 by taking off the 12 Avenue SW and Centre Street Dike which is proposed but not yet built.	2
49A	Complete Mitigation Scenario plus Hockey Stick Dike-Detail Design: 12 Avenue SW-Centre Street Dike is added to 37A Gen 2 with its detail design alignment, the most advanced available up to date. Minor improvements also became available while completing this scenario and were therefore included: a raised portion of 12 Avenue SW (to the west of the West Town Dike (WTD) and Hockey Stick Dike connection) and two new 2.7 m diameter culverts at the Baker Creek crossing of 12 Avenue SW (previously a single 1.6 m culvert) (Figure B).	2
50A	Complete Mitigation Scenario plus Hockey Stick Dike-Detail Design plus 72 Street SE lowering: this scenario addresses the project team's proposed solution of lowering a limited stretch of 72 Street SE embankment as further development of 49A and observing changes in the Highwood River/Little Bow River flow split.	2



The Town Flood Model used for the Flood Mitigation Effects Assessment in the Scoping Study was denominated Scenario 28A Generation 2 (Complete Mitigation Scenario) and included the entire set of mitigation features built after the 2013 flood event, as specified and illustrated in the Scoping Study (Advisian & Amec Foster Wheeler 2017).

Scenario 28A Generation 2 also included the conceptual representation of the 12 Avenue SW and Centre Street Dikes ("Hockey Stick Alignment"). The final design layout for the 12 Avenue and Centre Street Dike is shown in shown in Figure A (green line).

Figure A **Location of the Study Features around 35-18-29-W4**

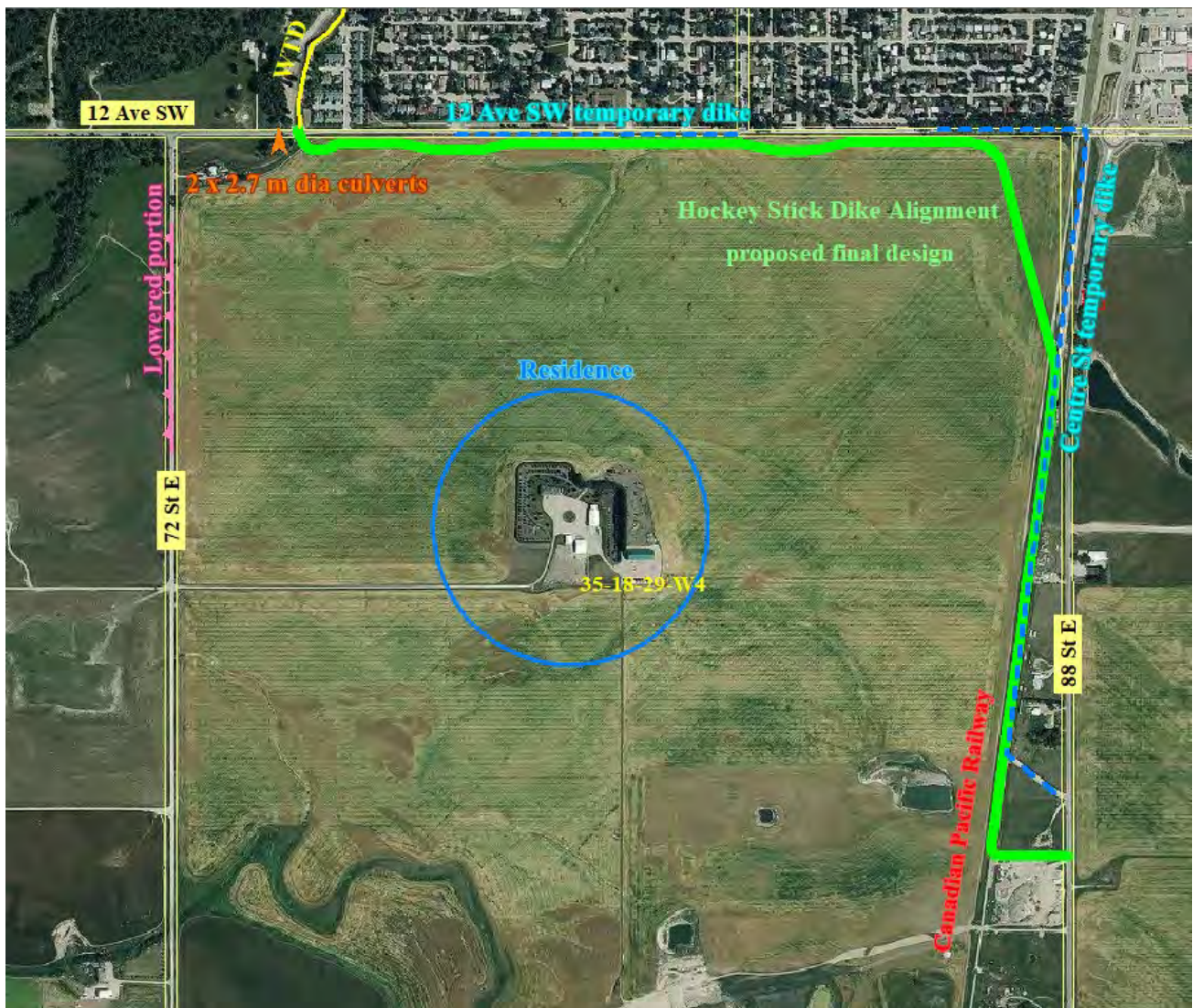


Figure A also shows, for documentation, the extent of 12 Avenue SW and Centre Street temporary dikes (dashed blue lines) built in the aftermath of the flood.

Scenario 28A Generation 2 was improved from Generation 1 with:

- The detailed assessment and verification at the railway and road crossings (Figure B); and



- Surveyed elevation data (versus LiDAR) along 12 Avenue SW, 72 Street E and 88 Street E (Range Road 291) around legal section 35-18-29 W4 shown in Figure A.

The existing condition model was developed from 28A Generation 2 by merely eliminating the proposed mitigation infrastructures of the 12 Avenue SW and Centre Street Dike. The existing condition scenario is titled Scenario 37A (Generation 2).

For the purposes of Phase 2 of the study the currently proposed 12 Avenue SW-Centre Street Dike or “hockey-stick” alignment based on detail design has then been added to the model thus creating Scenario 49A (Complete Mitigation Scenario plus Hockey Stick Dike-Detail Design). The Hockey Stick Alignment-Detail Design is shown in Figure A and in Figure 1, with the elevation profile of this dike shown in Figure 2. The alignment includes a south tail extension between the Canadian Pacific Railway track and 88 Street E (point M and the end point of the dike respectively in Figures 1 and 2).

Scenario 49A also differs to 37A through:

- Minor raising of 12 Avenue SW to the west of the West Town Dike (WTD) and Hockey Stick Dike connection, and
- Replacement of the single 1.6 m diameter culvert at the Baker Creek crossing of 12 Avenue SW with two 2.7 m diameter culverts (Figure B).

2.1 Additional Local Drainage Features in NE-32-19-28 W4

In September 2016 a field survey was conducted on three corrugated steel culverts located about 1.5 km and 2 km southeast of the Highway 2 crossing on the Highwood River. The locations of the culverts, of diameter 1000, 800 and 600 mm respectively are shown in Figure B below.

The magenta dots outlined area in Figure B was shown as inundated in the 2013 flood aerial photographs (Advisian & Amec Foster Wheeler 2017). The inundation was at least partially the result of the routing of water to this area via local drainage features such as the culverts. These culverts were added to the model after the September 2016 survey but not included in the original Town Models (2013 Landscape and Scenario 28A Generation 1) due to the regional nature of the analysis, developed between July 2013 and March 2014 for the 2013 Flood Mitigation Master Plan (WorleyParsons 2014). Model 28A Gen 1-estimated water levels adjacent to these inundated areas provided in fact conservative evaluations to support design and flood planning for the outlined area.

Water Survey of Canada (WSC) provided a preliminary estimate for the 2013 Highwood River inflow peak upstream of the Town, above Women’s Coulee Canal Inlet, to be 1,820 m³/s. This is the inflow magnitude prior to the Highwood-Little Bow flow split and is the primary discharge scenario that was evaluated in the Scoping Study (2017). In Scenario 28A flooding water is only marginally present in the magenta dot outlined area for an event of the 2013 flood magnitude because the culvert features were not included. It has to be noted that the WSC has since provided an updated peak flow magnitude of 1,760 m³/s for the 2013 event. WSC estimated the flood peaks using the slope-area methodology. Advisian confirmed this order of magnitude using backwater modelling.

Therefore, while peak flow estimates can always be refined based on updated information, the 1,820 m³/s has been maintained throughout the modelling of various scenarios over the period of studies relative to the 2013 flood since the estimate was provided by WSC. The reasons for this are as follows:



- It provides a consistent base of comparison and design;
- It provides conservative results whereas differences in water levels resulting from each of the peak flow estimates are expected to be minor due to the large area of inundation; and
- It is within the expected error of the median estimate (i.e. $1,760 \text{ m}^3/\text{s}$) considering a minimum error of 10% is often referenced for estimating peak flows using slope-area methodology.

Figure B **Location of the Surveyed Culverts in 32-19-28-W4**





The three CSP culverts were included in improved Scenario 28A Generation 2, and following Generation 2 scenarios, to allow to more accurately representing the behaviour of flooding in the area surrounding section 32-19-28-W4 in the Generation 2 models. In particular the only residence in quarter NE-30-19-28-W4, circled in Figure B, was under scrutiny.

The landowner, Roll Number 1928307500, indicated that in the event of 2013 the flooding water came very close to the residence, as confirmed by Figure 6.2.3 of the Scoping Study (Advisian & Amec Foster Wheeler 2017) reproduced herein as Figure 3.

2.2 Highwood River – Little Bow River Flow Split and SWD

Historic observations and hydraulic model analyses described in the Scoping Study (2017) indicate that before the 2013 flood, daily flood peaks above approximately 650 to 700 m³/s in the Highwood River (above Women's Coulee Canal Inlet) result in water overflowing (or "flow-splitting") to the Little Bow River watershed from the south Highwood River floodplain downstream of the Women's Coulee Canal Inlet. During these low probability infrequent flood events, overflow has been observed to flow east and south, flooding the Town (and areas south of the Town) before entering the Little Bow River.

Peak overflow to the Little Bow occurred below the Highwood River flow range of 650-700 m³/s in the early to mid-1900s. However, upgrades to the diking systems in Town over the last half century have decreased overflow to the Little Bow River and increased flow magnitudes contained in the Highwood River system, in and downstream of the Town (Advisian 2017). This means that the peak flow magnitude in the Highwood to approximately 675 m³/s is required upstream to cause overflow to the Little Bow.

Figure 4 includes a Table that shows the effect of the Town flood protection and mitigation structures in comparison with the June 2013 Landscape Scenario (Generation 2) in the case of an inflow from the upstream Highwood River of 1,820 m²/s, the preliminary 2013 flood magnitude estimate. The table in Figure 4 indicates, for Scenario 49A (Generation 2), an increase of approximately 260 m³/s in the Highwood River just downstream of the Town (location 2). Conversely, the Little Bow River is expected to experience a decrease in peak flow of 220 m³/s (location 4). Before the SWD was added to the model, i.e. in Scenario 37A, the flow increase in the Highwood River was of 250 m³/s, and the decrease in the Little Bow River was of 210 m²/s.

The Table in Figure 5 reports the analysis' results for an inflow from the upstream Highwood River of 940 m²/s. This peak flow is selected as it represents one of the intermediary threshold that has been used for the understanding of the Highwood-Little Bow flow split and flooding behaviour in the model assessment area. The Table indicates, for both Scenario 37A and 49A, an increase of approximately 30 m³/s in the Highwood River just downstream of the Town (location 2). In the Little Bow River (location 4) there is no noticeable change in peak flow for the existing condition (37A) versus the one for the June 2013 Landscape Scenario. Scenario 49A, with the addition of the Hockey Stick Alignment SWD, shows an increase of 5 m³/s in the Little Bow River.

The results confirm that flows to the Little Bow River from the Highwood River over the range from approximately 650 to 1,000 m³/s (measured upstream of Women's Coulee Canal inlet) have the potential to cause insignificant increases (e.g. no reported change considering uncertainty) when compared to the 2013 Landscape condition (Advisian & Amec Foster Wheeler 2017).



The Tables of Figures 4 and 5 reports predicted flows approximated to the nearest 10 m³/s (for flows above 100 m³/s) or the nearest 5 m³/s (for flows under 100 m³/s) to reflect the accuracy of the overall simulations. A lower accuracy range could in fact convey a sense of confidence not realistic for a regional model of this scale.

Finally Figure 6 shows the predicted change in peak flood levels, from about 12 Avenue SW to the Little Bow River crossing at Highway 2, produced by the introduction of the Hockey Stick Dike for a June 2013 (1,820 m³/s) inflow coming from the Highwood River upstream of Women's Coulee Canal inlet.

2.3 Lowered 72 Street E Concept

In Phase 2 – Stage 1 the MD and the project team identified another topographic change that modifies the Highwood-Little Bow flow split: the partial lowering of 72 Street SE along the divide of sections 34-18-29 W4 and 35-18-29 W4, indicated as "Lowered portion" in Figure A.

Following an indication from the MD, the road embankment in the simulation model was lowered by up to a meter where it was above the adjacent ground, or brought level with the adjacent ground if the embankment was higher by less than a meter. The portion of the road that has been lowered is shown also in Figures 4 and 5.

The topographic configuration resulted from such modification was named Scenario 50A.

Scenario 50A was developed specifically to examining the flooding effect on the downstream landowners, in particular Roll Number 1829355010, located east of the lowered portion of 72 Street SE and west of the Hockey Stick Alignment-Detail Design SWD, in legal quarter NW-35-18-29 W4 (the residence circled in Figure A).

3. Results

3.1 Impact Assessment on Landowner in NE-30-19-28-W4

The Generation 2 As-Built Mitigation Scenario plus the Hockey Stick Dike Alignment (Scenario 49A), that incorporated the minor drainage culverts shown in Figure B, was used to improve the accuracy of inundation extents and refine flood extent results around the residence in legal quarter NE-30-19-28-W4.

Figure C shows a detail of the inundation zones produced by the 2013 Flood Event with the 2013 Landscape Scenario and Scenario 49A around the residence in NE-30-19-28-W4 (Roll Number 1928307500).

It has to be noted that also the June 2013 Landscape Scenario has been updated with the three culverts in legal section 32-19-28-W4 (Figure B), to establish a consistent base of comparison.

**Figure C Inundation Zones around NE-30-19-28-W4**

The mapped results show that mitigation scenario 49A increases inundation's extent at the property.

This outcome was already indicated in Figure 6.2.3 of the Scoping Study (Advisian & Amec Foster Wheeler 2017) and Figure 3 for this document. Figure C shows the detail of the 2013 Landscape Scenario in comparison to Scenario 49A in quarter NE-30-19-28-W4.

According to the model results, the 2013 Landscape Scenario flood inundation zone came very close to the property but did not affect it, in consistency with the landowner's observations. Peak water elevation was estimated at 1033.05 m in the area during the 2013 flood.

As shown in the Table of Figure 4, Scenario 49A has an increase in predicted flow in the High River downstream of Town at 498 Avenue crossing due to the mitigation within and downstream of the Town. For Scenario 49A the house itself is not shown as flooded but the inundation zone affects the ancillary buildings and comes very close to the dwelling. Peak water elevation is 1033.30 m (an increase of 25 cm) in the area. This indicates that a flood of equal magnitude to the 2013 flood events will potentially result in water levels approximately 20-30 cm higher at the residence considering model uncertainty.

A number of maps complete the illustration of results around legal sections 32-19-28-W4 for an inflow of 1,820 m³/s at the Highwood River, the 2013 magnitude event.

Figures 7, 8 and 9 show the Scenario 49A predicted levels, depths and velocities.

Figure 10 represent the incremental inundation zone areas against the 2013 Landscape scenario.

3.2 Impact Assessment on the Landowner in NW-35-18-29 W4

The Generation 2 Complete Mitigation Scenario with the Hockey Stick Alignment-Detail Design SWD and lowered 72 Street SE (Scenario 50A) was used to observe the consequences on predicted flood results around the residence in legal quarter NW-35-18-29-W4 and the area downstream to the Little Bow River.

Figure 4 shows the effects in terms of change in flood levels of the partial lowering of 72 Street SE produced by the 2013 Flood Event. In other terms, flood levels of Scenario 49A have been subtracted from Scenario 50A for an inflow from the Highwood River of $1,820 \text{ m}^2/\text{s}$, the 2013 flood magnitude. Water peak elevation show water level increases from 0 to 0.02 m in the vast majority of the area from 72 Street SE to the Little Bow River crossing at Highway 2. However, the residence in legal quarter NW-35-18-29-W4 shows a limited spot to its north where the maximum increase in flood levels reaches 0.4-0.5 m.

Figure 5 shows the same change in flood levels of the partial lowering of 72 Street SE for an inflow from the Highwood River of $940 \text{ m}^2/\text{s}$. Increases in water peak elevation are considerably reduced and range mainly from 0 to 0.01 m downstream of 72 Street SE. A minimal change of 0 to 0.01 m is also observed in the southern fringes of the residence in legal quarter NW-35-18-29-W4.

A number of maps complete the illustration of results around the area from 72 Street SE to the Little Bow River crossing at Highway 2 for the inflows of $1,820 \text{ m}^3/\text{s}$ and $940 \text{ m}^3/\text{s}$ at the Highwood River.

Figures 11, 12 and 13 show the Scenario 50A predicted peak levels, depths and velocities for the inflow of $1,820 \text{ m}^3/\text{s}$.

Figures 14, 15 and 16 show the Scenario 50A predicted peak levels, depths and velocities for the inflows of $940 \text{ m}^3/\text{s}$.



4. Closure

We trust that this document satisfies your current requirements and provides suitable documentation for your records. If you have any questions or require further details, please contact the undersigned at any time.

Sincerely,



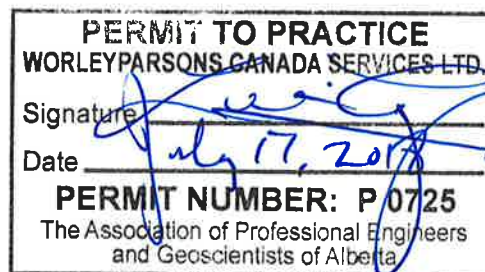
Andrea Pipinato, M.Sc., M.Eng., P.Eng.
Senior Water Resources Engineer

Roy Golaszewski
Senior Engineer

Senior Review by,

Joal Borggard, M.Eng., M.E.Des., CPESC, LEED AP, P.Eng.
Technical Director, Water Resources Engineering

Advisian, Americas





5. References

Advisian 2017. Highwood River Modelling - Flood Mitigation Effects Assessment. May 2017.

Advisian & Amec Foster Wheeler 2017. Scoping Study of Flood Related Areas of Concern on the Highwood River within the MD of Foothills and the Little Bow River Upstream of the Twin Valley Reservoir. March 2017.

WorleyParsons (WorleyParsons Canada Services Ltd.) 2014. 2013 Flood Mitigation Master Plan - Town of High River, Alberta. 24 March 2014.



Disclaimer

The information presented in this document was compiled and interpreted exclusively for the purposes stated in Section 1 of the document. WorleyParsons Canada Services Ltd., operating as Advisian (Advisian) provided this report for Municipal District of Foothills No. 31 solely for the purpose noted above.

Advisian has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this report, but makes no guarantees or warranties as to the accuracy or completeness of this information. The information contained in this report is based upon, and limited by, the circumstances and conditions acknowledged herein, and upon information available at the time of its preparation. The information provided by others is believed to be accurate but cannot be guaranteed.

Advisian does not accept any responsibility for the use of this report for any purpose other than that stated in Section 1 and does not accept responsibility to any third party for the use in whole or in part of the contents of this report. Any alternative use, including that by a third party, or any reliance on, or decisions based on this document, is the responsibility of the alternative user or third party.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of Advisian.

Any questions concerning the information or its interpretation should be directed to Andrea Pipinato or Joal Borggard.



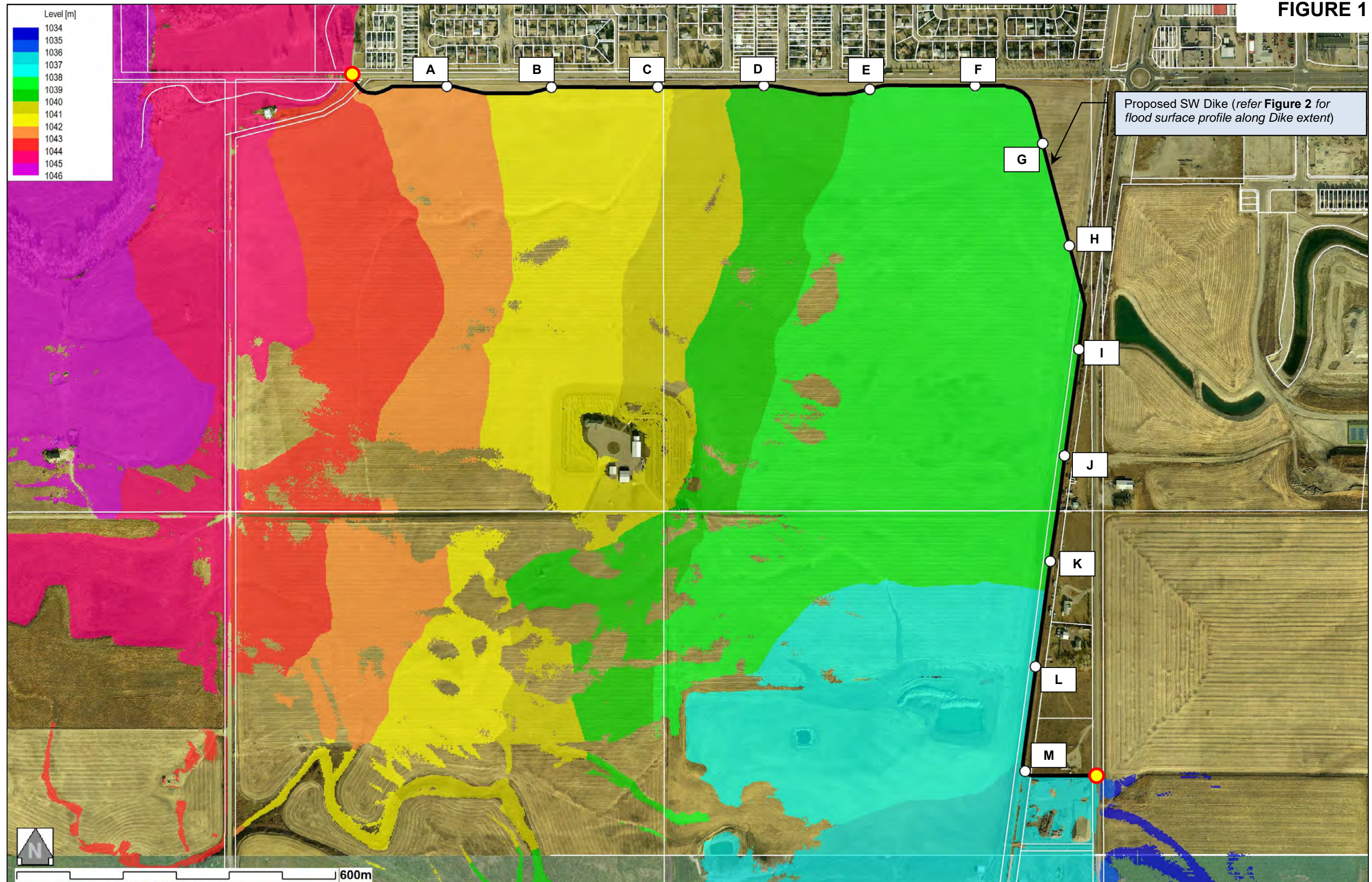
Advisian

WorleyParsons Group

Figures



FIGURE 1



Proposed SW Dike (refer **Figure 2** for flood surface profile along Dike extent)

FIGURE 2



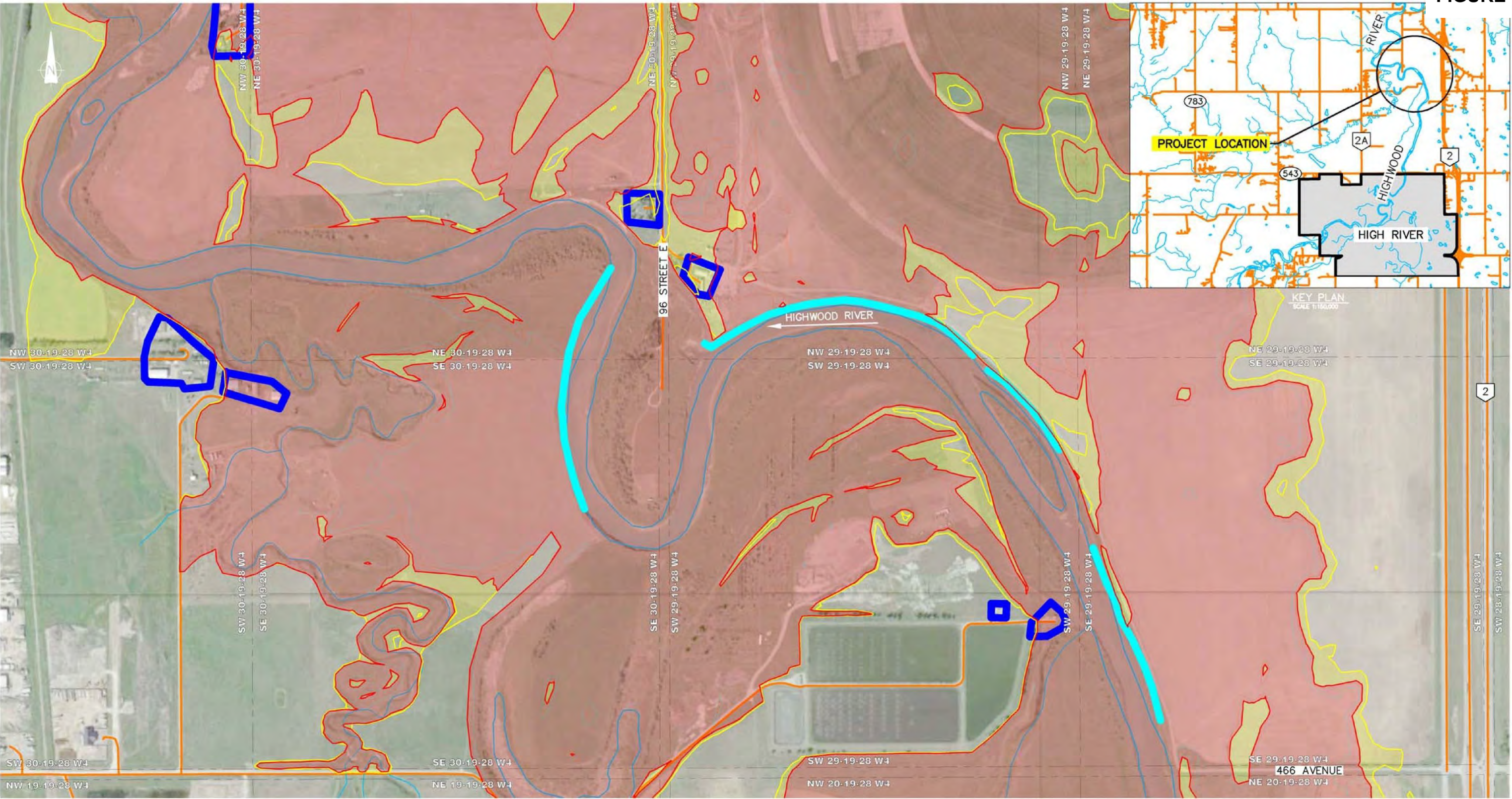
Advisian

WorleyParsons Group

High River
fgHRrg180321_Fig2_SW Dike with South Tail Profile1,820cms (49A).pdf

**DESIGN FLOODWATER SURFACE
PROFILES ALONG THE CREST OF THE PROPOSED
SOUTH WEST DIKE 49A (1,820cms)**

FIGURE 3



LEGEND:

- INCREMENTAL INCREASED FLOOD INUNDATION ZONE
- 2013 FLOOD EXTENT
- POTENTIAL BERM
- HEIGHTENED EROSION VULNERABILITY ZONE
- ROADS
- WATERBODIES

SCALE
1:7500
0 50 100 150 m



Created By:

Reviewed By:

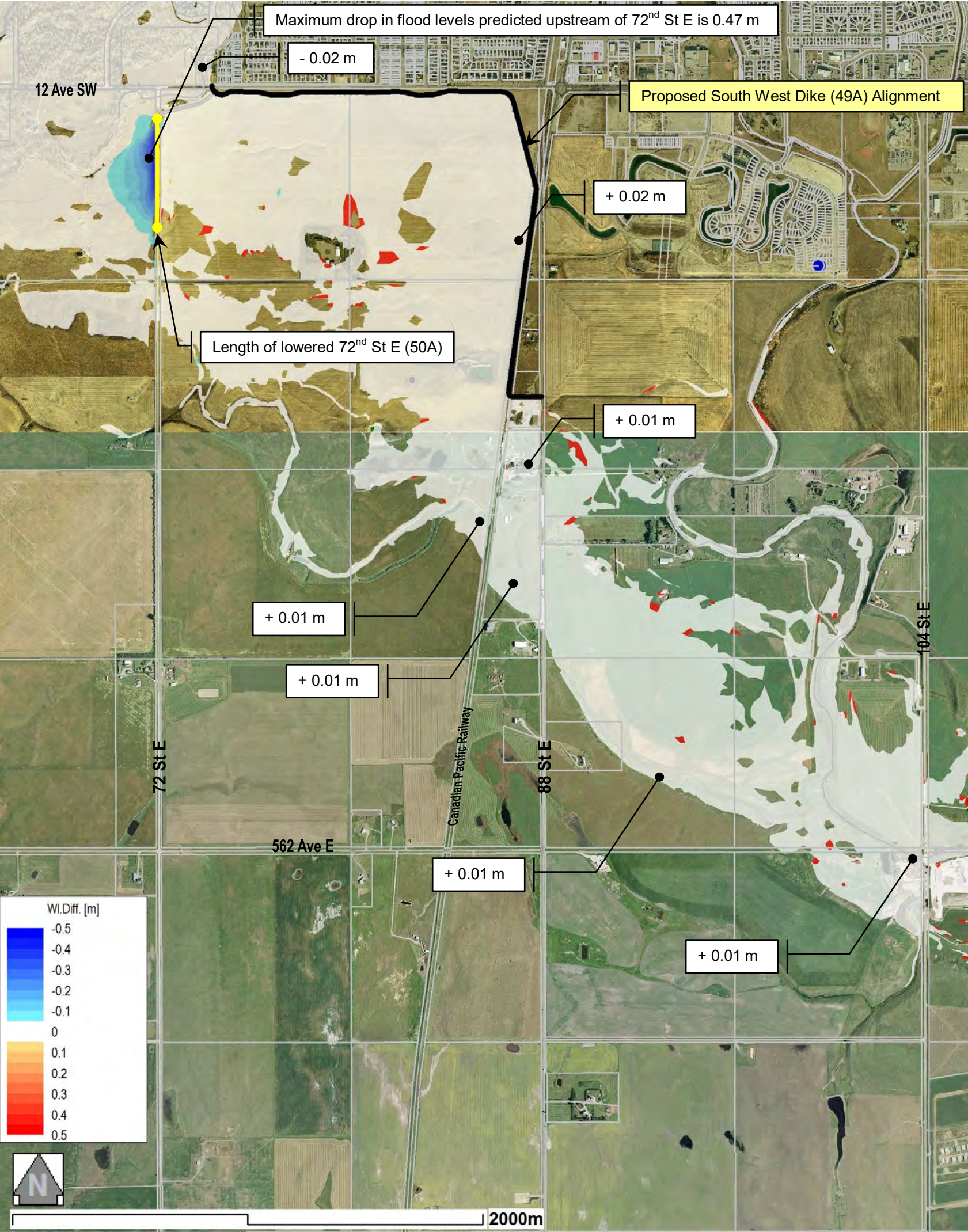


M.D. OF FOOTHILLS NO. 31

INCREMENTAL FLOOD DAMAGES AND MITIGATION
OPTIONS - 498 AVE TO BOW RIVER CONFLUENCE (3 OF 17)

Date: APRIL 2016 File Path: 216703-F623.dwg Figure No: 6.2.3 Rev: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons) and Amec Foster Wheeler Environment and Infrastructure (AMEC). WorleyParsons and AMEC have exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantee or warranties as to the accuracy or completeness of this information. WorleyParsons and AMEC assume no liability to any other party for any representations contained within.



NOTE:


Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	1,820	1,820	1,820	1,820
2. Highwood River – Downstream Town at 498 Ave Crossing	1,230	1,480 (+250)	1,490 (+260)	1,490 (+260)
3. Highwood River – At HWY2 Crossing	980	1,320 (+340)	1,330 (+350)	1,330 (+350)
4. Little Bow River – At 104 St East Crossing	510	320 (-190)	320 (-190)	330 (-180)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED CHANGE IN PEAK JUNE 2013 (1,820cms) FLOOD LEVELS DUE TO
PROPOSED MITIGATION CONDITION 50A (50A less 49A)



Advisian

WorleyParsons Group

Date: 6-MAR-18

Drawn By: R.G

Edited By:

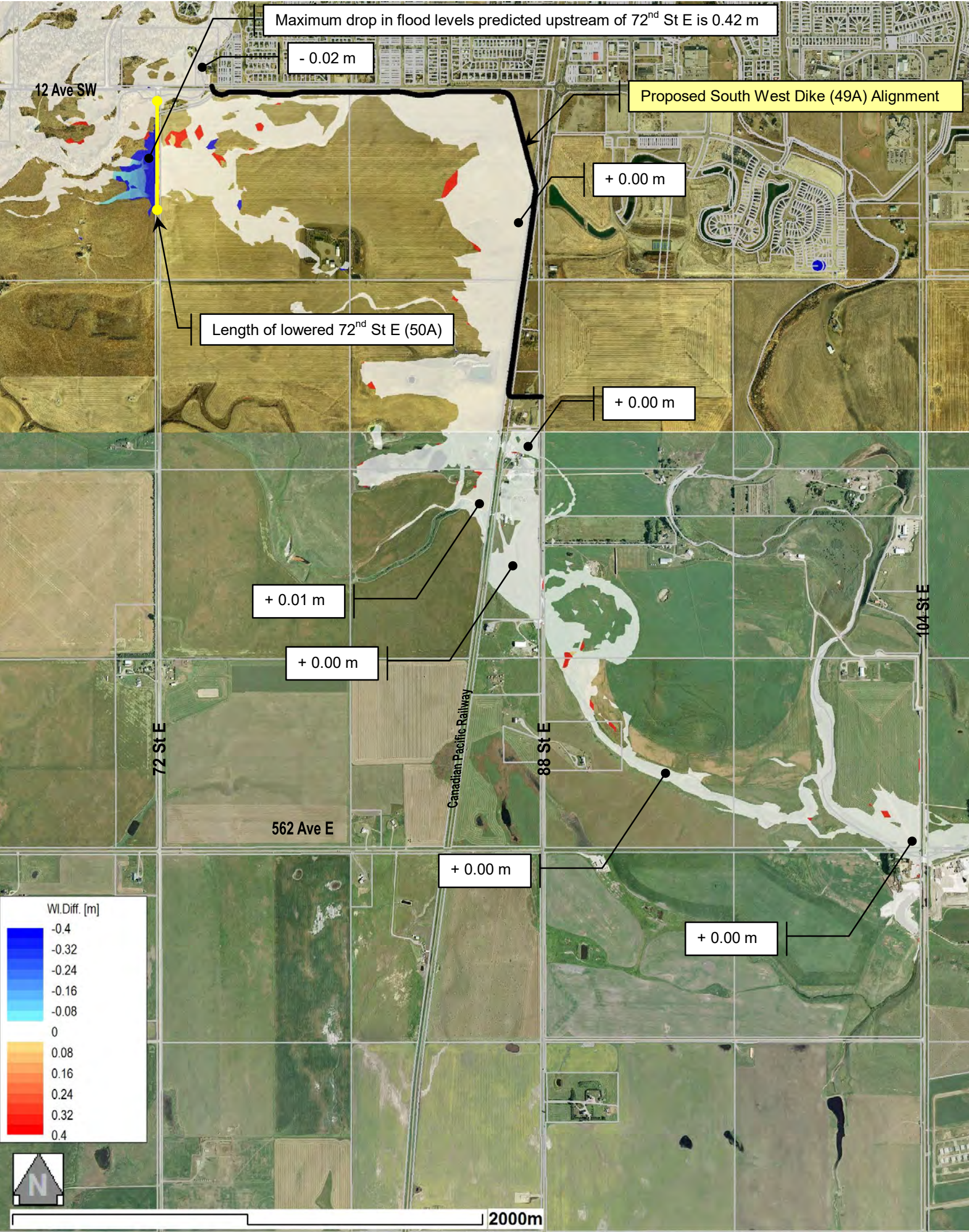
App'd By: J.B

Advisian Project No:
307011-00049

Figure No: 4

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.




NOTE:
Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	940	940	940	940
2. Highwood River – Downstream Town at 498 Ave Crossing	860	890 (+30)	890 (+30)	890 (+30)
3. Highwood River – At HWY2 Crossing	760	780 (+20)	780 (+20)	780 (+20)
4. Little Bow River – At 104 St East Crossing	40	40 (+0)	50 (+10)	50 (+10)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED CHANGE IN PEAK JUNE 2013 (940cms) FLOOD LEVELS DUE TO
PROPOSED MITIGATION CONDITION 50A (50A less 49A)

**Advisian**
WorleyParsons Group

Date: 6-MAR-18

Drawn By: R.G

Edited By:

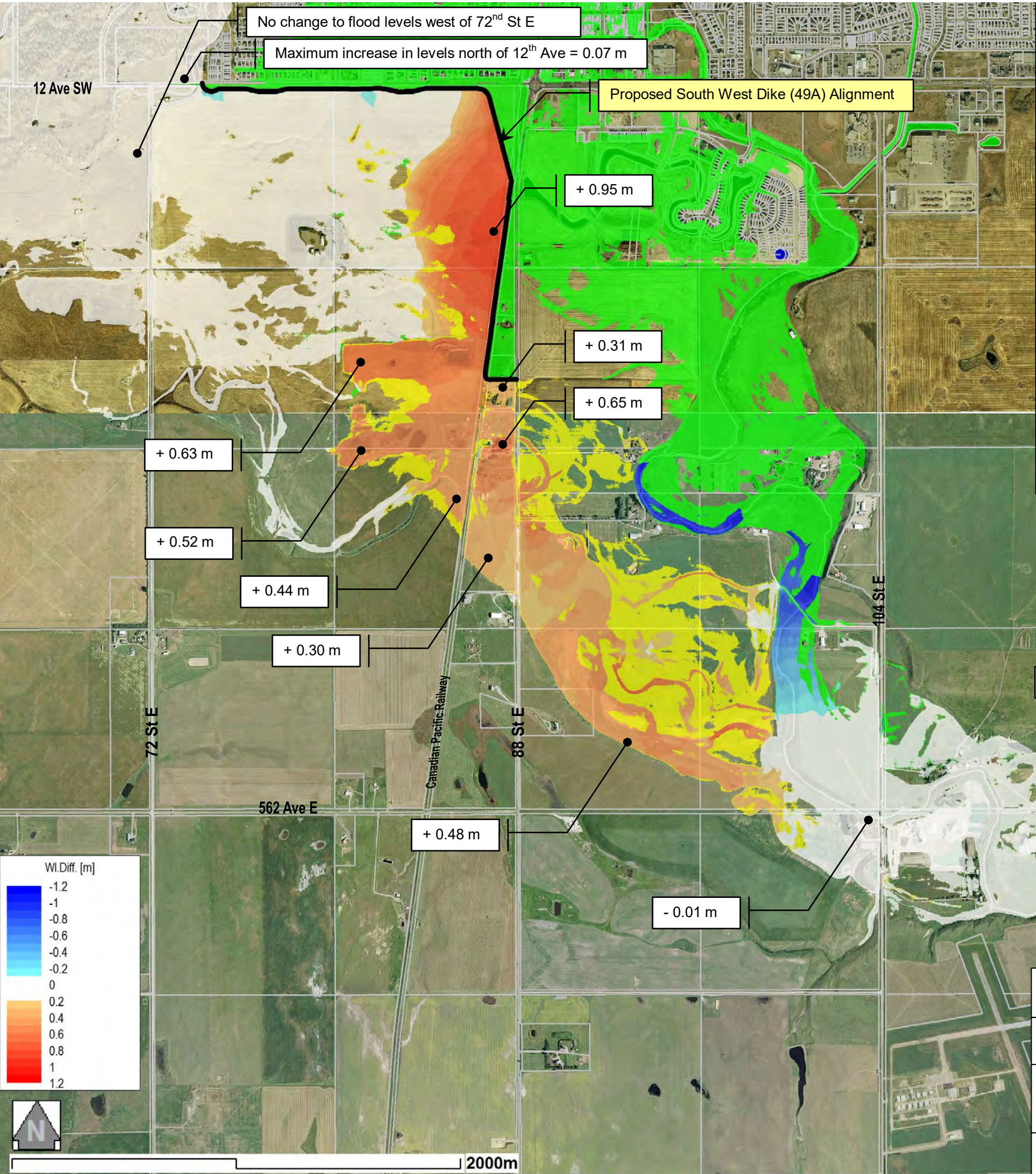
App'd By: J.B

Advisian Project No:
307011-00049

Figure No: **5**

Revision No: **A**

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.



NOTE:

Scenario 49A differs to 37A through:

- a. Inclusion of the South West Dike (SW Dike) with South Tail Extension,
- b. Minor raising of 12th Ave to the west of the West Town Dike and SW Dike connection, and
- c. Replacement of the single 1.6 m DIA. Culvert at the Baker Creek crossing of 12th Ave with two 2.7 m DIA. Culverts.

LOCATION	PREDICTED FLOW (m³/s) ^		
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]
1. High River Inflow – Upstream Town	1,820	1,820	1,820
2. High River – Downstream Town at 498 Ave Crossing	1,230	1,480 (+250)	1,490 (+260)
3. High River – At HWY2 Crossing	980	1,320 (+340)	1,330 (+350)
4. Little Bow River – At 104 St East Crossing	510	320 (-190)	320 (-190)


^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

LEGEND:

- Areas inundated during Mitigation Scenario 49A that are dry during Mitigation Scenario 37A
- Areas inundated during Mitigation Scenario 37A that are dry during Mitigation Scenario 49A

THE TOWN OF HIGH RIVER
SOUTH WEST DIKE WITH SOUTH TAIL

PREDICTED CHANGE IN PEAK JUNE 2013 (1,820cms) FLOOD LEVELS DUE TO
PROPOSED MITIGATION CONDITION 49A (49A less 37A)



Advisian

WorleyParsons Group

Date: 06-MAR-18

Drawn By: R.G

Edited By: R.G

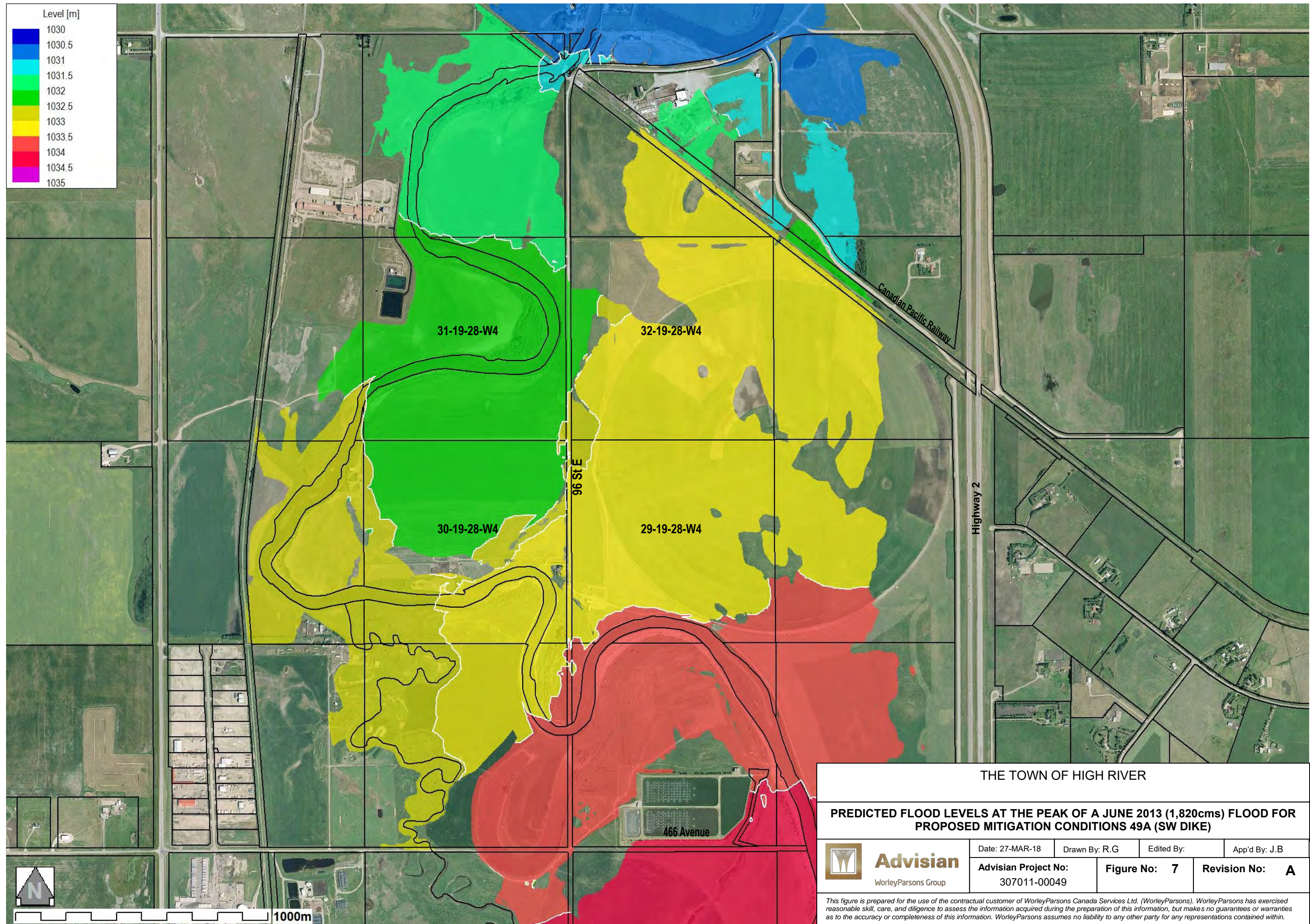
App'd By: J.B


Advisian Project No:
307011-00049

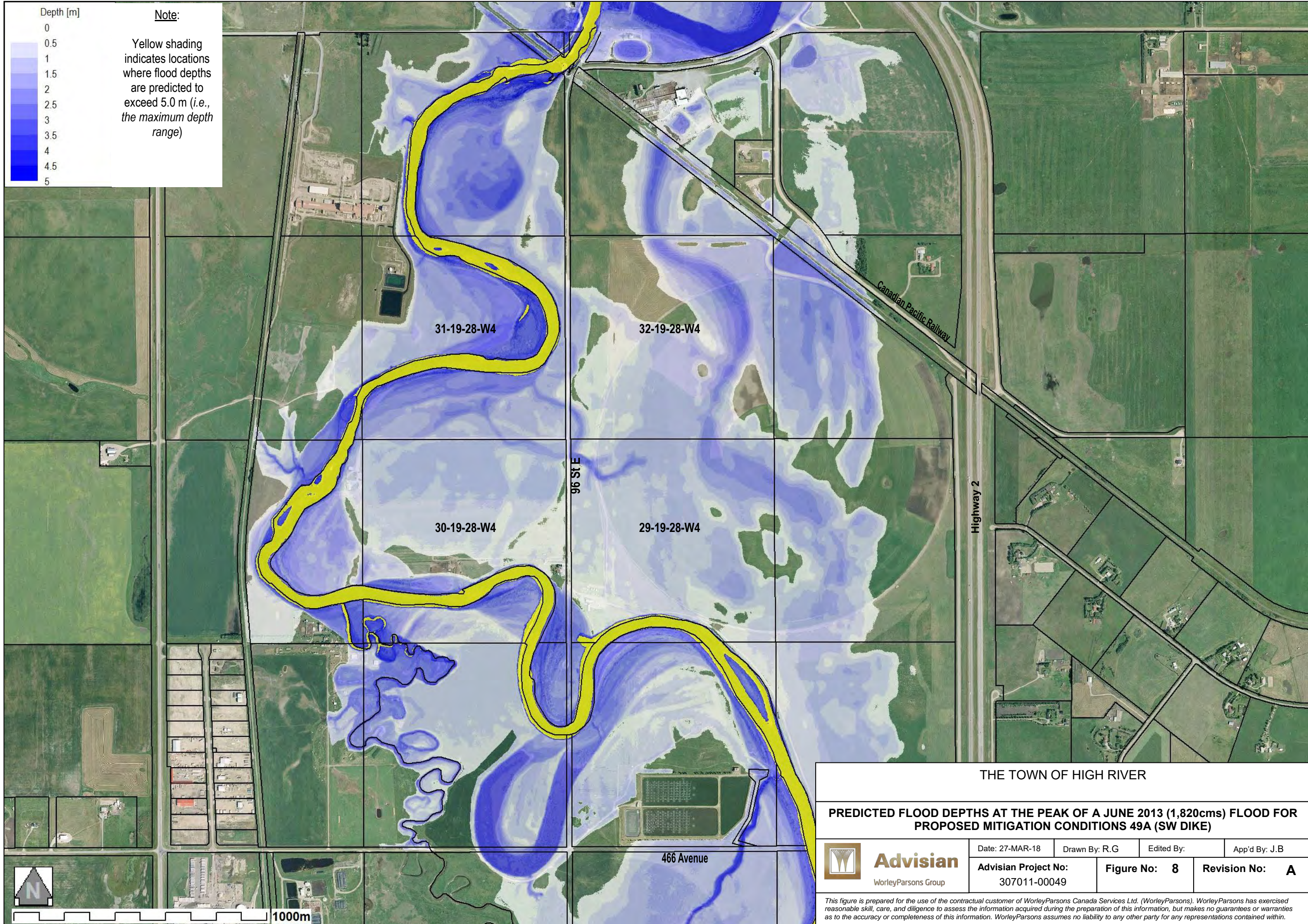
Figure No: 6

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.



THE TOWN OF HIGH RIVER			
PREDICTED FLOOD LEVELS AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD FOR PROPOSED MITIGATION CONDITIONS 49A (SW DIKE)			
 Advisian WorleyParsons Group	Date: 27-MAR-18	Drawn By: R.G	Edited By:
	Advisian Project No: 307011-00049	Figure No: 7	Revision No: A
<small>This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.</small>			



Depth [m]

0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Note:

Yellow shading indicates locations where flood depths are predicted to exceed 5.0 m (i.e., the maximum depth range)

31-19-28-W4

32-19-28-W4

30-19-28-W4

29-19-28-W4

96 St E

Canadian Pacific Railway

Highway 2

466 Avenue

THE TOWN OF HIGH RIVER

PREDICTED FLOOD DEPTHS AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD FOR PROPOSED MITIGATION CONDITIONS 49A (SW DIKE)



Advisian
WorleyParsons Group

Date: 27-MAR-18

Drawn By: R.G

Edited By:

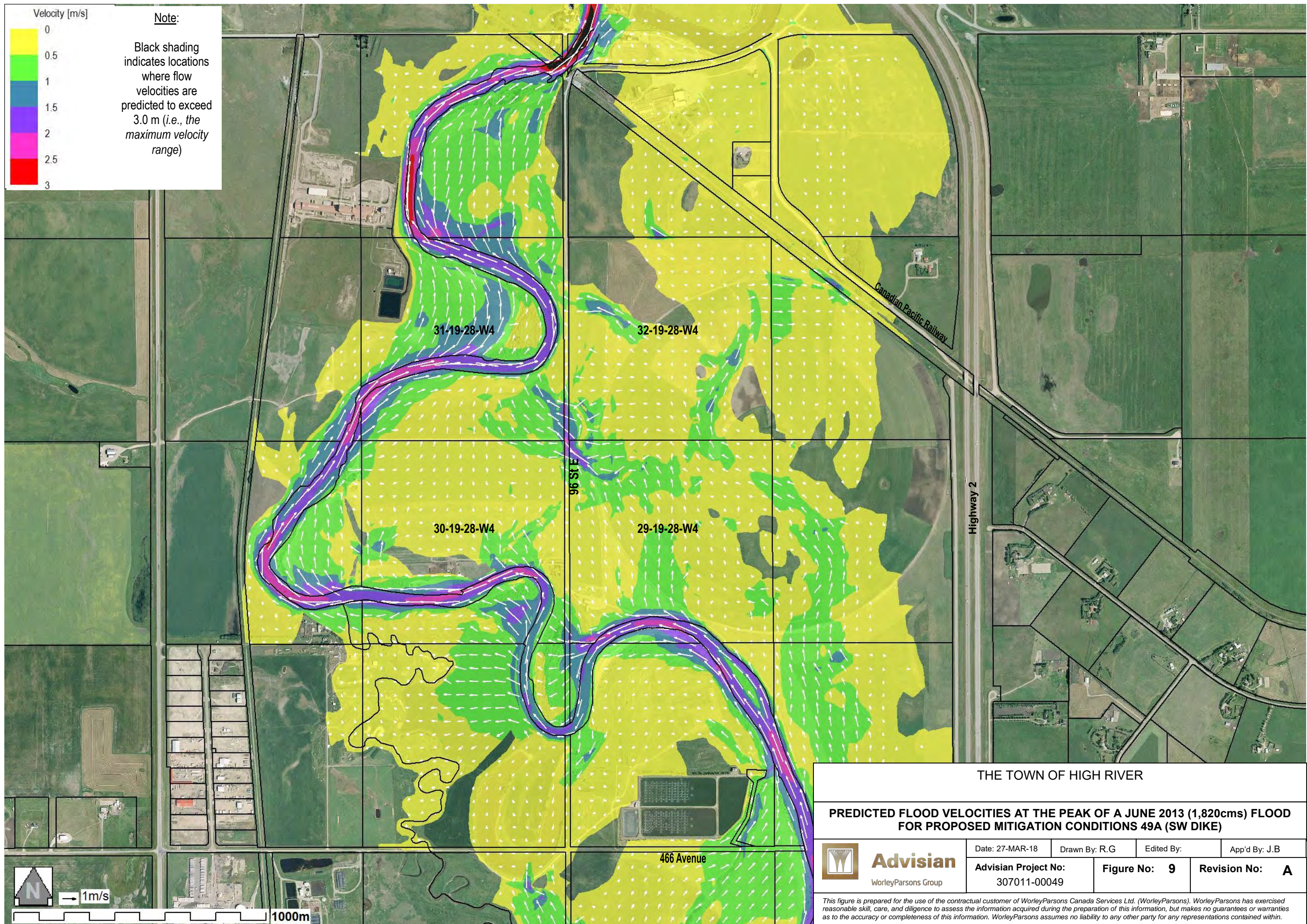
App'd By: J.B

Advisian Project No:
307011-00049

Figure No: 8

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.



THE TOWN OF HIGH RIVER

PREDICTED FLOOD VELOCITIES AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD
FOR PROPOSED MITIGATION CONDITIONS 49A (SW DIKE)



Advisian
WorleyParsons Group

Date: 27-MAR-18

Drawn By: R.G

Edited By:

App'd By: J.B



Advisian Project No:
307011-00049

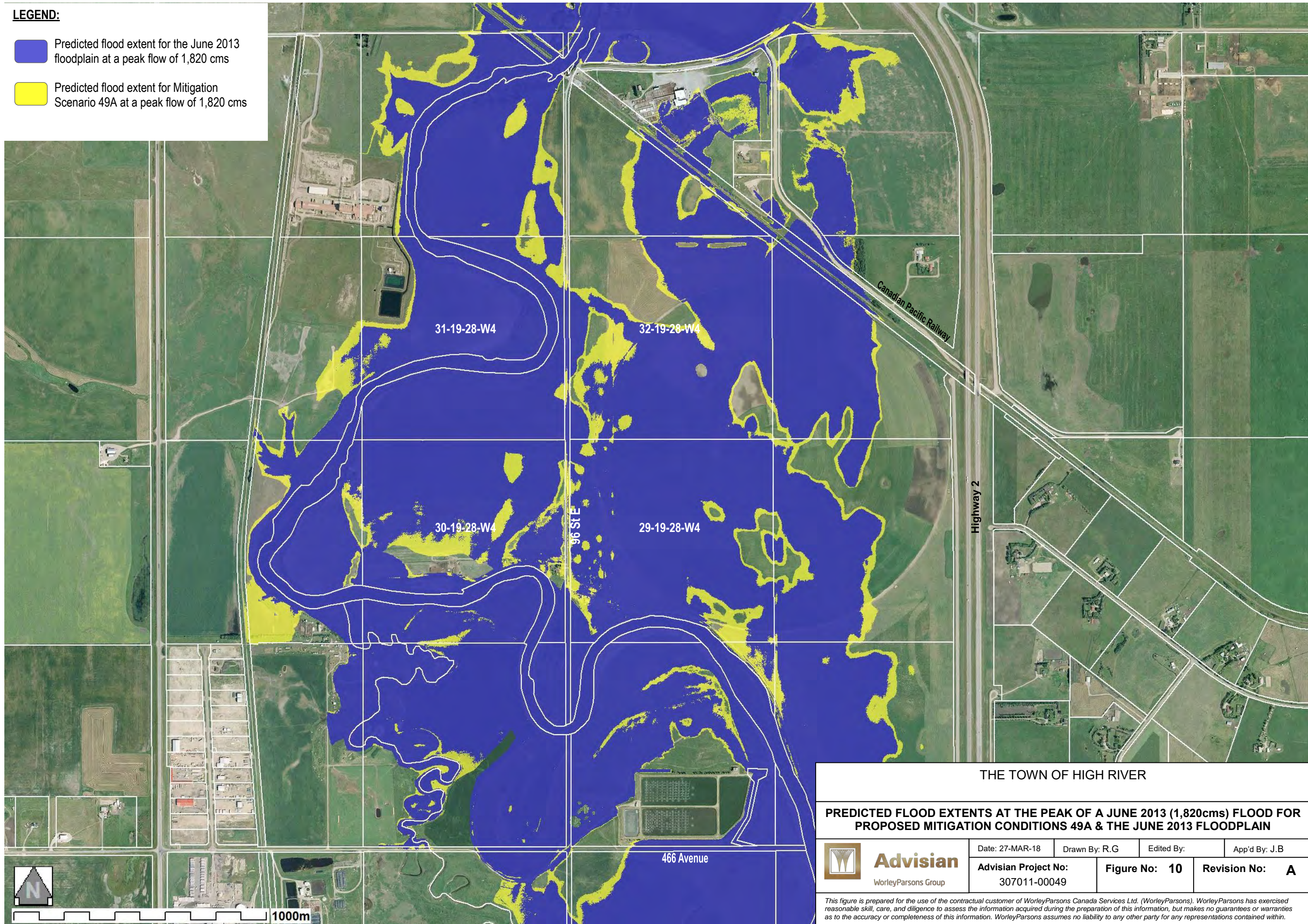
Figure No: 9

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.


LEGEND:

-  Predicted flood extent for the June 2013 floodplain at a peak flow of 1,820 cms
-  Predicted flood extent for Mitigation Scenario 49A at a peak flow of 1,820 cms

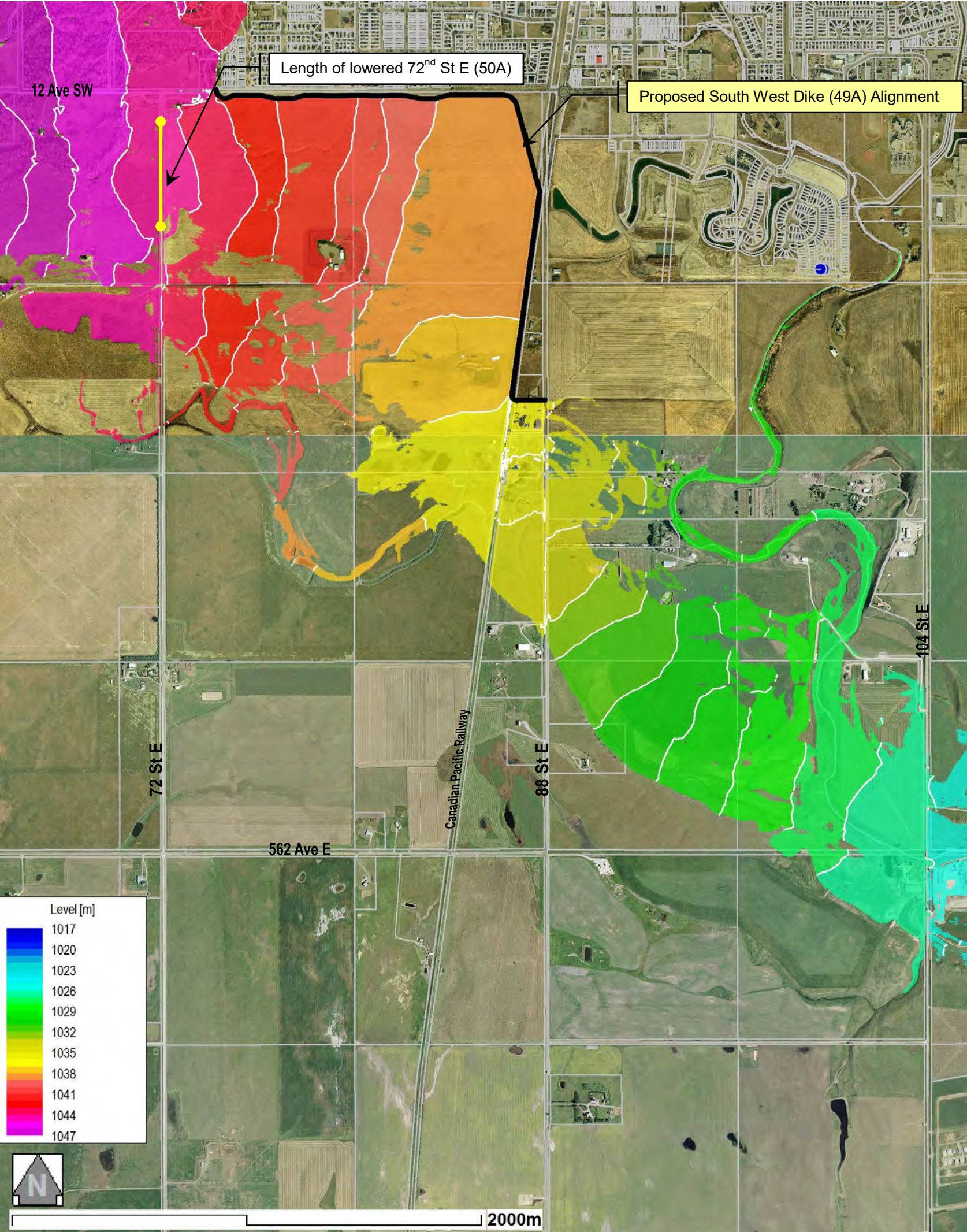


THE TOWN OF HIGH RIVER

PREDICTED FLOOD EXTENTS AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD FOR PROPOSED MITIGATION CONDITIONS 49A & THE JUNE 2013 FLOODPLAIN

 Advisian WorleyParsons Group	Date: 27-MAR-18	Drawn By: R.G	Edited By:	App'd By: J.B
	Advisian Project No: 307011-00049	Figure No: 10	Revision No: A	

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.



NOTE:
Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	1,820	1,820	1,820	1,820
2. Highwood River – Downstream Town at 498 Ave Crossing	1,230	1,480 (+250)	1,490 (+260)	1,490 (+260)
3. Highwood River – At HWY2 Crossing	980	1,320 (+340)	1,330 (+350)	1,330 (+350)
4. Little Bow River – At 104 St East Crossing	510	320 (-190)	320 (-190)	330 (-180)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED FLOOD LEVELS AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD FOR PROPOSED MITIGATION CONDITIONS 50A

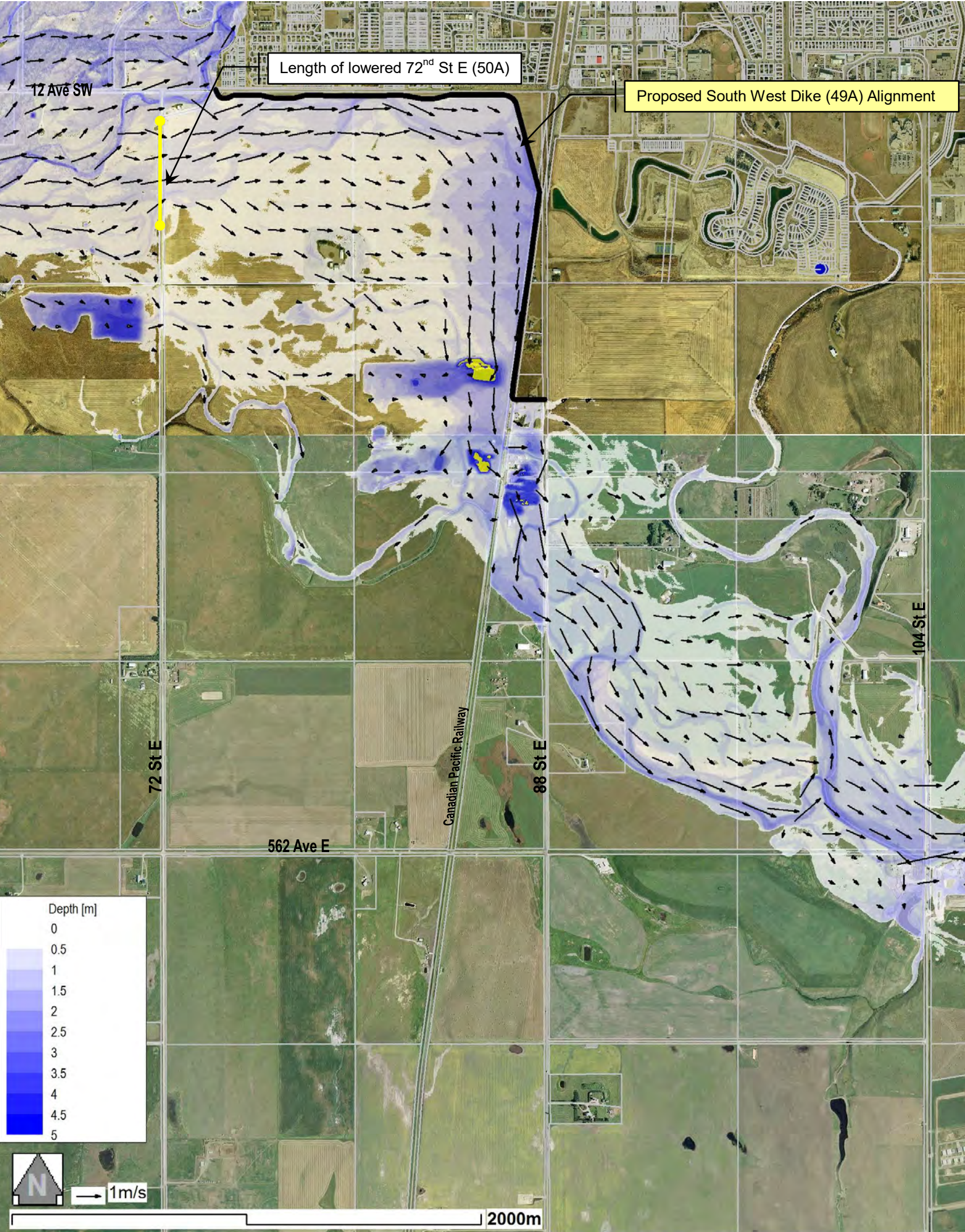


Advisian
WorleyParsons Group

Date: 21-MAR-18 Drawn By: R.G Edited By: App'd By: J.B

Advisian Project No: 307011-00049 Figure No: 11 Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.




NOTE:
Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	1,820	1,820	1,820	1,820
2. Highwood River – Downstream Town at 498 Ave Crossing	1,230	1,480 (+250)	1,490 (+260)	1,490 (+260)
3. Highwood River – At HWY2 Crossing	980	1,320 (+340)	1,330 (+350)	1,330 (+350)
4. Little Bow River – At 104 St East Crossing	510	320 (-190)	320 (-190)	330 (-180)

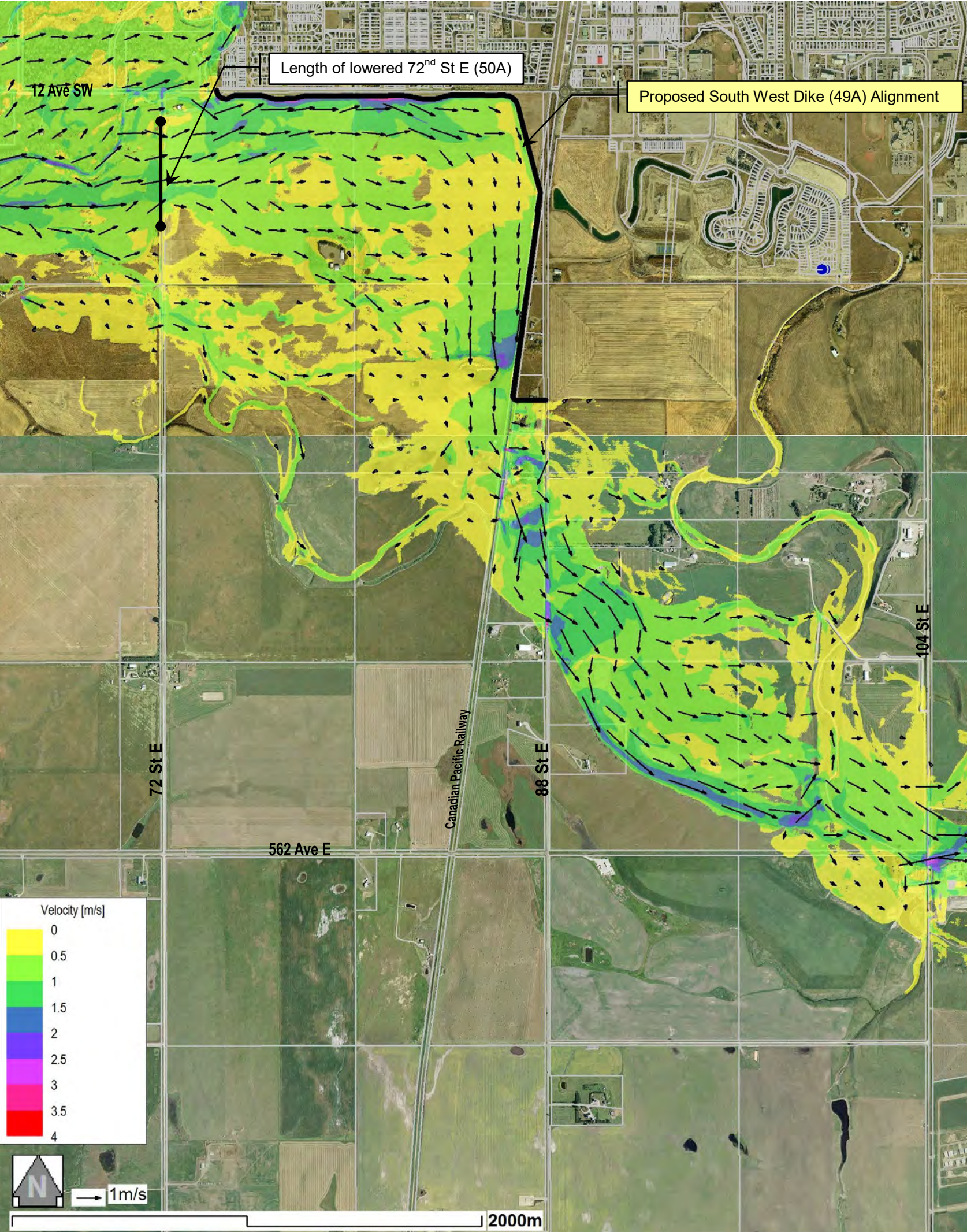
^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED FLOOD DEPTHS AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD FOR
PROPOSED MITIGATION CONDITIONS 50A

 Advisian WorleyParsons Group	Date: 21-MAR-18	Drawn By: R.G	Edited By:	App'd By: J.B
	Advisian Project No: 307011-00049	Figure No: 12	Revision No: A	

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.




NOTE:
Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	1,820	1,820	1,820	1,820
2. Highwood River – Downstream Town at 498 Ave Crossing	1,230	1,480 (+250)	1,490 (+260)	1,490 (+260)
3. Highwood River – At HWY2 Crossing	980	1,320 (+340)	1,330 (+350)	1,330 (+350)
4. Little Bow River – At 104 St East Crossing	510	320 (-190)	320 (-190)	330 (-180)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED VELOCITIES AT THE PEAK OF A JUNE 2013 (1,820cms) FLOOD FOR
PROPOSED MITIGATION CONDITIONS 50A



Advisian
WorleyParsons Group

Date: 21-MAR-18

Drawn By: R.G

Edited By:

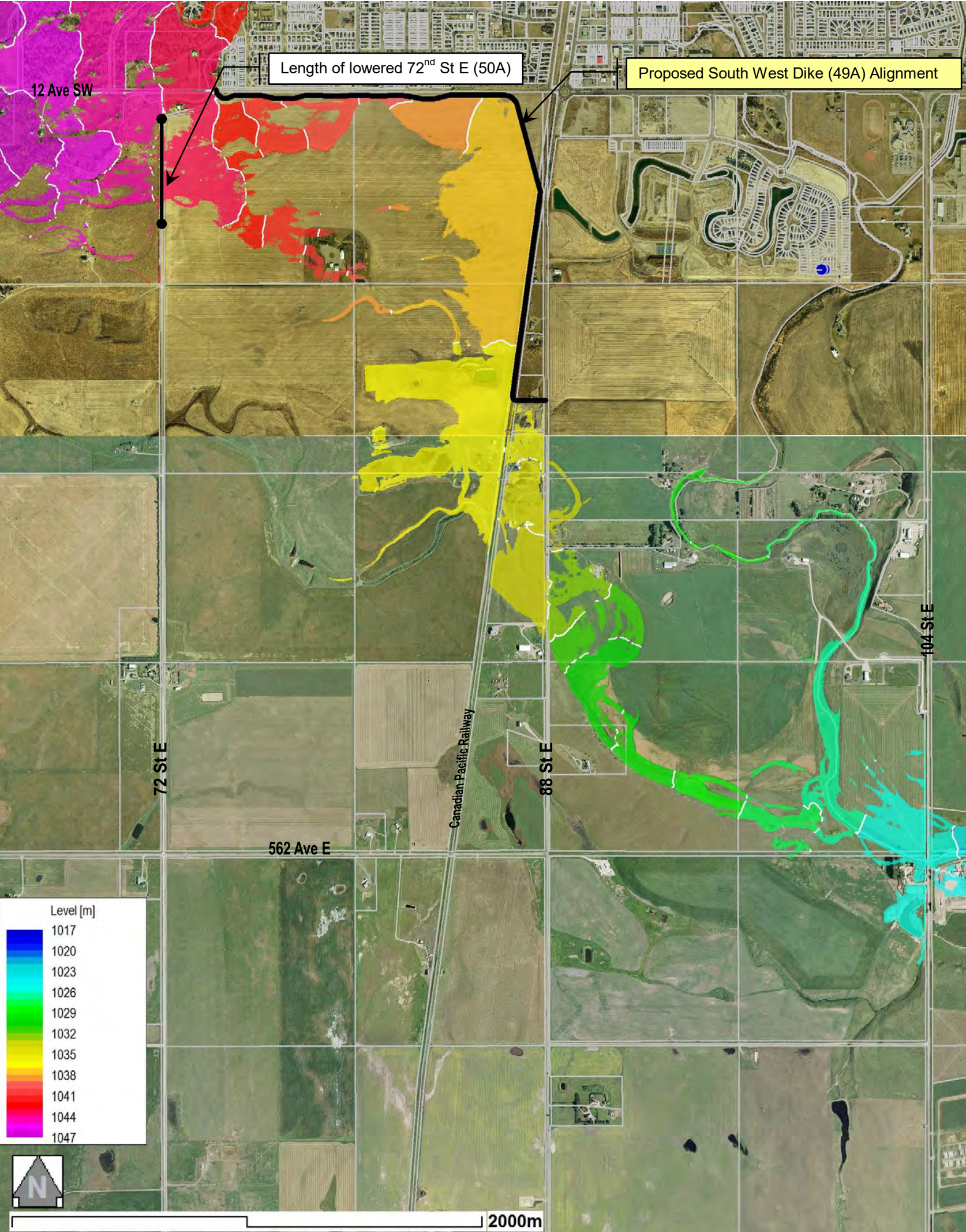
App'd By: J.B

Advisian Project No:
307011-00049

Figure No: 13

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.



NOTE:


Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	940	940	940	940
2. Highwood River – Downstream Town at 498 Ave Crossing	860	890 (+30)	890 (+30)	890 (+30)
3. Highwood River – At HWY2 Crossing	760	780 (+20)	780 (+20)	780 (+20)
4. Little Bow River – At 104 St East Crossing	40	40 (+0)	50 (+10)	50 (+10)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED FLOOD LEVELS AT THE PEAK OF 940 M³/S MAGNITUDE FLOOD FOR
PROPOSED MITIGATION CONDITIONS 50A



Advisian

WorleyParsons Group

Date: 21-MAR-18

Drawn By: R.G

Edited By:

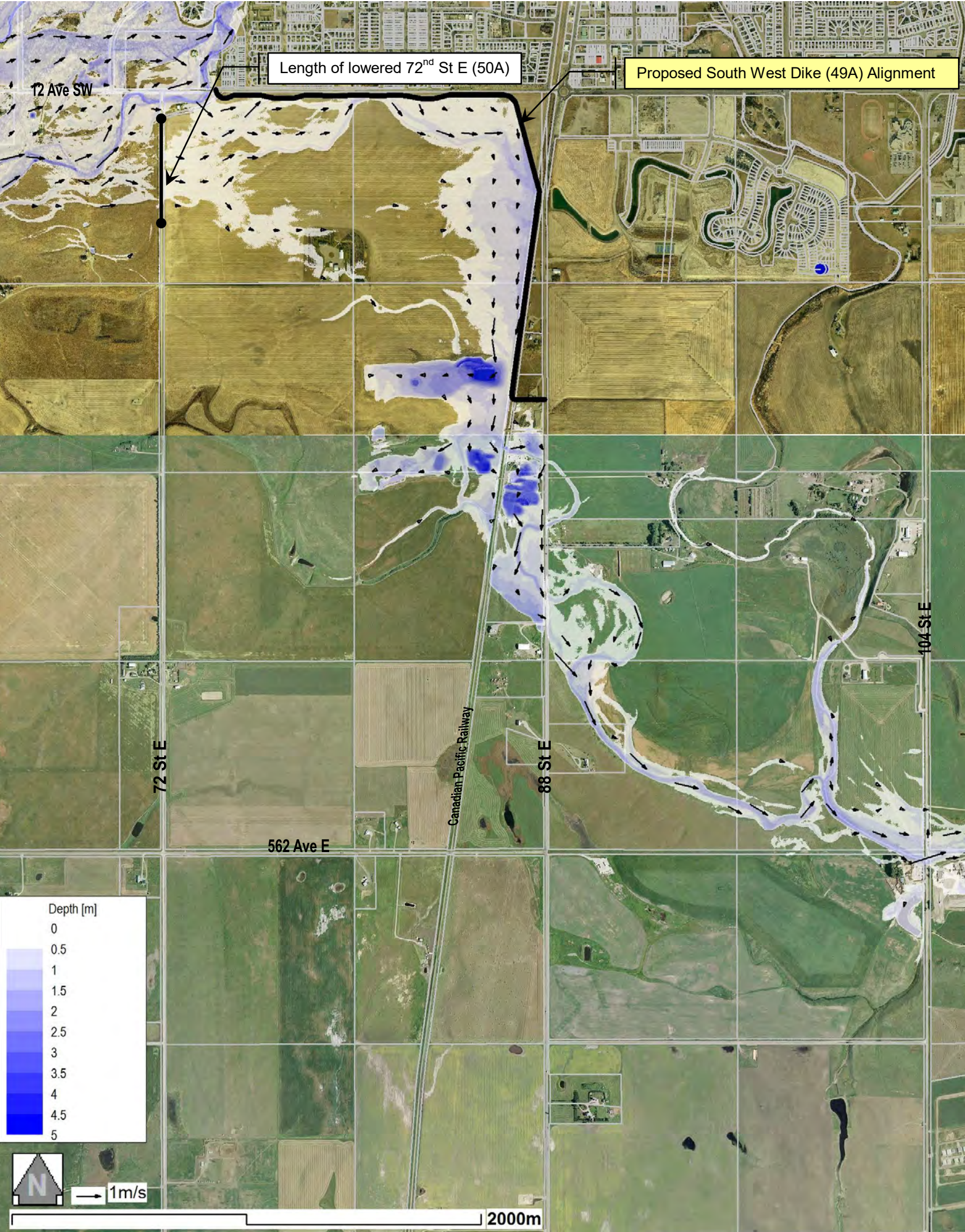
App'd By: J.B

Advisian Project No:
307011-00049

Figure No: 14

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.




NOTE:
Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	940	940	940	940
2. Highwood River – Downstream Town at 498 Ave Crossing	860	890 (+30)	890 (+30)	890 (+30)
3. Highwood River – At HWY2 Crossing	760	780 (+20)	780 (+20)	780 (+20)
4. Little Bow River – At 104 St East Crossing	40	40 (+0)	50 (+10)	50 (+10)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED FLOOD DEPTHS AT THE PEAK OF 940 M³/S MAGNITUDE FLOOD FOR
PROPOSED MITIGATION CONDITIONS 50A



Advisian
WorleyParsons Group

Date: 21-MAR-18

Drawn By: R.G

Edited By:

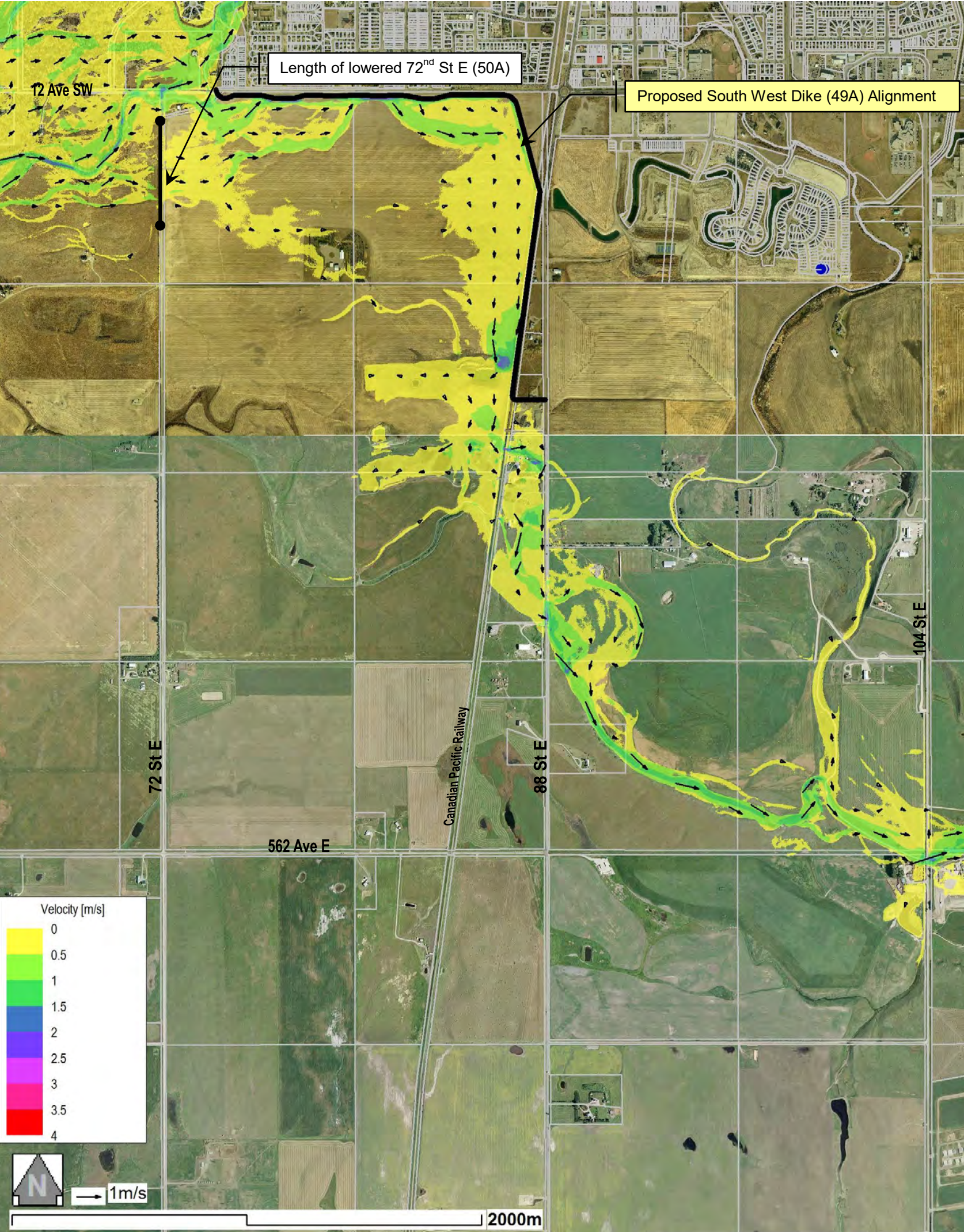
App'd By: J.B

Advisian Project No:
307011-00049

Figure No: 15

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.




NOTE:
Scenario 50A differs to 49A by only the lowering of part 72nd St E to have road crest elevations down to the adjacent ground levels; i.e., to make the road on grade.

LOCATION	PREDICTED FLOW (m³/s) ^			
	JUNE 2013 FLOODPLAIN	37A [PRESENT MITIGATION]	49A [SW DIKE + SOUTH TAIL]	50A [49A + LOWERED 72 nd St]
1. Highwood River Inflow – Upstream Town	940	940	940	940
2. Highwood River – Downstream Town at 498 Ave Crossing	860	890 (+30)	890 (+30)	890 (+30)
3. Highwood River – At HWY2 Crossing	760	780 (+20)	780 (+20)	780 (+20)
4. Little Bow River – At 104 St East Crossing	40	40 (+0)	50 (+10)	50 (+10)

^ The units digit provided are for relative comparison purposes only and do not reflect the accuracy of the model on which they are based. Peak flows at each location do not necessarily occur at the same time as a function of different travel times and varying degrees of flow attenuation upstream of each location.

THE TOWN OF HIGH RIVER
AFFECTS OF LOWERING 72ND ST E

PREDICTED VELOCITIES AT THE PEAK OF 940 M³/S MAGNITUDE FLOOD FOR
PROPOSED MITIGATION CONDITIONS 50A



Advisian
WorleyParsons Group

Date: 21-MAR-18

Drawn By: R.G

Edited By:

App'd By: J.B

Advisian Project No:
307011-00049

Figure No: 16

Revision No: A

This figure is prepared for the use of the contractual customer of WorleyParsons Canada Services Ltd. (WorleyParsons). WorleyParsons has exercised reasonable skill, care, and diligence to assess the information acquired during the preparation of this information, but makes no guarantees or warranties as to the accuracy or completeness of this information. WorleyParsons assumes no liability to any other party for any representations contained within.