NATURAL RESOURCES CONSERVATION BOARD

IN THE MATTER OF THE *NATURAL RESOURCES CONSERVATION BOARD ACT*, RSA 2000, c. N-3

IN THE MATTER OF NRCB APPLICATION NO. 1701 BY ALBERTA TRANSPORTATION

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

BOOK OF DOCUMENTS OF ALBERTA TRANSPORTATION TO THE REPLY SUBMISSIONS OF ALBERTA TRANSPORTATION TO THE INTERVENERS AND HEARING PARTICIPANTS WHO ARE OPPOSED TO THE SPRINGBANK OFF-STREAM RESERVOIR PROJECT ("SR1")

APPENDICES A TO I

VOLUME I OF II

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Appendix A to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

AT's Land Acquisition Program for SR1

Land Acquisition Program—Springbank Off-Stream Reservoir Project

Process and Principles
1. The Government of Alberta needs to acquire a total of 3,870 acres (1,566 hectares) of land for the Springbank Off-Stream Reservoir Project (SR1). The Government's preference is to acquire land voluntarily and to only resort to expropriation in the event voluntary acquisition is not possible.
2. To support the voluntary acquisition of land for the SR1 Project, the Government has retained an accredited and independent appraisal firm to carry out site-specific appraisals of all of the properties required for the project. These appraisals will estimate the fair market value of the lands required for the Project, as well as damages and any other compensation to which a landowner may be entitled under the *Expropriation Act.* Such damages/compensation may include business losses, relocation costs, etc. depending on the facts of the situation.
3. To support the appraisal of the lands required for the Project—and to ensure that the appraisals are as accurate as possible—landowners will be contacted by representatives of the government to try to arrange a site inspection and a meeting between the appraiser and each landowner before commencing the appraisal process.
4. Upon completion of the appraisal for a property, the landowner will be contacted to attempt to set up a meeting to deliver a copy of and to discuss the appraisal report. The Government will offer to purchase the property at the appraised value or, should that not be acceptable to the landowner, enter into voluntary purchase negotiations. If the Government is unable to come to a voluntary agreement with any landowner for the acquisition of his or her land, the Government will initiate expropriation proceedings. However, expropriation proceedings will not be initiated before the SR1 project has received approvals from the Natural Resources Conservation Board (NRCB) and from the federal government under applicable federal environmental assessment legislation.
5. If, after reviewing the Government's offer and appraisal, the landowner doesn't think the offer is fair, or isn't sure, the landowner may retain his or her own appraiser to carry out an appraisal. The Government will pay the cost of the landowner's appraisal, the only conditions being that the appraiser have appropriate professional accreditation (e.g., an AACI designation), the landowner provide a copy of the appraisal to the Government for its review, and the appraiser's costs are reasonable. This is consistent with the provisions of the *Expropriation Act*.
6. After the Government has had an opportunity to review the landowner's appraisal, the Government will offer to resume negotiations with the landowner with a view to reaching an

agreement on the amount of compensation payable.

7. If after the landowner has obtained his or her own appraisal the parties are still unable to reach agreement on the amount of compensation the government will proceed with expropriation. As noted above, the government will not commence expropriation proceeding until NRCB and federal environmental approvals for the project are in place.

8. At any time, the Government will be prepared to negotiate entering into an agreement with a landowner pursuant to section 30 of the *Expropriation Act*. This section provides that an owner may consent to the acquisition of land by an expropriating authority subject to the condition that compensation for the land will be determined by the Land Compensation Board of Alberta.

9. Under the *Expropriation Act*, the government is only legally able to expropriate land required for the project, that is, land within the project boundaries. The Project Area for the SR1 Project is irregular (i.e., it does not follow quarter section boundaries) as it is based on engineering calculations of the area that will be inundated during flood conditions. This would result in many "partial takings" (i.e., where only part of a quarter section or other titled unit is taken), leaving remnant parcels. Moreover, access to some of these remnant parcels post-acquisition may be difficult if not impossible. Therefore, the government will consider, on a case-by-case basis, acquiring entire parcels at a landowner's request. The government estimates that a total of 6,233 ac (2,522 ha) could potentially be acquired if every landowner asks to be bought out in full and doing so was reasonable in the circumstances.

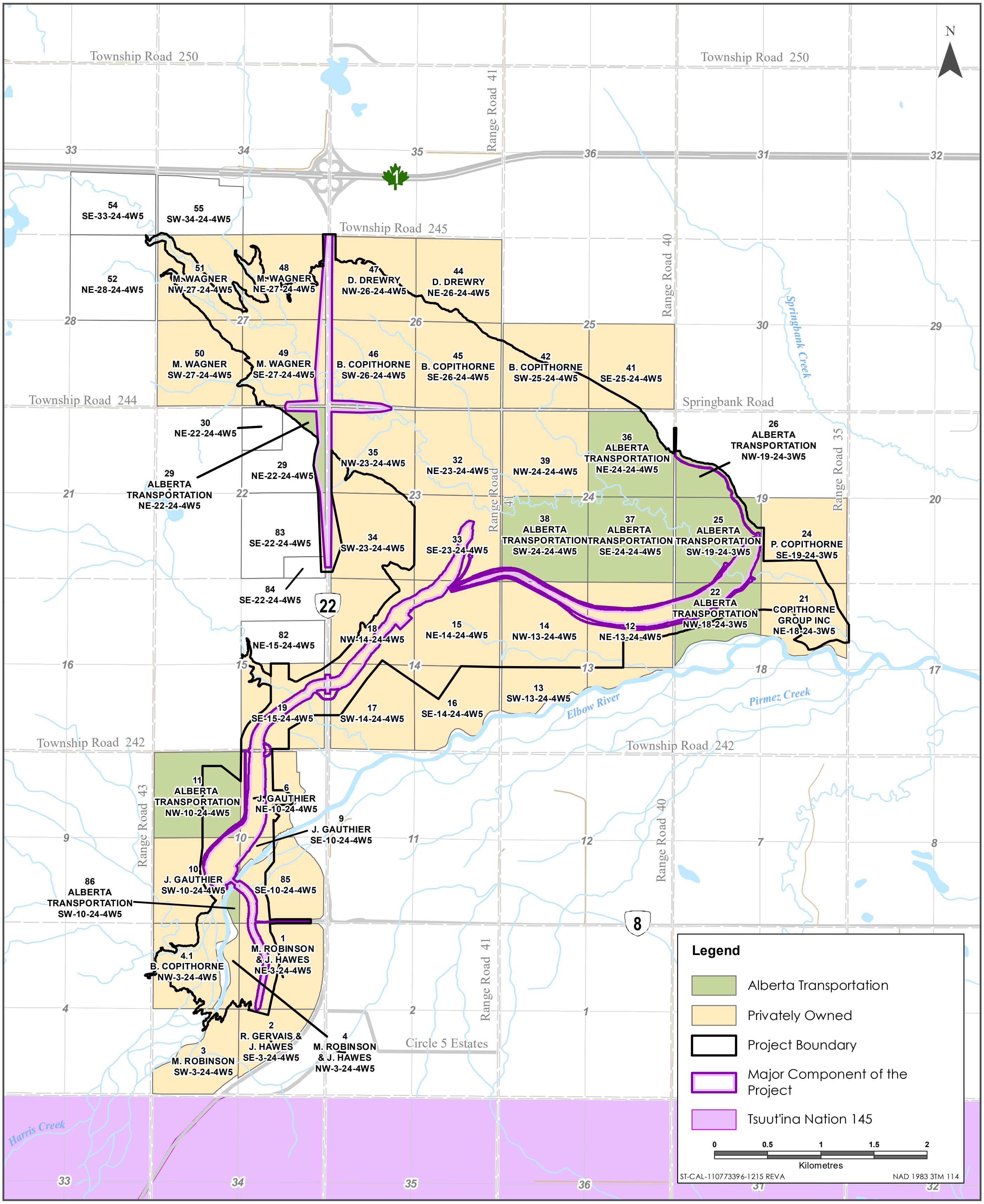
10. In the event the SR1 Project is not approved by either the NRCB or the federal government, and the Government has already acquired land for the Project, the Government will offer to sell the land back to any landowner who wishes. In anticipation that such a situation might arise, the Government is also prepared to make any voluntary purchase agreement conditional upon the Project receiving approvals from the NRCB and the federal government.

11. As per the *Expropriation Act*, the reasonable legal, appraisal and other costs actually incurred by a landowner in connection with land acquisition negotiations or expropriation proceedings will be paid by the Government.

12. The foregoing principles and processes are intended to serve as a guide to the conduct of the land acquisition program for the SR1 Project. The Government is prepared to be flexible in all negotiations with landowners, within the legal framework established by the *Expropriation Act*, and welcomes input on this land acquisition program.

Appendix B to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

Current map of all the land acquired to date by AT



Sources: Base Data - Government of Canada. Thematic Data - Government of Alberta

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

3/12/2021

Land Acquisition Status

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure1-1

Appendix C to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

<u>Full chronology of meetings with members of the SCLG</u>

Appendix "C"

Response to Appendix C of SCLG Written Submissions

Record of Engagement with members of the SCLG

July 18, 2014

The Government of Alberta (GoA) met with landowners potentially impacted by SR1, to share information with landowners regarding the current status of the proposed project and for landowners to ask questions and provide feedback to the GoA.

Landowners inquired about:

- why the GoA decided to proceed with the SR1 over other options and requested a decision-making timeline;
- why SR1 was not included in flood mitigation studies completed by Alberta WaterSMART;
- which stakeholders were engaged in the completion of these reports;
- why SR1 was selected for detailed engineering and design, and what makes SR1 feasible if other options were not;
- why an option that provides protection to Bragg Creek and Redwood Meadows was not selected;
- The GoA's flood policy;
- why they should provide flood mitigation for Calgary in exchange for their land;
- who was responsible for the project and which engineering firms would be eligible to submit proposals.

The GoA answered their questions and acknowledged engagement with landowners potentially impacted by SR1 to date had not been satisfactory and the GoA offered an apology. The GoA stated they were committed to engaging landowners as the process moved forward into the detailed engineering and design phase and the EIA phase. The GoA was interested in having the meeting to be a starting point for a mutually meaningful engagement process.

SCLG Members (including Scott Wagner) who attended:

- Phil Copithorne
- Susan Copithorne
- Brian Copithorne
- Marsha Wagner
- Scott Wagner
- Janet Hawes
- Mary Robinson
- Michele Luider

September 22, 2014

An email notification was sent to affected landowners providing the draft Terms of Reference for the EIA and advising that the project would be publicly advertised in local newspapers on September 24, 2014.

October 7, 2014

Brittany Goulding of Alberta Environment and Sustainable Resources Development (AESRD) attended a presentation given to the Rocky View Country Policy and Priorities Committee by Scott Wagner of Don't Damn Springbank ("**DDS**"). Concerns expressed by DDS included: inadequate consultation with landowners, little evidence provided on environmental impact and efficiency of the proposed Project, lack of consideration of other flood mitigation projects, and the withholding of information by the GoA.

March 3, 2015

Representatives of AT and AESRD and consultants from Stantec, AMEC and IBI Group met with a group of landowners that included the following members of SCLG:

- Marsha Wagner
- Susan Copithorne
- Mary Robinson
- Claudia Weigelsberger
- Phil Copithorne
- Janet Hawes
- Michele Luider
- Diana Drewry
- Lee Drewry
- Brian Copithorne

The purpose of the meeting was to discuss SR1 Project, including presentations on:

- Alberta flood mitigation in the Elbow River Basin;
- an Environmental Review of McLean Creek (MC1);
- the Benefit and Cost analyses that had been performed;
- the SR1 Project and regulatory processes;
- the Engineering and Design of SR1; and
- next steps involved with the Environmental Impact Assessment (EIA)

March 2015 to July 2016

AT had several meetings with SR1 landowners and/or their legal counsel to discuss access requirements to conduct field work.

October 26, 2016

Seamas Skelly of AT and representatives from DEMA Land Services met with Mary Robinson to participate in a walking tour of M. Robinson's property. M. Robinson pointed out possible teepee rings, an old camp site, the old Stoney Trail and provided a history of her ranch.

September 27, 2017

Email to several landowners, including some members of the SCLG, as a follow-up to questions raised in an Open House exit survey. The email addressed AT's need to work with directly affected landowners to acquire lands for the SR1 Project.

November 1 and 8, 2017

On November 1, 2017 AT held a technical briefing for landowners at the McDougall Centre in relation to the federal environmental assessment under the *Canadian Environmental Assessment Act, 2012*. Because several landowners were unable to attend the briefing on November 1, a second briefing was held on November 8.

The following members of the SCLG were sent email invitations (on October 30 and 31, 2017) to attend the technical briefings:

- Lee and Diana Drewry
- Michele Luider
- Janet Hawes
- Mary Robinson
- Brian Copithorne
- Phil Copithorne

May 22 and May 24, 2018

On May 22, 2018 a Project Open House was held in Springbank and on May 24, 2018 and Open House was held in Calgary. Records of attendance from these Open Houses indicate that the following members of the SCLG attended at least one of the Open Houses:

- Brian Copithorne
- David Klepacki
- Mary Robinson
- Tracey Feist
- Susan Copithorne
- Karen Massey
- Karin Hunter

November 30, 2018

Assistant Deputy Minister Crystal Damer and other representatives from AT, Alberta Justice, Stantec and Golder, met with Dave Klepacki, Karen Massey and Karin Hunter of the Springbank Community Association ("**SCA**"), Robert Madlener of the Flood and Water Management

Council ("**FWMC**") and Mary Robinson. Topics of discussion included the impacts of the 2013 flood on Redwood Meadows and the Springbank area, the unique challenges to SR1, air quality, water quality, land implications, traffic concerns, financial implications, social, cultural and environmental implications and tourism impairment. The comparative advantages and disadvantages of SR1 vs MC1 were discussed and Mr. Madlener presented information on the benefits of the Tri-River Joint Reservoir Project.

June 11, 2019

Telephone call between Karin Hunter of the SCA and Matthew Hebert of AT. Mr. Hebert advised that a stakeholder briefing on SR1 Round 1 Supplementary Information Requests ("**SIR**") would take place on June 13, 2019 at the McDougall Centre in Calgary.

June 12, 2019

Email from Karin Hunter to Matthew Hebert, advising that she would try to attend the June 13 stakeholder briefing. Ms. Hunter provided contact information for the Bragg Creek Community Association and Bragg Creek Chamber of Commerce and advised they were hosting an SR1 evening in Bragg Creek on June 17, 2019.

June 13, 2019

Update on the SR1 regulatory process, including Round 1 SIRs, presented by representatives of AT, including ADM Damer, Stantec and Golder. Karin Hunter of the SCA attended, as did representatives of Rocky View County.

SR1 Project representatives provided an update regarding the SR1 Project regulatory process, questions from the regulator and responses from Alberta Transportation. SR1 Project representatives provided an overview of regulator inquiries and responses regarding Project costs and benefits, additional flood mitigation considerations, land use, traditional uses, environmental impacts and water and aquatic life.

June 19, 2019

Email from Matthew Hebert to SCA (Karin Hunter) thanking her for attending the stakeholder meeting and inquiring when she would like to meet to review the SIR responses with AT's technical experts.

July 8, 2019

Email from Matthew Hebert to SCA (Karin Hunter) asking to speak by telephone as he had information he wanted to share.

July 8, 2019

Telephone call between Karin Hunter and Matthew Hebert. Mr. Hebert advised that the report of the independent expert (Martin Ignasiak) was scheduled to be released July 9 but had been postponed. Mr. Hebert advised he would follow up with Ms. Hunter once he had more information. Ms. Hunter advised they were reviewing the SIR responses and would follow up with AT.

July 23, 2019

Email from Matthew Hebert to SCA (Karin Hunter) inquiring if Ms. Hunter was available for a telephone call to discuss SR1.

July 25, 2019

Telephone call between Karin Hunter and Matthew Hebert. Mr. Hebert offered to meet with the SCA to review the June 2019 SIRs. Ms. Hunter advised that the SCA was currently reviewing the SIRs and would like to meet with AT in Fall 2019.

September 11, 2019

Email from Matthew Hebert to SCA (Karin Hunter) inquiring whether Ms. Hunter would be available for a telephone call later that week.

October 6, 2019

Email from Matthew Hebert to SCA (Karin Hunter) advising that AT was preparing written answers to Ms. Hunter's inquiries. M. Hebert requested a meeting between AT and SCA.

November 5, 2019

Email from Matthew Hebert to SCA (Karin Hunter) advising of filings made by AT to the regulators and where this project information could be found.

November 11, 2019

Email from Matthew Hebert to SCA (Karin Hunter) confirming that AT was working with TransCanada and other pipeline and utility companies regarding the relocation of infrastructure and pipelines.

November 24, 2019

Email from Matthew Hebert to SCA (Karin Hunter). Mr. Hebert provided the Conceptual Design Update Memorandum for SR1.

December 3, 2019

Email from Matthew Hebert to SCA (Karin Hunter) requesting a meeting to discuss any outstanding questions.

December 4, 2019

Email from Matthew Hebert to SCA (Karin Hunter). Mr. Hebert provided the draft "Guiding Principles and Directions for Land Use" document and a list of land management tools. Mr.

Hebert advised AT was proposing principles for future land use that would allow First Nations traditional activities and details of future land use would be determined through further engagement. Mr. Hebert advised he was available to meet to discuss the draft Guiding Principles and to respond to any other questions about the Project.

December 10, 2019

Email from Matthew Hebert to SCA (Karin Hunter). Mr. Hebert advised that AT submitted responses to the Round 1 SIRs from the provincial and federal regulators on June 14, 2019.

January 27, 2020

AT Minister Rick McIver, Project lead Matthew Hebert and other senior AT officials met with local MLA Miranda Rosin and the following members of the SCLG in Bragg Creek:

- Karin Hunter
- Brian Copithorne
- Dave Klepacki
- Karen Massey
- Lee Drewry
- May Robinson

April 14, 2020

Email from Matthew Hebert to the SCA (Karin Hunter), advising that Tsuut'ina Nation had provided letters of non-objection regarding SR1 to federal and provincial regulators on April 1, 2020. Mr. Hebert provided a website link to the news release.

May 12, 2020

Email from Matthew Hebert to the Elbow River Sustainability Alliance ("**ERSA**") (Karin Hunter), advising that the Government of Alberta has committed funding to SR1 for the following three years. Mr. Hebert provided a website link to the Government of Alberta news release.

June 2020

Letter sent by registered mail, from Matthew Hebert to SR1 directly affected and adjacent landowners (including some members of the SCLG), discussing the purpose of SR1, the regulatory process, and committing AT to engaging with stakeholders and First Nations. Mr. Hebert offered to discuss the project further and provided contact information.

June 1, 2020

Email from Matthew Hebert to the SCA (Karin Hunter) advising that AT had received SIRS from provincial and federal regulators as part of the EIA process.

June 3, 2020

Email from Matthew Hebert to the SCA (Karin Hunter) providing a website link to the SR1 Spring 2020 Project Update #2.

June 4, 2020

Email from Matthew Hebert to ERSA and SCA (Karin Hunter) advising that the project team was available for a conference call with ERSA to discuss SR1. Mr. Hebert indicated that the government's agreement with Tsuut'ina was confidential and subject to non-disclosure agreement and he could not provide details. Hebert advised pipeline relocation projects were managed by third parties.

June 30, 2020

Email from Matthew Hebert to the SCA (Karin Hunter), advising that AT has responded to the Round 2 SIRs from the provincial regulator.

July 12, 2020

Email from Matthew Hebert to the SCA (Karin Hunter), following up on June 4, 2020 email requesting a meeting. Mr. Hebert noted an article in local newspaper raising concerns about the project.

July 22, 2020

Email from Matthew Hebert to the SCA (Karin Hunter), providing a link to the website where AT's responses to Round 2 SIRs could be accessed.

September 20, 2020

Email from Matthew Hebert to SCA (Karin Hunter) advising of Community Information Sessions.

October 4, 2020

Email from Matthew Hebert to ERSA (Karin Hunter) advising that the NRCB had provided notice to convene a pre-hearing conference and information on how to access information.

October 7, 2020

Email from Matthew Hebert to ERSA (Karin Hunter) advising that the NRCB had provided notice that the Prehearing Conference had been scheduled for December 2, 2020.

October 15, 2020

Email from Matthew Hebert to ERSA (Karin Hunter) advising that the fall 2020 Project update and Community Information Session presentations were posted on the Project website. Mr.

Hebert noted the Project update would also be provided to adjacent and directly affected landowners in the Project area by registered mail.

October 22, 2020

Email from Matthew Hebert to the SCA (Karin Hunter), advising that AT had filed responses to IAAC SIRs on October 22, 2020, outlining the Government of Alberta's intended approach to future land use of the Project area.

November 8, 2020

Email from Matthew Hebert to the SCA (Karin Hunter), advising that the NRCB hearing would provide an opportunity for Ms. Hunter to raise concerns about the Project. Mr. Hebert advised he was prepared to meet with Ms. Hunter prior to the hearing to further discuss her concerns.

November 12, 2020

Email from Matthew Hebert to the SCA (Karin Hunter) regarding the IAAC environmental assessment process. Mr. Hebert advised that on November 6, 2020 AT received a letter from IAAC providing notification that AT's second round of responses were sufficient for the purposes of resuming their technical review. Mr. Hebert explained that on November 7, 2020 the federal legislated timeline for the review of SR1 resumed.

Appendix D to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

Technical memorandum prepared by Stantec correcting errata in Acoustic Environment Assessment

Stantec

Memo

To:	Matthew Hebert Alberta Transportation	From:	Jonathan Chui Stantec Consulting Ltd.
File:	110773396	Date:	March 5, 2021

Reference: Noise Assessment Errata – Existing Sound Level and Quiet Rural Area Adjustment

This memorandum is provided to identify and correct errata in a portion of the acoustic environment assessment for the Springbank Off-stream Reservoir Project (the Project) The acoustic environment assessment examined five scenarios based on the duration and type of construction activities. Scenario 4 represents construction activities greater than one year such as earthworks and roadworks for the construction of dam embankment, floodplain berm, and diversion channel. The errata are related to results in Scenario 4. The revised results outlined in the memorandum below indicate exceedance of the percent highly annoyed (%HA) threshold of 6.5% at 4 additional receptors: SR21, SR22, SR23, and SR37. These exceedances will be reduced to acceptable levels through mitigation measures and noise management plan implemented by Alberta Transportation. This correction does not change the conclusions of the acoustic environment assessment.

HEALTH CANADA “QUIET RURAL AREA” ADJUSTMENT

Health Canada defines a “quiet rural area” location with dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers and average density of 28 people per square km. In EIA, Volume 4, Appendix F, Acoustic Environment, Table 4B-3, receptors SR6, SR7, SR16, SR17, SR24, and SR36 were selected for the 10 dB “quiet rural area” adjustment based on the Health Canada noise guidance classification of “quiet rural area”. Hwy 22, Springbank Road, and Hwy 8 are considered heavily travelled roads based on the AUC Rule 12 definition. SR6, SR7, SR16, SR17, SR24, and SR36 meet the criteria for a “quiet rural area” as they are more than 500 m from heavily travelled roads with less than average density of 28 people per square km.

In considering all receptors represented by monitoring locations M1 and M4 (i.e., L_{dn} less than 45 dBA) that meets the Health Canada’s classification for “quiet rural area” described above, nine additional receptors (i.e., SR21, SR22, SR23, SR29, SR33, SR34, SR35, SR37, and SR51) should also have been considered as “quiet rural area” with the 10 dB adjustment included in the %HA calculations. Table 1 summarizes the revised “Quiet Rural Area” adjustment for all receptors. The values used in the 2018 EIA assessment are included for reference purposes. Bolded values in table indicate the revised values.

Reference: Noise Assessment Errata – Existing Sound Level and Quiet Rural Area Adjustment

Table 1 Revised Existing Sound Level and Quiet Rural Area Adjustment

Receptor ID	Quiet Rural Area Adjustment (dB)	
	Revised	EIA 2018 Assessment
SR01	0	0
SR02	0	0
SR03	0	0
SR04	0	0
SR05	0	0
SR06	10	10
SR07	10	10
SR08	0	0
SR09	0	0
SR10	0	0
SR11	0	0
SR12	0	0
SR13	0	0
SR14	0	0
SR15	0	0
SR16	10	10
SR17	10	10
SR18	0	0
SR19	0	0
SR20	0	0
SR21	**10**	0
SR22	**10**	0
SR23	**10**	0
SR24	10	10
SR25	0	0
SR26	0	0
SR27	0	0
SR28	0	0
SR29	**10**	0
SR30	0	0
SR31	0	0
SR32	0	0

Table 1 Revised Existing Sound Level and Quiet Rural Area Adjustment

Receptor ID	Quiet Rural Area Adjustment (dB)	
	Revised	EIA 2018 Assessment
SR33	**10**	0
SR34	**10**	0
SR35	**10**	0
SR36	10	10
SR37	**10**	0
SR38	0	0
SR39	0	0
SR40	0	0
SR41	0	0
SR42	0	0
SR43	0	0
SR51	**10**	0
SR57	0	0

RESULTS

The change in %HA results are revised with the 10 dB adjustment is applied at nine additional receptors. Table 2 summarizes the revised noise assessment results for Scenario 4. The bolded values indicate results that are different from the results presented in Table 4-13 of the 2018 assessment. The revised results indicate exceedance of the %HA threshold of 6.5% at 16 receptors instead of 12 receptors. These four additional receptors are SR21, SR22, SR23, and SR37.

Table 2 Predicted Sound Levels and Compliance – Scenario 4

Scenario 4 (greater than one year)—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation								
Receptor ID	Noise Contribution from Project (dBA)			Combined Project and Existing Sound Leve, L_{dn} (dBA)	Existing %HA	Combined Existing and Project % HA	Change in %HA	Meets Change in %HA limit of less than 6.5% (Yes/No)
	Daytime (L_d)	Nighttime (L_n)	Day-Night Equivalent (L_{dn})					
SR01	49.7	40.6	50.1	54.5	3.0	3.9	0.9	Yes
SR02	47.2	39.9	48.4	57.2	5.1	5.5	0.4	Yes
SR03	44.6	40.3	47.6	57.1	5.1	5.4	0.3	Yes
SR04	52.7	48.4	55.7	56.1	1.1	4.8	3.6	Yes
SR05	50.7	49.3	55.9	56.3	1.1	4.9	3.7	Yes

Reference: **Noise Assessment Errata – Existing Sound Level and Quiet Rural Area Adjustment**

Table 2 Predicted Sound Levels and Compliance – Scenario 4

Scenario 4 (greater than one year)—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation								
Receptor ID	**Noise Contribution from Project (dBA)**			**Combined Project and Existing Sound Leve, L_{dn} (dBA)**	**Existing %HA**	**Combined Existing and Project % HA**	**Change in %HA**	**Meets Change in %HA limit of less than 6.5% (Yes/No)**
	Daytime (L_d)	**Nighttime (L_n)**	**Day-Night Equivalent (L_{dn})**					
SR06	45.5	44.8	51.3	62.2	4.1	10.1	6.0	Yes
SR07	43.3	42.9	49.4	60.7	4.1	8.4	4.3	Yes
SR08	41.7	41.5	47.9	49.7	1.1	2.1	1.0	Yes
SR09	56.2	45.6	56.0	56.4	1.2	4.9	3.7	Yes
SR10	51.0	48.8	55.6	56.0	1.2	4.7	3.5	Yes
SR11	55.7	54.8	61.4	61.5	1.2	9.2	8.0	No
SR12	53.8	52.9	59.5	59.6	1.1	7.4	6.3	Yes
SR13	52.6	52.0	58.5	58.7	1.1	6.6	5.4	Yes
SR14	54.5	54.2	60.7	60.8	1.1	8.5	7.3	No
SR15	54.3	54.1	60.5	60.7	1.1	8.4	7.2	No
SR16	51.9	51.3	57.8	68.0	4.1	19.5	15.3	No
SR17	40.1	40.0	46.4	58.8	4.1	6.7	2.5	Yes
SR18	59.0	57.9	64.5	64.5	1.2	13.2	12.0	No
SR19	68.2	63.9	71.2	71.3	1.2	27.0	25.8	No
SR20	61.3	59.9	66.5	66.6	1.2	16.6	15.4	No
SR21	49.5	49.3	55.7	56.1	**4.1**	**15.8**	**11.7**	**No**
SR22	52.0	52.3	58.7	58.9	**4.1**	**21.2**	**17.1**	**No**
SR23	51.2	51.5	57.9	58.1	**4.1**	**19.6**	**15.5**	**No**
SR24	45.7	45.6	52.0	62.8	4.1	10.8	6.7	No
SR25	66.5	59.5	67.9	67.9	1.2	19.2	18.0	No
SR26	45.2	42.0	49.0	50.5	1.1	2.3	1.2	Yes
SR27	42.3	40.0	46.8	49.0	1.1	1.9	0.8	Yes
SR28	42.4	40.1	46.9	49.1	1.1	1.9	0.8	Yes
SR29	42.1	39.9	46.7	48.9	**4.1**	**6.8**	**2.7**	Yes
SR30	43.2	40.8	47.6	49.5	1.1	2.1	0.9	Yes
SR31	43.7	41.2	48.1	49.8	1.1	2.1	1.0	Yes
SR32	44.0	41.8	48.6	50.2	1.1	2.2	1.1	Yes
SR33	44.7	42.8	49.5	50.8	**4.1**	**8.6**	**4.4**	Yes

Reference: **Noise Assessment Errata – Existing Sound Level and Quiet Rural Area Adjustment**

Table 2 Predicted Sound Levels and Compliance – Scenario 4

Scenario 4 (greater than one year)—earthworks and roadworks, dam embankment, floodplain berm, diversion channel, daytime and nighttime operation								
Receptor ID	**Noise Contribution from Project (dBA)**			**Combined Project and Existing Sound Leve, L_{dn} (dBA)**	**Existing %HA**	**Combined Existing and Project % HA**	**Change in %HA**	**Meets Change in %HA limit of less than 6.5% (Yes/No)**
	Daytime (L_d)	**Nighttime (L_n)**	**Day-Night Equivalent (L_{dn})**					
SR34	44.9	43.2	49.9	51.1	**4.1**	**8.8**	**4.7**	Yes
SR35	45.5	43.8	50.5	51.6	**4.1**	**9.3**	**5.2**	Yes
SR36	49.8	49.3	55.8	66.1	4.1	15.8	11.7	No
SR37	50.5	50.8	57.2	57.4	**4.1**	**18.2**	**14.1**	**No**
SR38	54.4	52.6	59.3	59.5	1.1	7.2	6.1	Yes
SR39	55.0	52.4	59.3	59.4	1.1	7.2	6.1	Yes
SR40	65.6	56.0	65.8	65.8	1.2	15.3	14.0	No
SR41	68.3	61.9	70.0	70.0	1.2	23.9	22.7	No
SR42	36.7	29.5	38.0	56.6	5.1	5.1	0.0	Yes
SR43	42.3	36.7	44.5	56.8	5.1	5.2	0.2	Yes
SR51	42.0	42.0	48.4	50.0	**4.1**	**7.8**	**3.6**	Yes
SR57	42.6	40.2	47.0	49.2	1.1	2.0	0.8	Yes

Chui, Jonathan

Digitally signed by Chui, Jonathan
Date: 2021.03.05 15:00:28 -07'00'

Jonathan Chui P.Eng., INCE
Senior Associate
Noise Management Group

Phone: (403)7502337
jonathan.chui@stantec.com

Reference: Noise Assessment Errata – Existing Sound Level and Quiet Rural Area Adjustment

REFERENCES

Calgary Airport Authority 2019. Springbank Airport Community Noise Study. October 2019

YBW 2021. YBW Springbank Airport website
https://www.ybw.ca/YourNeighbourhoodAirport/NoiseManagement.aspx

Appendix E to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project (“SR1”):

Technical memorandum prepared by Stantec in response to the Austin Engineering Report

Stantec

Memo

To:	Matthew Hebert Alberta Transportation	From:	John Menninger, P. Eng. Cincinnati, OH
File:	110773396	Date:	March 10, 2021

Reference: Springbank Off-Stream Storage Project – SCLG Intervenor Submission

On behalf of the SR1 Concerned Landowners Group, Austin Engineering prepared a Design Review of the Springbank Off-Stream Storage Project (SR1) dated February 25, 2021 (Exhibit 256). Austin Engineering suggested two deficiencies of the design with regards to the Canadian Dam Association (CDA) Dam Safety Guidelines (2007) and listed a series of recommendations and issues.

The purpose of this memorandum is to provide the Natural Resources Conservation Board (NRCB) with Stantec's response to the Austin Engineering Design Review. The two suggested deficiencies are addressed in detail and the remaining recommendations / issues are covered in brief responses in Table 1 attached to this memorandum.

Emergency Spillway Capacity

Austin Engineering states that the SR1 Project design does not meet the CDA Dam Safety Guidelines for the following reason:

> *The Storage Dam is assigned a consequence classification of Extreme, yet the Emergency Spillway cannot safely discharge the design inflow of 600 m^3/s.*

It is our opinion that Austin Engineering is misinterpreting the CDA Guidelines for spillway design. The CDA Dam Safety Guidelines (2007) state:

> *The discharge facilities should be capable of passing the IDF, taking into account the routing effect of the reservoir, without infringing on the minimum freeboard requirements.*

The design of the SR1 Emergency Spillway meets these criteria, as presented below, without relying on closure of the Diversion Inlet gates. There is no requirement to pass the design flow or peak flow into a reservoir without consideration of routing effects of the reservoir.

The design of the Emergency Spillway is presented in Section 9.6 of the Springbank Off-Stream Storage Project Preliminary Design Report (Exhibit 159). The Emergency Spillway provides an emergency outlet in the event flows entering the Off-stream Storage Reservoir exceed its design storage capacity. The Emergency Spillway consists of a 135 m-wide side channel concrete drop structure, a riprap exit channel between retaining walls, and an excavated outlet channel which returns flow to the Elbow River. The crest elevation of the Emergency Spillway overflow weir is elevation 1210.75 m which correlates to the design storage capacity. The maximum design head is elevation 1212.0 m which correlates to the maximum design pool elevation. The maximum design pool elevation of 1212.0 m was determined through freeboard calculations using CDA Dam Safety Guidelines (2013) which account for wind setup and wave runup to maintain 1.5 m of freeboard to the Off-stream Storage Reservoir Dam crest elevation of 1213.5 m.

Reference: Springbank Off-Stream Storage Project – SCLG Intervenor Submission

Planned operations for Springbank Off-Stream Storage Project will not activate the Emergency Spillway. Prior to complete filling of the reservoir storage capacity (EL 1210.75 m), the Diversion Inlet gates would be closed, preventing additional diversion. This planned operation is presented in Figure 1 below.

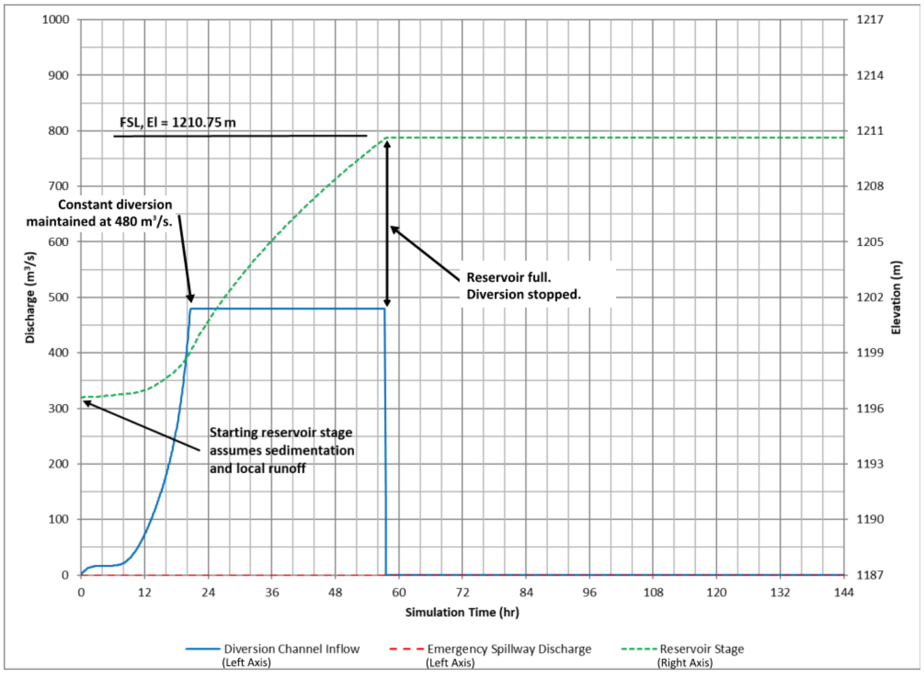


Figure 1 Reservoir Routing – Design Flood Operations (PMF)

Multiple risk mitigation measures and redundant systems have been incorporated into the design to reduce the risk of the Diversion Inlet gates failing to close. These include the sizing of the gates systems, the selection of hoist operators, the addition of a debris deflection barrier, backup power generation and manual overrides for lowering the gates without power.

However, because an equipment or operational failure could result in the Diversion Inlet gates not being closed, the Emergency Spillway provides passive redundancy to prevent the Off-stream Storage Reservoir from exceeding the maximum design pool elevation of 1212.0 m during the Probable Maximum Flood (PMF) event. The system was evaluated for a worst-case scenario in which the gates were left completely open and flow was allowed to enter the Diversion Channel uncontrolled. For these scenarios, Stantec routed the PMF hydrograph through the diversion structure. The diversion structure was assumed to operate according to design operations during this hydrograph, diverting up to 480 m^3/s into the diversion channel, however once the PMF hydrograph exceeded the design capacity of the gates to maintain 480 m^3/s, the scenario assumes that flow is diverted uncontrolled into the Diversion Channel. During this scenario, the PMF event results in a peak discharge of 872 m^3/s entering the Diversion Channel.

Stantec used an unsteady 1D HEC-RAS hydraulic model to simulate freeboard in the Diversion Channel, flow over the Emergency Spillway and stage in the Off-stream Storage Reservoir during the uncontrolled PMF diversion hydrograph. While a peak discharge of 872 m^3/s may enter the diversion channel, the peak of this hydrograph occurs while the Off-stream Storage Reservoir still has available storage capacity and before the

Reference: Springbank Off-Stream Storage Project – SCLG Intervenor Submission

Emergency Spillway activates. By the time the Emergency Spillway activates at Elevation 1210.75 m, the inflow hydrograph is on the descending limb. The design results in a maximum discharge over the Emergency Spillway of 317 m^3/s and a maximum reservoir stage of 1211.9 m. Results hydrographs for the uncontrolled PMF event diversion scenario are presented in Figure 2.

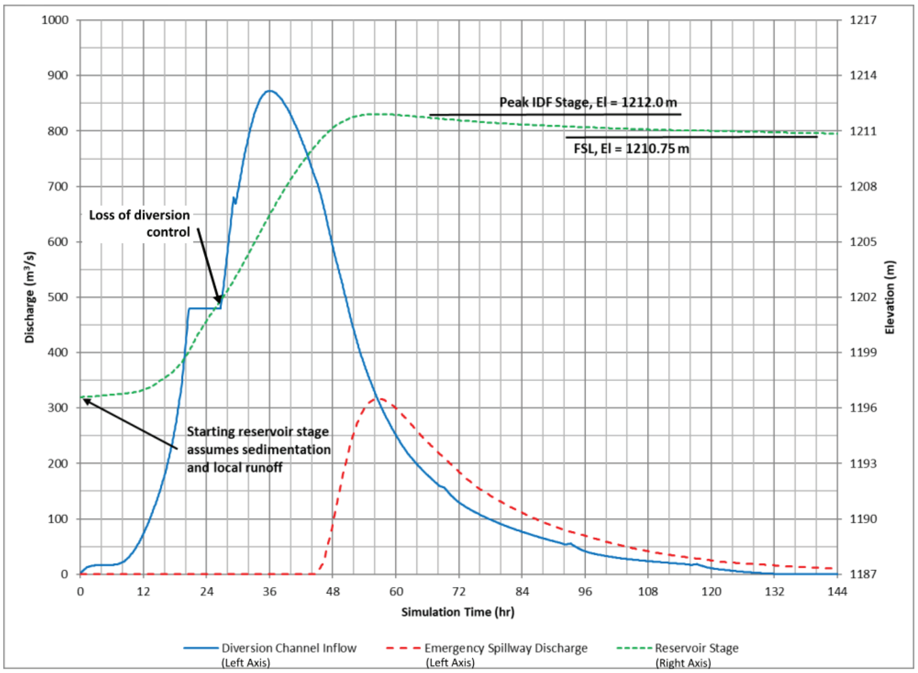


Figure 2 Reservoir Routing – PMF (Assuming Gates Fail Open)

As presented, the Emergency Spillway and reservoir can safely pass the Probable Maximum Flood without relying on the Diversion Inlet gates closing and while maintaining adequate freeboard. This meets the CDA Design Guidelines and industry standard of practice.

Pseudo-Static Factor of Safety for Dam Stability

Austin Engineering also states that the SR1 Project design does not meet the CDA Dam Safety Guidelines for this reason:

> *The minimum required factor of safety against slope failure with pseudo-static loading (1.0) is not achieved for the Storage Dam.*

It is our opinion that Austin Engineering is misinterpreting the CDA Guidelines for seismic stability. In CDA's Technical Bulletin Geotechnical Considerations for Dam Safety (2007), it is stated in Section 6.5.1:

> *The seismic safety assessment of existing or proposed embankment dam is usually performed in phases, beginning with simplified methods, such as pseudo-static analyses, and using suitably conservative input assumptions…If these simplified methods prove unsuccessful, the assessment progresses to more detailed methods including Newmark-type deformation analyses…"*

Reference: Springbank Off-Stream Storage Project – SCLG Intervenor Submission

This process is further explained in the CDA's Draft Technical Bulletin: Application of Dam Safety Guidelines to Mining Dams (2019) which states (emphasis added):

> *The pseudo-static target of 1.0 is used to support the screening level assessment for potential deformations of concern. A pseudo-static analysis method has* ***no direct correspondence with the physical performance of an earth structure during seismic loading****. It is important to note that the pseudo-static factor of safety is intended to provide an indication of the potential for significant deformation of the crest of the dam.* ***Pseudo-static factors of safety less than 1.0 may be acceptable if a deformation assessment shows that the deformations due to seismic loading would be acceptable*** *(reiterating that there is no liquefaction or strain softening casing large deformation).*

The Geotechnical Analysis presented in the Preliminary Design Report (Exhibit 159) follows the guidance from the CDA as outlined above. A pseudo-static analysis was performed at each stability cross section for the dam. As noted, two sections indicated a factor of safety below 1.0. For these two sections, Stantec then performed a Newmark deformation analysis that indicated a maximum deformation of 230 mm. This deformation was deemed acceptable considering the proposed operation as a dry dam with a temporary pool and the design freeboard of 1.5 metres to the Probable Maximum Flood and 2.75 metres to the Full Service Level.

Design Review Recommendations

Table 1 of Austin Engineering's Design Review includes a list of recommendations / identified concerns. This table has been replicated with an additional column providing the Board with Stantec's response to these recommendations and concerns. Please see attached.

Stantec Consulting Ltd.

PROFESSIONAL ENGINEER ALBERTA
JOHN MENNINGER
LICENSED TO PRACTICE
2021-03-10

PERMIT TO PRACTICE
STANTEC CONSULTING LTD
RM SIGNATURE:
RM APEGA ID #: 94199
DATE: 2021-03-10
PERMIT NUMBER: P000258
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

John Menninger P. Eng.
Senior Principal
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Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

<table>
<tr><th colspan="2">Recommendation Number/ Identified Concern</th><th>Recommendation
(Summary)</th><th>Response</th></tr>
<tr><td>1</td><td>Diversion Inlet capacity</td><td>The bottom elevation of the access bridge across the Diversion Inlet (to the gate hoists) is shown as 1215.5 m (Ex 159 page 343). The inlet invert elevation is 1211.5 m. This gives a maximum flow depth below the access bridge of 4 m before the water surface hits the bottom of the bridge.

Austin Engineering recommends the Diversion Inlet maximum discharge capacity be reviewed and modelled with the access bridge in place.

We recommend that the Diversion Inlet access bridge design be reviewed to ensure that adequate freeboard (between the bridge and water surface) is achieved during passage of the design flow of 600 m3/s.</td><td>The upstream access bridge support beam is purposefully set at EL 1215.5 m to function as a breast wall with the potential to limit flows into the channel when upstream water surface elevations exceed the design headwater elevation.

Hydraulic calculations for the design flow of 600 m^3/s are presented in Section 8.2.4 of the Preliminary Design Report (PDR) (Exhibit 159).</td></tr>
<tr><td>2</td><td>Emergency Spillway discharge capacity</td><td>The Emergency Spillway maximum discharge capacity (360 m3/s) is less than the Diversion Channel design flow or the maximum diversion intake flow.

A reassessment of the Emergency Spillway should be considered to increase the discharge capacity from 360 m3/s to 600 m3/s (or to match the maximum capacity of the Diversion Inlet).

The safety of the Storage Dam should not rely solely on the ability of operators (or electrical systems) to close the Diversion Inlet gates.</td><td>It is our opinion that Austin Engineering is misinterpreting the CDA Guidelines for spillway design. The CDA Dam Safety Guidelines (2007) state:

The discharge facilities should be capable of passing the IDF, taking into account the routing effect of the reservoir, without infringing on the minimum freeboard requirements.

As explained above, the design of the SR1 Emergency Spillway meets these criteria without relying on closure of the Diversion Inlet gates. There is no requirement to pass the design flow or peak flow into a reservoir without consideration of routing effects of the reservoir.</td></tr>
<tr><td>3</td><td>Diversion Structure total capacity</td><td>We recommend the following:
1. Diversion Inlet capacity be reviewed due to the access bridge breastwall and headwall causing a flow restriction.
2. Stantec should confirm the Elbow River water surface elevation that results in the fuse plug being removed down to an invert elevation of 1215.8 m. i.e. Does the WSE need to be 1217.2 m for a minimum duration of 2.76 hours to remove the entire 208 m long fuse plug, or will a WSE of 1216.9 m be sufficient based on the erosion starting at the pilot channels and progressing over the length of the fuse plug over 2.76 hours?
3. More information should be provided on the Diversion Structure rating curve with various operation combinations of the Diversion Inlet, Service Spillway, and Auxiliary Spillway.
4. It should be confirmed that the Service Spillway Obermeyer weir can operate at flow depths greater than 5.8 m (with debris flow included) in order to safely pass the IDF in combination with the Auxiliary Spillway.</td><td>1. The Diversion Inlet capacity was reviewed in both numerical and physical models and checked with hand calculations. This information is presented in Section 8.2.4 of the PDR.
2. As indicated in Appendix F.3 of the PDR (Exhibit 180), fuse plug erosion will begin at EL 1216.9 m correlating to a flow rate 1930 m^3/s. Complete erosion of the fuse plug is estimated at 2.76 hours, which is approximately 1 hour prior to the arrival of the peak of the IDF at 2210 m^3/s.
3. Hydraulic information including rating curves for the full operations range and critical design loading conditions of the Diversion Inlet, Service Spillway and Auxiliary Spillway are presented in the PDR. Additional operating conditions can be constructed utilizing the data presented for the three rating curves. This logic will be developed with design of the control system.
4. During the IDF, the Service Spillway gates will be lowered to the open position (fully lowered). When depths exceed 5.8 m, there is no need to operate / raise the Service Spillway gates.</td></tr>
</table>

Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

Recommendation Number/ Identified Concern		Recommendation (Summary)	Response
4	Flood flow estimation uncertainty due to: • Climate Change • Limited historical records prior to 1934 • Snowmelt	We recommend that the Probable Maximum Precipitation (PMP) analysis be reviewed as part of the final design to confirm rain-on- snow has been included in the PMP. We recommend that consideration for forest fire and climate change be made as an allowance in the flood flow determination. We recommend an allowance to account for these uncertainties be included within the design flood prior to completing final design of the diversion structure components and sizing of the Diversion Inlet gates and final sizing of the emergency spillway.	The PMP analysis is a meteorological exercise that specifically considers rainfall. The Probable Maximum Flood (PMF) considered rain-on-snow in two components. The unit hydrographs were calibrated to historic events that included rain-on-snow (2005 and 2013). The PMF development included the addition of snow melt to runoff hydrograph. Neither Provincial nor CDA Guidelines require the addition of climate change and forest fire to be added to a PMF analysis. The proposed operations for the project are to close the Diversion Inlet gates to restrict flows to the Diversion Channel to 600 m^3/s and to prevent overfilling of the reservoir. The Emergency Spillway has been designed to convey the required discharge from an uncontrolled PMF. It is our opinion that this assumption incorporates sufficient conservatism into the design.
5	Stoplog slots and gate guide heaters	Austin Engineering recommends the inclusion of stoplog slots, at a minimum, preferably with at least enough stoplogs to isolate one intake gate, upstream of the Diversion Inlet gates to facilitate annual testing, reduce the requirements for fish salvage during testing and allow for future maintenance of the gates. In addition, due to the cold climate in the region for portions of the year and the necessity to keep the system functional, we recommend the inclusion of gate guide heaters.	The Diversion Inlet sill elevation is positioned 1.5 metres above the bed of the Elbow River. This sill elevation corresponds with a discharge in the Elbow River with a recurrence interval of 1:2 years. The Diversion Inlet gates can be tested during lower seasonal flows without risk of discharge to the channel and fish stranding. Stoplogs are therefore not required. The Diversion Structure will operate during heavy rain events that occur during warmer periods. Over the last 100 years of record, the structure would have operated during the period of late May to early July. For this reason, cold weather operation is not anticipated, and gate guide heaters are not included.
6	Emergency Spillway flow conveyance	We recommend that the outlet of the Emergency Spillway be channelized with riprap or other erosion protection between the downstream extent of the Emergency Spillway and the return to the Elbow River to prevent embankment scour on the downstream side.	The design of the Emergency Spillway is underway. The need for erosion protection is part of this design and will be reviewed by AEP Dam Safety as part of Alberta Transportation's *Water Act* application.
7	Auxiliary Spillway	We recommend the Diversion Inlet gate operation between WSEs of 1216.9 m and 1217.2 m be documented, as well as contingencies for the following conditions: • The fuse plug does not operate as expected; or • Activation of the fuse plug causes water quality (sedimentation and turbidity) issues downstream.	As stated in the PDR, Appendix F.3 (Exhibit 180), design of the Auxiliary Spillway assumes that no diversion occurs. The Diversion Inlet gates are assumed closed and therefore gate operations are the same between EL 1216.9 and 1217.2 m. Planned activation of the fuse plug would occur for flows that exceed a 1:500 year recurrence interval. Potential impacts on water quality and sedimentation will be negligible in comparison to the sediment transport occurring within the Elbow River flows.
8	Flood protection between Service Spillway and Glenmore Dam	We recommend flood maps be produced, showing the flood extents within the Elbow River between the Service Spillway and the Glenmore Dam, for Service Spillway discharge flows of 160 m^3/s. 760 m^3/s and 1600 m^3/s. The three flood maps should be used to determine impacts and identify if flood protection works are required along this stretch of the Elbow River.	SR1 will reduce downstream flooding during operation. Residual flooding may still occur downstream but will be substantially less than current flood risk.

Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

Recommendation Number/ Identified Concern		Recommendation (Summary)	Response
9	Control Building location	We recommend that the Control Building be located in an area that would not be subject to flooding, or where access to the building will not be impeded by flooding, permitting the SR1 reservoir to continue to be of benefit during a flood event and reduce operational risks during a large flood event. Consideration should be given to helicopter access near the Control Building in the case of damage occurring to the access road along the Diversion Channel between Township Road 242 and the Diversion Inlet and we recommend a clear landing area be included in the final design.	The Control Building is not subject to flood risk. The Control Building is located at EL. 1219.3 m. The water surface elevation for the Probable Maximum Flood is 1217.8 m. Approximately 1.5 metres of freeboard is provided for the Probable Maximum Flood. Two access roads are provided to the Control Building and are positioned significantly higher than the diversion flows proposed for project. Access to the roadways and Control Building is provided through local roadways and may be accessed via helicopter if necessary.
10	Factor of Safety of the Storage Dam and Floodplain Berm under pseudo-static loading	The minimum factor of safety for the Storage Dam under pseudo-static loading is 0.7 (at Section 22+500). The minimum factor of safety for the Floodplain Berm under pseudo-static loading is 1.0 (at Section 1+600). It would be imprudent to construct a new dam with a safety factor at or below the minimum CDA Dam Safety Guidelines (CDA 2013) safety factor thresholds. We recommend that the design of the Storage Dam be modified to ensure the minimum required factor of safety of 1.0 be achieved for the pseudo-static scenario under seismic loading. Consideration should also be given to increasing the Floodplain Berm factor of safety under this load case.	It is our opinion that Austin Engineering is misinterpreting the CDA Guidelines for seismic stability. In CDA's Technical Bulletin Geotechnical Considerations for Dam Safety (2007), it is stated in Section 6.5.1: *The seismic safety assessment of existing or proposed embankment dam is usually performed in phases, beginning with simplified methods, such as pseudo-static analyses, and using suitably conservative input assumptions…If these simplified methods prove unsuccessful, the assessment progresses to more detailed methods including Newmark-type deformation analyses…"* The Geotechnical Analysis presented in the Preliminary Design Report (Exhibit 159) follows the guidance from the CDA as outlined above. A pseudo-static analysis was performed at each stability cross section for the dam. As noted, two sections indicated a factor of safety below 1.0. For these two sections, Stantec then performed a Newmark deformation analysis that indicated a maximum deformation of 230 mm. This deformation was deemed acceptable considering the proposed operation as a dry dam with a temporary pool and the design freeboard of 1.5 metres to the Probable Maximum Flood and 2.75 metres to the Full Service Level. For the Floodplain Berm, the pseudo-static stability Factor of Safety is 1.0. This meets CDA Design Guidelines.

Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

Recommendation Number/ Identified Concern		Recommendation (Summary)	Response
11	Fracking exclusion zone	During a review of the available documentation on the National Resources Conservation Board (NRCB) website, Austin Engineering did not encounter any reference to fracking induced seismic events. As a significant amount of fracking has been undertaken within Alberta, the approval to commence construction of the SR1 reservoir needs to be undertaken with a dedicated fracking exclusion zone surrounding the project extents. This zone is to be established by the design engineers to ensure that the SR1 structure is not damaged due to fracking within proximity of the structure.	In response to NRCB and AEP Supplemental Information Request 1 Question 474 (Exhibit 96 – Page 54), Alberta Transportation stated: “An exclusion zone was presented as a possible risk management strategy; however, the design of the dam is not contingent upon the establishment of an exclusion zone. In accordance with CDA (2007), a probabilistic seismic hazard assessment (PSHA) was performed to define ground motion parameters for use in seismic design for the dam. Existing evidence of induced seismicity was incorporated into the PSHA model through inclusion of induced events in the regional and local source models; this is accounted for in the seismic design of the dam. Based on the deaggregation of the seismic hazard, the design considers a magnitude six (6 Mw) earthquake, which is larger than any induced earthquake recorded in the Province of Alberta (Macias-Carrasco et al. 2011; Stern et al. 2016). The earthquake motion was applied in proximity (less than 25 km) to the dam. This produced a peak ground acceleration of 0.28 g, which was incorporated into the design of the dam. During the annual dam safety review and inspection, publicly available records of recent earthquakes (natural or induced) within 25 km of the dam will be reviewed. Should new trends in seismic activity be observed, potential impacts to the design assumptions and operations of the facility will be reviewed and mitigation strategies, if necessary, evaluated and enacted.”
12	Emergency operation of the Diversion Inlet gates	As the mechanical and electrical details for the project have not been provided at this time, we believe that it is imperative to the safety of the overall structure that the Diversion Inlet gates fail closed under their own weight. Table 5-2 on Page 706 of Ex 20 indicates that in the case of mechanical and electrical failure preventing typical gate operation, the gate hoists (wire rope) will have hoist brakes that can be released allowing the gates to be lowered. If this is implemented in the final design, we recommend that the hoist brakes be capable of manual release. It is unclear how operators will access the hoist breaks in the event of an emergency. As such, we recommend that the final design consider access to this critical location for operation during a high flood flow event, should loss of power occur at the structure.	The Diversion Inlet gate design will include wire rope hoists with a manual release and fan brake. This arrangement will allow for the gates to be lowered without power. Access to the hoist bridge may be achieved from either side of the Diversion Inlet structure. The most likely access is from the east near the control building which is positioned approximately 20 metres from the hoist bridge.
13	Emergency backup power and automatic switching	As the SR1 project is to function during a large flood event of an emergency nature, we recommend that emergency backup power be included as part of the overall project scope, with emergency power being capable of powering all monitoring instrumentation, the intake gates, and the service spillway weir. The emergency power generator should be set to automatically start with an automatic transfer switch to provide real-time backup power in the event of an emergency. This backup generator should not be located in an area where flood flows could impede the safe operation of the generator or operator access for re-fueling should an electrical outage extend over a long period of time.	Emergency backup power is included with the design and is sized to allow for all required operations. An automatic transfer switch will also be included. The generator will be located within the control building and safely positioned from flood risk.

Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

Recommendation Number/ Identified Concern		Recommendation (Summary)	Response
14	Springbank Road acting as a dam	We recommend that, if not already considered, drainage upgrades and stability assessments for Springbank Road be included in the final project design.	The hydraulics of the existing culverts beneath Springbank Road were reviewed during design. It was determined that they provide sufficient capacity to balance water surface elevations within 0.5 m on either side of the road during reservoir filling. No additional upgrades are recommended.
15	Emergency (secondary) low level outlet through Storage Dam	We recommend consideration be given for the addition of a secondary low level outlet (or enlargement of the current low level outlet) through the Storage Dam to be utilized if an emergency drawdown of the reservoir is needed and requiring dewatering much faster than the current low level outlet would allow. A secondary outlet would be preferable, as this would allow for draw down in the event the primary low level outlet were to fail or become blocked.	As discussed in Section 10.4.2 of the PDR, the LLOW design capacity was selected based on industry standards for evacuation times for a reservoir. No basis for increased capacity has been provided.
16	Intake screen design on low level outlet	The intake screen on the low level outlet (through the Storage Dam) needs to be able to accommodate silt deposits anticipated within the reservoir and be able to drawdown water to the top of the anticipated silt deposit. We recommend that the screens be designed with sufficient height to accommodate (at a minimum) a 1.0 m silt layer at the bottom of the reservoir (or the maximum height of the silt anticipated).	The LLOW intake structure has a total height of 8 metres with trash rack openings extending to the top of the structure. The lowest trash rack panel is 1.8 metres tall. These dimensions will facilitate drawdown with sufficient height to accommodate silt accumulation.
17	Riprap on upstream face of Storage Dam (wave runup)	The preliminary design does not indicate riprap on the upstream face of the Storage Dam. While the structure is not continuously operated, it will be subject to the design cases and loads associated with wind setup and wave runup over its lifespan. Austin Engineering recommends that riprap be included for armouring along the upstream face of the Storage Dam.	The upstream face of the dam is subject to varying reservoir levels during filling and draining. This varying level will reduce risks associated with progressive erosion from wind driven waves. The combination of cohesive clay soils and vegetation will provide sufficient mitigation during the short exposure time periods.
18	Differential settlement of the Storage Dam	Differential settlement of the Storage Dam needs to be considered during the design of the low level outlet and associated concrete piping/conduit based on the anticipated settlement within this portion of the dam. Stresses are likely to be quite significant due to the settlement over time. If differential settlement along the crest of the Storage Dam occurs and results in a lowering of the overall crest elevation. instrumentation set points will need to be adjusted to maintain adequate freeboard during diversion of the design flood event.	Differential settlement along the LLOW conduit is addressed in Section 10.4.6.3 of the PDR. The Final Design will address estimated settlement and elongation along the conduits. Total settlement and camber will be used to design appropriate joint spacing in the conduits and to select the types of joint collars used. Settlement along the dam crest is addressed through a proposed overbuild. Monitoring will be performed during construction and post-construction including survey of crest elevations to maintain adequate freeboard.
19	Silt removal within the Off-Stream Storage Reservoir	We recommend that a thorough plan be developed prior to completion of final design to allow for the introduction of access roads, drainage, and drainage ditches within the reservoir, sloped towards the low level outlet (conduit), to facilitate maximum dewatering and provide good access for removal of the silt deposit. Knowing the locations of these access roads, along with potential stockpile locations, in advance will allow for crews and equipment to work logically and methodically with a pre-established plan for removal of the silt from the reservoir. These pre-established access roads will also provide better access for fish rescue and minimize the amount of time required to salvage fish and remove the silt.	Removal of silt from the reservoir is not proposed. Introduction of roads and drainage ditches within the reservoir may aid in dewatering; however, the additional disturbance would cause a further loss of available habitat and plant communities which in our opinion would outweigh their value.

Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

Recommendation Number/ Identified Concern		Recommendation (Summary)	Response
20	Dam commissioning	Due to the high-risk and higher probability of failure during first fill, we recommend instrumentation be carefully considered. Instrumentation for the structure should include settlement monitoring, slope inclinometers, piezometers (vibrating wire), in addition to water level monitoring within both the reservoir and the upstream reaches of the river. Each piece of instrumentation should have trigger levels determined in advance by the design engineers. Should the first fill condition then happen without adequate presence of design engineers, the instrumentation could be interlocked with the Diversion Inlet gates to stop flow into the reservoir should any of the instrumentation trigger levels set by the designers be reached during filling. Austin Engineering has concerns over the first fill of the SR1 reservoir occurring during a flood event, as a high percentage of reservoir failures occur during the first fill. It would be prudent to include first fill and commissioning requirements within the SR1 Approval to Construct. Should this not be included, an instrumentation and monitoring plan needs to be clearly outlined, indicating cut-off levels with reliable logic, piezometers, slope inclinometers, and settlement monitors designed to close the intake gates and commence immediate emergency discharge from the low level outlet should any of those trigger levels be met. However, it would be much more prudent to have the first fill and commissioning undertaken outside of a flood event to reduce the risk to downstream occupants, infrastructure, and environmental habitat. A plan for the first fill and commissioning is critical to the operation of the structure and should address the higher risk in early operations of the structure that would occur on a repetitive basis during flood events.	An Instrumentation and Monitoring Plan is in development with Final Design. The Operations, Maintenance and Surveillance Plan will include provisions for first filling and be submitted to AEP Dam Safety prior to operation as required under the Water Act and in accordance with the Alberta Dam and Canal Safety Directive.
21	Safety Management Plan	We recommend that a draft Safety Management Plan be developed and submitted to the NRCB prior to construction approval being granted.	The Safety Management Plan will be submitted to and reviewed by AEP Dam Safety prior to operation as required under the Water Act and in accordance with the Alberta Dam and Canal Safety Directive.
22	Emergency plans and response	There is a large travel distance from Calgary to the dam. Although we are unsure where the operators will be located when a flood event occurs, this needs to be taken into consideration to ensure that flood forecasting is adequately undertaken to provide operators with an adequate response time to reach the SR1 reservoir in time to divert water during a major flood event. Austin Engineering is recommending that approval of this project does not go forward without submission of a draft dam emergency plan and emergency response plan.	Alberta Environment and Parks, in close coordination with the City of Calgary, currently performs flood forecasting for the Elbow River. Forecasting requirements are incorporated into the current Operations Flow Chart (see IAAC Round 2 IR4-01, Exhibit 218) and indicate mobilization and response times. AEP Dam Safety will review the EMP and ERP prior to operations authorization as required under the Water Act and in accordance with the Alberta Dam and Canal Safety Directive.
23	Dam break inundation mapping	We recommend that the Storage Dam break inundation mapping be updated to show velocity and flow depths. We recommend that a separate dam break analysis and inundation mapping be produced for the Floodplain Berm for inclusion in the emergency plan.	Inundation mapping will be updated for the development of the EMP.

Reference: **Springbank Off-Stream Storage Project – SCLG Intervenor Submission**

Table 1 Responses to Design Review Recommendations / Identified Concerns

Recommendation Number/ Identified Concern		Recommendation (Summary)	Response
24	Operation. Maintenance and Surveillance documentation	We recommend that the following be documented prior to project approval: • Elbow River flows that trigger Diversion Inlet gate opening and closing • Glenmore Reservoir levels that trigger the Diversion Inlet gate opening • SR1 Reservoir levels that trigger Diversion Inlet gate closing • All aspects of weir and gate operation including the use of manual versus electrical systems • All aspects of Low Level Outlet operation and Storage Reservoir draining • How forecasting systems be used to predict trends for operation • The overall training and operation plan, including operational accountability for the structures • Roles and responsibilities, particularly in regard to dam safety management • Inspection frequencies and requirements (including monitoring for erosion on the upstream side of the Floodplain Berm) • Maintenance schedules • Instrumentation details and monitoring requirements • All weir flow rating curves (Diversion Inlet, Service Spillway, and Auxiliary Spillway) • Auxiliary Spillway fuse plug operation (and emergency operation) • Floodplain Berm Stage-Storage Curve • Off-Stream Storage Reservoir Stage-Storage Curve • Conditions or events requiring the closure of Springbank Road • Fish salvage requirements prior to Storage Reservoir draining • Storage Reservoir dewatering and sediment removal plan	An Operations and Maintenance Plan will be developed with the facility operator and owner (AEP) and submitted to AEP Dam Safety for review prior to authorization to operate as required under the Water Act and in accordance with the Alberta Dam and Canal Safety Directive.

Appendix F to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

Technical memorandum prepared by Stantec in response to Ian Dowsett Report

Stantec

Memo

To:	Matthew Hebert Alberta Transportation	From:	Matt Wood, P.Eng. Calgary 25th Street SE
File:	110773396	Date:	March 10, 2021

Reference: Response to Mr. Ian Dowsett Submission from SCLG

Stantec Consulting Ltd. (Stantec) has reviewed the Springbank Concerned Landowners Group (SCLG) 2021 submission by Mr. Ian Dowsett titled "*Review of Safety, Hazards and Risks Associated with the Commissioning and Operation of the SR1 Off-stream Embankment Dam*" (Exhibit 259). Stantec has identified the following key points that are made in that submission that warrant rebuttal or clarification.

Implications to Residents and Properties Located Between the SR1 and Glenmore Reservoirs

As noted by Mr. Dowsett, SR1 "will moderate flood levels in the Elbow River". In fact, SR1 provides a considerable reduction in flood risk to all downstream properties including those between the Diversion Structure and Glenmore Reservoir. Operation of SR1 can reduce flood risk between the diversion structure and Glenmore Reservoir by removing up to 600 m^3/s from the flood peak. In the 2013 design flood, the peak flow from that event could have been cut in half from 1240 m^3/s to 640 m^3/s. In a 1:100-year flood event of 765 m^3/s (Stantec 2020) the flow could be reduced to as low as 165 m^3/s. With the contribution of 10,000 dam^3 of active flood storage capacity at Glenmore, SR1 can provide flood risk reduction for events up to 2013 flood event (approximately a 1:200-year flood event) for the Elbow River downstream of Glenmore.

Selection of Hydrographic Information

Stantec acknowledges that every flood event has a unique hydrological profile (hydrograph) and that it is unlikely that an event exactly like the 2013 flood will occur in the future. Stantec disagrees with Mr. Dowsett that the uniqueness of the events will cause a variation in SR1's performance because the diversion structure will be able to divert up to 600 m^3/s of floodwaters from any event that it experiences in the future, irrespective of that event's estimated frequency or hydrologic profile.

Mr. Dowsett suggests that only the 2013 flood was considered. This is not correct: Stantec has presented examples of SR1's performance in simulations of 3 different flood events of varying sizes. The results of the simulations are presented both in the EIA, Exhibit 45 (Stantec 2018) and in IAAC Round 2, IR4-01, Exhibit 218 (IAAC 2020).

Size of SR1

Mr. Dowsett questions whether SR1 has been appropriately sized. SR1's design flood was selected in accordance with Provincial standards and practices (minimum 1:100-year flood) (AEP 2021). The largest flood on record was the 2013 flood with a return period estimated at over 1 in 200-years and was selected as the design flood for the Project.

Further, there is a factor of safety in both the design of the reservoir volume (10%) and the maximum diversion rate (25%) to account for unknowns at the time of design. This is common engineering practice. The maximum diversion rate required to achieve the 2013 design basis of reducing flows downstream of Glenmore to 170 m^3/s is 480 m^3/s (note 160 m^3/s was selected to coincide with Glenmore's low-level outlet). A factor of safety of 25% was added to the maximum diversion rate resulting in design maximum diversion rate of 600 m^3/s. In addition, an increase of 10% to the reservoir's storage volume over that which was needed to achieve the 2013 design basis was included in the design. Estimates made for climate change fell within the factor of safety that had been applied to the Project's volume and diversion rates. The factors of safety applied to the reservoir volume and diversion rate mean that, in fact, SR1 has been designed so that even a flood somewhat larger than the 2013 flood could be safely accommodated.

Reference: Response to Mr. Ian Dowsett Submission from SCLG

Emergency Management System

Mr. Dowsett references the Guideline for Emergency Preparedness for Flood Emergencies (Alberta Environment 2003) and suggests that it is “a little light” for “a big dam”. Stantec notes that these guidelines have been superseded by the Alberta Dam and Canal Safety Directive (2018) described below.

The Government of Alberta has a very robust Emergency Management System for dam safety that applies to all of its water management facilities, including those classified as extreme consequence like the Oldman Dam and the Dickson Dam. The requirements for emergency management are stipulated in the Water Act, Part 6 of the Water (Ministerial) Regulation – Dam and Canal Safety and the Alberta Dam and Canal Safety Directive making them part of the provincial regulatory framework for all dams and even 3rd party dams in Alberta. It is a program that has been reviewed and tested through technologies, industry best practices, stakeholder participation, and operational experience.

SR1’s extreme consequence classification is not unique in Alberta as evident by the number of dams with such classifications presented in this online mapping tool: http://damsafetymap.alberta.ca/. There is much precedent for emergency management at such facilities in Alberta.

The Alberta Dam and Canal Safety Directive (GoA 2018) under *the Water Act* stipulates that SR1 requires an Emergency Management Plan (EMP) that comprises:

- An Emergency Preparedness Plan (EPP) that identifies: potential emergency situations related to the safety of the dam; procedures to manage emergency situations in the event of a failure; key personnel and their responsibilities; key stakeholder groups and notification protocols.
  - The EPP is a public document and distributed to key internal and external stakeholders and responders.
  - The EPP provides these stakeholders with the information needed for them to refine their own internal emergency response plans for flood events and are revisited annually and revised as required.
  - Alberta Environment and Parks regularly coordinates annual “pre-season” working sessions with all key stakeholders downstream of extreme and very high consequence facilities, this will also apply to SR1.
  - It is important to note that under the legislation it is the local authorities who are responsible for leading the response (e.g., evacuation) to a dam safety related emergency within their jurisdiction, not the Government of Alberta.
- An Emergency Response Plan (ERP) that is an internal document used by dam operators to direct their activities at the site when dealing with a potentially emergent situation.
  - These activities would include (but are not limited to) securing the site, instrumentation response, controls, internal (personal information) contacts, identifying the hazard, mobilizing resources, remedial measures as required.
  - The ERP is revisited annually, or as required, to ensure all information is current.
  - Much of the ERP focuses initially on the internal GOA mobilization (and decision-making process) and may not lead to a broader emergency response; but it does outline to staff the process should the situation escalate.
- A Flood Action Plan (FAP) that provides instruction on operations during periods of flood.

Reference: Response to Mr. Ian Dowsett Submission from SCLG

The Alberta Dam and Canal Safety Directive (2018) includes review of these plans by the Director as part of the *Water Act* approval process and the components of the plan are required to be reviewed periodically; higher consequence dams such as SR1 must be reviewed more often than lower consequence dams. Additional information on the Government of Alberta's Operational Plan for Dam Safety (2019) is available at the following website:

> https://open.alberta.ca/dataset/7883a200-06b6-4c94-b3bc-7f391be86d93/resource/9c152dbf-6eba-4414-b7cb-9d97fa42e812/download/dam-safety-regulator-operational-plan-2019-20.pdf

The EPP, ERP and FAP have not yet been prepared for SR1. The preparation of these documents is the responsibility of the operator (AEP) and the timing of preparation does not occur until construction procurement is complete and the project is closer to its commissioning phase. This is because the plans require information on equipment models, construction records and other details of the facility that are not known at this this time. AEP will begin preparation of the EPP, ERP and FAP following regulatory approval of SR1 and in parallel with the construction process. This will include communications with the City of Calgary, Rocky View County and the Tsuut'ina Nation.

Consequences Associated with a 2013 Flood with SR1 Embankment Project Operating

Mr. Dowsett states that the residual flood risk downstream of SR1 and upstream of the Glenmore Reservoir from 640 m^3/s during a 2013 flood event is similar to that of 1:50-year flood. Stantec does not dispute this but notes that this is a considerable reduction in flood risk to these properties. Without SR1 the flows through this reach of river may have been 1240 m^3/s, more than double those depicted from a flow rate of 607 m^3/s in the draft 1:50 year inundation maps (Golder 2020, Exhibit 258), and the same as what was experienced in 2013. Without SR1 there would be more area inundated, depths in the inundated areas would be greater, flow velocities would be higher and there would be more debris within that flow. In short, there would be considerably more damage to these properties from another 2013 flood event without SR1 in place than would occur with it in place.

Stantec Consulting Ltd.

PROFESSIONAL ENGINEER
MATT WOOD
ALBERTA
2021-03-11

PERMIT TO PRACTICE
STANTEC CONSULTING LTD
RM SIGNATURE: ______
RM APEGA ID #: 68346
DATE: 2021-03-11
PERMIT NUMBER: P000258
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c. Matthew Hebert - Alberta Transportation
John Menninger – Stantec Consulting Ltd.
David Luzi – Stantec Consulting Ltd.

Reference: Response to Mr. Ian Dowsett Submission from SCLG

REFERENCES

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IAAC (Impact Assessment Agency of Canada) Information Request Package 4 – Technical Review Round 2. 2020. IR4-01: Project Operation – Release Scenarios. (Exhibit 218)

Springbank Concerned Landowners Group (SCLG). 2021. Appendix I: *Review of Safety, Hazards and Risks Associated with the Commissioning and Operation of the SR1 Off-stream Embankment Dam*, authored by Ian Dowsett.(Exhibit 259)

Stantec (Stantec Consulting Ltd.). 2018. Environmental Impact Assessment Volume 3B Section 6: Assessment of Potential Effects on Hydrology. 83 pp. (Exhibit 45)

Stantec. 2020. Preliminary Design Report Appendix B – Hydrology. (Exhibit 173)

Appendix G to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

<u>Technical memorandum in response to Dr. Jon Fennell Report</u>

Stantec Consulting Ltd.
200-325 25th Street SE, Calgary Alberta T2A 7H8

File: 110773396

Attention: Matthew Hebert
Alberta Transportation

Dear Mr. Hebert,

Reference: Response to Springbank Concerned Landowners Group; Dr. Fennell Witness Report

INTRODUCTION

This letter report is prepared in response to the Springbank Concerned Landowners Group (SCLG) submission to the NRCB dated February 26, 2021. The SCLG retained Dr. Jon Fennell to conduct a review of the hydrogeology, groundwater-surface water interaction, geochemistry and climate change implications of the Project and his report was included as Appendix K of the SCLG submission (Exhibit 261).

Dr. Fennell's evidence summarizes four topic areas that in his opinion are deficiencies in the Environmental Impact Assessment and subsequent filings submitted to the NRCB, and in turn forms the basis of SCLG's concerns related to these topics. The four topic areas Dr. Fennell has identified as concerns include:

1. Knowledge of the hydrogeologic regime and its influence on the impacts of SR1.
2. Efficacy of the groundwater modelling to allow an informed decision to be made regarding whether or not to approve the application.
3. Review of the geochemical and water quality issues that could arise if SR1 is constructed and operated as planned.
4. Climate change considerations including the impacts from extreme flood and drought conditions, and how that might affect the safe and efficient operation of SR1.

This letter report provides further clarification regarding the issues Dr. Fennell has raised and provides information that describes how these issues have in fact been considered and addressed in the design of the SR1 Project and EIA. This letter is structured to follow the presentation of issues that Dr. Fennell provided.

CONCERN #1: KNOWLEDGE OF THE HYDROGEOLOGIC REGIME AND ITS INFLUENCE ON THE SUCCESS OF SR1

On page 5 of Dr. Fennell's report, he presents as Figure 1 a geologic cross section (B-B') adopted from Moran (1986) which he asserts is representative of conditions in the SR1 Project area. The Moran (1986) report is a regional scale study of the greater Calgary area, and while informative of the regional geologic context, is not suitable for use in support of a local scale assessment of geologic conditions in the SR1 Project area. In particular, the geologic cross section that Dr. Fennell presents as evidence of the local conditions (B-B') indicates the presence of a surficial fluvial gravel channel (denoted as unit Gg in red on the cross section) and a fluvial channel sand (denoted as unit Cs in yellow) that are not present in the Study Area. This has been confirmed through the drilling of more than 150 Project specific boreholes within the PDA as are presented in the Hydrogeology Technical Data Report Update (Exhibit 110).

Figure 1 herein presents the location of cross section B-B' and the borehole locations from which it is informed, relative to the SR1 PDA. It should be noted that cross section B-B' presented in the Moran (1986) report and cited by Dr. Fennell is situated east of the PDA and is informed by only a small number of boreholes spaced kilometres apart from each other. It is also unclear why cross section A-A' from the same Moran (1986) report, which is situated closer to the PDA than cross section B-B', was not presented. Cross section A-A', while being similarly limited by data paucity, does not indicate the presence of the surficial fluvial gravel (unit Gg) or fluvial channel sand (unit Cs) which were interpreted to exist along cross section B-B', and is more consistent with the hydrogeologic framework of the PDA as has been summarized in the Hydrogeology Technical Data Report Update (Exhibit 110). Figure 5 from the Moran (1986) further confirms that the surficial fluvial gravel (unit Gg) is not present in the SR1 PDA.

Dr. Fennell asserts that the presence of the surficial fluvial gravel (unit Gg) and fluvial channel sands (unit Cs) should have necessitated the collection of more information regarding the hydraulic conductivity of the surficial unconsolidated sediments, given that the presence of these coarse textured sediments would lead to higher variability in those measured values. However, since these coarser textured units are not present in the SR1 PDA, a smaller range of variability is reasonably expected given the consistently clay and silt dominated lithologies of the lacustrine and till units that have been described in the Hydrogeology Technical Data Report Update (Exhibit 110). While Dr. Fennell is correct that the range of hydraulic conductivities measured were estimated through the completion of three in-situ well response tests, several other attempts to measure the hydraulic conductivity values were attempted during the Hydrogeology field program. Some of these test attempts were unsuccessful due to the extremely slow water level recovery in the monitoring wells and lack of sufficient depths of standing water within the well casing. Because of this practical limitation, an estimate of the hydraulic conductivity at these locations could not be quantified. However, qualitatively it can be deduced that the hydraulic conductivity at these locations is even lower than at those locations where a successful test was completed because water level recoveries were even slower than at locations where a successful test was yielded.

On page 6 of his report, Dr. Fennell cites a study of fractures within surficial deposits and their effect on hydraulic conductivity (Hendry 1982) to support his assertion that fractures in the lacustrine and till deposits underlying the SR1 Project are likely present. The Hendry (1982) study is based on boreholes drilled in the Bow River Irrigation District, southeast of the Calgary area, roughly between Lethbridge and Medicine Hat, and thus are not directly representative of conditions observed in the SR1 PDA. The study examines the effects of fractures on the hydraulic conductivity of tills in Southern Alberta and in general concludes that fractures in tills can increase the hydraulic conductivity at a macro scale, through the creation of secondary porosities that increase those values above their non-fractured matrix values. While this is true, the 'large scale fractures' observed in the Hendry (1982) report have not been observed within the upper lacustrine clays or tills in the SR1 PDA based on extensive examination of core samples, and in turn the effect of secondary porosities on the hydraulic conductivities are anticipated to be minimal and limited to the upper few metres near ground surface. Further on page 7 of his report, Dr. Fennell correctly notes that the local tills of the Spy Hill Formation contain notable amounts of montmorillonite, which indeed does swell when hydrated as he has noted. Because water levels within the upper clays/tills in the SR1 reservoir area are in general near ground surface, the bulk of these units are continuously saturated with water in their existing state, and thus the potential for the formation of 'large scale' desiccation fractures beneath the shallow water table is minimal. For these types of fractures to occur to depths that would be material, the clays would need to be completely dried out which is not likely due to the high water table position.

CONCERN #2: EFFICACY OF THE GROUNDWATER MODEL

Dr. Fennell asserts in this section that the hydraulic conductivity value assigned the upper layers of the model in the SR1 PDA is one order of magnitude lower than those values reported in Hendry (1982) for fractured tills. However, as was previously noted above, the clays/tills within the PDA do not exhibit 'large scale fractures' as are noted in the Hendry (1982) report. The hydraulic conductivity values carried in the numerical model were assigned based on both field measurements of this value, and in addition through the calibration of the numerical model whereby those values were adjusted in order to minimize residuals between observed and simulated values. Thus, the hydraulic conductivity values are constrained by both the field measured values, and through examination of the model's ability to accurately represent water levels within the PDA and thus constitute best estimates of these values.

Despite having confidence in the hydraulic conductivity values assigned within the numerical model, several sensitivity analysis simulations were also conducted to examine effects on groundwater in the event that hydraulic conductivity values were underestimated. These sensitivity analysis simulations examined effects on groundwater if hydraulic conductivity values were increased by a factor of 1,000 above the best estimates previously noted. In addition, effects on pore pressures were in fact examined under the most conservative scenario, where the complete external loading due the 'weight of the water' impounded in the reservoir was applied directly to the underlying bedrock, assuming that none of this external load would be borne by the overlying clays/tills. Further conservatism was added by conducting these simulations under steady state conditions, representing the scenario where water in the reservoir is held indefinitely. Numerical simulation results under this most conservative scenario indicate that effects on groundwater are still limited to areas within the LAA, and the magnitude of effects under this scenario will be such that they can still be managed through implementation of the mitigations presented in the EIA.

Despite the presence of two low permeability units underlying the reservoir that will limit the potential for vertical migration of water downward into bedrock, for conservatism the EIA does in fact contemplate this effect pathway as valid. The EIA acknowledges that there could be effects on groundwater quality, but concludes overall that they will not be significant due to their limited spatial extent based on the numerical simulation results, infrequent occurrence that are limited to operational flood events, short term duration while water is held within the reservoir, and reversibility once the water within the reservoir is released. Examination of the groundwater flow patterns under either baseline or operational conditions indicate that in general, groundwater flow within the bedrock are generally directed south or southeast from the reservoir area to where the water discharges in the Elbow River Valley. The limited number of groundwater users in areas downgradient from the reservoir area means that should these effects arise, they will be detectable via the groundwater monitoring program (which has been designed with the potential for these effects in mind) and manageable through the implementation of further mitigation measures for the few that are within the potentially affected area.

Dr. Fennell ultimately concludes in this section that "the geotechnical risk associated with higher pore pressures anticipated in the underlying sediments therefore remains in question" but does not acknowledge that the groundwater effects assessment is not intended to assess geotechnical risks. Rather, the assessment of potential geotechnical risks are addressed in Section 10.3 of the Preliminary Design Report

(Exhibit 159) and Section 12.5 of Appendix D – Geotechnical Assessment Report (Exhibit 173). The design and stability of the dam will undergo further review by Alberta Dam Safety for authorization under the *Water Act*. Thus, a lack of discussion around geotechnical risks within the groundwater effects assessment is not a deficiency in the assessment, but rather a separate scope of investigation that is presented elsewhere within the regulatory filings.

CONCERN #3: LACK OF REVIEW FOR GEOCHEMICAL ISSUES AND WATER QUALITY

Dr. Fennell indicates in his review of the hydrochemistry for groundwater obtained from the SR1 Project area that the groundwater sampled from the surficial deposits is chemically similar to the groundwater sampled from the upper bedrock, and thus is an indication of hydraulic communication between the two intervals. The EIA does acknowledge that the shallow unconsolidated and upper bedrock units share a complex flow regime that is a reflection of the relatively high topographic relief in the area together with the complex underlying geologic structure. These factors lead to a flow system that is, locally within the LAA, under both recharge (downward directed) and discharge (upward directed) groundwater flow conditions. In general, average TDS concentrations within the upper bedrock are lower than average TDS concentrations in the unconsolidated clays/tills. The main mechanism through which groundwater from deeper intervals can naturally be less mineralized than shallow intervals is if the transit time through the subsurface is shorter in the deeper interval. For this to be the case, it follows that groundwater within the deeper system did not solely originate from groundwater within the overlying shallow system and as such vertical downward recharge from the unconsolidated clays/tills into bedrock does not dominate the flow system.

It is a oversimplification to imply that because the upper unconsolidated and upper bedrock units are connected, that in turn there will be high potential for downward 'flushing' of naturally occurring minerals into the underlying bedrock given that in many areas the vertical flow direction is upward directed. While during flood operations the vertical gradients are anticipated to be downward directed due to the additional head of water imparted by the impounded water, once that water is released the vertical gradients will revert to their baseline conditions since the topographic drivers that govern that potential will remain unchanged. Thus in the topographically lower areas of the reservoir, water that temporarily migrates downward into the clays/till would again flow upward back toward ground surface once the flood water is released and gradients return to baseline conditions.

On page 17 of Dr. Fennell's report, he introduces two Eh-pH diagrams for selenium and uranium, and further highlights regions within those diagrams that represent anticipated conditions for local groundwater. These diagrams indicate that the local system is currently under oxidizing conditions. What is not clear from these diagrams is how the introduction of oxygenated flood water into a system that is already oxygenated would exacerbate the situation given the lack of other species above the currently applicable regions of the diagrams. Dr. Fennell also does not mention that the Eh-pH diagrams represent stability regions for mineral forms under equilibrium conditions. In reality, these potential reactions are kinetically limited and take time to occur. It is more likely that over the short term duration of impoundment of flood water, that if it were able to migrate downward at a high rate as he suggests, then it would serve to further dilute the concentrations of metals in solution.

CONCERN #4: CLIMATE CHANGE CONSIDERATIONS

SR1's design basis is to mitigate flood damages from another event that is the size of the 2013 event. This event is the largest recorded in the hydrometric record and has an estimated return period of just over

1:200 years. Stantec has added 25% to the maximum diversion capacity required to achieve that design basis and an additional 10% to the reservoir storage volume from what was required to meet that design basis.

Dr. Fennell makes an argument that there may have been larger floods on the Elbow River prior to the record; but as Dr. Fennell points out, “the larger flow events recorded in the neighboring Bow River have not been documented for this River” (the Elbow River).

Dr. Fennell then presents hydroclimatic records showing tree ring data correlated to mean water yield on the South Saskatchewan River. Tree rings are indicative of annual changes in moisture and not reflective of specific flood events that could happen within that year. While the Elbow River is a tributary of the South Saskatchewan River, the information presented is not specific to the Elbow River and the basin scale upon which the results are based leave interpretation as to where in the South Saskatchewan Watershed the water was generated. The graphs and their interpretation do not provide any useful metrics to determine flood event based peak flows or volumes on the Elbow River and is not specific enough for use in design. The information merely presents a speculative argument that there could have been floods larger than the 2013 event prior to the record.

Dr. Fennell compares the South Saskatchewan tree ring record (Figure 10) to the observed and estimated flow data from the Elbow River (Figure 11) and states: “When compared to the most recent flood events documented for the Elbow River (Figure 11), it is would appear that the assessment of flood conditions has not captured the full range of conditions that could be expected”. Stantec is in agreement with this statement. The tree-ring work referenced by Dr. Fennell is interesting and aims to understand the long-term hydrologic variability in the South Saskatchewan river basin. The analysis in Sauchyn and Ilich (2017) looks at annual variability and wet and dry periods in the tree ring record by generating weekly flows. The overall objective of the paper is not to investigate event based hydrology or produce peak flow data. Axelson et al. (2009) concluded that their tree-ring data was not able to account for high annual flow generation process in higher-elevation areas such as those responsible for floods in the Elbow River. Stantec appreciates the usefulness of tree-ring data as a tool to understanding historic hydrologic processes, however the data currently available is not at a resolution that allows for estimates to be used in engineering design, for example annual peak instantaneous flows.

Stantec notes that the correlation between the two records is poor, specifically there was a major flood event on the Elbow River in 1932 that is not visible in the tree ring record. The tree ring record also appears to identify ‘wet years’ in the 1920’s on the South Saskatchewan River that had tree rings exceeding the 90^{th} percentile but which were not nearly as large as the rings which occurred in 1995 (which was greater than a 1:20 year event but less than a 1:50 year event). When looking at the records on the Elbow River we see that the 1995 flood was not proportionally more severe than the floods in the 1920’s. While tree rings are a useful tool for re-creating models of past climate and annual trends in flow, they are coarse generalities and not of a high enough resolution no correlation to draw exact inferences for the Elbow River that can be used for design. They are not a substitute for measured hydrometric data.

Dr. Fennell also presents changes in annual and seasonal precipitation from General Circulation models using RCP 8.5 and states that “annual precipitation is anticipated to increase up to 12% annually by the end of the century and up to 34% during the Spring period”. Stantec notes Mr. Fennell’s comment that this is the ‘worst-case scenario’. While the frequency and magnitude of floods may change in the future, the projection presented is speculative and based only on the use of RCP scenario 8.5 which simulates no reductions in carbon emissions from current trends. Canada and many countries around the globe have committed to reducing carbon emissions, putting the use of RCP 8.5 as a potential scenario into question.

Regardless, in IAAC Conformity 3-01, Stantec utilized RCP 8.5 in an assessment of the impacts of climate change on flood frequency. Unlike Dr. Fennell's assessment which looked at trends in total precipitation, Stantec's assessment looked at changes to event-based precipitation through the use of climate change impacts to intensity-duration-frequency curves. The resulting change in precipitation were run through a hydrologic model to estimate potential impacts on flood frequency from climate change. The results showed the potential for a 12% increase in the magnitude of a 200-year flood event. Stantec included a 25% increase in the maximum diversion rate of SR1 as factor of safety. The factor of safety included in the design is more than double that which would be required for increases in peak flow magnitude due to climate change simulations using RCP 8.5.

Dr. Fennell then refers to snowpack measurements stating that "in any given year there is a 50% chance of an above normal snowpack." While snowmelt did contribute to runoff during the 2013 flood event, there is low correlation between measurements of snowpack size and flood peaks in the Elbow Basin. Figure 1 below shows the 5 largest flood events in the Elbow River watershed and their snow water equivalents.

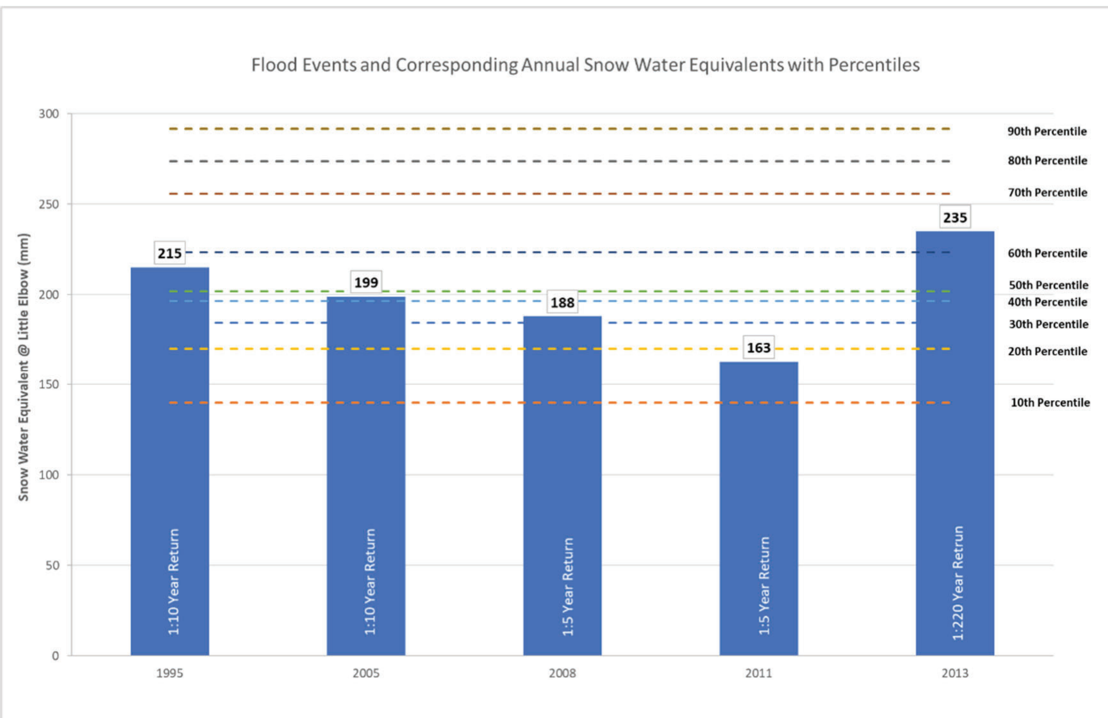

Figure 1: Graph showing snow water equivalents for the five largest floods in the Elbow River since snowpack records began.

Of note is that 2005, 2008 and 2011 were all below the 50th percentile for snow water equivalents. The 1995 flood was just over the 50th percentile and 2013, the flood of record, was just over the 60th percentile.

Figure 2 below shows that the years with the largest snowpacks (greater than the 75th percentile) have produced some of the smallest floods.

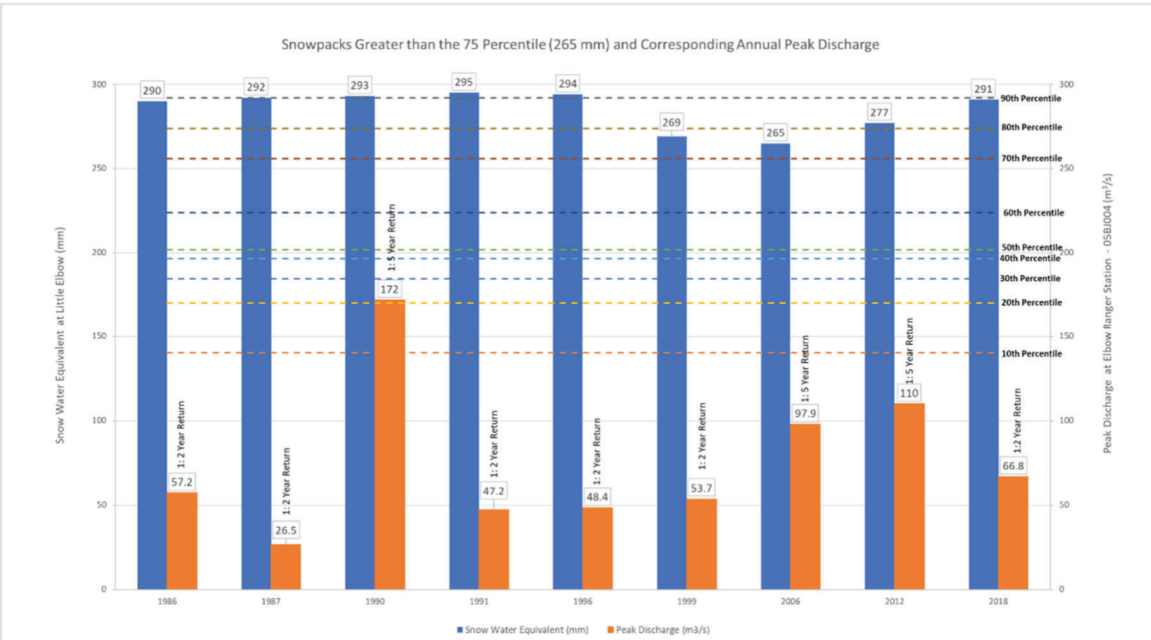

Figure 2: Graph showing floods from years when snowpack exceeded the 75th percentile in the Elbow River since snowpack records began.

The largest event has a return period of approximately a 1:7-year flood and may be the only event in Figure 2 that would have triggered a diversion with SR1, and even that diversion would have been pending the forecast at that time. While rain-on-snow events are an important mechanism for flooding in the Elbow River, the relationship to snow water equivalent or snowpack depth is not clear and it is not correct to assume that changes in snowpack will change flood magnitudes.

It is also not appropriate to assume that precipitation falling earlier in the season will create more runoff because those same changes that alter the seasonality of precipitation will also change how that precipitation falls throughout the year and how the landscape routes that precipitation. A warmer winter could mean less snow at lower elevations and a smaller snowpack during the heavy rainfall period in the spring. Such a scenario could result in smaller flood events.

Dr. Fennell notes that flood frequency statistics change every year with new hydrometric data. Stantec agrees. The design basis of SR1 is not dependent upon the return period of the 2013 event, only that its peak flow rate greatly exceeds that of the 100-year provincial standard and the event is the largest flood in the hydrometric record on the Elbow River. Stantec also notes that flood frequency in the Elbow River was assessed using a method that separates the events based on their characteristics, similar to that which is proposed by Dr. Fennell. The results of that assessment are presented in the Preliminary Design Report Appendix B (Exhibit 173).

Dr. Fennell also states that “there is also a complete lack of consideration for drought conditions”. This is incorrect. The Government of Alberta did review the potential for ‘wet dams’ in their assessment of Flood Mitigation Measures from the Bow River, Elbow River and Oldman River Basins (AMEC 2014). The wet dam upstream of Glenmore scored lower than the dry reservoir as noted in the multi-criteria decision making process in Appendix B of that document. Stantec also notes that drought mitigation does not necessarily need to be in the form of water storage.

SR1 improves water security at Glenmore in any given year. It does this by allowing the City of Calgary to allocate the more of the available storage in the reservoir to water supply in the spring. This means that the City will no longer need to draw down the Glenmore Reservoir to the lower levels they have been operating at in the spring, and at risk that the flows don’t materialize to fill it back up for supply. By reducing the flood risk the City’s water supply is more secure.

Reference

AMEC. 2014. Southern Alberta Flood Recovery Task Force Flood Mitigation Measures for the Bow River, Elbow River, and Oldman River Basins.

Regards,

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DATE: 2021-03-11
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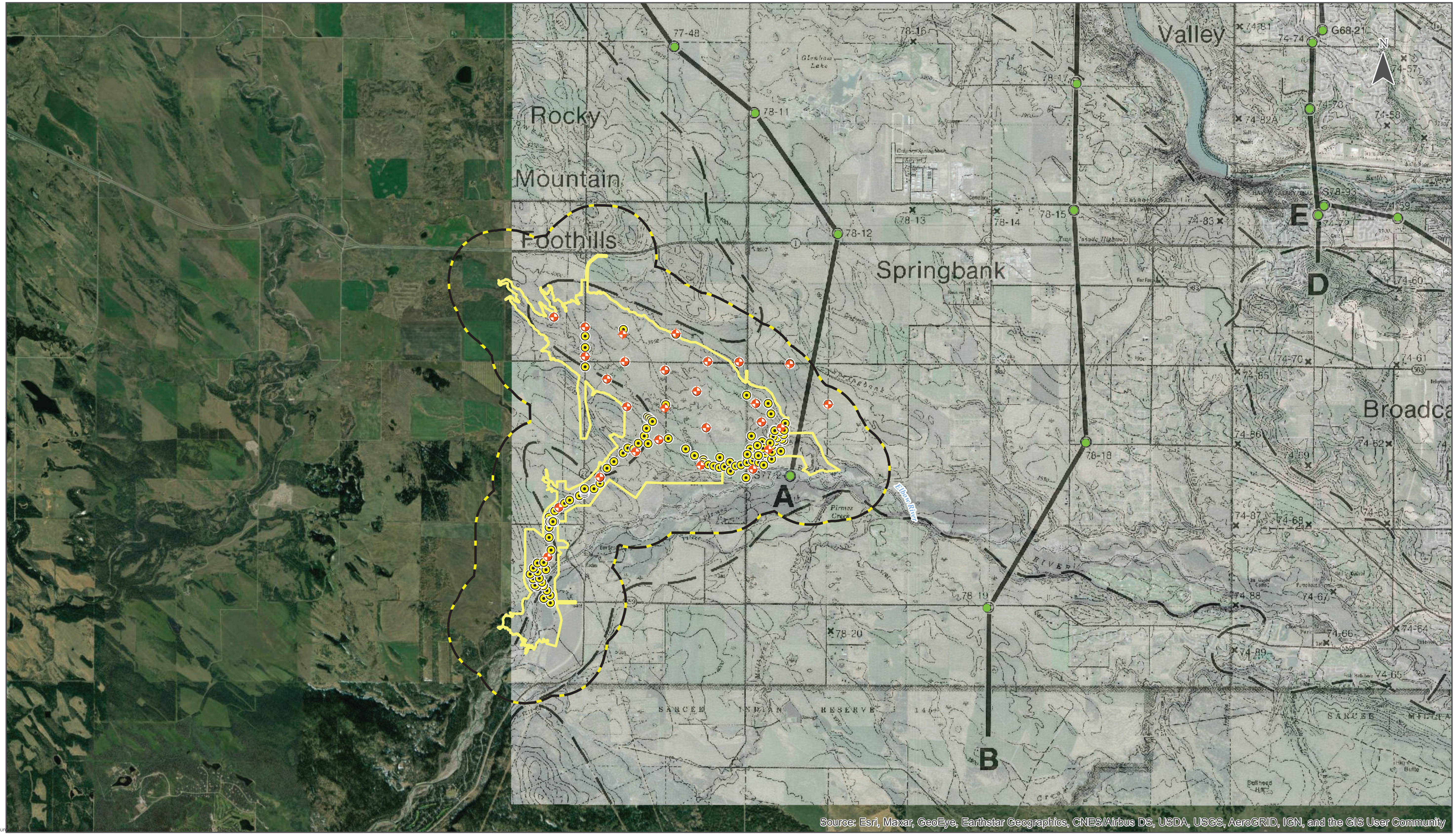
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Attachment:

c. Matthew Hebert – Alberta Transportation
David Brescia – Stantec Consulting Ltd.



Borhole Locations used in Moran (1986) Cross Sections
SR1 Groundwater Monitoring Well
SR1 Geotechnical Borehole
Local Assessment Area
Project Development Area

0 1 2
kilometres
NAD 1983 3TM 114

Moran (1986) Cross Section Locations

Figure 1

Stantec

Appendix H to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

<u>Technical memorandum prepared by Stantec in response to Allan Locke's Report</u>

Stantec

Memo

To:	Matthew Hebert	From:	Lacey AuCoin, Dave Brescia, Dave Luzi, Matt Wood
	Alberta Transportation		Stantec Consulting Ltd.
File:	110773396	Date:	March 10, 2021

Reference: Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)

At the request of Alberta Transportation, Stantec Consulting Ltd. conducted a review of the SR1 Concerned Landowner Group (SCLG) *Fish and Fish Habitat - Springbank Offstream Reservoir Project* report prepared by Allan Locke in February 2021 (Exhibit 266).

Stantec Consulting Ltd. would like to provide clarification on select technical items that are identified in Mr. Locke's report. Furthermore, a response to the recommendations he has proposed in his report is provided where appropriate.

ITEMS OF CLARIFICATION

FISH PASSAGE AT DIVERSION STRUCTURE

Mr. Locke has provided an accurate summary of Alberta Transportation's fish passage analysis. He recommends that it would be prudent to demonstrate that the diversion structure is not the limiting factor to fish passage during low flows (Page 5, Locke 2021), indicating that the intended purpose of the 3Q10 criterion was for short-term passage obstruction.

While we recognize there are many hydrologic metrics that can represent low-flow, the $3Q10_{Low}$ was selected because it paired well with the $3Q10_{High}$, which as Mr. Locke points out, has some basis in fish biology. The $3Q10_{Low}$ of 0.8 m^3/s that was assessed in Biologically Sensitive Period (BSP) 4 represents the 1:10-year 3-day low for the winter months of December to April. For context, the lowest monthly flows recorded at the Bragg Creek gauge between 1934 and 2019 for the months of December, January, February and March are 2.36 m^3/s, 1.89 m^3/s, 2.01 m^3/s and 1.63 m^3/s respectively.

BSP-4 (i.e., a time of year associated with low flows) is associated with the overwintering period of fish species. Much of the river is frozen to bed or splayed out through the ice during the driest winter months of BSP 4 and passage is often limited under existing (baseline) conditions. The design aims to concentrate all water that is flowing at low flow periods to the thalweg, and it is anticipated that open water will be maintained in the fish passage mitigations longer than parts of the river downstream and upstream of the diversion structure where the thalweg is wider and shallower.

The results of the $3Q10_{Low}$ demonstrate that fish passage is maintained during non-flood and post-flood operations for all species and sizes where passage is possible under existing (baseline) conditions. Alberta Transportation is committed to monitoring the fish passage works and mitigating if conditions for fish passage do not align with the predicted velocities and depth of the fish passage analysis. For low flow mitigation, this could include the addition of more cobbles, gravels and sands in the v-weir steps to limit seepage to maintain flow at the surface.

Reference: **Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)**

FISH ENTRAINMENT INTO THE DIVERSION CANAL

Mr. Locke has acknowledged the complex nature of characterizing entrainment risk during flood operation and summarizes efforts that have been made by AT to develop quantitative estimates in the absence of quantitative models for fish entrainment in flood settings. His report discusses the studies that Alberta Transportation has referenced to inform entrainment assumptions for the Project, particularly Post et. al. (2006).

By way of clarification, the entrainment assumptions presented in the EIA (80% entrainment) and Round 2 AEP IR 74 (Exhibit 138; entrainment) reflect different scales and context; there is not necessarily a contradiction between the two percentages. The assumption of 80% entrainment (Volume 3B, Section 8.2.4.1) is relative to a localized area near the diversion structure: "*fish that are upstream and near the diversion structure or being swept downstream during flooding";* whereas the assumption of 1% entrainment applies to the Elbow River population or the LAA (70 km river length) during a design flood. It is expected that a relatively higher proportion of fish will be entrained near the diversion inlet, but that the entrainment rate declines as increasingly distant reaches of the river are included in the analysis.

Post et. al. (2006) was the only entrainment study referenced in the assessment material that presented entrainment data from a single diversion source in a manner that could be compared to population data of the donating waterbody. This important information was considered when predicting fish loss relative to the donor population in the Elbow River. The study proximity to the Project was not the main driver for the reliance on this material, but its location was useful given that the species composition is relatively consistent with our assessment. Other studies reviewed (Round 2 AEP IR 74, Exhibit 138) included the investigation of entrainment quantities relative to flow, velocity, time, or diel patterns, the effects to population abundance as a result of multiple diversion points, or comparisons between screened and unscreened pipes. These other studies provided useful insight into fish entrainment relative to physical and biological characteristics of river diversions but lacked important information on donor populations to compare population impacts in a manner that will be similar to the Project.

To further clarify, a direct application of the Post et al. (2006) percentages to the Project was not done; rather, their findings were used to contextualize the assumptions set forth in the EIA. Post et al. (2006) reported 2,229 fish over 150 mm fork length entrained in the Carseland canal (comprised of rainbow trout, brown trout, mountain whitefish) compared to 513,021 fish over 150 mm fork length in the Bow River (Table 2 of Post et al. 2003). The entrainment rate (relative to Bow population) can be calculated as 0.46%. As noted in Round 2 IR 74 (Exhibit 138) there was limited population data available for fish under 150 mm fork length in the Bow River and thus comparisons of entrainment rates relative to the donor population were limited to larger sized fish in Post et al. (2006); it is possible that the entrainment rate of all life stages could be higher if a comparison was conducted for the entire population. The entrainment assumption of 1% for the Project is considered appropriate for all age classes given that the duration of diversion (i.e., up to 4 days during a design flood) is considerably less than that reported in Post et al. (2006), wherein diversion and fish entrainment were considered over several months.

The entrainment assumptions in the EIA and SIRs were developed in consideration of the relationship between flow and entrainment, backwater effects that are predicted to occur during diversion, and the duration of operation (i.e., the Project is designed to divert water for 0.4 days to 3.75 days). Backwater effects are an important consideration for the Project effects and some visual representations are provided to supplement this review (Attachment A). These backwater figures demonstrate that opportunity exists for fish to seek refuge upstream of the diversion inlet during a flood.

Reference: Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)

Fish entrainment, and subsequent risks of fish mortality as a result of the Project, will be included as a residual effect in the Application for Authorization under the federal *Fisheries Act*. Post-flood monitoring, including an estimate of fish that are entrained in the reservoir, will be a commitment in the *Fisheries Act* authorization. If post-flood monitoring indicates that fish entrainment and fish mortality estimates are underestimated, DFO could request additional offsetting be conducted to account for the differences.

RECOMMENDATIONS

FISH EXCLUSION METHODS

In his report, Mr. Locke makes the following recommendations (page 7):

> *"In view of the foregoing, it is recommended the Proponent be prepared to do all that can be reasonably done to keep impact to fish low. It is recommended that effort be put towards doing all that is possible to exclude fish from entering the diversion canal. For instance, during operations just prior to opening the gates and during the time the gates are open, investigate whether using a sound device will move fish away from the structure. This will require looking at similar operations globally and the Proponent should be prepared to conduct research. All possible solutions should be investigated."*

Alberta Transportation is receptive to the installation of a sound device to deter fish from entering the diversion inlet. Other possible solutions identified through discussions with DFO (and others) will be assessed for possible use to further mitigate effects. In terms of the statement that Alberta Transportation do "all that can be reasonably done to keep impact to fish low," Alberta Transportation is unclear as to what other deterrents to fish entering the diversion channel Mr. Locke is contemplating, but is open to discussing other mitigation options that might exist.

Mr Locke also recommends (page 7):

> *"For annual maintenance, it is recommended the final design of the system include a stop-log facility to isolate the gates so fish can be rescued and put back into the river before the gates are opened and water goes down the canal."*

Alberta Transportation agrees with the value of temporary measures in isolating the gates for maintenance. While stoplogs are not proposed for gate isolation, the isolation plan for maintenance includes provisions for the use of temporary measures, like bulk bags and sand bags to isolate the gates individually.

Another recommendation made by Mr. Locke is (page 7):

> *"For those times where the flows that are diverted are relatively small, consider installing a fish return system in the canal. It would be portable system in that it would be installed for those flows where it would be efficient to use, and then removed. A fish return system would not be practical at the upper range of design flows for the canal. There are examples of fish return systems in Alberta that are owned and operated by the Government of Alberta."*

Alberta Transportation does not believe that a fish return system on the diversion canal is feasible because of the characteristics of flow in the diversion channel during both high-rate diversions and low-rate diversions. Mr. Locke does however present an interesting point about low-rate diversions and the potential to trap fish

Reference: Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)

on the receding limb of the diversion hydrograph. Alberta Transportation is receptive to investigating the feasibility of installing a low flow channel and fish trap in the form of a depression in the diversion channel bottom where fish could accumulate and can be more easily rescued in post-flood operations.

RELEASE OF WATER BACK TO THE ELBOW RIVER

In reviewing the submitted material with regards to sediment, temperature and dissolved oxygen, Mr. Locke made the following suggestion (page 11):

> *"Given the inherent complexity of the Project as it relates to fish and fish habitat, evaluating late and early release scenarios is prudent. Based on the modeling that has been carried out there still remains the potential for impact to fish and fish habitat. It is recommended modeling be continued to examine all possible flow release scenarios to strive for the best possible design for the Project to reduce impact to fish and fish habitat."*

As Mr. Locke indicated, with the inherent complexity of the processes involved, the decision was made to model the two bookend release scenarios to understand the boundaries of the potential effects of the project on sediment and fish and fish habitat. It is believed that the adaptive management approach in response to findings in the monitoring plan would be a better place to understand and evaluate the potential effects of the project than additional modelling. The monitoring data collected during operations can be used to potentially update the models with the observed data, if required, to assess project performance and provide feedback to strategies for future operational events.

Similar to the suggestion to reduce sediment through operation of the low-level gate, Mr. Locke states (at pages 11 to 12) that:

> *"having the means to withdrawal [sic] water from anywhere in the water column should be investigated. Having a multi-port tower, or similar device, means the release of water can be controlled to take water at one or several locations in the water column at any one time depending on the temperature, dissolved oxygen and sediment levels. This way, water of varying quality can be blended. Similarly, the Proponent should continue evaluating the design of the reservoir and outlet gate to enhance the settling of sediment and the capture of fish."*

While Alberta Transportation acknowledges the suggested arrangement is innovative and could allow AEP to mix waters during discharge, we do not feel it is warranted. Waterbody stratification is a function of water density; conditions in the reservoir are expected to prevent thermal stratification from occurring. Fine suspended sediments remaining in the water column during the weeks following reservoir filling and wind generated turbulence are expected to prevent stable thermal layers from forming. Water remaining in the reservoir long enough to stabilize and form thermal layering will be prevented from doing so because reservoir drawdown will result in water levels too shallow to stratify.

With respect to the timing of the release of flood waters from the reservoir Mr. Locke made the following comments (page 12):

> *"If needed, modeling successive less protective Environmental Flow criterion can continue until such time it is met for a reasonable amount of time. At this point consideration can be given to focus in on those times when the Environmental Flow criterion is not met. Perhaps one Environmental Flow criterion can be used for those times when flows are above bankfull, and another Environmental Flow*

> *criterion can be used when flows are below bankfull. Given the potential for impact, and knowing there will be trade-offs amongst water quality parameters, evaluating as wide a range of possible flow release scenarios is warranted."*

Alberta Transportation is not prepared to commit to additional modeling at this time. The range of scenarios modelled were designed to assess the range of potential release scenarios that could be achieved operationally and having regard to expected environmental concerns. The early and late release scenarios have accounted for many of the concerns Mr. Locke has mentioned. Reducing the release rates beyond those that have been currently modelled (i.e. beyond the late release scenario) will result in additional effects related to many of the water quality concerns Mr. Locke has identified as well as potentially effecting egg incubation periods for species that have spawned in the fall.

PRE-PROJECT BASELINE DATA

Mr. Locke states in his report that (Page 13):

> *"Beginning immediately and before the final design is completed, pre-project baseline fish presence and fish population data should be collected. There currently does not exist any quantitative baseline data for this reach of the Elbow River. It is well known that assessing fish populations in medium sized rivers such as the Elbow River means a variety of sampling gear will be required to collect data. In order to fully understand and estimate the impacts of this project, an assessment of all life stages needs to occur. Conducting fish population estimates is difficult and requires a concerted effort. It is recommended the Proponent work with the fishery managers and scientists in the Provincial and Federal governments to develop a baseline data collection program."*

Alberta Transportation undertook a fish presence and fish population study within the boundaries of the LAA (i.e., Glenmore Reservoir to Elbow Falls) in August 2020. In addition, redd surveys were completed in November 2019 and October 2020. Construction is scheduled to begin as early as fall 2021 pending project approvals; therefore, information collected through these programs is current and reflective of pre-construction baseline conditions. Alberta Transportation is of the opinion that collecting more data is not warranted and is not committing to replicating or supplementing these efforts.

In addition, a habitat mapping program of the entire extent of the Elbow River between Glenmore Reservoir and Elbow Falls was undertaken in 2019 and 2020. Habitat suitability index (HSI) modelling was subsequently completed for key indicator species at all life stages using the habitat data collected through this program. The intent of this program was to collect baseline data that could support the effects assessment, as well as fulfill pre-construction baseline survey requirements with habitat information for all life stages.

POST-PROJECT MONITORING

Mr. Locke states that (page 13):

> *"Given the uncertainty due to the uniqueness of the proposed structure, the possible frequency and magnitude in flood conditions that may occur, the effectiveness of the mitigation measures should be monitored to demonstrate there are no significant adverse effects. With respect to fish passage, the diversion structure should be monitored to demonstrate it is working as intended. This should include measuring flows, depths and velocities, as well as demonstrating that fish are free to move through the structure for any non-flood event flow, and any flow throughout the year.*

Reference: **Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)**

As outlined in Round 2 NRCB IR 33b (Exhibit 138), Alberta Transportation is committed to monitoring conditions for fish passage (e.g., flow, velocity, depth) using an acoustic doppler current profiler (ADCP, or equivalent) and comparing these conditions to the expected swim performance data that formed the basis of design. This approach provides a non-invasive method of assessing fish passage conditions. With respect to the suggestion that monitoring should aim to demonstrate that *"fish are free to move through the structure for any non-flood event flow, and any flow throughout the year",* Alberta Transportation can commit to implement monitoring efforts at different times of year to evaluate passage at high and low flows. Fish passage monitoring commitments will be finalized through consultation with DFO for the *Fisheries Act* Authorization.

Mr. Locke also makes the following recommendation (page 13):

> *As discussed previously, rescuing fish from the reservoir will be very difficult even if ideal conditions exist. Monitoring fish stranding should be conducted for the time there is water in the reservoir. Once water recedes in the outlet channel, monitoring should be conducted to ensure fish have not become trapped and can exit to the Elbow River. For all fish monitoring, human safety is of the upmost importance and a thorough and comprehensive safety plan should be developed.*

Alberta Transportation is committed to preparing a comprehensive safety plan to accompany the monitoring commitments for this Project.

Finally, Mr. Locke states (page 13):

> *Given the Project will be permitted by the Provincial and Federal Governments, it is assumed a detailed monitoring program for fish and fish habitat will be developed in collaboration with the Provincial and Federal fishery managers and scientists."*

Mr. Locke's assumption is correct, the draft monitoring plans that have been prepared for the purposes of the aquatic ecology EIA will be progressed in collaboration with provincial and federal agencies.

DISCUSSION OF RISKS TO BULL TROUT

Mr. Locke states that (page 14):

> *"Given the information, it is likely the Project will not cause significant adverse effects on fish and fish habitat. However, with respect to bull trout, given the uncertainty regarding the lack of precise life stage presence, population data, and any unique life history characteristics in this reach of the Elbow River, the uncertainty associated with determining entrainment, and the efficacy of rescuing of fish, it is possible the impact could be greater than is stated by the Proponent. Depending upon the frequency of the operation of the structure, the potential impact could be significant, particularly if two flood events occur within a 10-year period. The number of bull trout in this reach of the Elbow River is relatively small compared to, for example, the Bow River. If a high percentage of fish from a relatively small population is lost from the system, this presents a significant adverse risk."*

Alberta Transportation acknowledges that the Project has the potential to affect bull trout or its critical habitat. However, the likelihood that the project will have an impact on bull trout population is low, given what is known of their current distribution (DFO 2020). Current bull trout density in the Elbow River watershed is 'very low' for adults (GOA 2018) and their distribution is predominantly located upstream of the project.

Reference: Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)

As noted by Mr. Locke, Alberta Transportation recognizes that some historical data demonstrates the presence of bull trout downstream of the PDA in the fall. These findings were acknowledged in Round 2 AEP IR 69 (Exhibit 138) and is reflective of fieldwork completed between 2003 and 2005 (Popowich and Paul 2006). Additional historical records are presented in Round 2 IR 69, Appendix 69-1, Section 3.2.2 (Exhibit 141). More recent field data suggests that bull trout occurrences downstream of the PDA are likely low. Bull trout are predominantly present in the upper reaches of the LAA (i.e., upstream of the Project), as noted by Mr. Locke and as is evident from the 2020 bull trout capture results in Attachment B. The frequency of operation is expected to be irregular and therefore some cohorts of bull trout will not be affected by flood operation. Mr. Locke identifies that the risk to bull trout may be higher than suggested in the EIA if two flood events occur within a 10-year period. Alberta Transportation acknowledges this possible risk but believes this risk is low due to the irregular frequency of operation and current population distribution of bull trout.

It is anticipated that the Government of Canada will provide guidance on offsetting requirements or the potential need for additional mitigation to meet the requirements of Section 79(2) of the Species at Risk Act to avoid or lessen Project effects, including effects to bull trout and its critical habitat for a SARA-compliant Fisheries Act authorization.

Stantec Consulting Ltd.

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Attachments
Attachment A: Flow 2D Data of Project Backwater Area
Attachment B: Bull Trout Capture Locations in Fish Population Study 2020

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RM APEGA ID #: 68346
DATE: 2021-03-11
PERMIT NUMBER: P000258
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Reference: Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)

REFERENCES

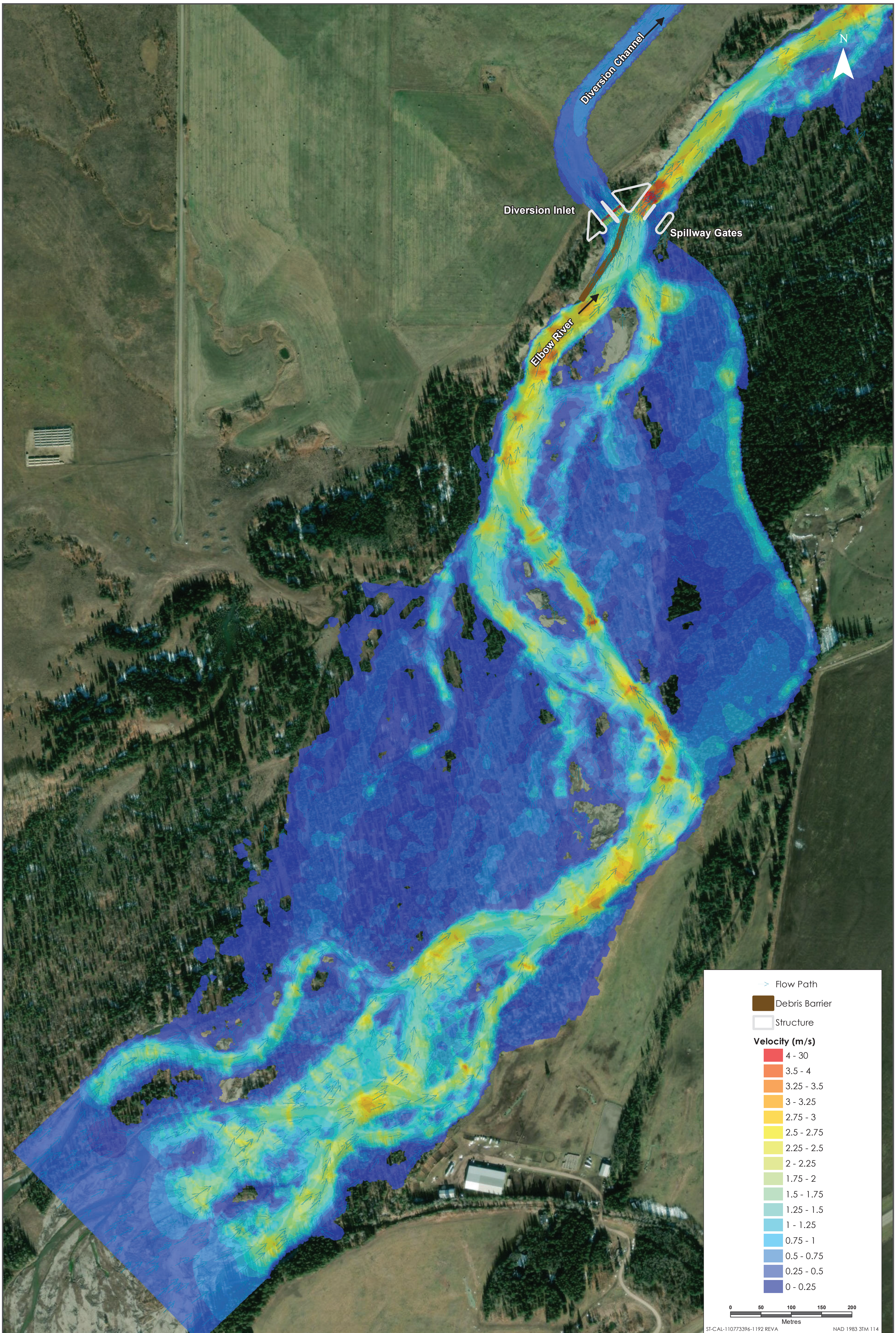
DFO (Fisheries and Oceans Canada). 2020. Recovery Strategy for the Bull Trout (Salvelinus confluentus), Saskatchewan-Nelson Rivers populations, in Canada [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. viii + 130 pp.

GOA (Government of Alberta). 2018. Bull trout fish sustainability index: current adult density. Available at: Bull trout fish sustainability index maps – Open Government (alberta.ca). Accessed March 4, 2021.

Popowich, R.C. and A.J. Paul. 2006. Seasonal movement patterns and habitat selection of bull trout (Salvelinus confluentus) in fluvial environments.

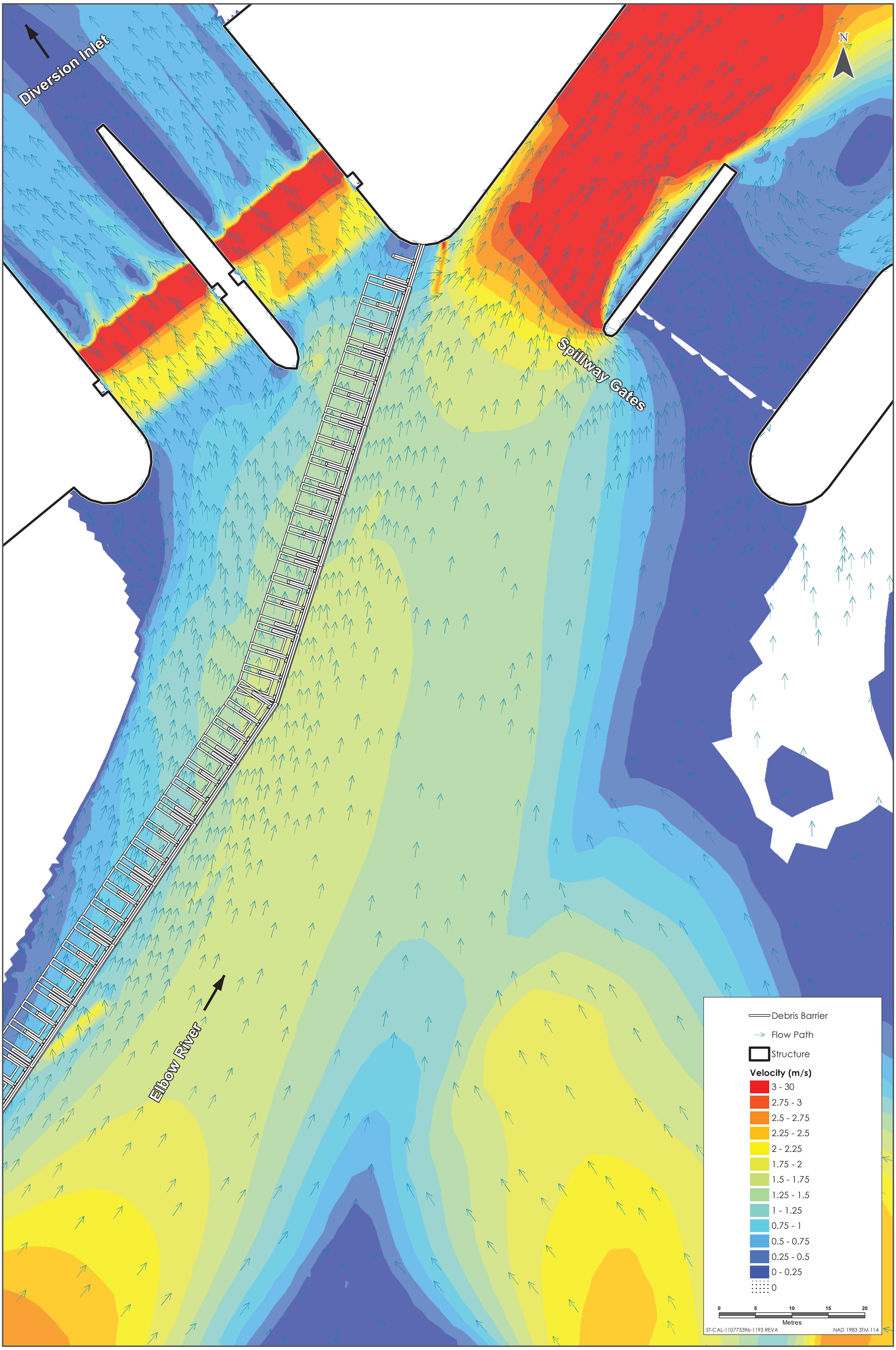
Post, J., B. van Poorten, T. Rhodes, P. Askey, and A. Paul. 2006. Fish entrainment into irrigation canals: an analytical approach and application to the Bow River, Alberta, Canada. North American Journal of Fisheries Management. 26:875-887.

ATTACHMENT A FLOW 2D DATA OF PROJECT BACKWATER AREA



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Elbow River Flow Paths and Velocities in the River Channel and Flood Zone Through the Project Spillway and Diversion Inlet that May Affect Fish Displacement and Entrainment; During 1:10 Year Flood Scenario Operations



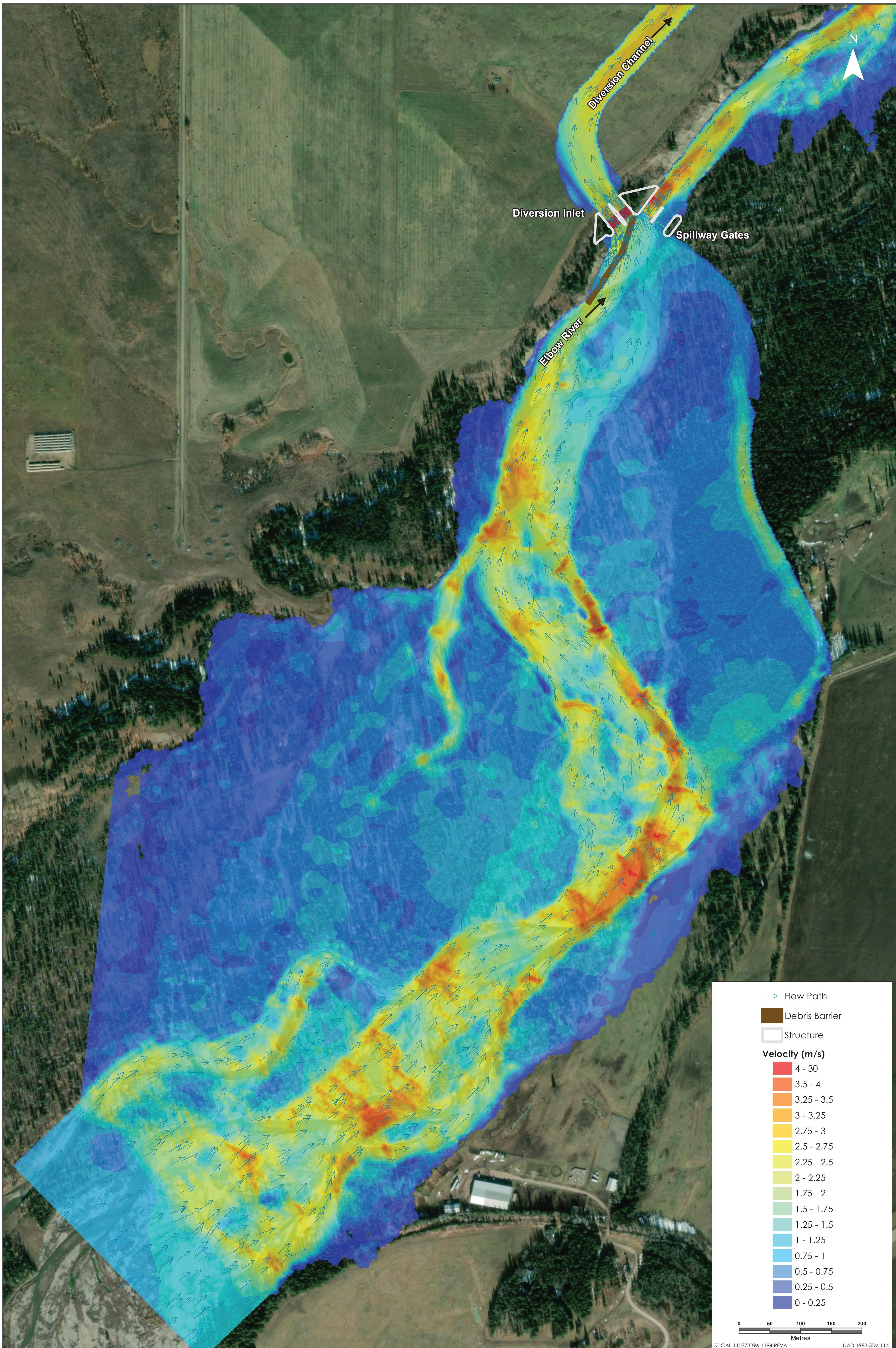
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Elbow River Flow Paths and Velocities in the River Channel and Flood Zone Through the Project Spillway and Diversion Inlet that May Affect Fish Displacement and Entrainment; During 1:10 Year Flood Scenario Operations

Stantec

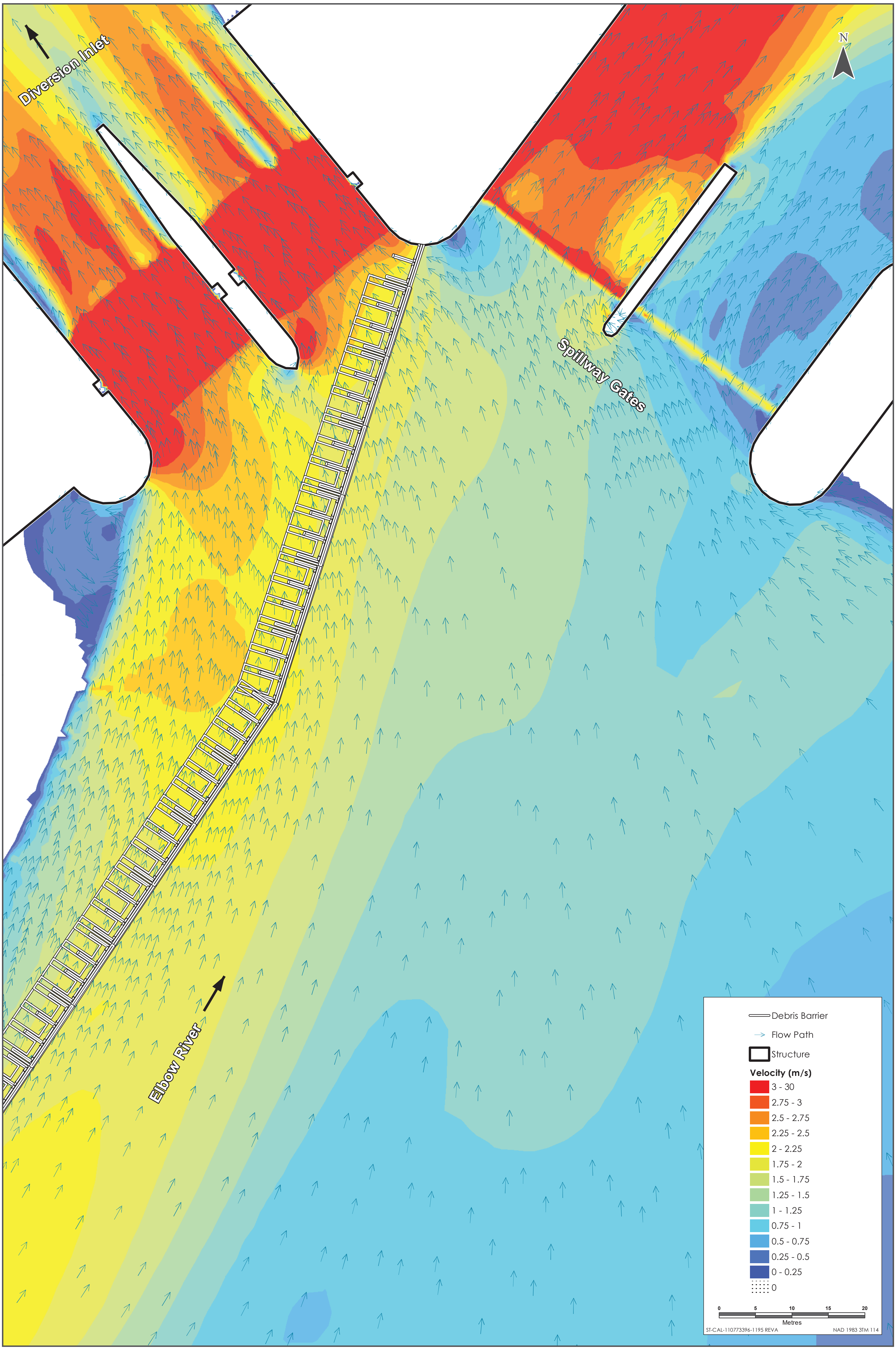
ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Attachment A, Figure 2



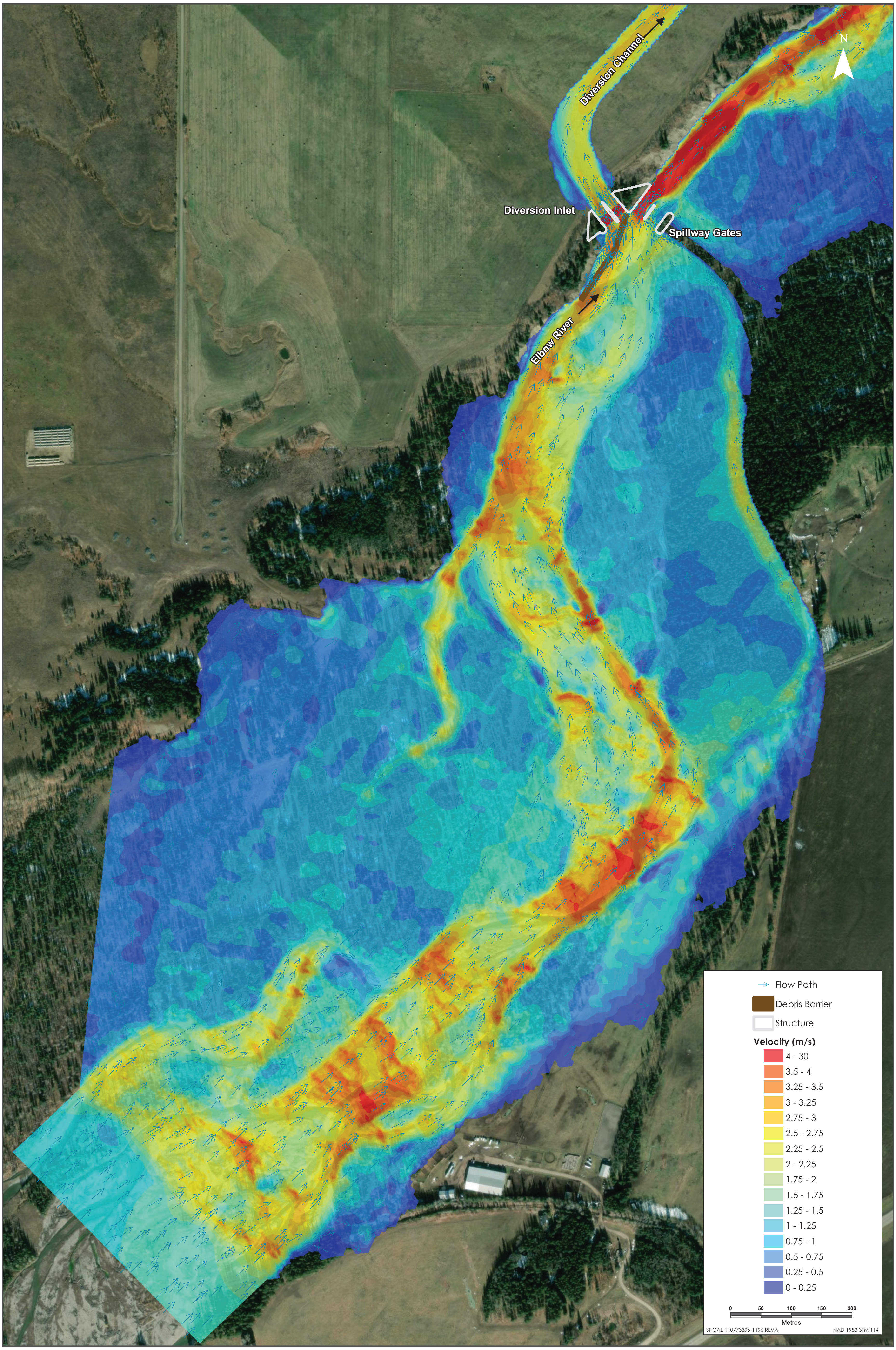
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.
Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Elbow River Flow Paths and Velocities in the River Channel and Flood Zone Through the Project Spillway and Diversion Inlet that May Affect Fish Displacement and Entrainment; During 1:100 Year Flood Scenario Operations



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

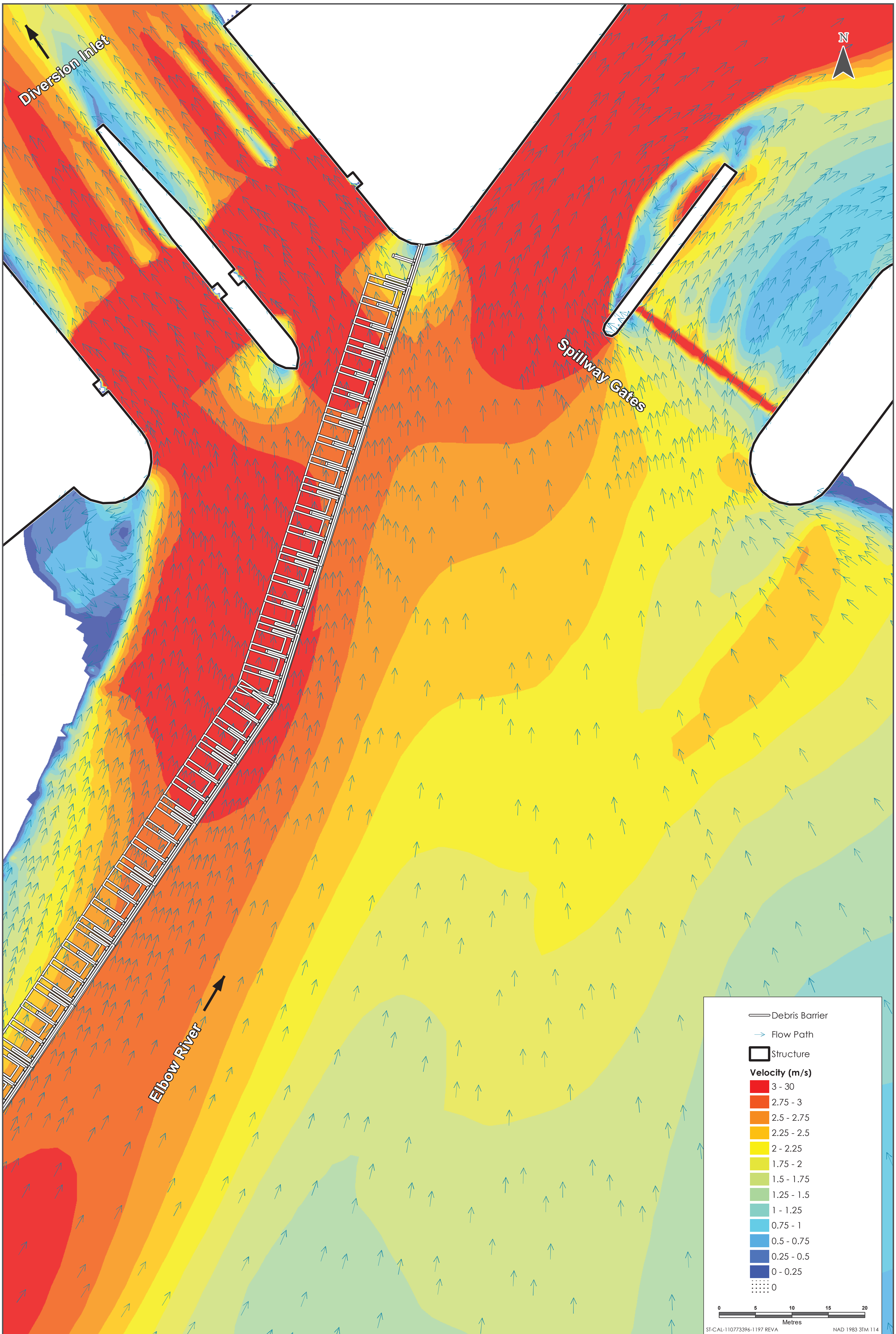
Elbow River Flow Paths and Velocities in the River Channel and Flood Zone Through the Project Spillway and Diversion Inlet that May Affect Fish Displacement and Entrainment; During 1:100 Year Flood Scenario Operations



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd. Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Elbow River Flow Paths and Velocities in the River Channel and Flood Zone Through the Project Spillway and Diversion Inlet that May Affect Fish Displacement and Entrainment; During Design Flood Scenario Operations

Stantec

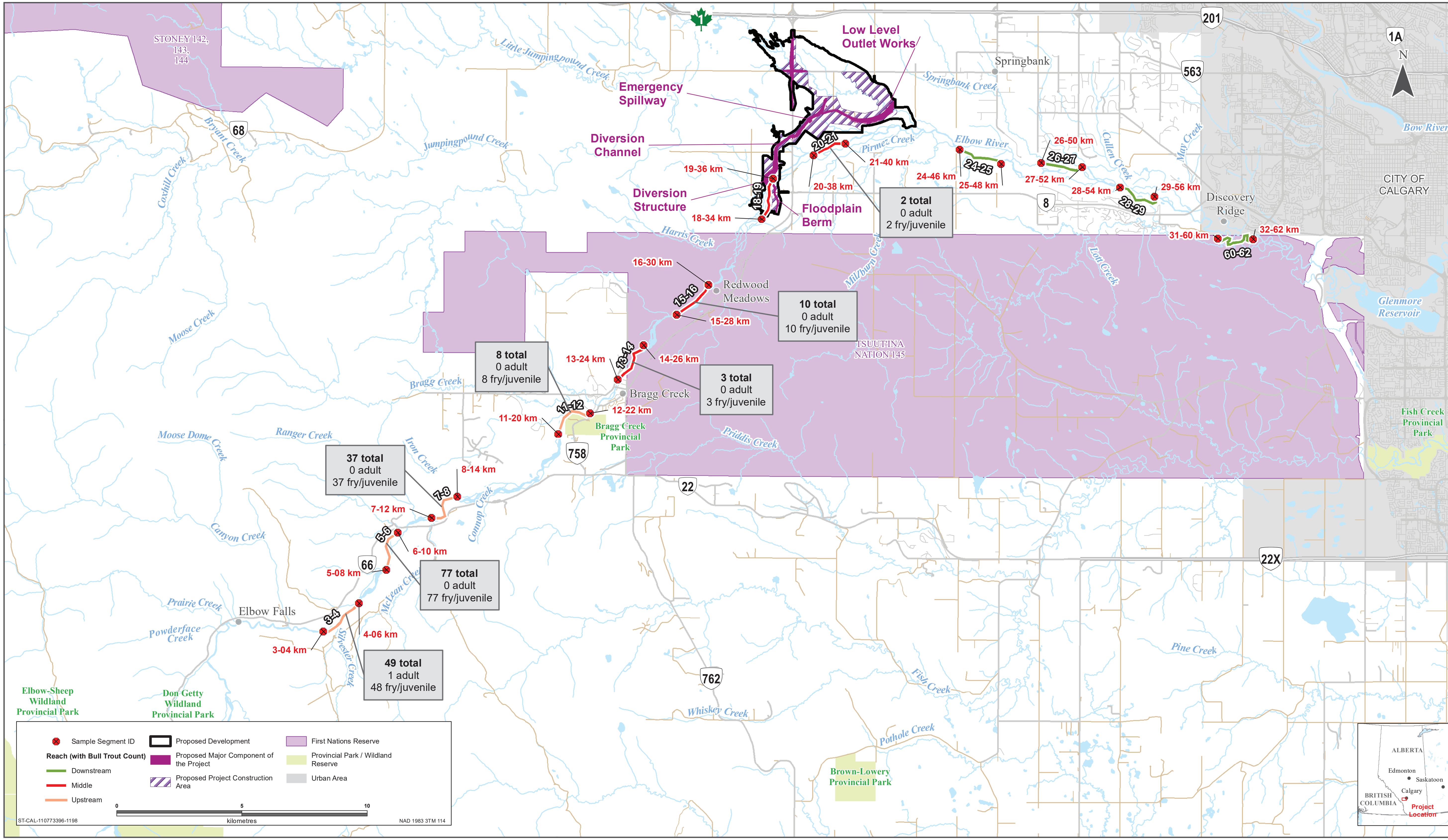


Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Elbow River Flow Paths and Velocities in the River Channel and Flood Zone Through the Project Spillway and Diversion Inlet that May Affect Fish Displacement and Entrainment; During Design Flood Scenario Operations

Reference: Review of Fish and Fish Habitat Report prepared by Allan Locke, Appendix N of SR1 Concerned Landowner Group (SCLG) February 26, 2021 Submission (Exhibit 266)

ATTACHMENT B BULL TROUT CAPTURE LOCATIONS IN FISH POPULATION STUDY 2020



Sources: Base Data- Government of Alberta, Government of Canada. Thematic Data - Stantec Ltd.

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Bull Trout Capture Locations in Fish Population Study 2020

Attachment B

Appendix I to
The Reply Submissions of Alberta Transportation to the Interveners and Hearing Participants who are Opposed to the Springbank Off-Stream Reservoir Project ("SR1"):

<u>Technical memorandum prepared by Stantec in response to Brian Zelt Report</u>

Stantec

Memo

To:	Alberta Transportation Recipient's Office	From:	Reid Person, M.Eng., P.Eng. Stantec Consulting Ltd.
File:	110773396	Date:	March 11, 2021

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

1.0 INTRODUCTION

The SR1 Concerned Landowners Group (SCLG) submission of February 26, 2021 included a report prepared by Zelt Professional Service Inc. (Zelt PSI) (Appendix Q of the SCLG submission) providing a critical review of fugitive dust emissions and predicted particulate matter concentrations presented in Volume 3B, Section 3 Air Quality and Climate (Exhibit 42) and Volume 4, Appendix E, Dispersion Modelling for Wind-Eroded Sediment from the Off-Stream Reservoir Technical Data Report (Exhibit 67) of the Alberta Transportation Springbank Off-Stream Reservoir Project Environmental Impact Assessment (EIA). The report identified errata, critiqued several aspects of the methodology including the selected meteorological data, emission estimation method and assumptions. The Zelt PSI report also provided alternate dispersion model predictions adopting revised assumptions which shows higher predicted TSP, PM_{10} and $PM_{2.5}$ concentrations. The Zelt PSI report concluded that the assumptions adopted in the EIA result in bias of the emissions and predicted concentrations lower than what would be expected.

Stantec Consulting Ltd. has reviewed the Zelt PSI report and prepared the following response to noted errata, critique, and alternate air quality model predictions. This response is structured to respond to the issues identified in the Zelt PSI report including noted errata; meteorological data; the influence of sediment surface roughness, sediment area and sediment particle size distribution on emission estimates; updated dispersion modelling predictions; and implications on EIA air quality and human health risk assessment conclusions.

Based upon the analysis presented in this report, the fundamental conclusions presented in Volume 3B, Section 3 Air Quality and Climate (Exhibit 42) and Volume 4, Appendix E, Dispersion Modelling for Wind-Eroded Sediment from the Off-Stream Reservoir Technical Data Report (Exhibit 67) are unchanged. Specifically, in consideration of the low recurrence of the floods that can result in substantial sediment deposition, the proposed mitigation measures of revegetation and application of a tackifier, Alberta Transportation’s commitment to monitor and adaptively manage and enhance dust control efforts as required to minimize wind erosion risk, it is expected that fugitive dust emissions would not have significant adverse effects on ambient air quality or human health.

2.0 AIR QUALITY ASSESSMENT

2.1 ERRATA

The Zelt PSI report notes two errata:

- It was noted that $PM_{2.5}$ emission rates presented in Table 3.3 of Exhibit 67 appear to assume a $PM_{2.5}$/TSP ratio of 0.0375 rather than 0.075 as stated within the document. Upon review of the emission calculation equations, a calculation error was discovered which resulted in estimated $PM_{2.5}$ emissions being 50% too low for both the design and 1:100 year flood scenarios. $PM_{2.5}$ emission rates and dispersion model results have been updated to correct the calculation error. Refer to Sections 2.8 and 2.9 of this memorandum for the corrected emission estimates and dispersion model predictions.
- The Zelt PSI report stated that Exhibit 67 inconsistently described an assumed dust control efficiency of 86% but assumed 84% in calculation. This is not correct. Exhibit 67 is consistent throughout the document that a dust control efficiency of 84% is selected consistent with application of a chemical dust suppressant (WRAP 2006) and that 84% dust control is consistently used throughout the calculations.

2.2 METEOROLOGICAL DATA

The Zelt PSI report states that the modelling assessment in EIA, Volume 4, Appendix E (Exhibit 67) was performed using the Alberta Environment and Parks MM5 regulatory meteorological data set which biases occurrence of high wind speeds and that this was completed without regard to verification with local wind measurements. This is not correct.

SIR Response 208 (Exhibit 92) details how meteorological observations from the Springbank Airport were considered as a possible data source for preparing meteorological data for dispersion modelling, but that the methodological requirements in Alberta Environment and Park’s (AEP) Air Quality Model Guideline (AQMG) (AEP 2013) do not allow for use of the Springbank Airport data. While it is acknowledged that the MM5 based meteorological data underestimates frequency of occurrence of higher wind speeds, this bias is offset by adopting other conservative assumptions in the modelling such as evaluating infrequent, high-magnitude flood scenarios (1:100 year and 2013 design flood events) rather than a more commonly occurring lower magnitude flood, use of a threshold friction velocity on the low end of values published in the literature representing a fresh (uncrusted) sediment surface, ignoring the mitigation effects of rainfall events and ignoring the 24 m tall dam structure which sits between the sediment and nearest receptors in the model.

The AQMG describes the allowable types of meteorological data that can be used to create a meteorological dataset for use with a regulatory dispersion model such as CALPUFF or AERMOD for an EIA. The AQMG states that either at least one year of “on-site” (defined as a meteorological monitoring station located within the boundary of a facility) meteorological measurements or the 5-year AEP MM5 meteorological dataset (2002-2006) distributed by AEP must be used for refined modelling assessment. There are no meteorological observational data available from a location within the PDA (i.e., on-site), therefore the AEP AQMG requires the use of the AEP MM5 dataset.

With the CALMET meteorological processor, it is also possible to combine both MM5 data with concurrent (2002-2006) meteorological surface station measurements (i.e., blend both MM5 and surface station data) if suitable data are available. The AEP AQMG states that a dataset should not be used if fewer than 90% of annual measurements are available. The Springbank Airport station observations record covered only 18 hours per day (from 4 am to 10 pm) up to April 2014. This results in 10,950 missing hours (25% of hours) of observations from the Springbank Airport over the 2002 to 2006 period. Starting April 2014, the station began recording observations 24 hours per day. Over the 2002 to 2006 period, the Springbank Airport station does not meet the AEP AQMG 90% criteria for dispersion modelling.

Further, Section 3.2 of the AQMG (https://open.alberta.ca/dataset/e796eeb3-4e88-456c-9dcb-79808c4f926a/resource/3f30ef73-eb06-4deb-a033-5a018d42d24a/download/2013-airqualitymodelguideline-oct1.pdf) states that "**No other meteorological datasets are acceptable**". The text is bolded and underlined in the AQMG to emphasize that no other approach other than the one adopted by Stantec Consulting in Exhibit 67 is acceptable to AEP. Air quality modelling completed in support of EIAs where the air quality assessment has adopted assumptions that deviate from this AEP AQMG in an effort to improve accuracy have previously been rejected by AEP and modelling has had to be revised using the standard AQMG approach (AEP 2013; ERCB 2013). Dr. Zelt's critique of the selection and use of the meteorological data in EIA, Volume 4, Appendix E (Exhibit 67) is essentially a disagreement with AEP's meteorological data selection and processing requirements in the AQMG.

The Zelt PSI report presents revised air quality dispersion model predictions using the AERMOD dispersion model and states that the model is based upon meteorological data that has been "corrected" to avoid underestimation of maximum wind speeds associated with following AEP's AQMG. The adoption of a Springbank Airport based meteorological dataset as applied in the Zelt PSI report appears to not comply with the AEP AQMG.

2.3 FRICTION VELOCITY

During the post-flood scenario, deposited sediment will cover vegetation and change the microscale properties of the surface reflected an unvegetated sediment covered landscape. Consistent with this change, Exhibit 67 has characterized the surface roughness of the sediment as 0.005 m which is representative of a flat smooth surface. Dr. Zelt argues that a larger surface roughness value of 0.05 m should be used due to larger macro scale terrain features such as vegetation, hills and slopes and that this increased roughness length value will result in increased friction velocity and increased particulate emissions. This is not correct.

Dr. Zelt's suggestion to use a larger roughness length is not consistent with the literature nor the application of the roughness length value in the context of the microscale (not macro scale) processes that initiate and control dust emission flux. Moving air provides the driving forces for particle movement while surface particles exert an opposite force on the wind. Momentum from the moving air is transferred to surface particles which reduces the speed of the near-surface winds. This wind-particle interaction is controlled by roughness elements on the surface where u* is the "small-scale" friction velocity referred to the local shear stress and Z0 is the "local" roughness length of surface (Marticorena et al 1997). Menut et al (2013) described this as the soil particle diameter dependent "aeolian" roughness length and describes how this parameter is distinct from the larger mesoscale roughness lengths referenced by Dr. Zelt.

The wind speed necessary to result in fugitive dust emission from deposited sediment is associated with the saltation wind speed threshold of the sediment which is governed by the micro-scale shear force interacting with surface roughness elements. When wind speeds exceed this threshold, saltation starts to occur which is the vibrating or hopping motion of sand-sized particles. The movement of the larger sand-sized particles then causes emissions and suspension of smaller particles within the sediment. The dust flux (i.e., emission rate) depends on several factors including the amount of the clay-silt fraction in the soil, the shear velocity, and the saltation flux under certain shear velocities (Rubinstein et al 2020).

The aerodynamic roughness of wind erodible surfaces has been evaluated in a number of wind tunnel based studies. The complex relationships between aerodynamic roughness length, sand transport rate, wind velocity and friction velocity has often been described in the literature as the Blowing Sand Boundary Layer (BSBL) (i.e., micro-scale) with a number of researchers indicating that aerodynamic roughness length of the sediment surface characterizes the BSBL (Owen 1964, Gillette 1999). More recent research (Dong et al 2003) has indicated that the relationship between the aerodynamic roughness length and shear velocity is more complex than that originally proposed by Owen (1964) due to the variation with height of the shear stress caused by the blown sand movement. Dong et al (2003) calculated surface roughness values based upon wind profile measurements for a variety of sediment surfaces, sediment particle sizes and wind speeds. Dong et al (2003) found that aerodynamic roughness increases with dust emission rate ranging from approximately 0.1 mm to 2 mm (0.0001 m to 0.002 m) at low and high dust emission rates, respectively. Dong et al (2003) also found that aerodynamic roughness lengths varied from 0.02 mm to 2 mm (0.0002 m to 0.002 m) across a range of tested sand particle sizes.

EIA, Volume 4, Appendix E (Exhibit 67) assumed an appropriate surface roughness length of 0.005 m based upon standard regulatory emission inventory guidance for open unvegetated terrain (U.S. EPA 2006). The application is consistent with the theoretical basis of the parameter and is larger compared to experimentally determined surface roughness values from wind tunnel experiments. The roughness length values adopted by Dr. Zelt do not realistically represent the governing sediment roughness properties that control particle saltation and emission flux.

2.4 THRESHOLD FRICTION VELOCITY

The Zelt PSI Report adopts a threshold friction velocity of 0.75 m/s to reflect a 'crusted' or undisturbed surface where sediment is more resistant to wind shear and higher wind speeds are required to initiate saltation. Surface roughness and threshold friction velocity values are not independent variables. The controlling mechanism determining the threshold friction velocity in measured soils is the surface roughness parameterized by roughness length and it is necessary to select a threshold friction velocity that is consistent with the selected roughness length.

The threshold friction velocity of 0.75 m/s assumption is inconsistent with the assumed surface roughness values of 0.05 m and 0.2 m adopted by Dr. Zelt for sediment and vegetated areas, respectively. Surface roughness controls the transfer of momentum from the wind to soil particles. Soils with a larger sediment roughness require a higher friction velocity (i.e., more wind energy) to initiate saltation. This relationship is shown in Figure 3-1 of Exhibit 67 from Marticorena (1997). From this Figure, it is evident that threshold friction velocity necessary to initiate saltation (i.e., dust emissions) for surfaces with 0.05 m and 0.2 m roughness exceed 3 m/s. The assumptions adopted by Dr. Zelt are internally inconsistent and overestimates dust emissions.

The threshold friction velocity selected for dispersion modelling in EIA, Volume 4, Appendix E (Exhibit 67) of 0.31 m/s is both theoretically appropriate and consistent with measured values in the literature for a sediment roughness of 0.005 m. Fugitive dust wind erosion measurements to experimentally determine friction velocity thresholds completed throughout the Athabasca Oil Sands Region across a range of surfaces (Watson 2014) indicated friction velocity threshold in the range of 0.19 to 0.32 m/s over similar surfaces (tailings dikes and tailings sand beaches). This is consistent with the threshold friction velocity adopted in Exhibit 67.

2.5 SEDIMENT AREA

The Zelt PSI report states that the assumption that emissions are likely to occur from only the area where more than 10 cm of sediment deposition in EIA, Volume 4, Appendix E (Exhibit 67) results in an underestimation of dust emissions. Dr. Zelt calculated revised areas of sediment depth both greater than and less than 10 cm of sediment and also estimated emissions for the entire flooded reservoir assuming thinner depths of sediment is also a source of fugitive dust emissions. These assumptions together result in increased emission estimates.

Exhibit 67 estimated the areas with sediment greater than 10 cm depth based upon preliminary hydrological and sediment transport modelling that was presented in Volume 3B, Section 6 (Exhibit 45) and Volume 4 Appendix J, Hydrology TDR (Exhibit 72) for a 1:100 year flood and a design flood. This sediment transport modelling indicated that sediment depths greater than 10 cm could cover an approximate area of 82 ha in the reservoir for the 1:100 year flood and an approximate area of 155 ha for a design flood. Areas with thin sediment (less than 10 cm deep) were assumed (Exhibit 67) to not materially impact vegetation and hence not be a substantial source of wind erosion emissions since vegetation will still be present to mitigate wind erosion.

Additionally, revised hydrological and sediment transport modelling was completed as part of IAAC Round 2 SIRs, Package 4, Response to IR4-01 (Exhibit 218) which resulted in increased estimates of areas with greater than 10 cm sediment depth. The updated sediment model estimated 148 ha (early release) to 183 ha (late release) for the 1:100 year flood and 323 ha (early release) to 341 ha (late release) for a design flood. Dr. Zelt did not use the sediment areas from either of the two hydrological and sediment transport model-based area predictions.

Unlike Exhibit 67, the Zelt PSI report estimates emissions from the entire flooded area, including areas with sediment depths less than 10 cm. Dr. Zelt assumes vegetation in these areas achieves 98% control referencing Grantz et al (1998). The Zelt PSI assumption of 98% control from areas with thin sediment is similar to the assumption adopted in Exhibit 67 that these areas do not represent a material wind erosion risk.

It is recognized that there is uncertainty associated with the hydrological and sediment transport model-based estimates of sediment deposition area. The sensitivity of emission estimates and dispersion model predictions to changes in the area are evaluated in Sections 2.8 and 2.9 of this memorandum.

2.6 SEDIMENT PARTICLE SIZE DISTRIBUTION

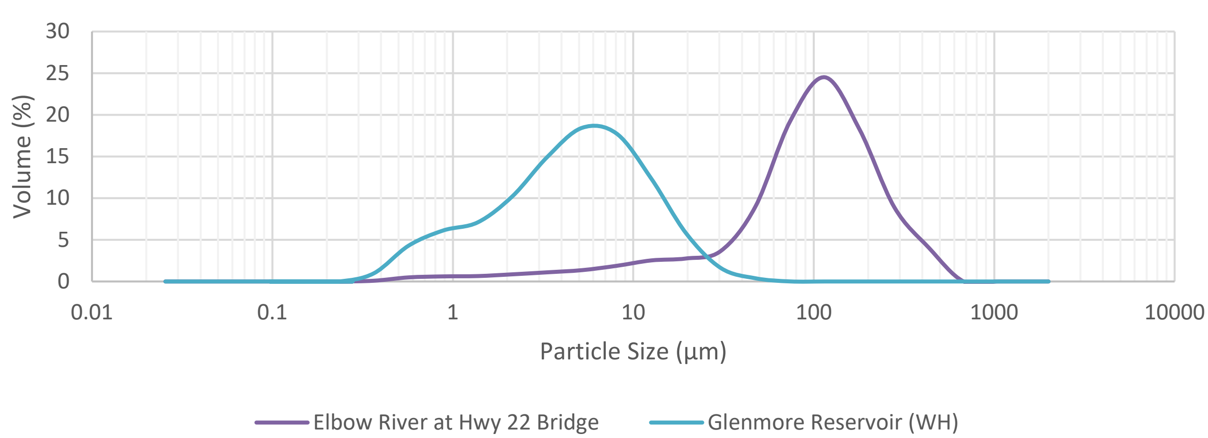
The Zelt PSI report provides an overview of hydrological processes and fundamentally different assumptions related to the particle size distribution of the suspended sediment than those adopted for the EIA (Exhibit 67). The data selected and assumptions adopted by Dr. Zelt are not appropriate for SR1.

The Zelt PSI report does not apply the particle size distribution predictions (i.e., 22% silt, 72% sand) obtained from the hydrological and sediment transport model in Volume 3B, Section 6 (Exhibit 45) and Volume 4 Appendix J, Hydrology TDR (Exhibit 72) which corresponds to the estimates of suspended sediment properties of the Elbow River during a flood. Based upon these hydrological and sediment transport model predictions, the particle size distribution adopted in Exhibit 67 results in a sediment classification of “sandy loam” (type MS) and this governs the selection of the fugitive dust emissions flux equation. Dr. Zelt states that this assumption is problematic since the sediment deposited within the Springbank Off-Stream Reservoir should not be expected to be the same as those measured or modelled along Elbow River. Rather, Dr. Zelt states that the suspended sediment should be assumed to consist mainly of much finer sediment representative of the suspended sediment distributions measured in the non-river, slow flowing waters of the Glenmore Reservoir. Dr. Zelt then presents particle size distributions from sediment sampled from the Glenmore Reservoir from Yang (2018) which indicates a mean aerodynamic particle size diameter of 5 µm. Dr. Zelt uses the Glenmore Reservoir sediment data to justify adopting a “fine silt” soil classification (type FS) and the adoption of a much higher $PM_{2.5}$ to TSP ratio of 0.23 rather than the 0.075 value stated in Exhibit 67. These assumptions result in higher dust emission rates than those calculated in Exhibit 67.

Yang (2018) provides measurements of suspended particle size distributions for the upper reaches of the Elbow River (at multiple sampling locations) as well as bottom sediment from the Glenmore Reservoir. Mean suspended particle diameters ranging from 33 µm to 243 µm were measured in the Elbow River which demonstrate increased coarse particles compared to the mean particle diameters ranging from 3.16 µm to 7.23 µm in the Glenmore Reservoir bottom sediment. This shows that the suspended sediment distribution in the flowing waters of the Elbow River are biased towards larger particles than compared to deposited sediment downstream in the Glenmore Reservoir. Yang (2018) notes in the same report that water flow velocity plays an important role on particle size distribution. Specifically, Yang (2018) notes that year over year sampling in Drum Creek resulted in mean suspended particle size diameters of 77.0 µm and 4.63 µm for 2009 and 2010, respectively with the 2009 sample representative of spring conditions with higher flows and 2010 measurements in summer and fall during lower flows.

Yang (2018) includes suspended particle size distributions measured at a sampling location on the Elbow River near at the Highway 22 bridge which is located near the Springbank Off-Stream Reservoir Project intake structure. Figure 1 compares the particle size distribution adopted by Dr. Zelt from the Glenmore Reservoir bottom sediment to the suspended particle size distribution measured by Yang (2018) at the Elbow River Highway 22 sampling location. Dr. Zelt has selected a sediment particle size distribution reflecting the hydraulic conditions of an impounded, anthropogenically formed reservoir created by building a dam on a river (Yang 2018). This is not equivalent to the Springbank Off-Stream Reservoir Project. Figure 1 indicates that suspended sediment particles in the Elbow River smaller than 2.5 µm make up only a very small fraction of the sediment. Use of the Glenmore Reservoir sediment is not appropriate to justify a $PM_{2.5}$ to TSP ratio of 0.23.

Figure 1: Particle Size Distribution (Yang 2018)



The general overview of hydrological processes that Dr. Zelt describes is correct; however, clarifications are required. Dr. Zelt appears to not have reviewed the Suspended Sediment Modelling Approach Report (IAAC Round 2 SIRs, Package 4, Appendix 1-1 (Exhibit 218)). A 2D hydrodynamic and sediment transport model was developed to evaluate the effects of the Project on total suspended solids (TSS) for the hydrographs considered. The model considered an approximately 40 km reach from Bragg Creek to the Glenmore Reservoir. Model domains considered with and without the Project cases. The upstream and downstream boundary conditions were hourly flows in the Elbow River as determined by the Water Survey of Canada (WSC) hydrometric station at Bragg Creek (05BJ004) and daily water levels in Glenmore Reservoir. A TSS rating curve was developed using available information at the WSC station. The rating curve was used to predict TSS in the Elbow River at a given discharge. Suspended sediment in the Elbow River was characterized using data collected by Hudson (1983). The model was then run and the TSS parameters and characteristics were hydraulically modelled and the results reflected hydraulic processes driven by the models. This means that the conditions in the reservoir simulate the hydraulic conditions the determine the suspension and deposition of TSS. The model is constrained by the sediment concentrations in the Elbow River at the upstream end and simulates the fundamental physical processes governing sediment transport into the Springbank Off-Stream Reservoir Project Reservoir including the predicted particle size distribution. The hydraulic characteristics in the Project reservoir are different than those in the Glenmore Reservoir and suspended sediment sizes would not be expected to be the same. The assumption adopted by Dr. Zelt, using observations from the Glenmore Reservoir, are expected to overestimate the quantity of the fine sediment expected to be found in the Project reservoir. This likely results in an overestimate of dust emissions.

It is recognized that there is uncertainty associated with the hydrological and sediment transport model-based estimates of sediment particle size distribution and the spatial variation of the distribution throughout the sediment deposit. The sensitivity of emission estimates and dispersion model predictions to changes in sediment distribution assumptions are evaluated in Sections 2.8 and 2.9 of this memorandum.

2.7 EMISSION ESTIMATES – CORRECTED ERRATA

Same as in the EIA, wind erosion emissions from the post-flood sediment in the off-stream reservoir are estimated based on methods developed by ENVIRON and the Western Regional Air Partnership (WRAP) Regional Modeling Center (RMC) (Mansell et.al 2006). Wind erosion emissions are generated when the wind exceeds a threshold wind friction velocity defined based on the characteristics of the soil subject to erosion. In the context of air quality and human health impacts, wind erosion refers to the vertical emission and transport of the finer particles rather than wind erosion of all soil particles (including larger particles that can move by saltation and creep) in the context of effects on soil characteristics and agricultural land capability.

A summary of estimated fugitive dust emission rates for the 1:100 year flood and design flood is presented in Table 2-1 (referred to as Case 1). The $PM_{2.5}$ emission rates in the table include the correction to the $PM_{2.5}$/TSP ratio to 0.075 noted in the errata. Emissions are presented assuming the same 84% dust control efficiency corresponding to application of chemical dust suppressant (i.e., tackifier). The sediment area for each flood corresponds to a sediment depth of at least 10 cm and the probability of wind within each wind speed category is estimated from CALMET 5-year time series (based upon MM5 data) at the approximate centre of the sediment area in the off-stream reservoir. Total emissions are calculated by multiplying the emission flux for each wind speed category with the probability of wind within that wind speed category.

After correction of the calculation error, $PM_{2.5}$ emission rates have doubled from the values presented in EIA, Volume 4, Appendix E (Exhibit 67).

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

Table 2-1 Wind Erosion Emission Rates (Case 1)

Flood Scenario	Sediment Area [a] (m²)	Wind Speed Category —	Lower Limit Wind Speed (m/s)	Upper Limit Wind Speed (m/s)	Mean Wind Speed [b] (m/s)	Wind Probability [c] (%)	Dust Control Efficiency [d] (%)	Emission Rate with Applied Dust Mitigation (kg/d) $PM_{2.5}$	PM_{10}	TSP
1:100 year flood	820,578	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		5.4	36	72
		3	5.5	6.5	5.93	4.8		4.3	29	58
		4	6.5	8.5	7.24	3.1		4.8	32	63
		5	8.5	11	9.39	0.73		2.2	15	29
		6	11	17	12.19	0.11		0.6	4.3	8.6
		Total Emissions:				**100**		**17**	**115**	**231**
Design flood (approximately, 1:200 year flood)	1,553,792	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		10	68	136
		3	5.5	6.5	5.93	4.8		8.2	55	110
		4	6.5	8.5	7.24	3.1		9.0	60	120
		5	8.5	11	9.39	0.73		4.2	28	56
		6	11	17	12.19	0.11		1.2	8.2	16
		Total Emissions:				**100**		**33**	**219**	**437**

NOTES:
[a] Sediment area corresponding to sediment depth equal or greater than 0.10 m.
[b] Mean wind speed for each wind speed category calculated from CALMET 5-year time series at the approximate centre of the sediment area in the off-stream reservoir.
[c] Probability of wind within each wind speed category estimated from CALMET 5-year time series at the approximate centre of the sediment area in the off-steam reservoir.
[d] Control efficiency corresponds to application of chemical dust suppressant (i.e. tackifier).

2.8 EMISSION ESTIMATES – SENSITIVITY ANALYSIS

Recognizing that there is uncertainty associated with the hydrological sediment transport model predictions including two sets of hydrological model sediment predictions, a sensitivity analysis is provided to consider a range of possible emission estimates and dispersion model predictions associated with different sediment areas and the influence of variation in sediment particle size distributions. Emission estimates are provided in Tables 2-2, 2-3 and 2-4 to evaluate the effect of increases to predicted sediment area discussed in Section 2.5 and the assumption that areas within the sediment deposit may have a more silt-weighted sediment particle size distribution as discussed in Section 2.6.

For the sensitivity analysis, sediment area predicted from the revised hydrological and sediment transport modelling provided as part of IAAC Round 2 SIRs, Package 4, Response to IR4-01 (Exhibit 218) for the late release scenarios were adopted consisting of a 183 ha area for the 1:100 year flood and a 341 ha area for a design flood. As detailed in Attachment C: Revised Post-Flood Soil Properties and Related Assessment Conclusions, the revised hydrological and sediment transport model indicated that soil texture and sediment thickness will vary systematically with distance from the outlet of the diversion channel. Deeper sediments of coarser texture will predominate closer to the diversion channel mouth. Shallower sediments of higher clay and silt content will predominate further out from the diversion channel mouth. Areas of sandy texture will tend to be deepest, areas of clayey sediment will tend to be shallowest, and silty soils will be intermediate in thickness. To evaluate the sensitivity of the model predictions to an increase in finer textured sediment, a case consisting of 80% of the sediment area with a “fine silt” soil classification (type FS) and 20% area with a soil classification of “sandy loam” (type MS) is considered.

Three sensitivity cases are considered consisting of:

- Case 2: Original Sediment Area, Increased Sediment Area with Fine Sediment
- Case 3: Increased Area of Deposited Sediment, Original Sediment Size Assumptions
- Case 4: Increased Area of Deposited Sediment, Increased Sediment Area with Fine Sediment

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

Table 2-2 Wind Erosion Emission Rates (Case 2)

Flood Scenario	Sediment Area [a]	Wind Speed Category	Lower Limit Wind Speed	Upper Limit Wind Speed	Mean Wind Speed [b]	Wind Probability [c]	Dust Control Efficiency [d]	Emission Rate with Applied Dust Mitigation: $PM_{2.5}$	PM_{10}	TSP
	(m^2)	—	(m/s)	(m/s)	(m/s)	(%)	(%)	(kg/d)		
1:100 year flood	820,578	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		41	276	552
		3	5.5	6.5	5.93	4.8		32	215	430
		4	6.5	8.5	7.24	3.1		34	227	454
		5	8.5	11	9.39	0.73		15	100	200
		6	11	17	12.19	0.11		4.2	28	56
		Total Emissions:				**100**		**127**	**846**	**1,692**
Design flood (approximately, 1:200 year flood)	1,553,792	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		78	522	1,044
		3	5.5	6.5	5.93	4.8		61	407	815
		4	6.5	8.5	7.24	3.1		64	430	859
		5	8.5	11	9.39	0.73		28	190	379
		6	11	17	12.19	0.11		7.9	53	106
		Total Emissions:				**100**		**240**	**1,602**	**3,203**

NOTES:
[a] Sediment area corresponding to sediment depth equal or greater than 0.10 m.
[b] Mean wind speed for each wind speed category calculated from CALMET 5-year time series at the approximate centre of the sediment area in the off-stream reservoir.
[c] Probability of wind within each wind speed category estimated from CALMET 5-year time series at the approximate centre of the sediment area in the off-steam reservoir.
[d] Control efficiency corresponds to application of chemical dust suppressant (i.e. tackifier).

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

Table 2-3 Wind Erosion Emission Rates (Case 3)

Flood Scenario	Sediment Area [a]	Wind Speed Category	Lower Limit Wind Speed	Upper Limit Wind Speed	Mean Wind Speed [b]	Wind Probability [c]	Dust Control Efficiency [d]	Emission Rate with Applied Dust Mitigation		
								$PM_{2.5}$	PM_{10}	TSP
	(m^2)	—	(m/s)	(m/s)	(m/s)	(%)	(%)	(kg/d)		
1:100 year flood	1,835,999	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		12	80	160
		3	5.5	6.5	5.93	4.8		9.7	65	129
		4	6.5	8.5	7.24	3.1		11	71	142
		5	8.5	11	9.39	0.73		4.9	33	66
		6	11	17	12.19	0.11		1.4	9.7	19
		Total Emissions:				**100**		**39**	**258**	**517**
Design flood (approximately, 1:200 year flood)	3,414,136	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		22	149	298
		3	5.5	6.5	5.93	4.8		18	120	241
		4	6.5	8.5	7.24	3.1		20	132	264
		5	8.5	11	9.39	0.73		9.2	61	123
		6	11	17	12.19	0.11		2.7	18	36
		Total Emissions:				**100**		**72**	**480**	**961**

NOTES:

[a] Sediment area corresponding to sediment depth equal or greater than 0.10 m.

[b] Mean wind speed for each wind speed category calculated from CALMET 5-year time series at the approximate centre of the sediment area in the off-stream reservoir.

[c] Probability of wind within each wind speed category estimated from CALMET 5-year time series at the approximate centre of the sediment area in the off-steam reservoir.

[d] Control efficiency corresponds to application of chemical dust suppressant (i.e. tackifier).

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

Table 2-4 Wind Erosion Emission Rates (Case 4)

Flood Scenario	Sediment Area [a]	Wind Speed Category	Lower Limit Wind Speed	Upper Limit Wind Speed	Mean Wind Speed [b]	Wind Probability [c]	Dust Control Efficiency [d]	Emission Rate with Applied Dust Mitigation		
								$PM_{2.5}$	PM_{10}	TSP
	(m^2)	—	(m/s)	(m/s)	(m/s)	(%)	(%)	(kg/d)		
1:100 year flood	1,835,999	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		93	617	1,234
		3	5.5	6.5	5.93	4.8		72	481	963
		4	6.5	8.5	7.24	3.1		76	508	1,015
		5	8.5	11	9.39	0.73		34	224	448
		6	11	17	12.19	0.11		9.4	62	125
		Total Emissions:				**100**		**284**	**1,893**	**3,785**
Design flood (approximately, 1:200 year flood)	3,414,136	1	0	4.5	2.44	81.6	84	0	0	0
		2	4.5	5.5	4.94	9.7		172	1,147	2,295
		3	5.5	6.5	5.93	4.8		134	895	1,790
		4	6.5	8.5	7.24	3.1		142	944	1,888
		5	8.5	11	9.39	0.73		63	417	834
		6	11	17	12.19	0.11		17	116	232
		Total Emissions:				**100**		**528**	**3,519**	**7,039**

NOTES:
[a] Sediment area corresponding to sediment depth equal or greater than 0.10 m.
[b] Mean wind speed for each wind speed category calculated from CALMET 5-year time series at the approximate centre of the sediment area in the off-stream reservoir.
[c] Probability of wind within each wind speed category estimated from CALMET 5-year time series at the approximate centre of the sediment area in the off-steam reservoir.
[d] Control efficiency corresponds to application of chemical dust suppressant (i.e. tackifier).

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

2.9 UPDATED DISPERSION MODEL PREDICTIONS

Fugitive particulate matter emission rates depend upon the properties of the surface material (e.g., sediment particle size distribution, moisture content, vegetation cover, surface roughness), the occurrence and history of surface disturbances, and meteorological conditions (e.g., wind speed, temperature, and relative humidity). There is considerable uncertainty associated with the ability to accurately estimate fugitive dust emissions and this results in uncertainties in the associated ambient TSP, PM_{10} and $PM_{2.5}$ concentration predictions. This uncertainty is discussed in EIA, Volume 3A, Section 3.6 (Exhibit 24). Nonetheless, fugitive dust emission estimates and air quality dispersion modelling can be used to obtain a first order understanding of potential magnitude, geographic extent, and frequency of maximum concentrations associated with Project sediment deposition.

As detailed in Section 3.3 of Exhibit 67, it is important to recognize that, while the air quality model assumes an 84% dust control efficiency associated with the application of a chemical dust suppressant (i.e., a tackifier), that the effectiveness of the mitigation is dependent upon selected chemical product, concentration applied, weather conditions between reapplication and reapplication frequency. The dilution ratio, chemical application rate and time between reapplications of a chemical stabilizer can be adjusted to achieve and maintain lower or higher levels of fugitive dust control. The ability to reapply or alter the application of the chemical dust suppression to improve effectiveness is a key component of adaptive management. For example, the U.S. Bureau of Mines study calculated that a 90% level of control can be maintained over a three-month summer period with one initial application and one reapplication of typical dust suppressant (Olson and Veith 1987). Mitigation can also be enhanced using a variety of non-chemical techniques including temporary wind fencing, vegetation wind breaks, and planting fast growing cover crops. Alberta Transportation has committed to employing ambient air quality and meteorological monitoring in conjunction with dust control and revegetation efforts to support evaluation of mitigation effectiveness and allow for adaptation of mitigation, as necessary.

2.9.1 Updated EIA Predictions

The predicted maximum ambient concentrations of $PM_{2.5}$, PM_{10} and TSP for the 1:100 year flood scenario and design flood are summarized in Tables 2-5 and 2-6 (Case 1), respectively. Concentration isopleth maps for Case 1 (1:100 year flood and design flood) are included in Attachment A.

The updated $PM_{2.5}$ concentration predictions are approximately double the values in EIA, Volume 4, Appendix E (Exhibit 67). However, the predicted maximum $PM_{2.5}$ concentrations for Case 1 remain below the ambient air quality criteria for all averaging periods. The predicted maximum PM_{10} and TSP concentrations remain unchanged from the values in Exhibit 67.

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

Table 2-5 Maximum Predicted Ground-Level Concentrations for the 1:100 Year Flood Scenario (Case 1)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	13.7	17	0	27.4	34	0	50
	24-hour	11.0	29	21.8	73	0	8.29	29	0	21.8	73	0	38
	24-hour [e]	11.0	27 [b]	18.5	66	0	1.33	5	0	18.5	66	0	7
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	54.0	**108**	1 d/a	78.4	**157**	2 d/a (1 d/a)	69
TSP	24-hour	51.0	100	163	**163**	131 d/a	107	**107**	1 d/a	165	**165**	2 d/a (131 d/a)	65

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

Table 2-6 Maximum Predicted Ground-Level Concentrations for the Design Flood (Case 1)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	30.4	38	0	42.8	54	0	71
	24-hour	11.0	29	21.8	73	0	19.2	66	0	31.0	**107**	1 d/a (0 d/a)	62
	24-hour [e]	11.0	27 [b]	18.5	66	0	3.26	12	0	18.5	68	0	18
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	124	**248**	4 d/a	149	**297**	8 d/a (1 d/a)	84
TSP	24-hour	51.0	100	163	**163**	131 d/a	245	**245**	4 d/a	303	**303**	10 d/a (131 d/a)	81

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

2.9.2 Sensitivity Analysis Model Predictions

The predicted maximum ambient concentrations of $PM_{2.5}$, PM_{10} and TSP for the sensitivity model cases (Cases 2, 3 and 4) for a 1:100 year flood and a design flood are summarized in Tables 2-7 to 2-12. Concentration isopleth maps for Cases 2, 3 and 4 (1:100 year flood and design flood) are included in Attachment A.

The predicted maximum $PM_{2.5}$, PM_{10} and TSP concentrations for Cases 2, 3 and 4 are greater than the model predictions (Case 1) in EIA, Volume 4, Appendix E (Exhibit 67). The increase in maximum predicted concentrations is 2 to 5 times for Case 2, 20% to 80% for Case 3, and 4 to 10 times for Case 4. For Case 3, the predicted maximum $PM_{2.5}$ concentrations remain largely below the ambient air quality criteria.

The areas of exceedance of the 24-hour $PM_{2.5}$ ambient criteria for a design flood extend to the east of the PDA up to approximately 1.5 km for Case 2, up to approximately 180 m for Case 3 and up to approximately 4.8 km for Case 4.

Table 2-7 Maximum Predicted Ground-Level Concentrations for the 1:100 Year Flood Scenario (Case 2)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	98.3	**123**	7 h/a	109	**137**	14 h/a (0 h/a)	90
	24-hour	11.0	29	21.8	73	0	58.3	**201**	2 d/a	69.4	**239**	4 d/a (0 d/a)	84
	24-hour [e]	11.0	27 [b]	18.5	66	0	10.0	37	0	21.1	78	0	48
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	381	**762**	12 d/a	404	**807**	30 d/a (1 d/a)	94
TSP	24-hour	51.0	100	163	**163**	131 d/a	752	**752**	11 d/a	803	**803**	32 d/a (131 d/a)	94

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

Table 2-8 Maximum Predicted Ground-Level Concentrations for the Design Flood (Case 2)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	224	**280**	92 h/a	235	**293**	96 h/a (0 h/a)	95
	24-hour	11.0	29	21.8	73	0	136	**469**	7 d/a	147	**507**	14 d/a (0 d/a)	93
	24-hour [e]	11.0	27 [b]	18.5	66	0	24.2	90	0	35.3	**131**	6 d/a (0 d/a)	69
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	884	**1,768**	30 d/a	906	**1,813**	56 d/a (1 d/a)	98
TSP	24-hour	51.0	100	163	**163**	131 d/a	1,739	**1,739**	30 d/a	1,790	**1,790**	59 d/a (131 d/a)	97

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

Table 2-9 Maximum Predicted Ground-Level Concentrations for the 1:100 Year Flood Scenario (Case 3)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	23.8	30	0	34.8	43	0	68
	24-hour	11.0	29	21.8	73	0	15.2	52	0	26.2	90	0	58
	24-hour [e]	11.0	27 [b]	18.5	66	0	2.08	8	0	18.5	68	0	11
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	98.9	**198**	2 d/a	121	**243**	3 d/a (1 d/a)	82
TSP	24-hour	51.0	100	163	**163**	131 d/a	195	**195**	2 d/a	246	**246**	4 d/a (131 d/a)	79

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

Table 2-10 Maximum Predicted Ground-Level Concentrations for the Design Flood (Case 3)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	65.1	81	0	76.1	95	0	86
	24-hour	11.0	29	21.8	73	0	32.5	**112**	1 d/a	43.6	**150**	2 d/a (0 d/a)	75
	24-hour [e]	11.0	27 [b]	18.5	66	0	5.58	21	0	18.5	68	0	30
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	216	**433**	7 d/a	239	**478**	16 d/a (1 d/a)	91
TSP	24-hour	51.0	100	163	**163**	131 d/a	431	**431**	7 d/a	482	**482**	18 d/a (131 d/a)	89

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

Table 2-11 Maximum Predicted Ground-Level Concentrations for the 1:100 Year Flood Scenario (Case 4)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	170	**212**	46 h/a	181	**226**	47 h/a (0 h/a)	94
	24-hour	11.0	29	21.8	73	0	107	**368**	2 d/a	118	**406**	10 d/a (0 d/a)	91
	24-hour [e]	11.0	27 [b]	18.5	66	0	15.8	58	0	26.8	99	0	59
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	696	**1,393**	20 d/a	719	**1,438**	41 d/a (1 d/a)	97
TSP	24-hour	51.0	100	163	**163**	131 d/a	1,372	**1,372**	19 d/a	1,423	**1,423**	48 d/a (131 d/a)	96

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

Table 2-12 Maximum Predicted Ground-Level Concentrations for the Design Flood (Case 4)

Substance	Averaging Period	Background Concentration	Ambient Criteria [a]	Base Case (includes Background Concentrations)			Project Case			Application Case (includes Background Concentrations)			Percent Contribution of Project to Application Case
				Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria	Maximum Concentration	Percent of Ambient Criteria	Maximum Frequency above Ambient Criteria [f]	
		(µg/m³)	(µg/m³)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	(µg/m³)	%	(h/a or d/a)	%
$PM_{2.5}$	1-hour [d]	11.0	80	27.3	34	0	466	**583**	152 h/a	477	**596**	157 h/a (0 h/a)	98
	24-hour	11.0	29	21.8	73	0	232	**800**	17 d/a	243	**838**	33 d/a (0 d/a)	95
	24-hour [e]	11.0	27 [b]	18.5	66	0	41.4	**153**	8 d/a	52.5	**194**	19 d/a (0 d/a)	79
PM_{10}	24-hour	22.4	50 [c]	50.8	**102**	1 d/a	1,542	**3,083**	50 d/a	1,564	**3,128**	67 d/a (1 d/a)	99
TSP	24-hour	51.0	100	163	**163**	131 d/a	3,070	**3,070**	49 d/a	3,122	**3,122**	69 d/a (131 d/a)	98

NOTES:
[a] AAAQO/G: Alberta Ambient Air Quality Objectives and Guidelines (AEP 2019)
[b] CAAQS: Canadian Ambient Air Quality Standards (CCME 2012; 2017)
[c] BC AAQO: British Columbia Ambient Air Quality Objectives (BC MOECCS 2020)
[d] Concentration represents the 9th highest 1-hour concentration
[e] Concentration represents the 3-year average of the annual 8th highest 24-hour average concentrations
[f] The first value represents maximum frequency above ambient criteria near the east PDA boundary; the value in brackets represents maximum frequency near the intersection of the TransCanada Highway and Highway 22. Frequency values represent maximum of 5 modelled years.
Percent values greater than 100% are in **bold** text.

3.0 HEALTH RISK ASSESSMENT

The human health risk assessment (Exhibit 77) and the assessment of potential effects on public health (Exhibit 54) relied on air dispersion model predictions of particulate matter concentrations. Specifically, exposure ratios (ERs) are used to characterize risks, where the ER is the comparison of the estimated receptor exposure to the exposure limit (benchmark or toxicological reference value; TRV). For inhalation exposures to chemicals of potential concern (COPC), an ER that is less than 1.0 has a low or negligible health risk (i.e., exposure is less than the limit). An ER that is greater than 1.0 does not necessarily indicate that the health risks are unacceptable but does require a more detailed evaluation of the significance of the estimated risks and may indicate the need for mitigation (Alberta Government 2019). Exposure estimates are the predicted concentrations of airborne COPCs that are modelled in the air quality and climate assessment (see Section 2.9). The exposure limits are derived by regulatory agencies using a conservative approach intended to protect human health, including sensitive members of the population such as infants, children, the elderly and women of child-bearing age. The exposure limits for the human health risk assessment are described in Exhibit 77.

Given the updated $PM_{2.5}$ concentrations described above, updated ERs are provided here for both the maximum point of impingements (MPOI) and the 58 human receptor locations previously described in Exhibit 54 (Volume 3B, Table 15-4) and Exhibit 36 (Volume 3A, Figure 15-2).

The air quality assessment considers ambient TSP, PM_{10} and $PM_{2.5}$ concentration predictions and the health risk assessment focused on the finer fraction, $PM_{2.5}$. While coarse dust (which is included in TSP and PM_{10}) may also be produced during wind erosion, when inhaled, it is trapped in the upper respiratory passages (e.g., mouth, nasal cavity, pharynx) which are subsequently swallowed. By contrast, $PM_{2.5}$ can penetrate deep into the lungs, bronchioles and alveoli. Federal and international health regulatory agencies (e.g., Health Canada, World Health Organization) recognize that health risk from dust inhalation is primarily associated with fine particulate matter ($PM_{2.5}$), rather than coarse particulate matter (such as that included with TSP, PM_{10}). For example, Health Canada (2016) reviewed studies that indicated, "…only limited evidence that crustal coarse particulate matter from Asian dust storm events has an effect on mortality, in spite of the extremely high levels of PM_{10} from dust storms". Consequently, coarse dust from wind erosion is discussed in terms of the air quality (Section 2.9), but $PM_{2.5}$ is used for human health risk characterization.

3.1 RISK CHARACTERIZATION FOR UPDATED EIA PREDICTIONS OF $PM_{2.5}$

As indicated in Attachment B, Tables 3-1 and 3-2, the updated ERs are less than 1.0 at the MPOI and the human receptor locations for the updated EIA predictions presented in Case 1. This indicates that there are no unacceptable risks to human receptors from inhalation exposures to $PM_{2.5}$ from wind-blown dust during post-flood operations.

3.2 RISK CHARACTERIZATION FOR SENSITIVITY ANALYSIS MODEL PREDICTIONS OF $PM_{2.5}$

One of the components of a human health risk assessment is an uncertainty assessment. The uncertainty assessment provides an indication of the validity and confidence in the risk estimates, and describes uncertainties associated with the data, predictive modelling and other factors that could affect the final risk estimate. The results of the air dispersion model sensitivity analysis of fugitive dust (i.e., Case 2, Case 3, and Case 4) allow for quantitative assessment of the uncertainty associated with $PM_{2.5}$ exposures following an infrequent event (i.e., 1:100 year and 1:200 year flood events). The exposure ratios for these additional cases are provided in Attachment B, Table 3-3 to 3-8.

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

The ERs for Case 3 are less than 1.0 at the 58 receptor locations. The ERs for Case 2 and Case 4 (where finer sediments are assumed) are greater than 1.0 at one or more receptor locations for one or more scenarios. For the receptor locations with ERs greater than 1.0, a frequency analysis indicating the number of occurrences of concentrations greater than the exposure limit for the Application Case is provided in Attachment B, Table 3-9. As indicated, the maximum frequency of occurrence is less than 30 hours per year (<1% of time) for 1-hour exposure and less than 14 days per year (<4% of time) for 24-hour exposure.

Based on this uncertainty analysis, partial mitigation to reduce fugitive dust emissions (i.e., assumed dust control efficiency of 84%) could still result in an unacceptable short-term risk to human health at residential locations under some circumstances (i.e., sediment with higher fines content and either 1:100 year or design flood scenarios). As noted in Section 2.9, more intensive mitigation measures such as adjusting the dilution ratio, chemical application rate and time between reapplications of a chemical stabilizer can be used to achieve and maintain higher levels of fugitive dust control. These more intensive mitigation measures are expected to be effective in reducing concentrations of $PM_{2.5}$ to levels below the applicable benchmarks and reduce the risk to human health.

4.0 SUMMARY AND CONCLUSION

Based upon the analysis presented in this report, the effects on air quality and human health and mitigation recommendations are summarized as follows:

- Fugitive dust control mitigation including both revegetation and application of dust control chemicals (i.e., a tackifier) is recommended along with ambient air quality monitoring to ensure mitigation is effective. There are proven and effective dust control methods that, when properly applied, can control dust and minimize wind erosion risk with a high degree of effectiveness. Based upon ambient monitoring, the dilution ratio, chemical application rate or time between reapplications of a chemical stabilizer should be adjusted to achieve and maintain high levels of fugitive dust control.
- Alberta Transportation has committed to conducting ambient monitoring after a flood event to monitor potential effects associated with windblown sediment. Monitoring for TSP and $PM_{2.5}$ at a location near the east PDA boundary will be conducted for 16 months after a flood event (i.e., from the flood event to the end of the fall season in the following year) to facilitate the timely application of additional mitigation measures for fugitive dust, if excessive TSP or $PM_{2.5}$ levels are measured. Whether it is necessary to employ monitoring longer than 16 months will be determined in consultation with stakeholders and regulatory agencies.
- Quantification of fugitive dust predictions is challenging and there is considerable uncertainty with emission estimates and dispersion model predictions. The sensitivity analysis demonstrates larger variation in predicted concentrations associated with assumptions related to quantity of finer sediment than to changes in assumed sediment area.
- The joint combination of a large flood occurring that results in substantial sediment and the occurrence of very high wind speed conditions that can result in short-term elevated particulate matter concentrations is very infrequent.
- Given the low recurrence of the floods that can result in substantial sediment deposition, the proposed mitigation measures of revegetation and application of a tackifier, Alberta Transportation’s commitment to monitor and adaptively manage and enhance dust control efforts as required to minimize wind erosion risk, it is expected that fugitive dust emissions would not have significant adverse effects on ambient air quality or human health.

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

5.0 CLOSURE

This report was prepared for the sole benefit of Alberta Transportation and their representatives. The report may not be relied upon by any other person or entity without the express written consent of Stantec Consulting Limited and Alberta Transportation. Any uses which a third party makes of this report, or any reliance on decisions made based on it, are the responsibilities of such third parties. Stantec accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Should additional information become available, which differs significantly from our understanding of conditions presented in this report, we request that this information be brought to our attention so that we may reassess the conclusions provided herein. We trust that the above information meets with your present requirements. Should you have any questions or require further information, please contact the undersigned.

Respectfully Submitted,

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Attachments:
Attachment A: Concentration Isopleth Maps
Attachment B: Human Health Risk Assessment Tables
Attachment C: Revised Post-Flood Soil Properties

6.0 REFERENCES

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March 11, 2021

Alberta Transportation

Reference: Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions

ATTACHMENT A: CONCENTRATION ISOPLETH MAPS

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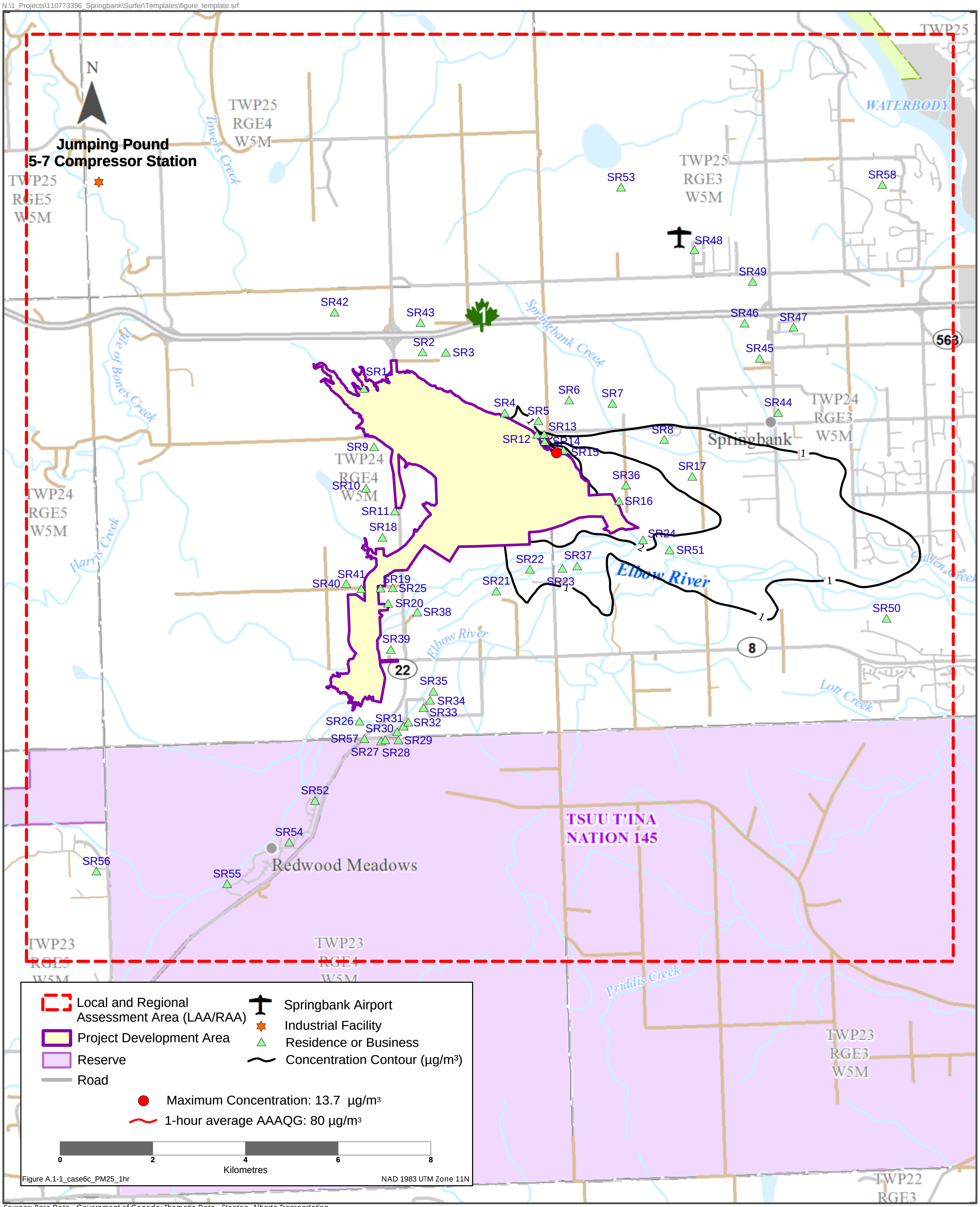

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration
(Case 1, 1:100 Year Flood - Project Case)

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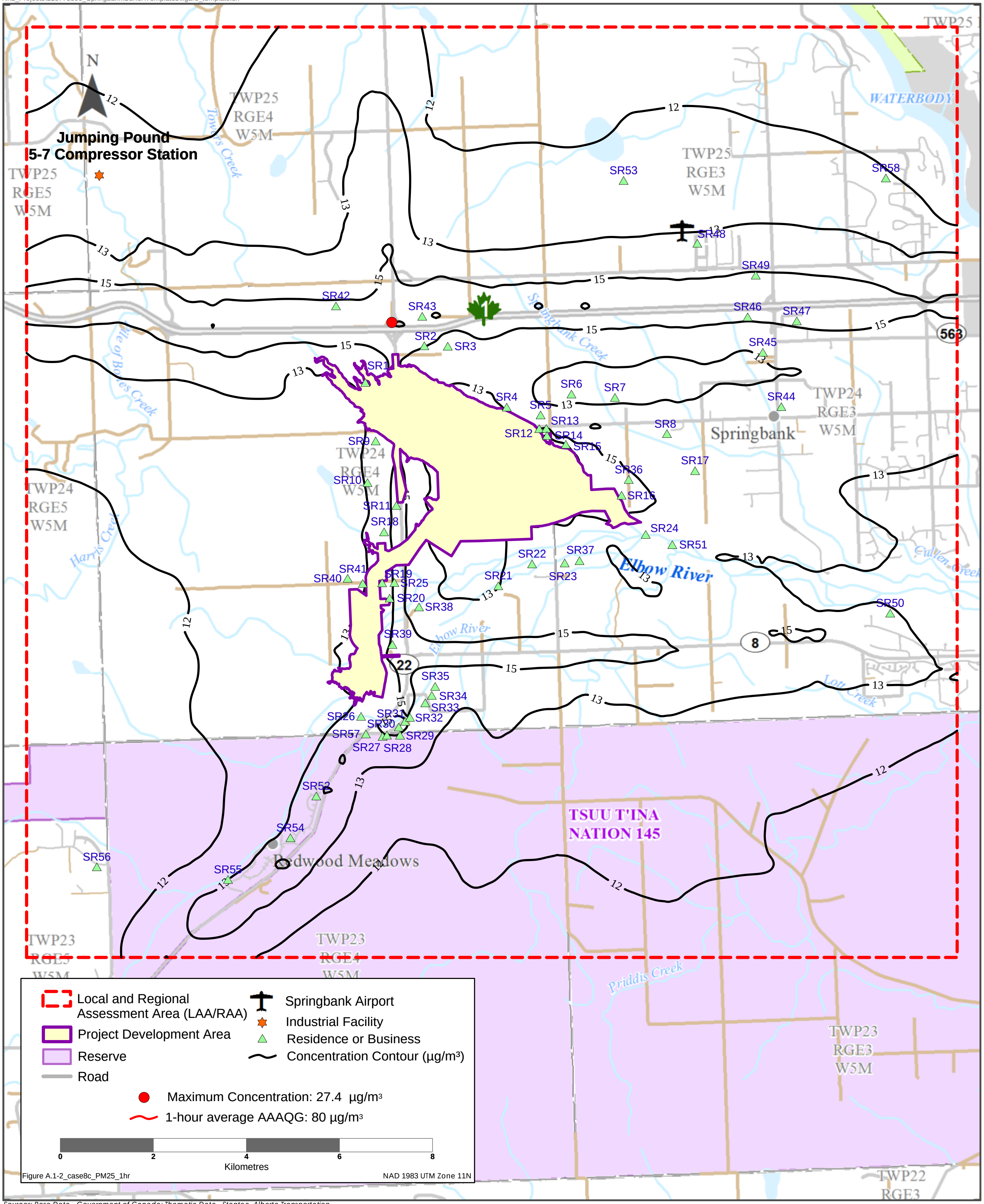
SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.1-1



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 1, 1:100 Year Flood - Application Case)

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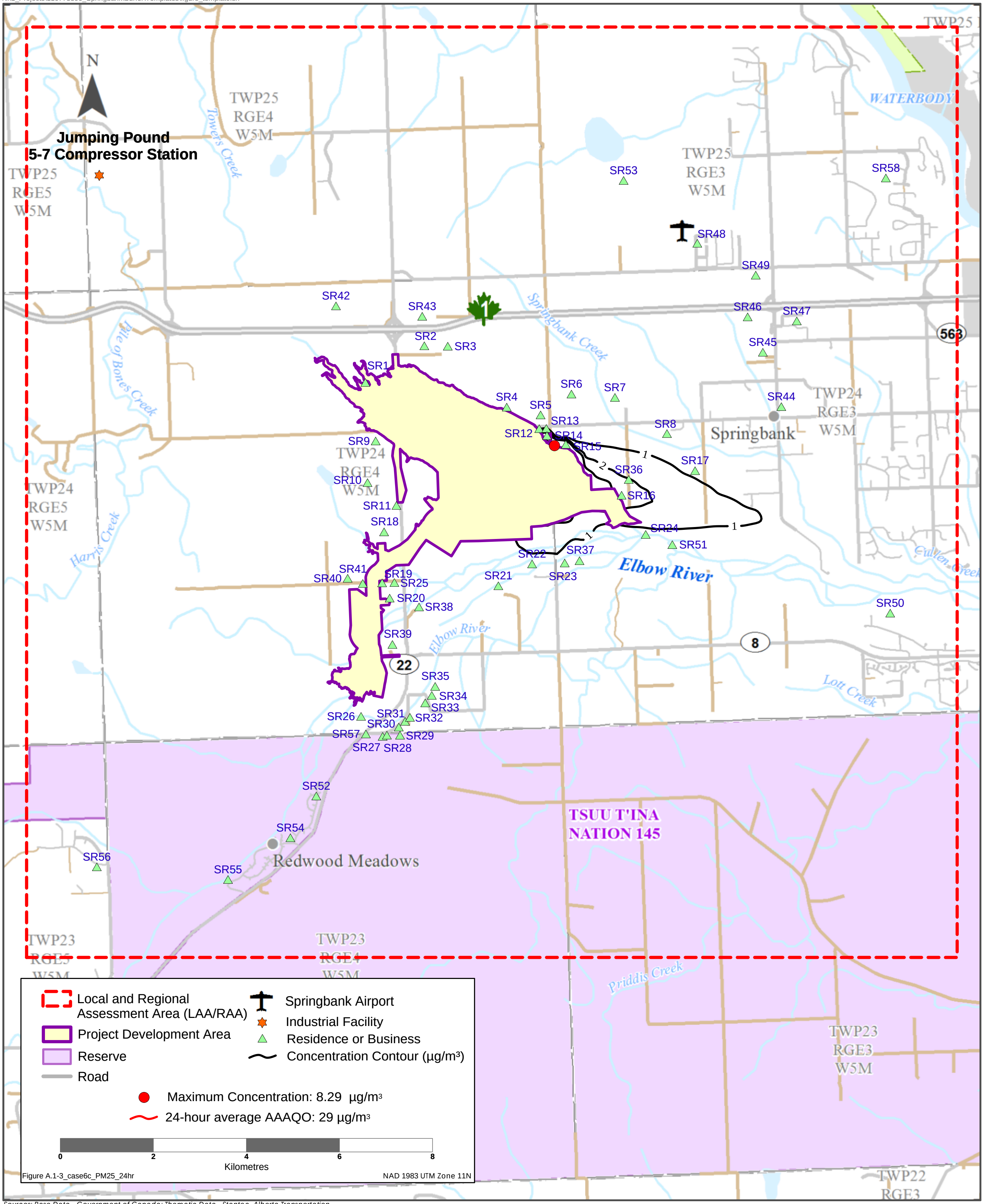

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:100 Year Flood - Project Case)

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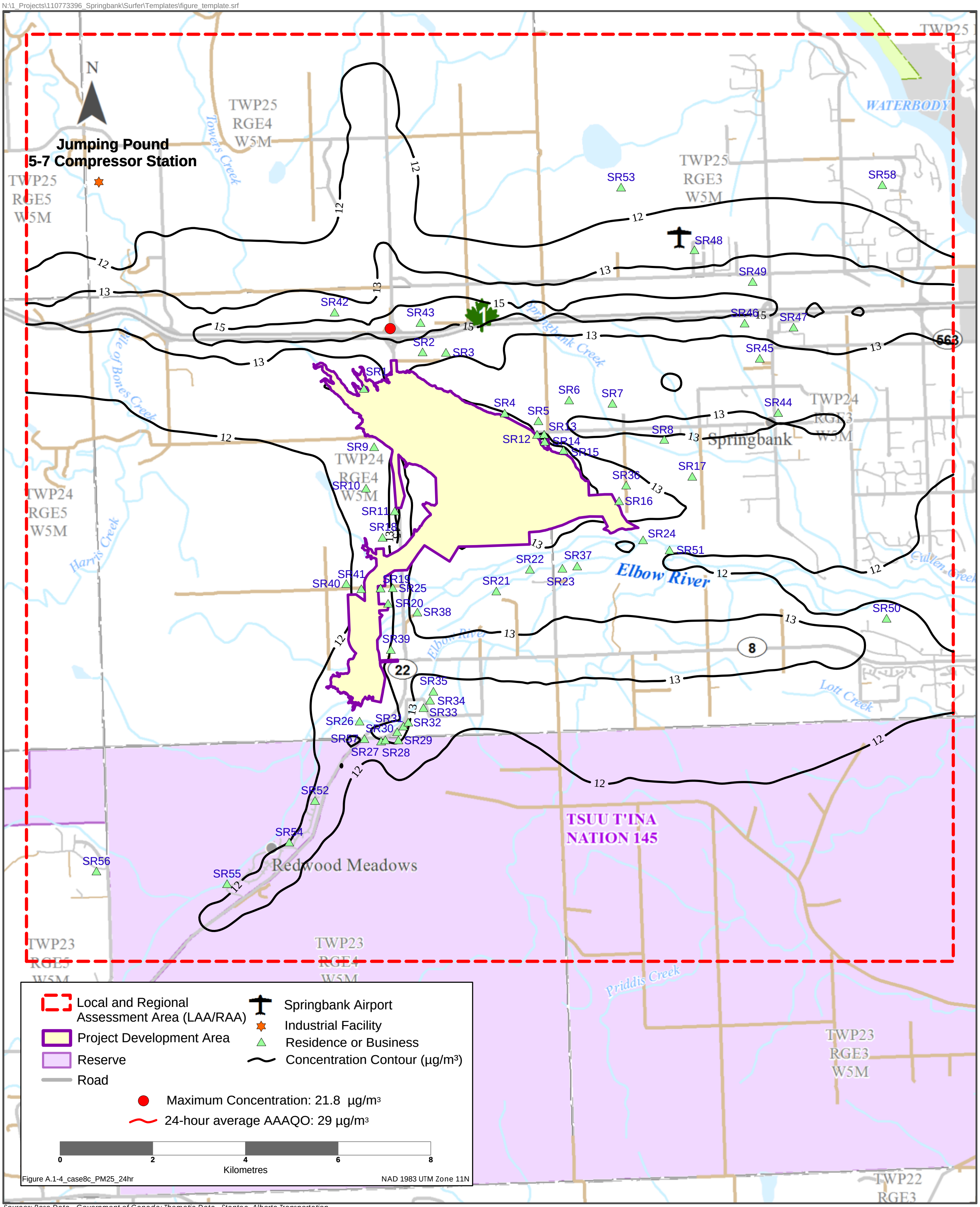
Figure A.1-3



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:100 Year Flood - Application Case)

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Figure A.1-4

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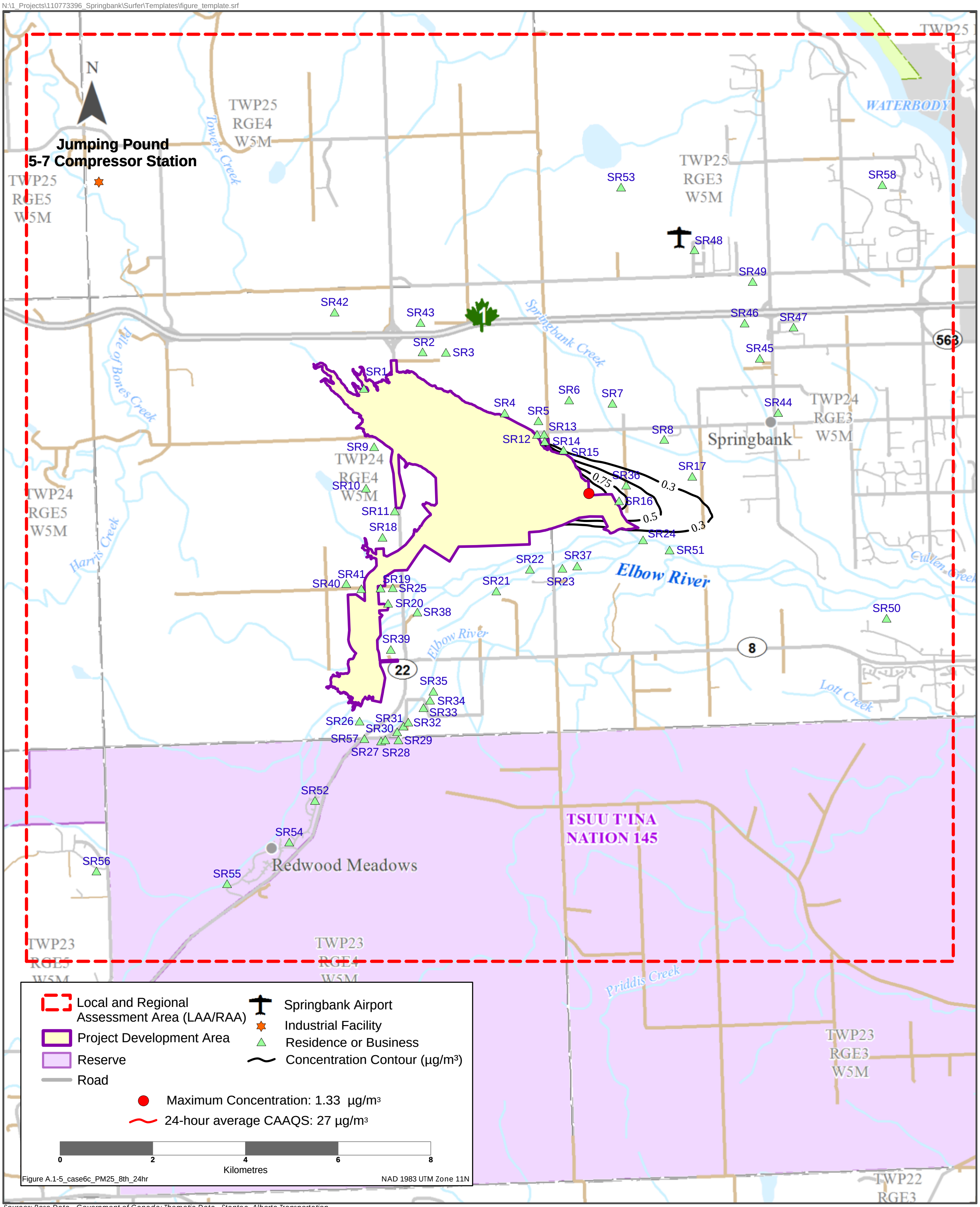

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:100 Year Flood - Project Case)

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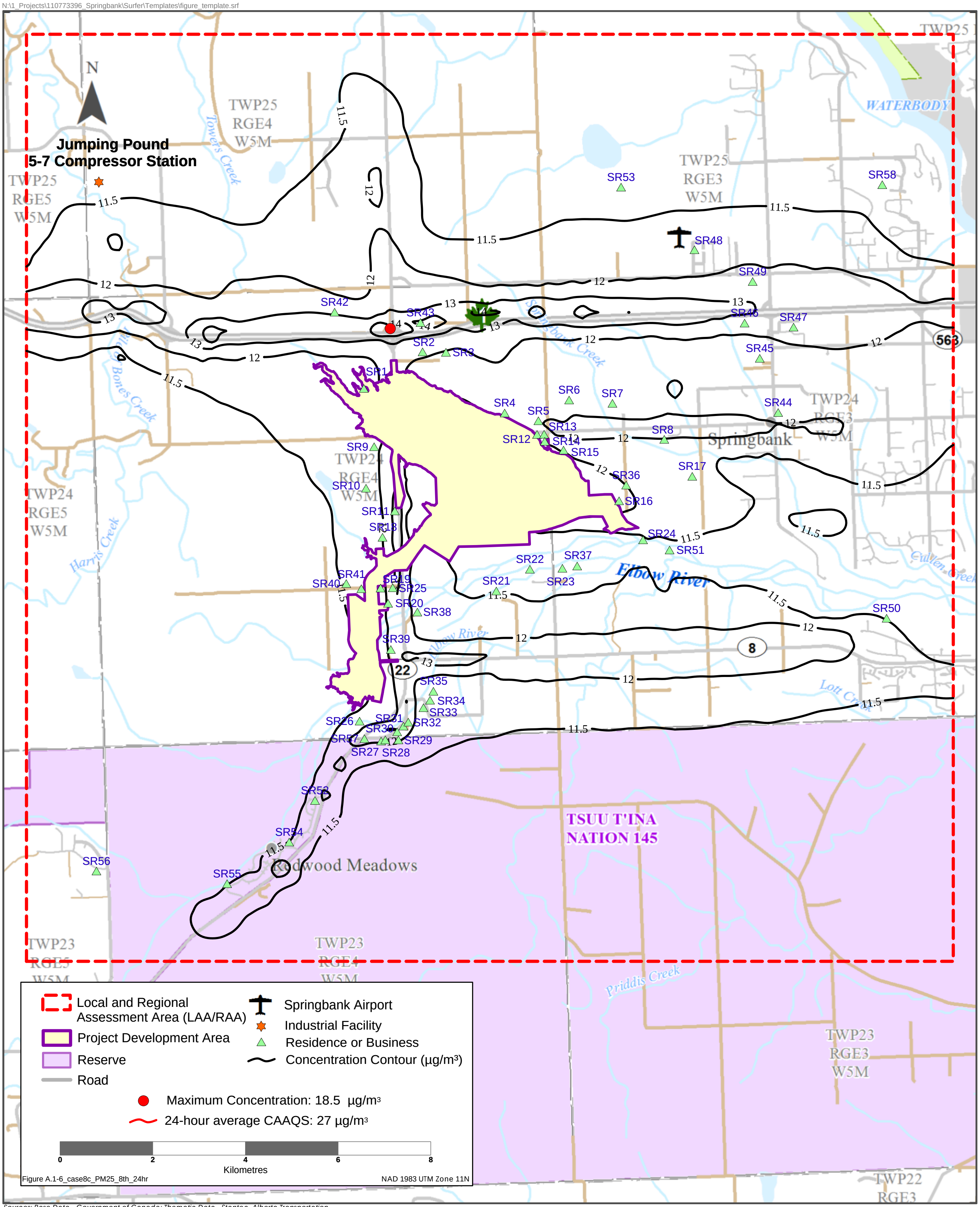
Figure A.1-5



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:100 Year Flood - Application Case)

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Figure A.1-6

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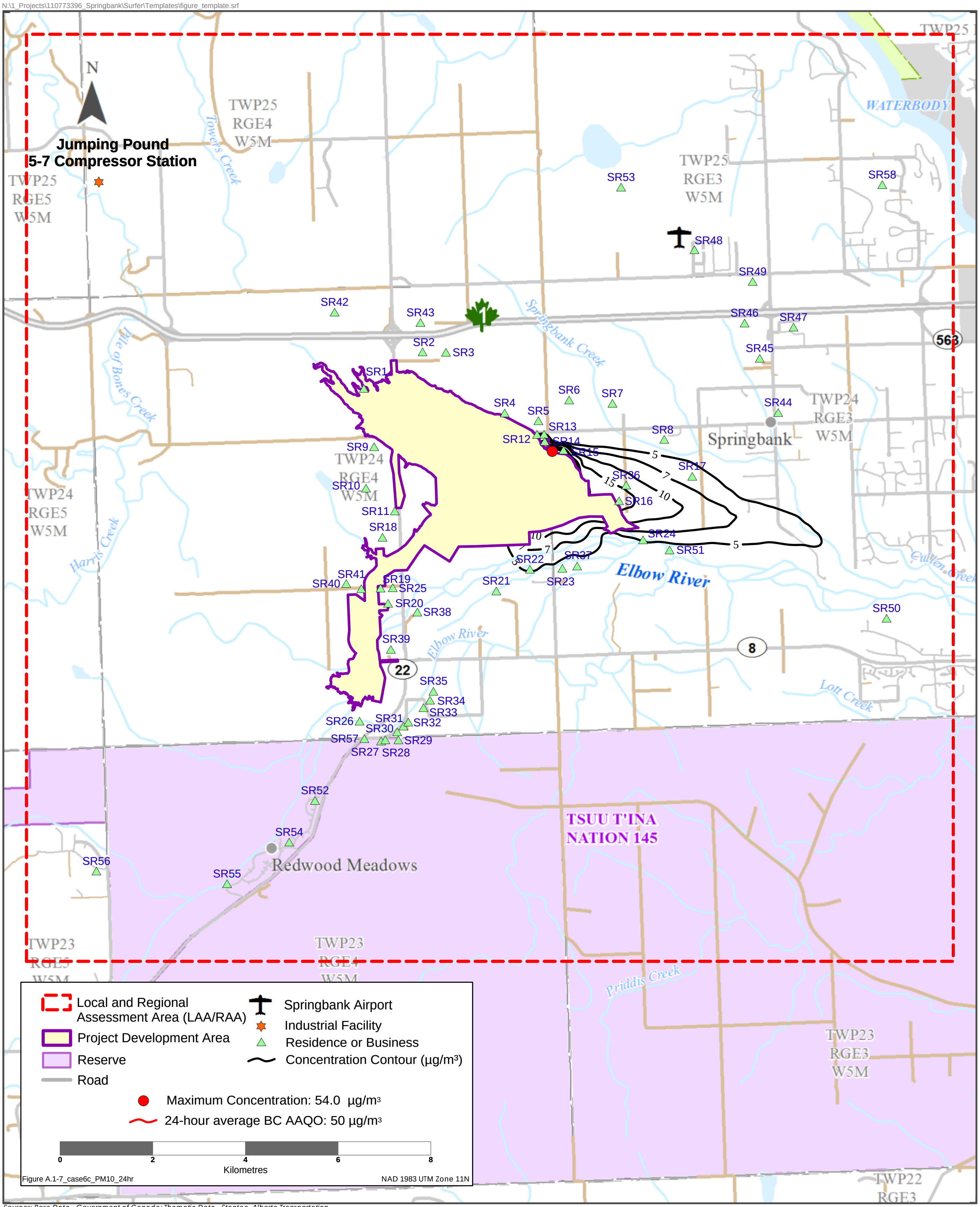

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 1, 1:100 Year Flood - Project Case)

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Figure A.1-7

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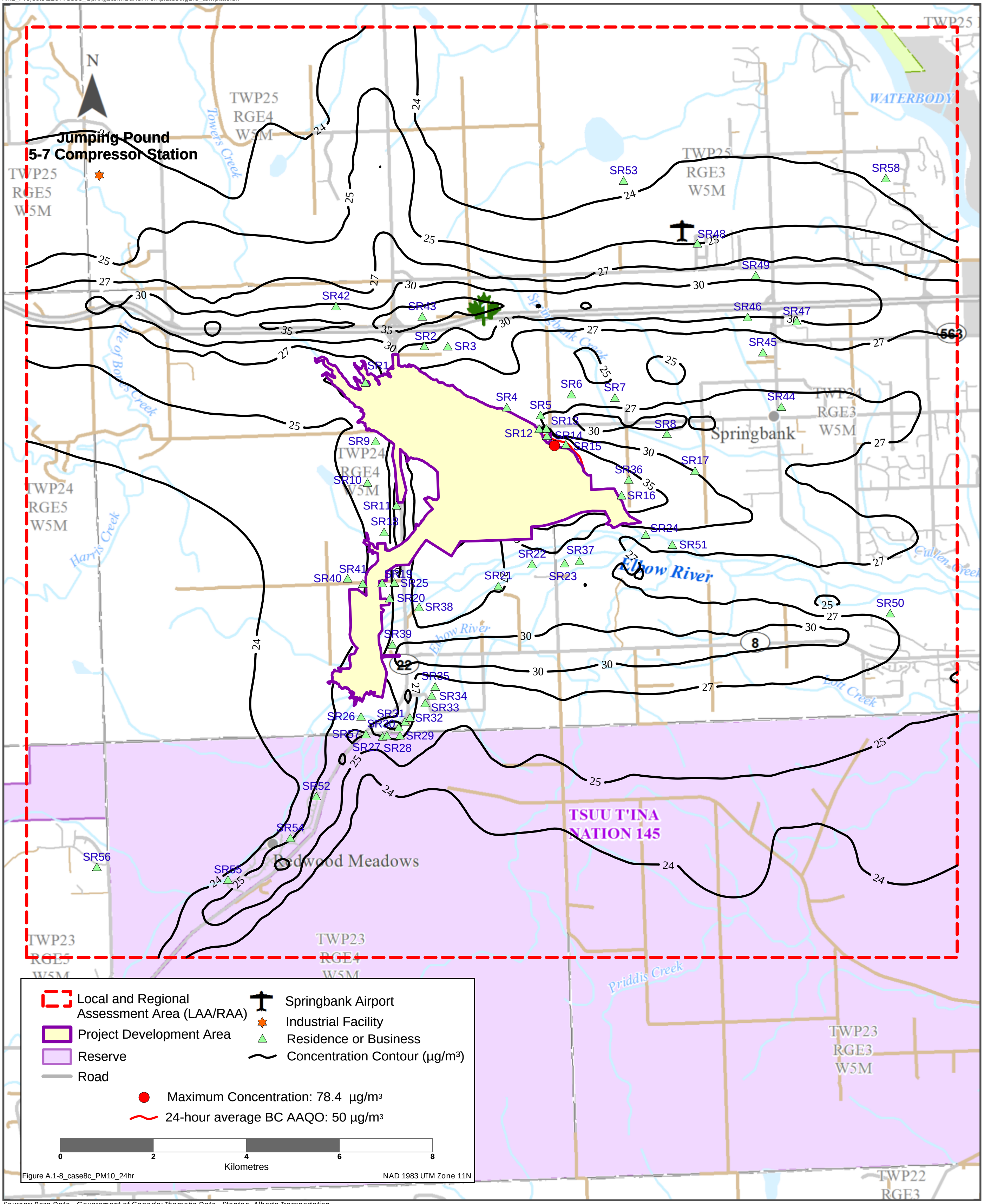

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 1, 1:100 Year Flood - Application Case)

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Figure A.1-8

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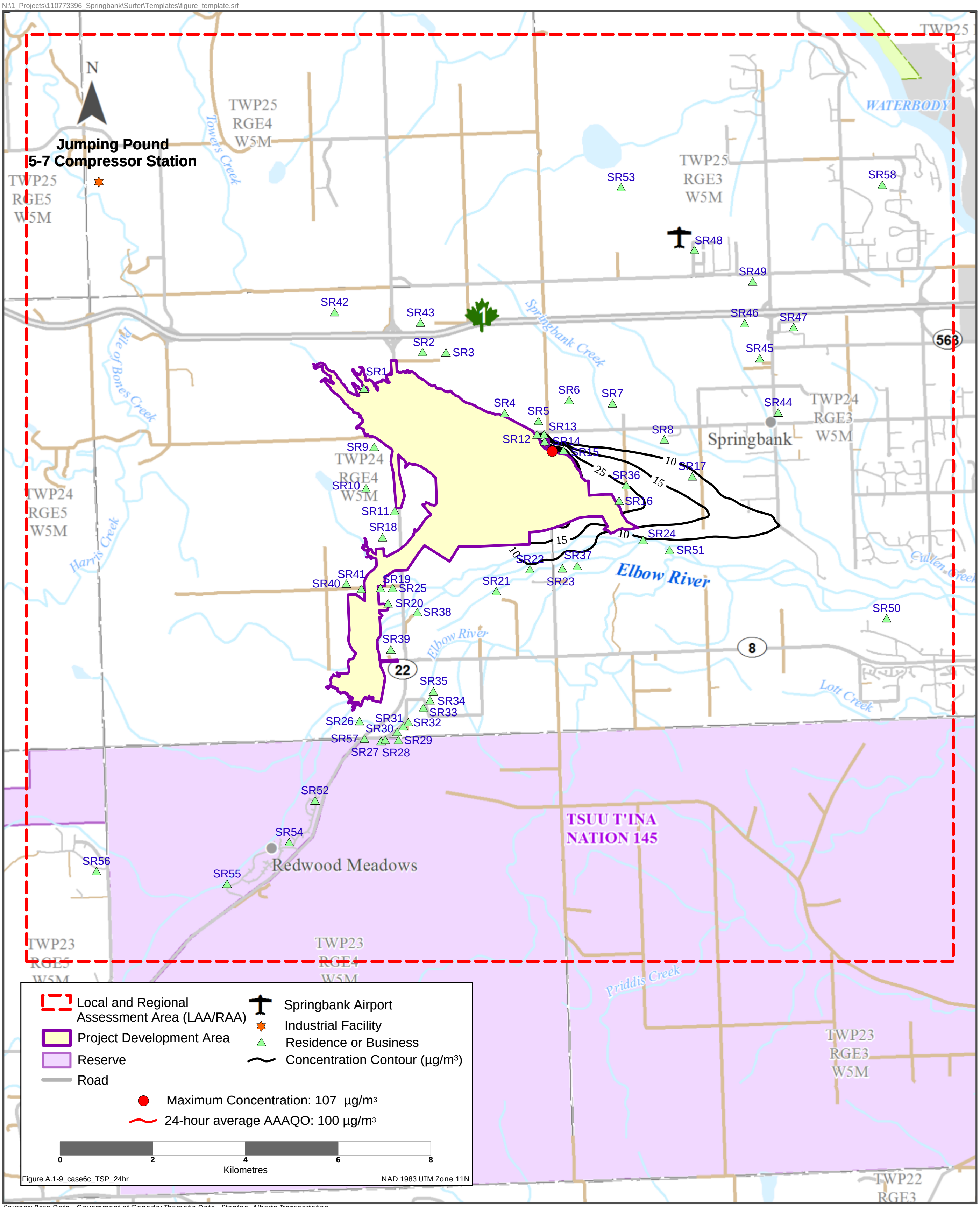

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 1, 1:100 Year Flood - Project Case)

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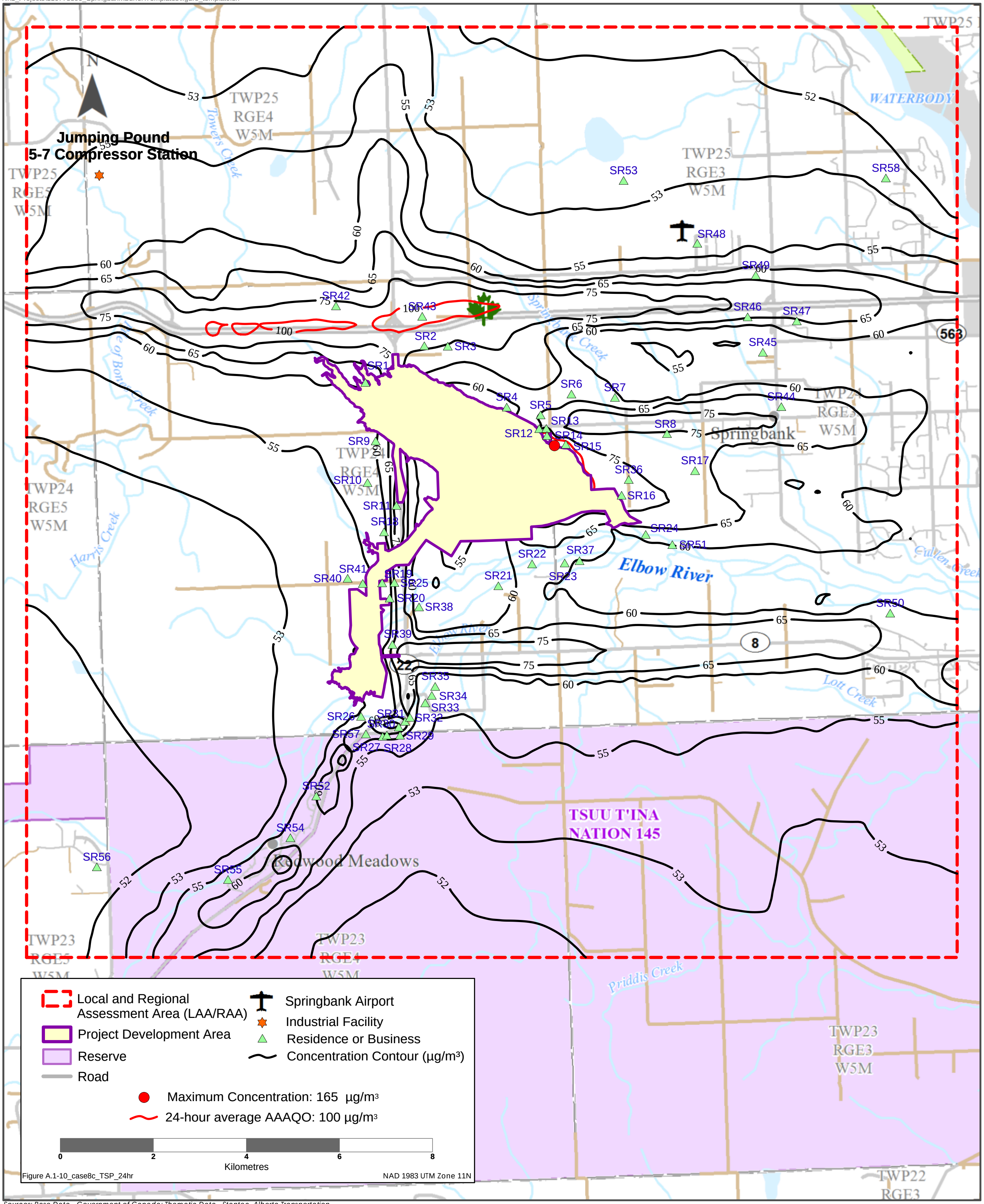
Figure A.1-9



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

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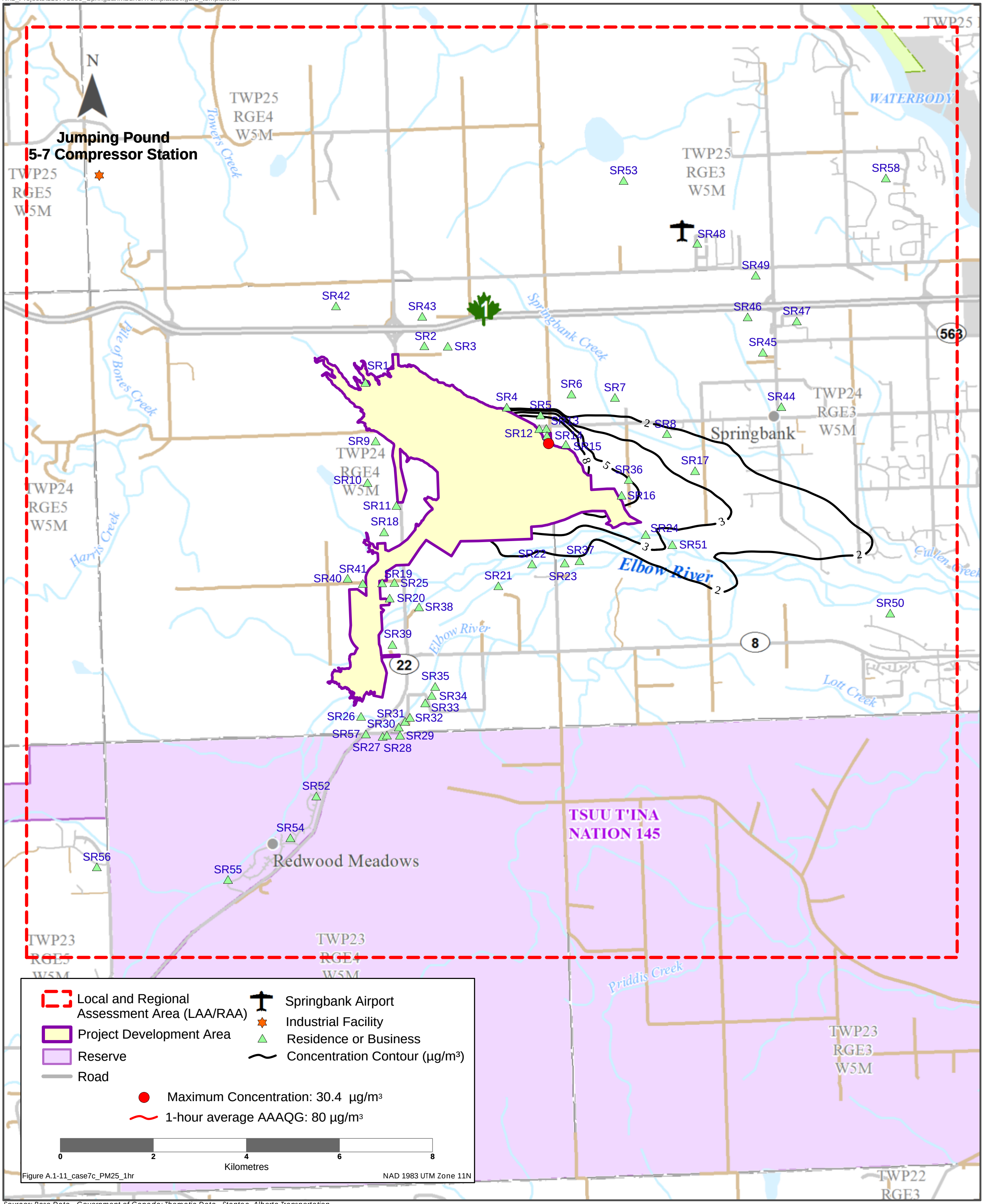

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 1, 1:200 Year Flood - Project Case)

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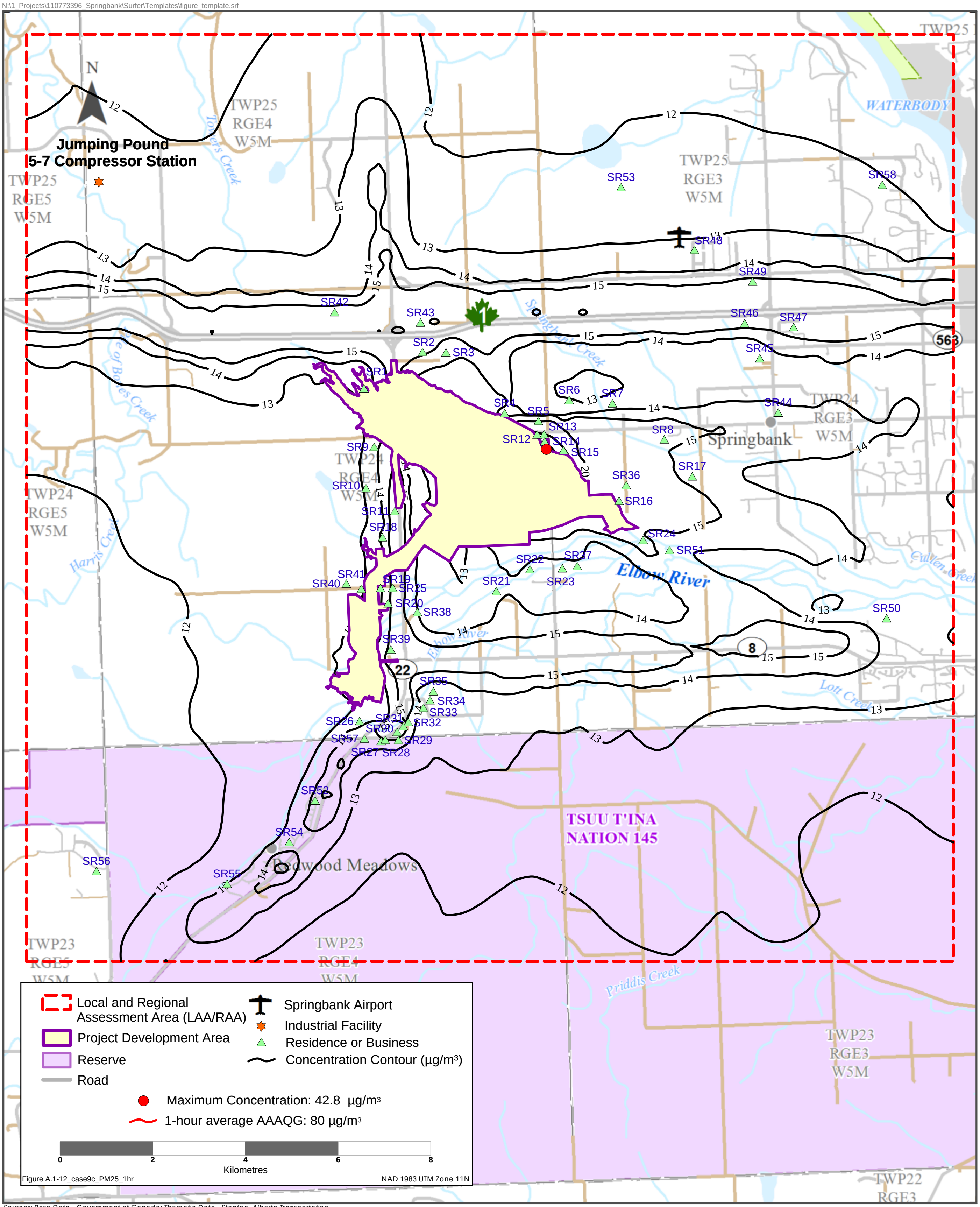
Figure A.1-11



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 1, 1:200 Year Flood - Application Case)

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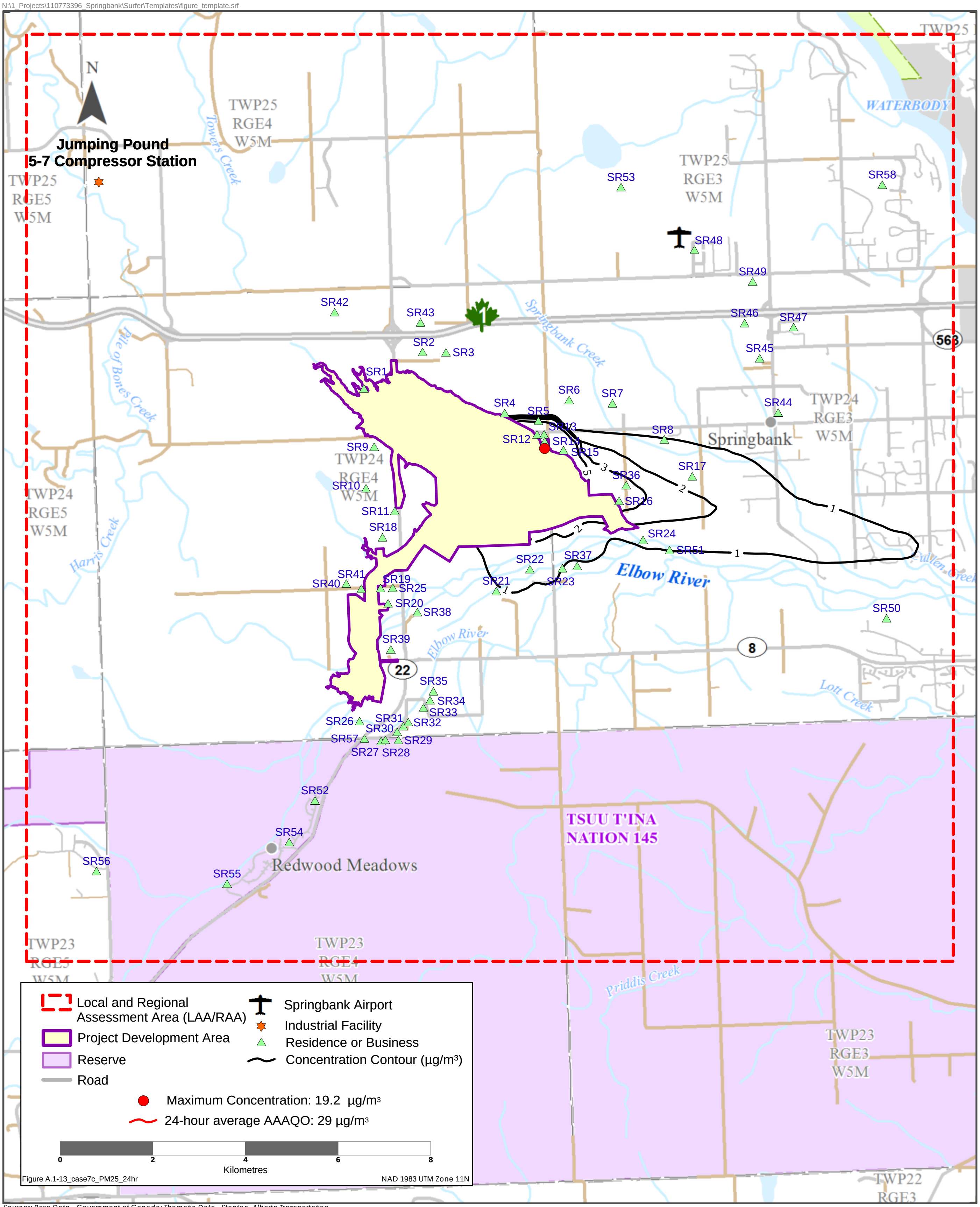
Figure A.1-12



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:200 Year Flood - Project Case)

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Figure A.1-13

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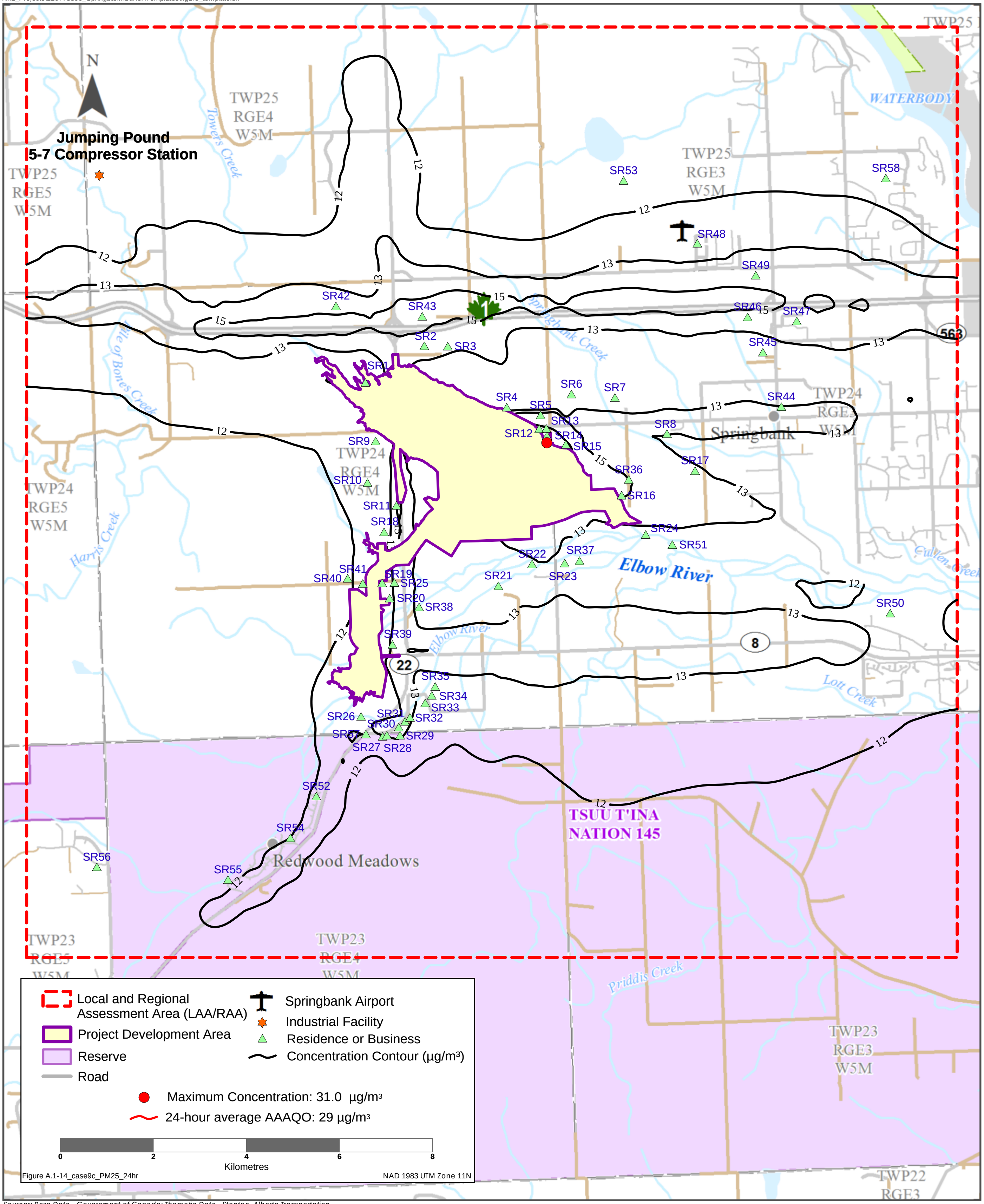

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:200 Year Flood - Application Case)

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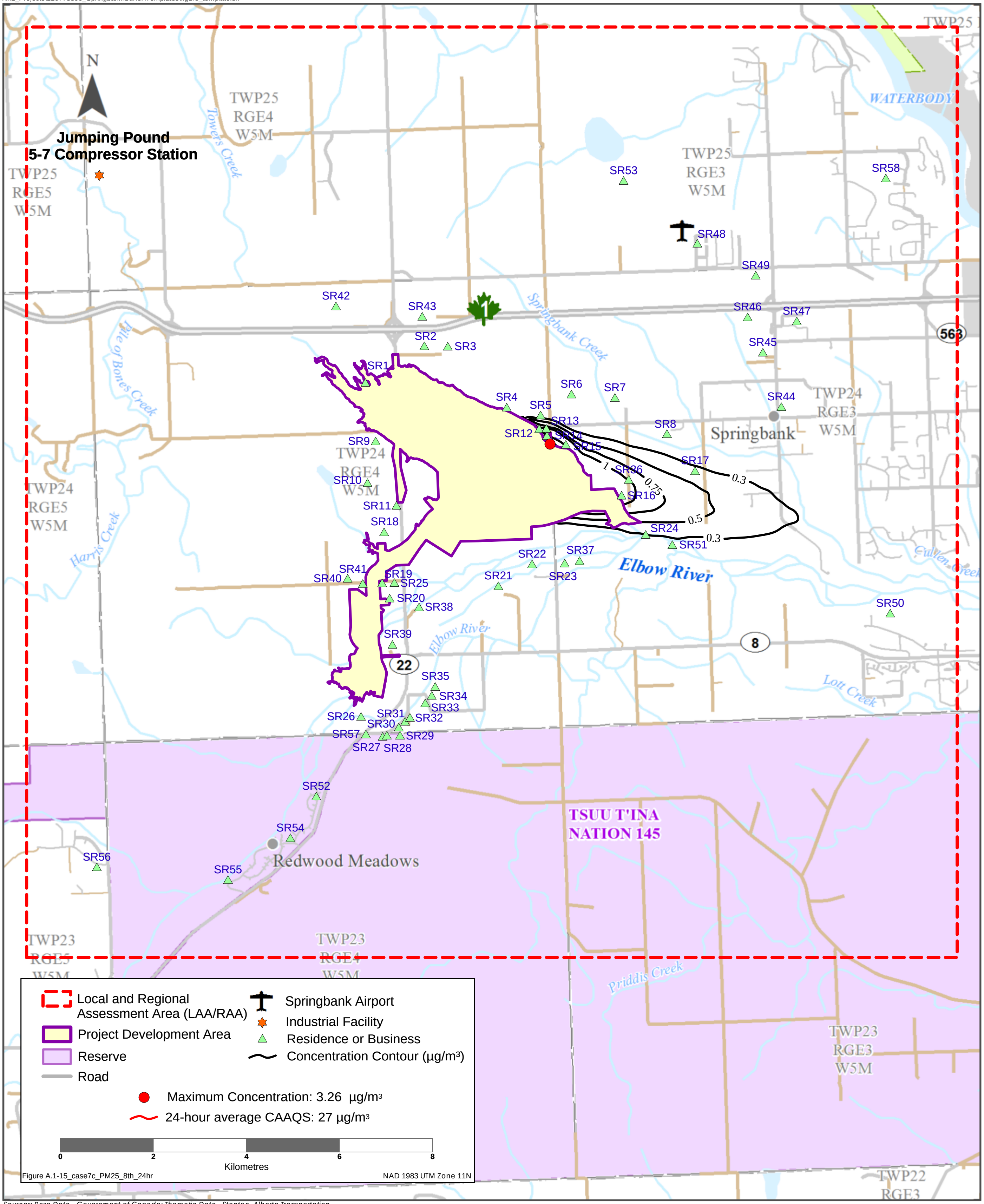
Figure A.1-14



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:200 Year Flood - Project Case)

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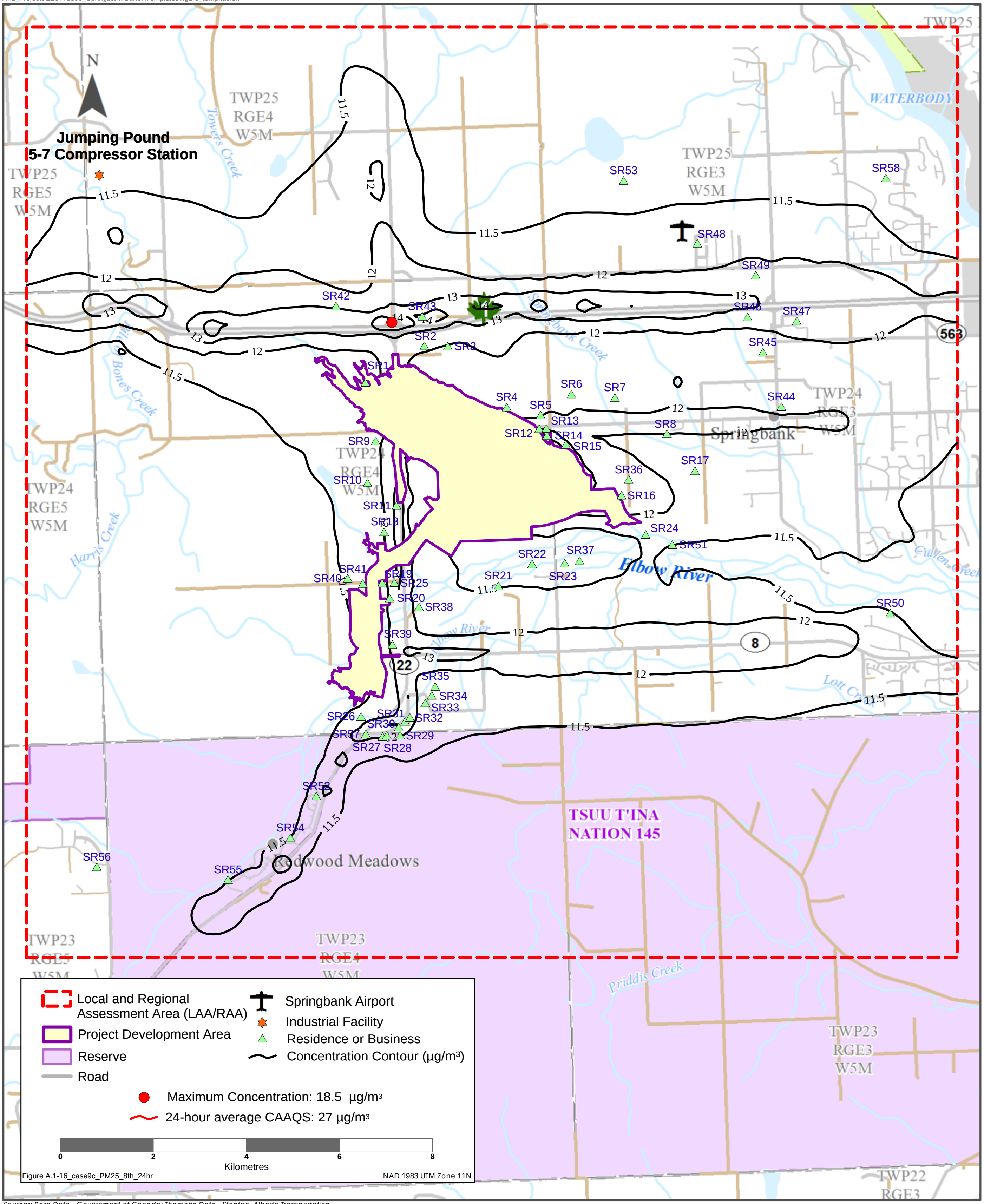

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 1, 1:200 Year Flood - Application Case)

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Figure A.1-16

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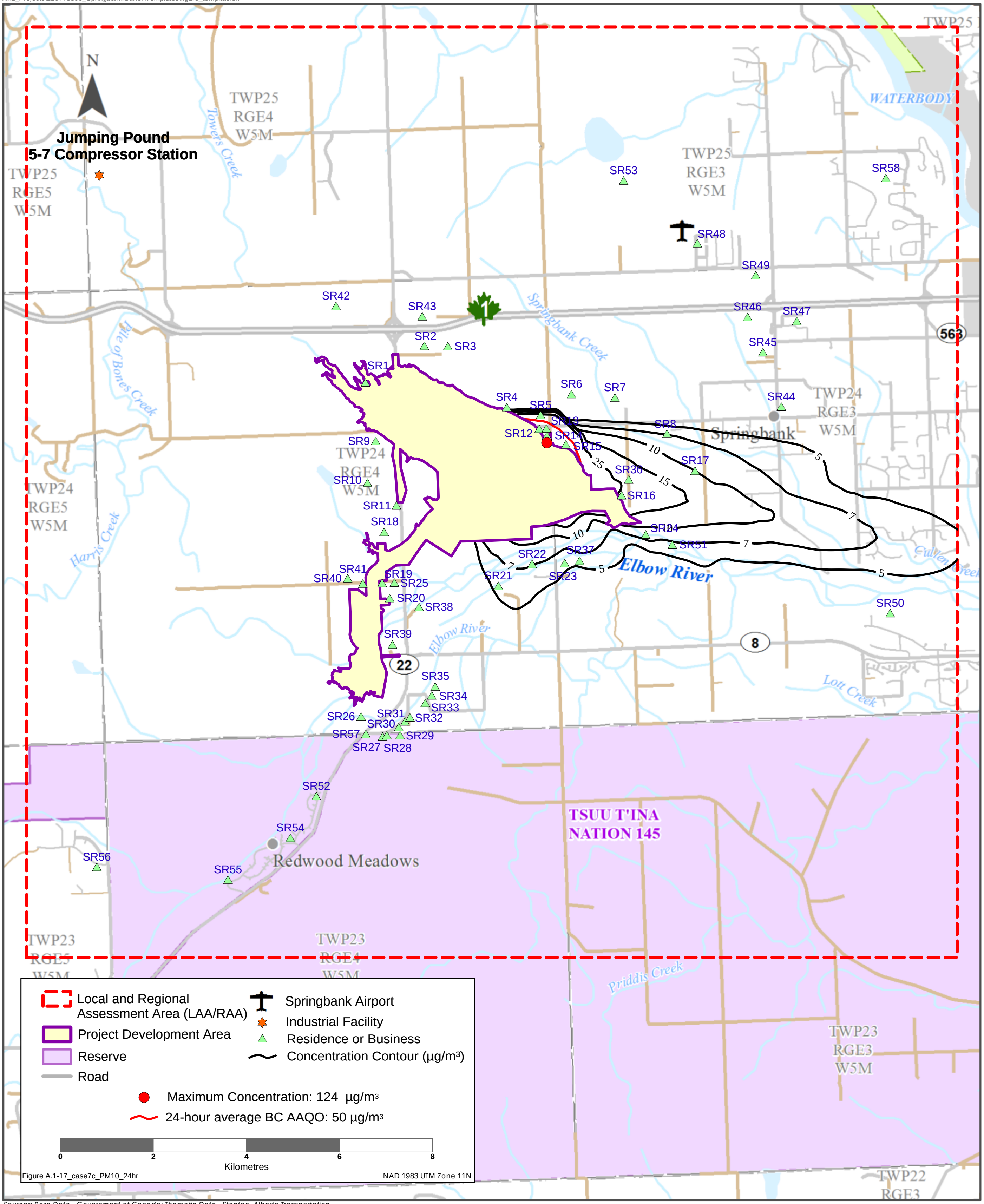

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 1, 1:200 Year Flood - Project Case)

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Figure A.1-17

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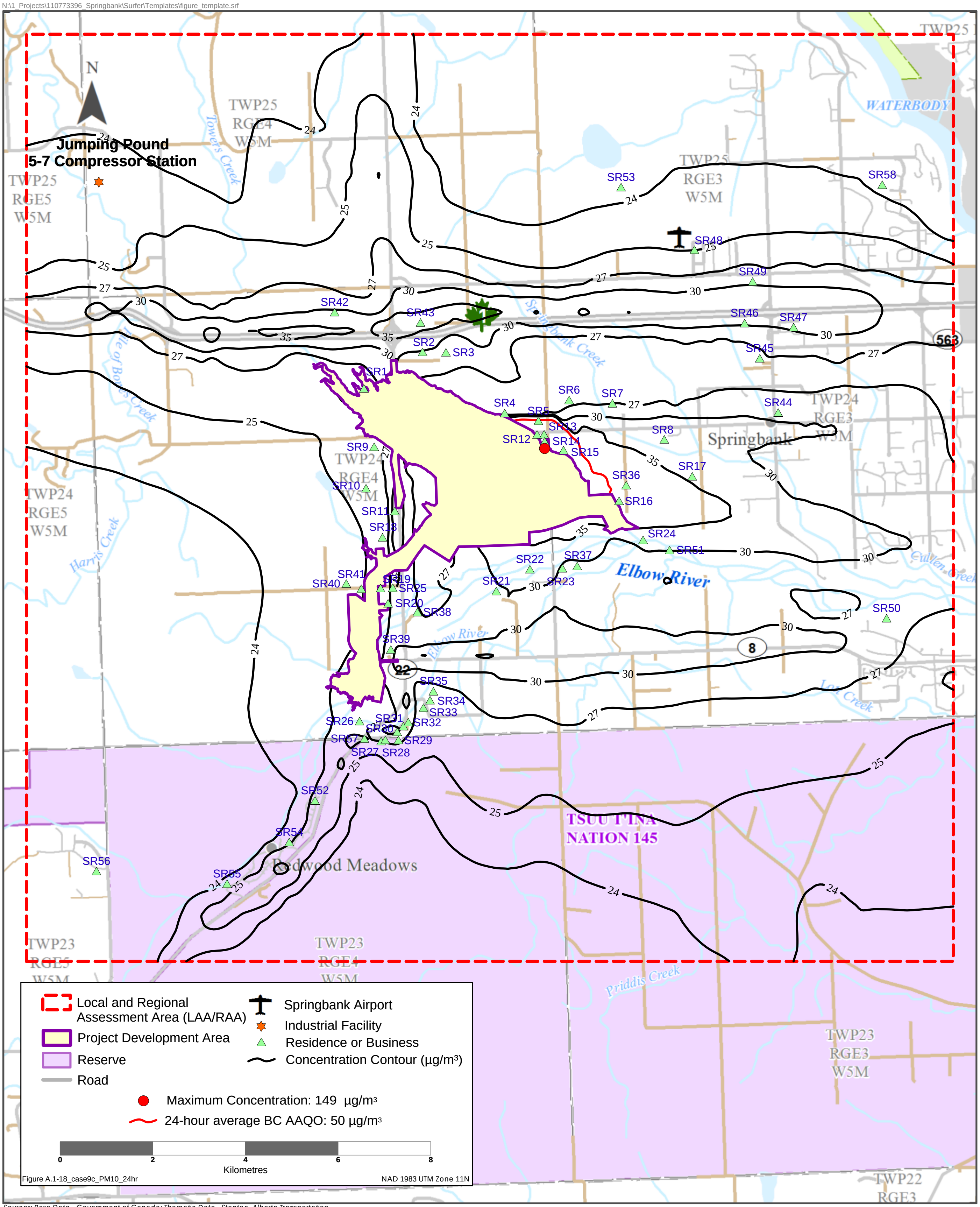

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 1, 1:200 Year Flood - Application Case)

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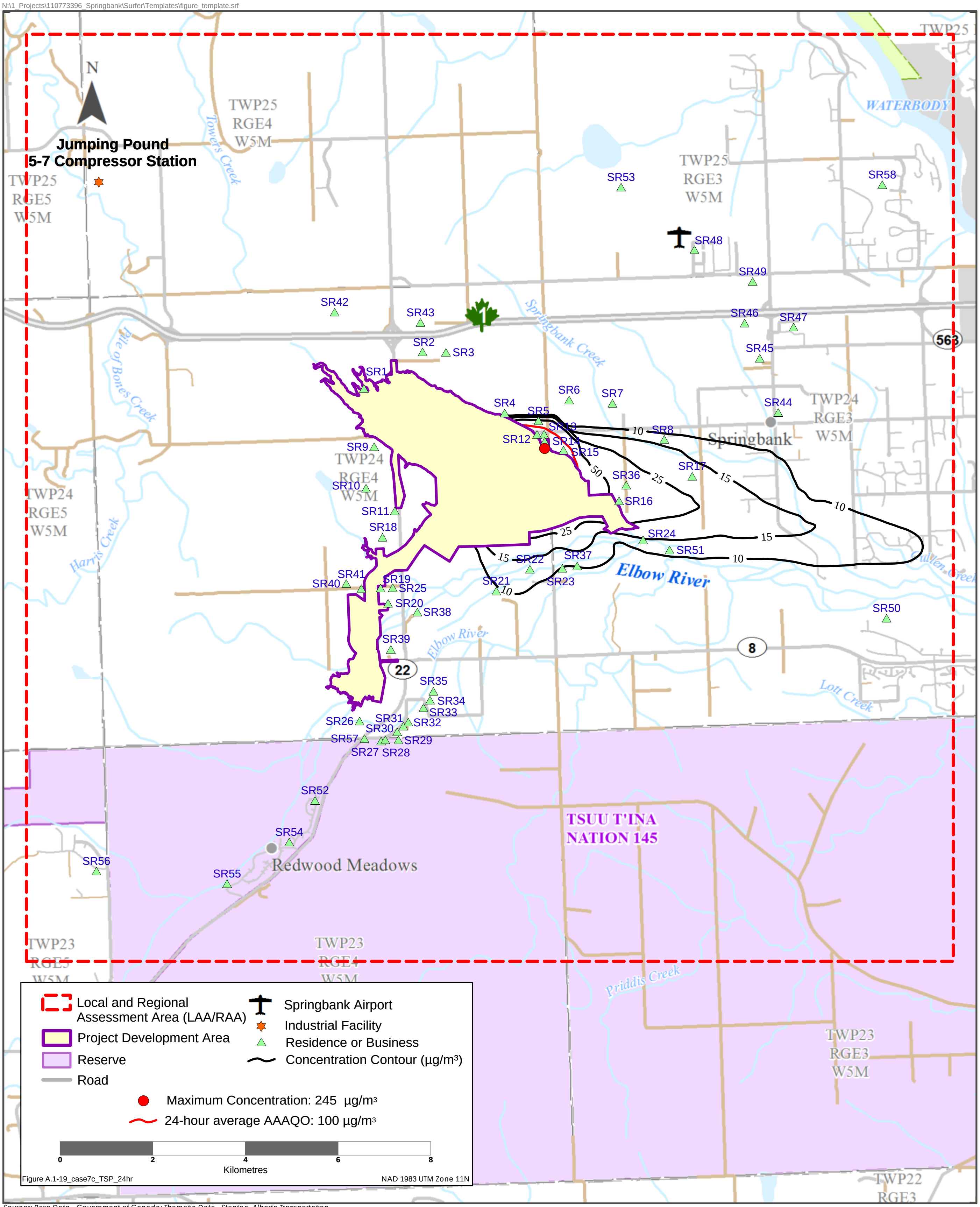
Figure A.1-18



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 1, 1:200 Year Flood - Project Case)

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Figure A.1-19

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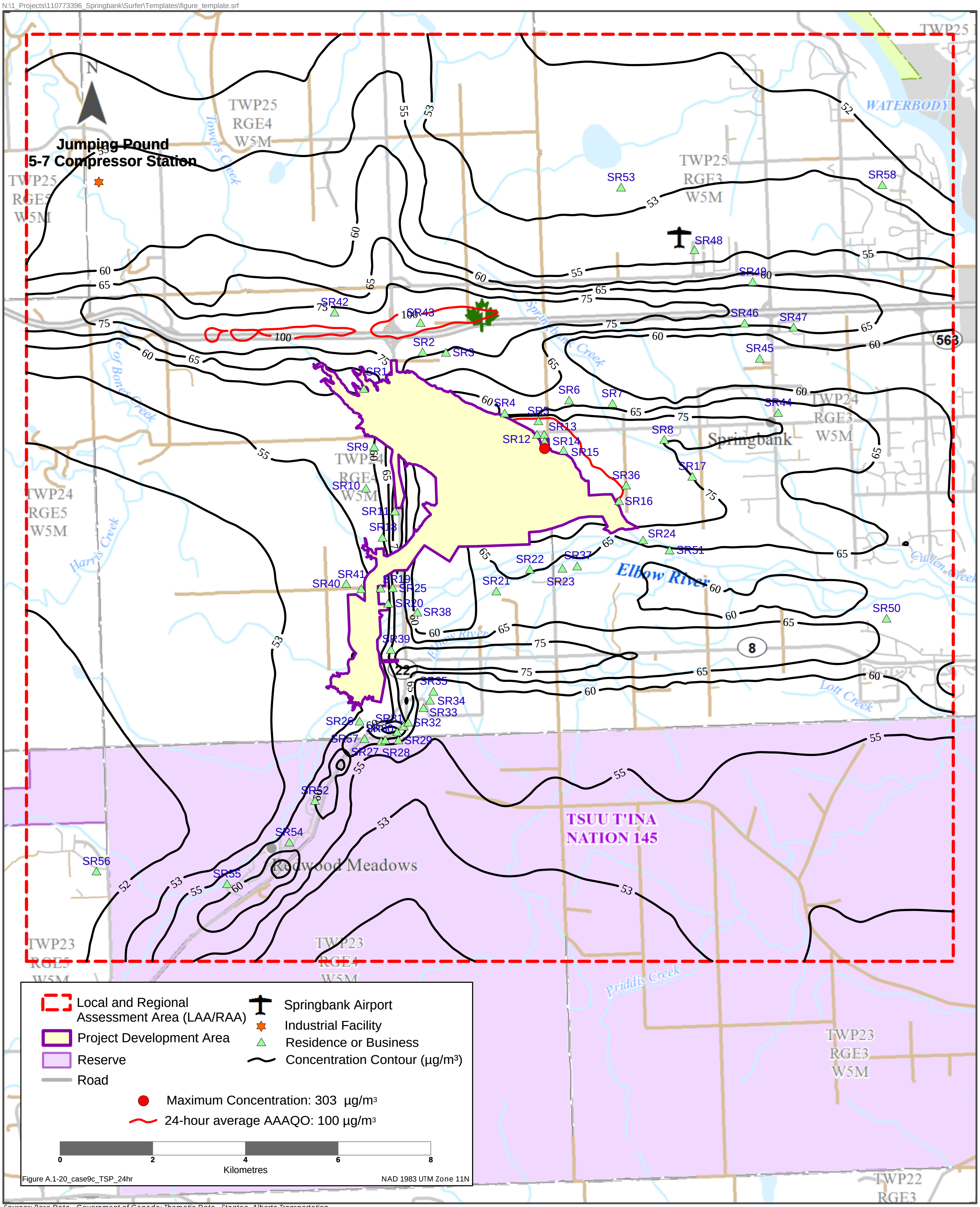
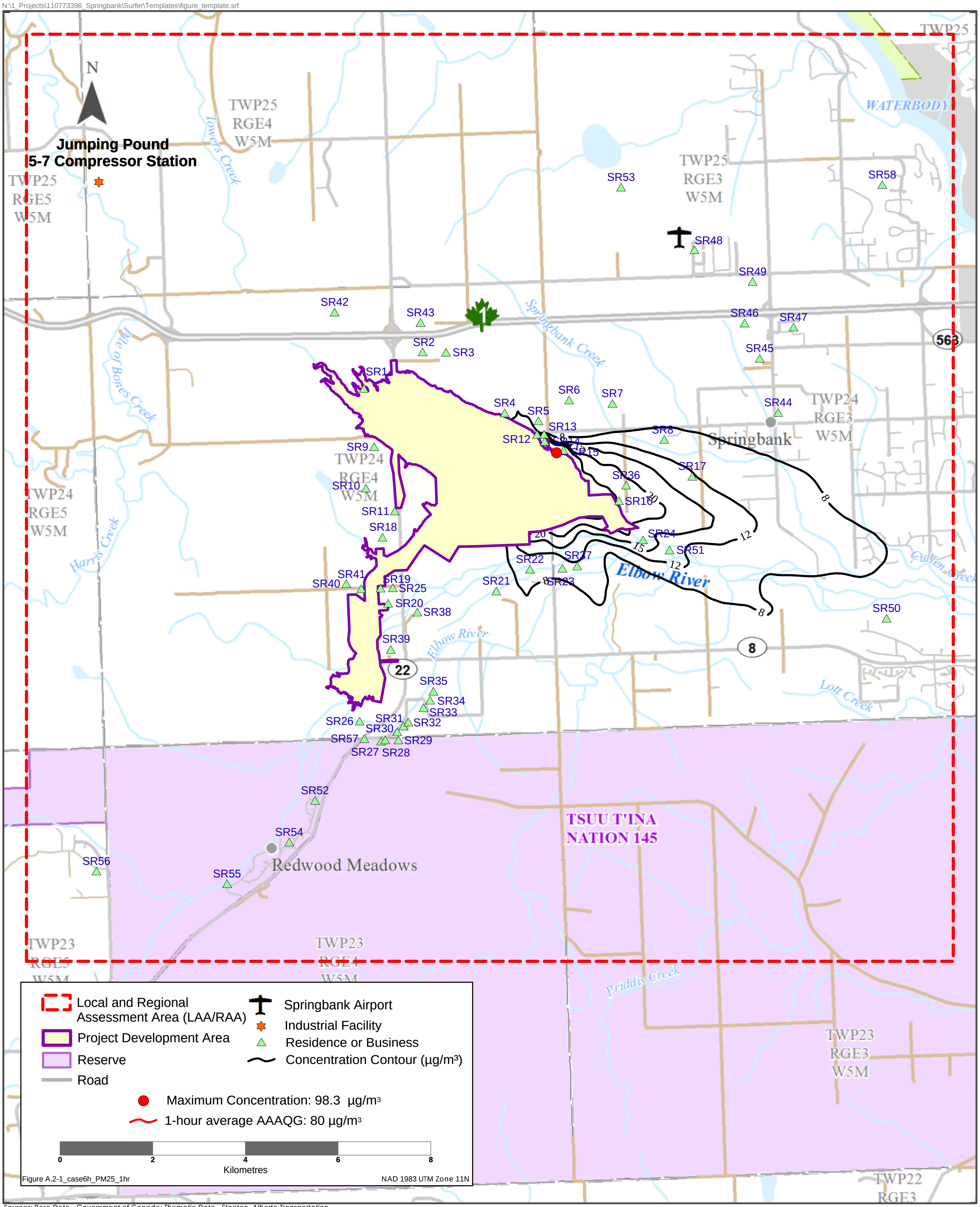


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 1, 1:200 Year Flood - Application Case)



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 2, 1:100 Year Flood - Project Case)

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Figure A.2-1

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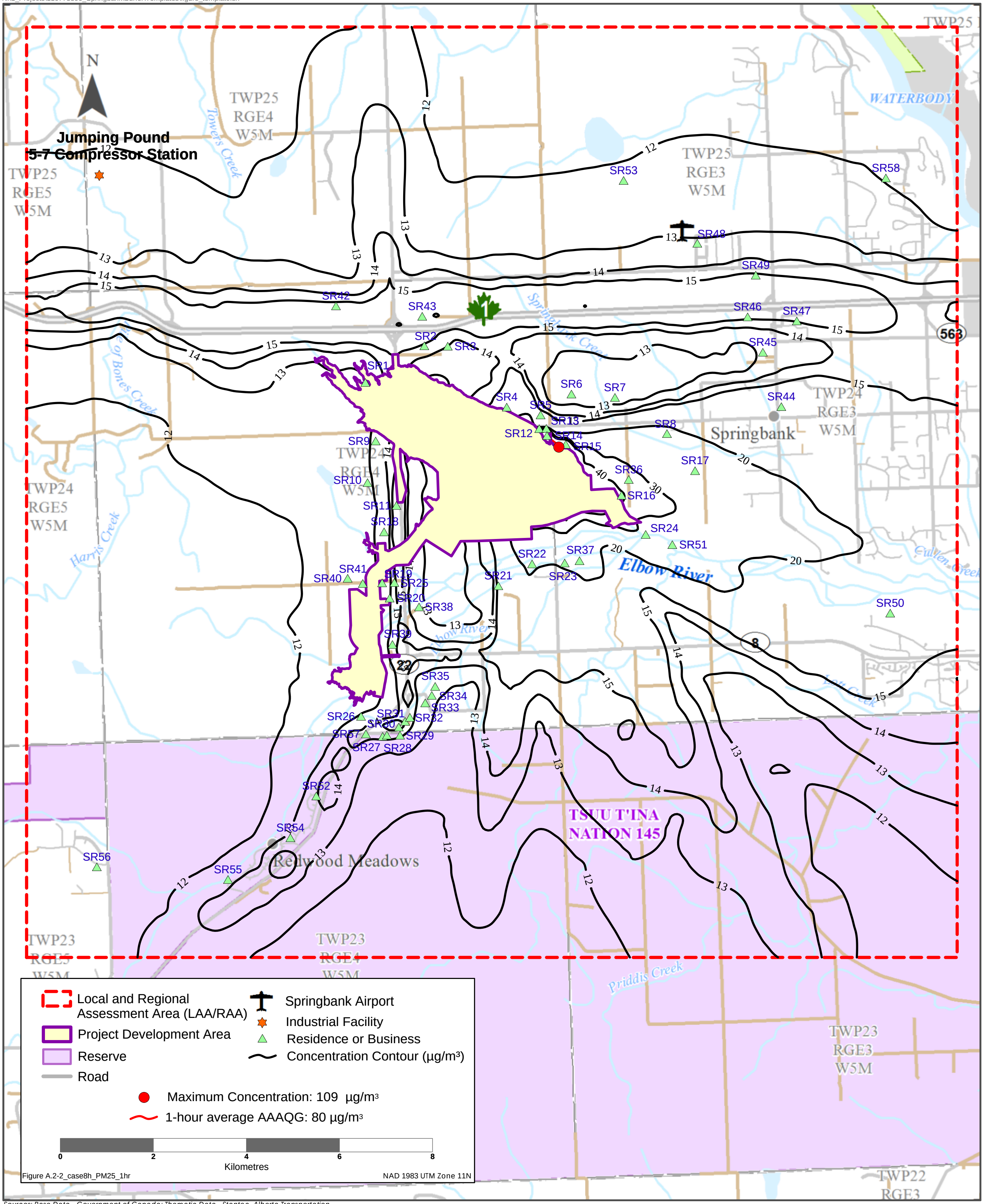

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration
(Case 2, 1:100 Year Flood - Application Case)

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SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-2

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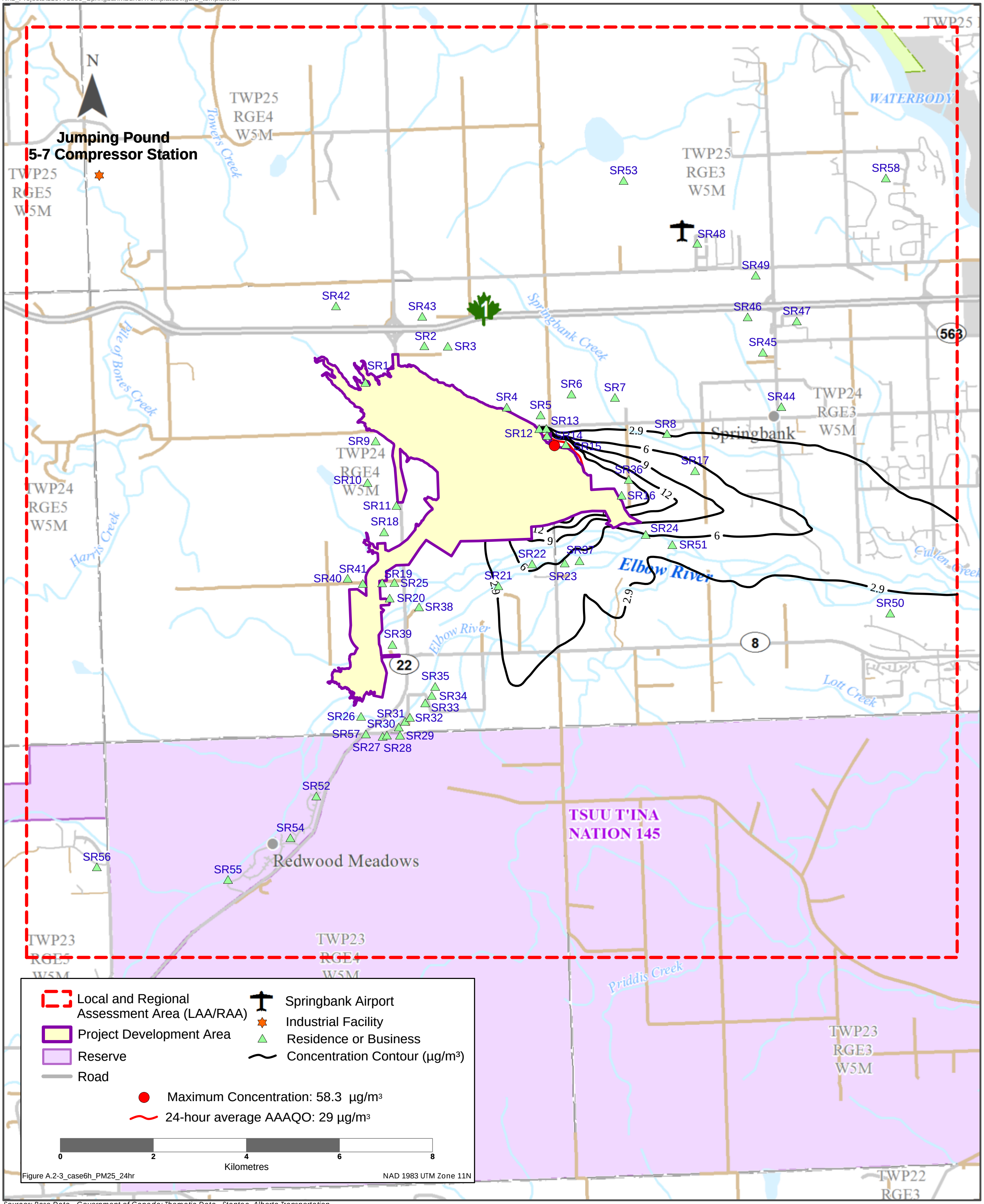

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-3

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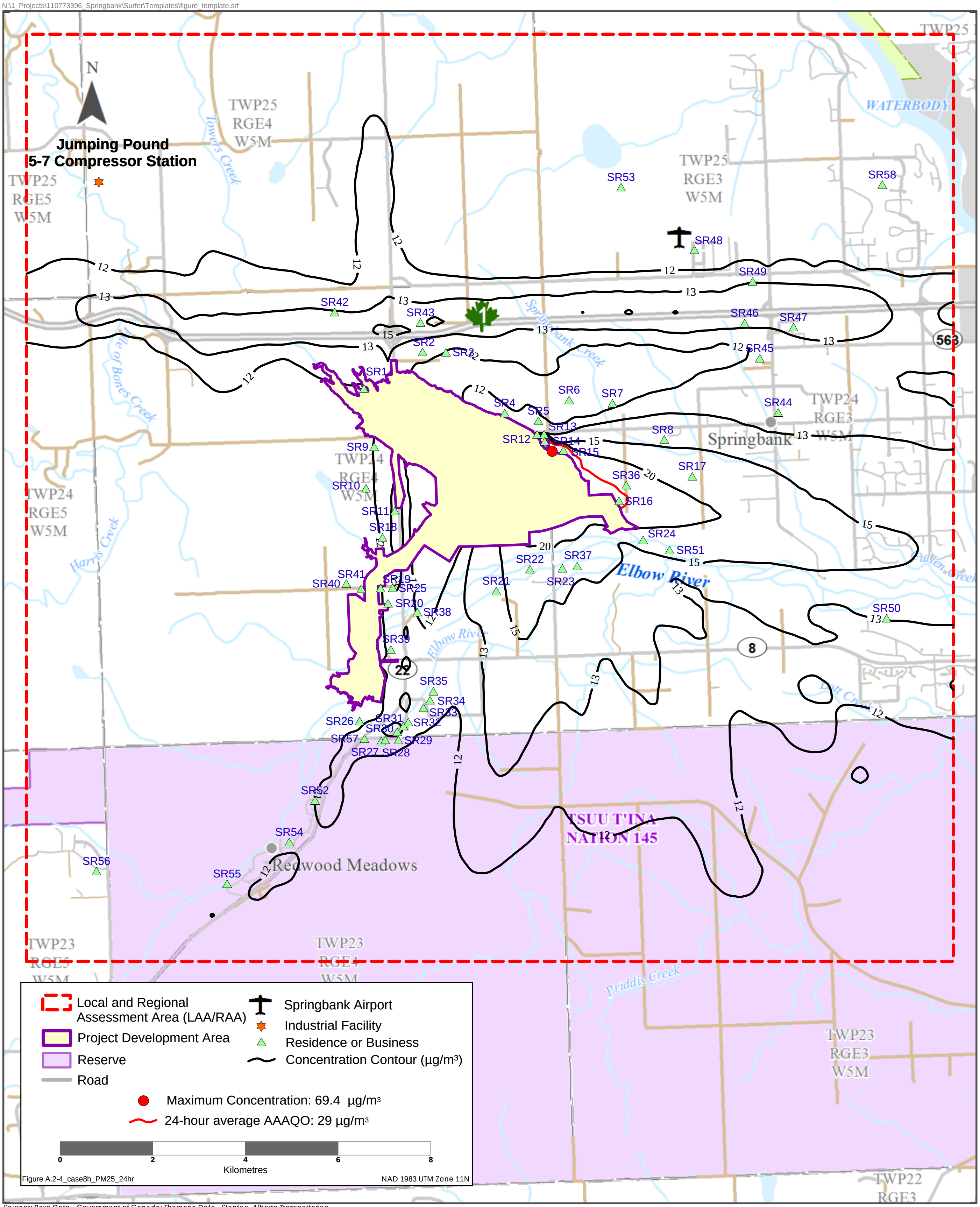

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-4

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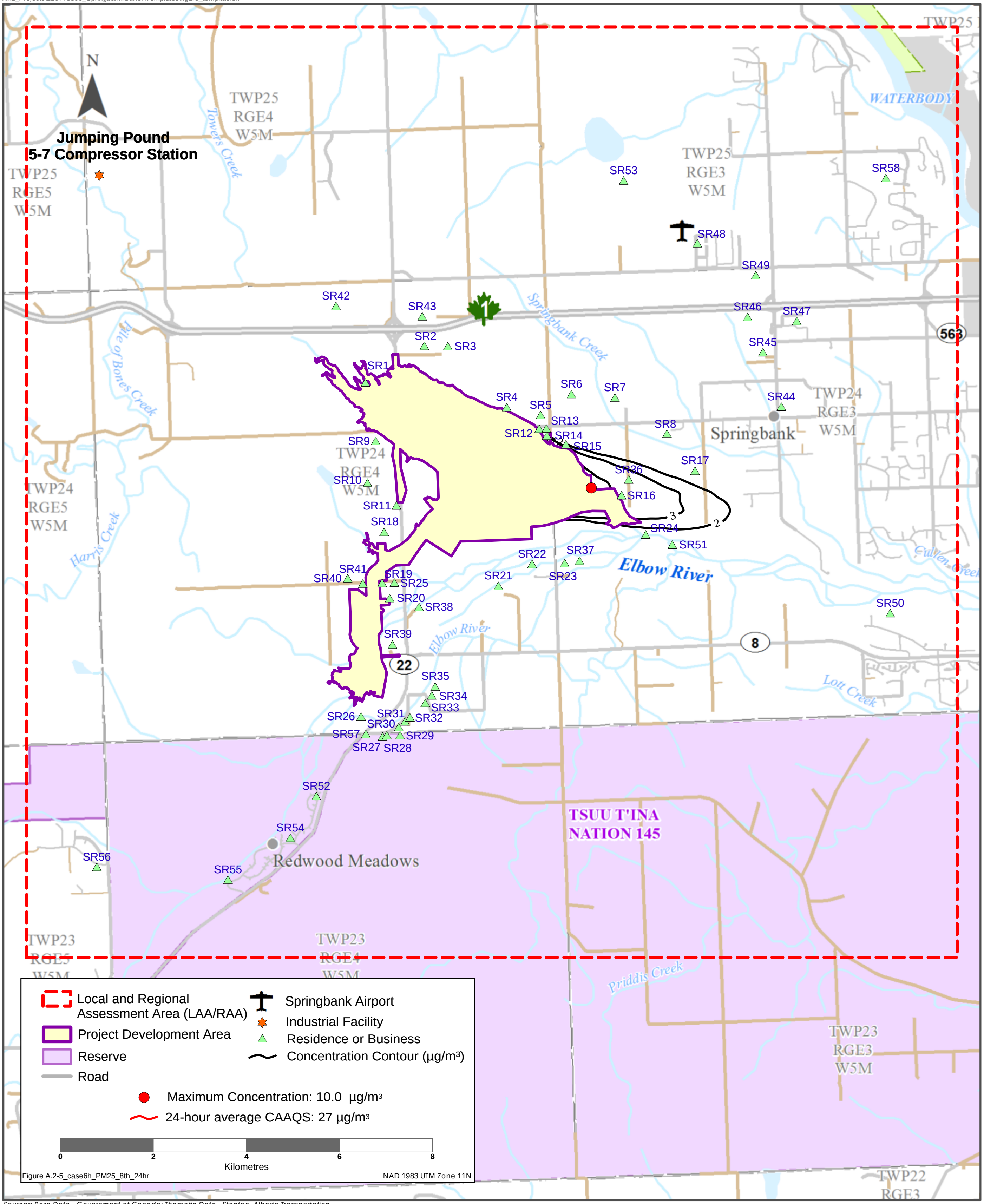


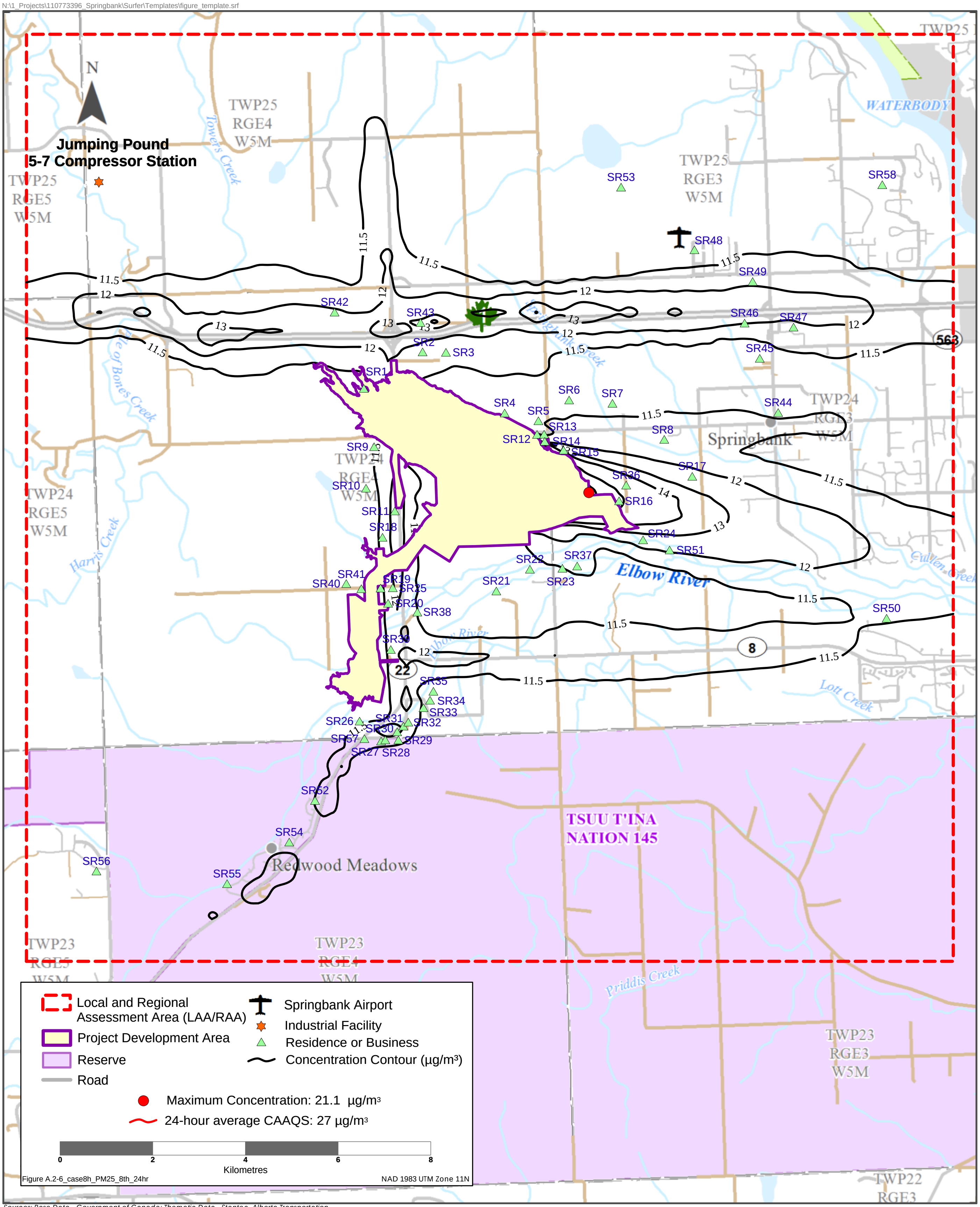
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-5



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-6

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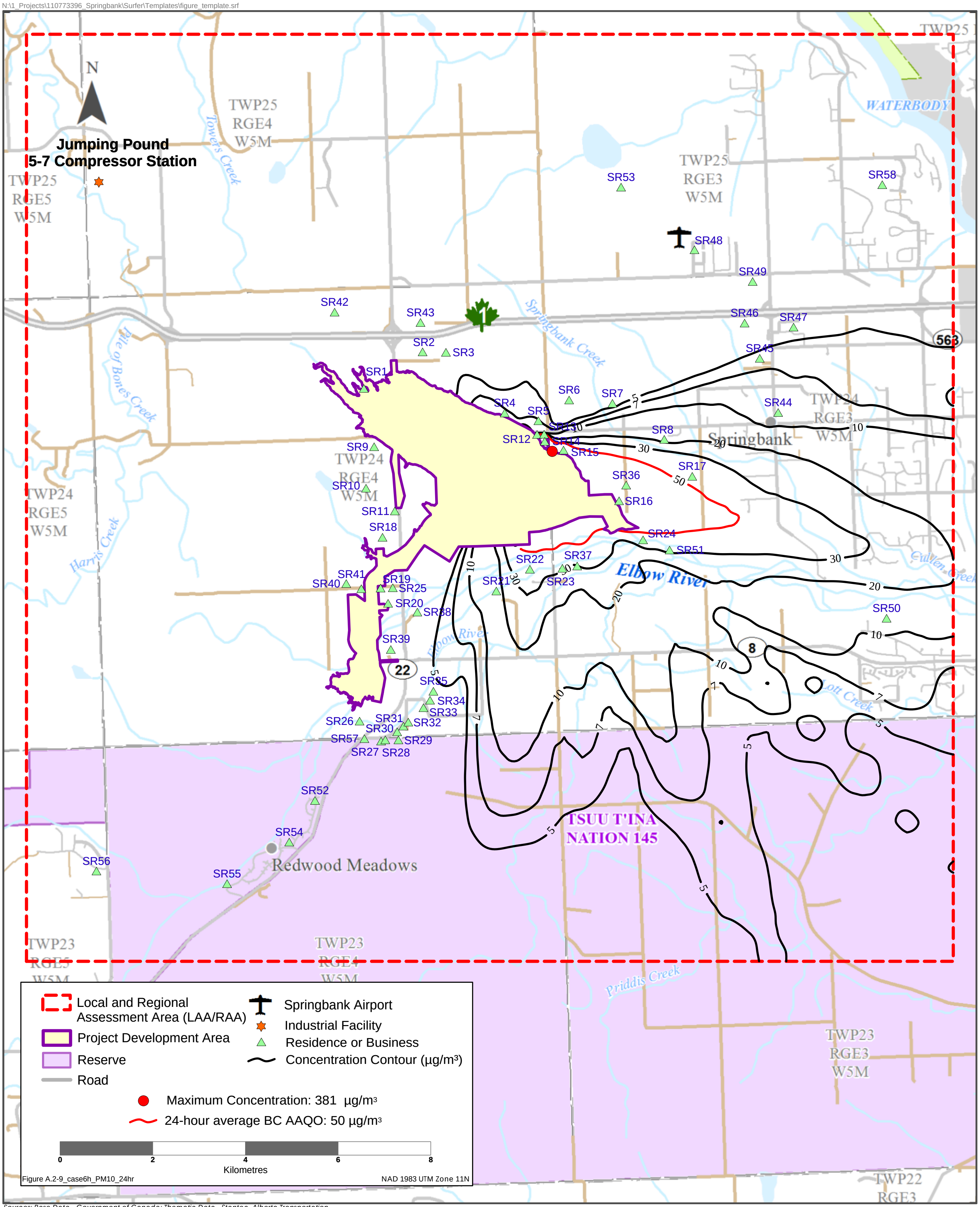

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 2, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-7

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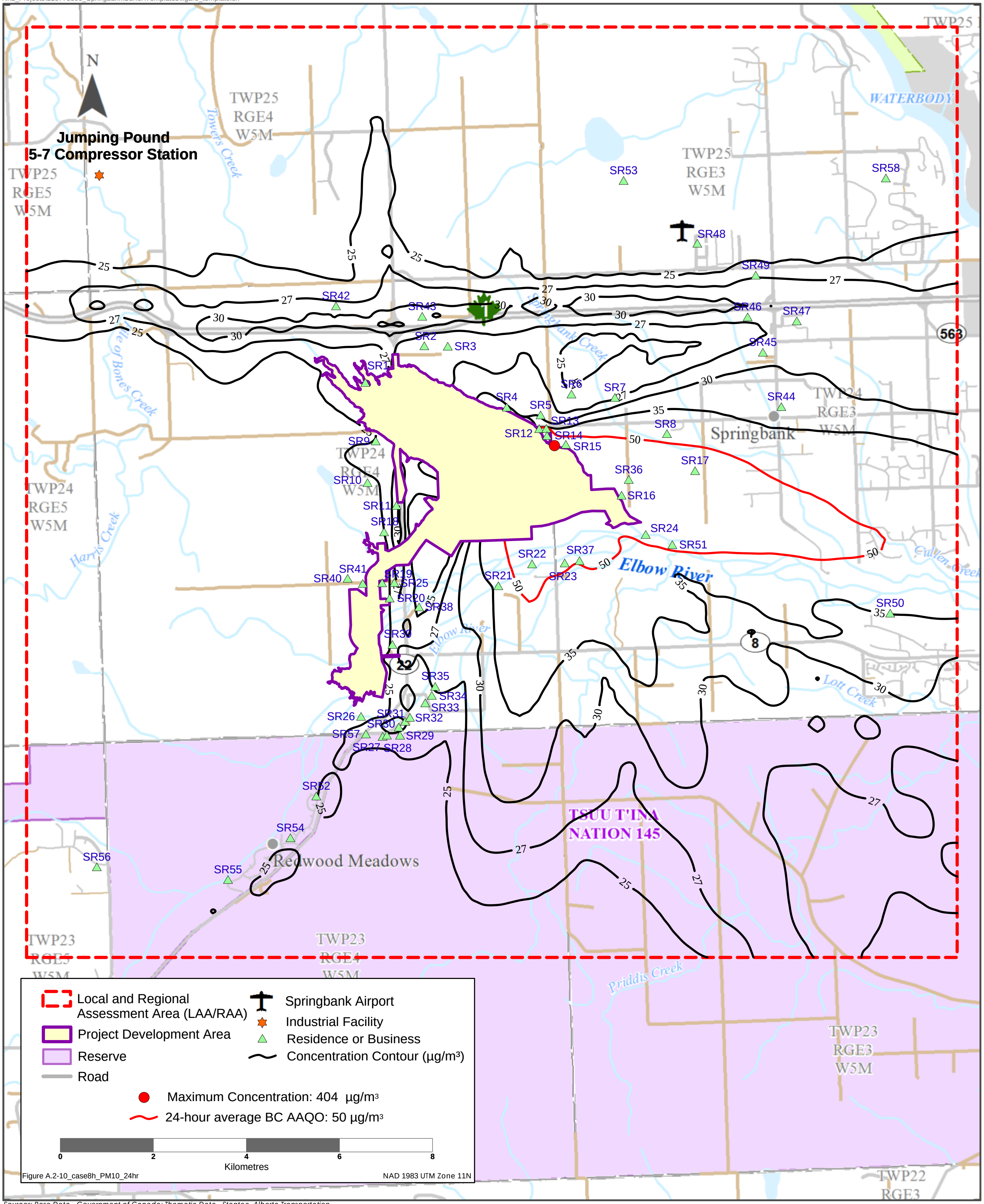

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 2, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-8

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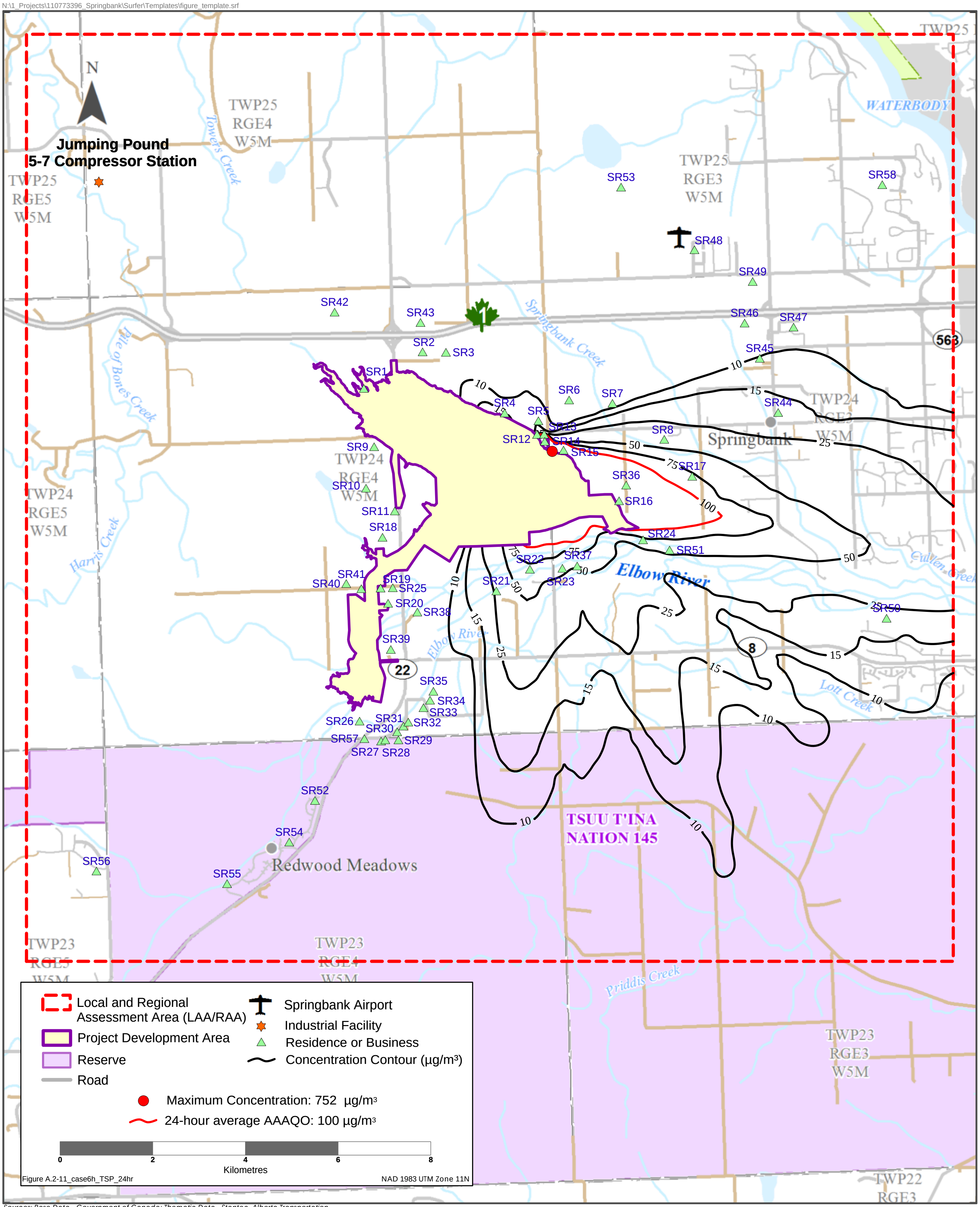

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 2, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-9

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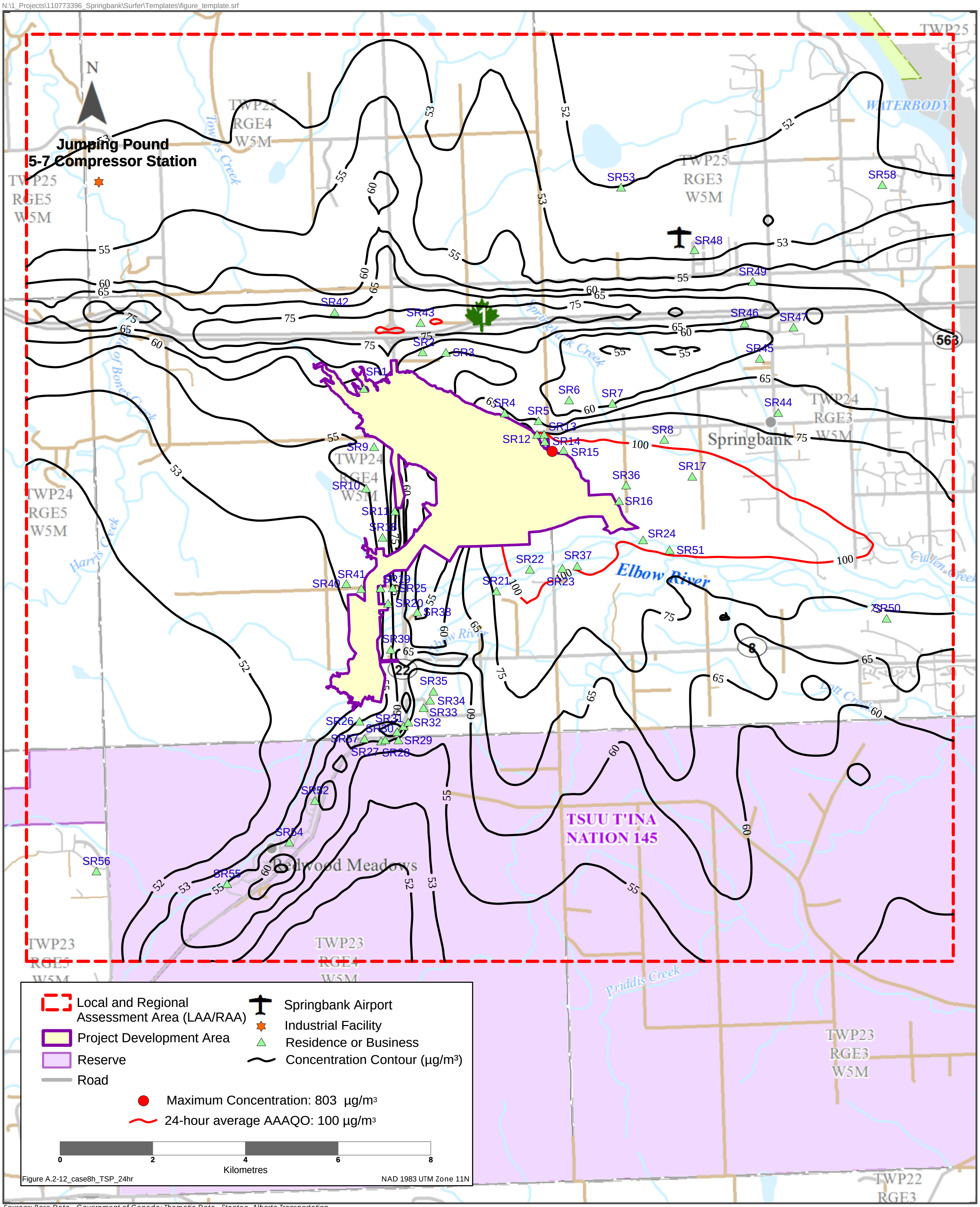

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 2, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-10

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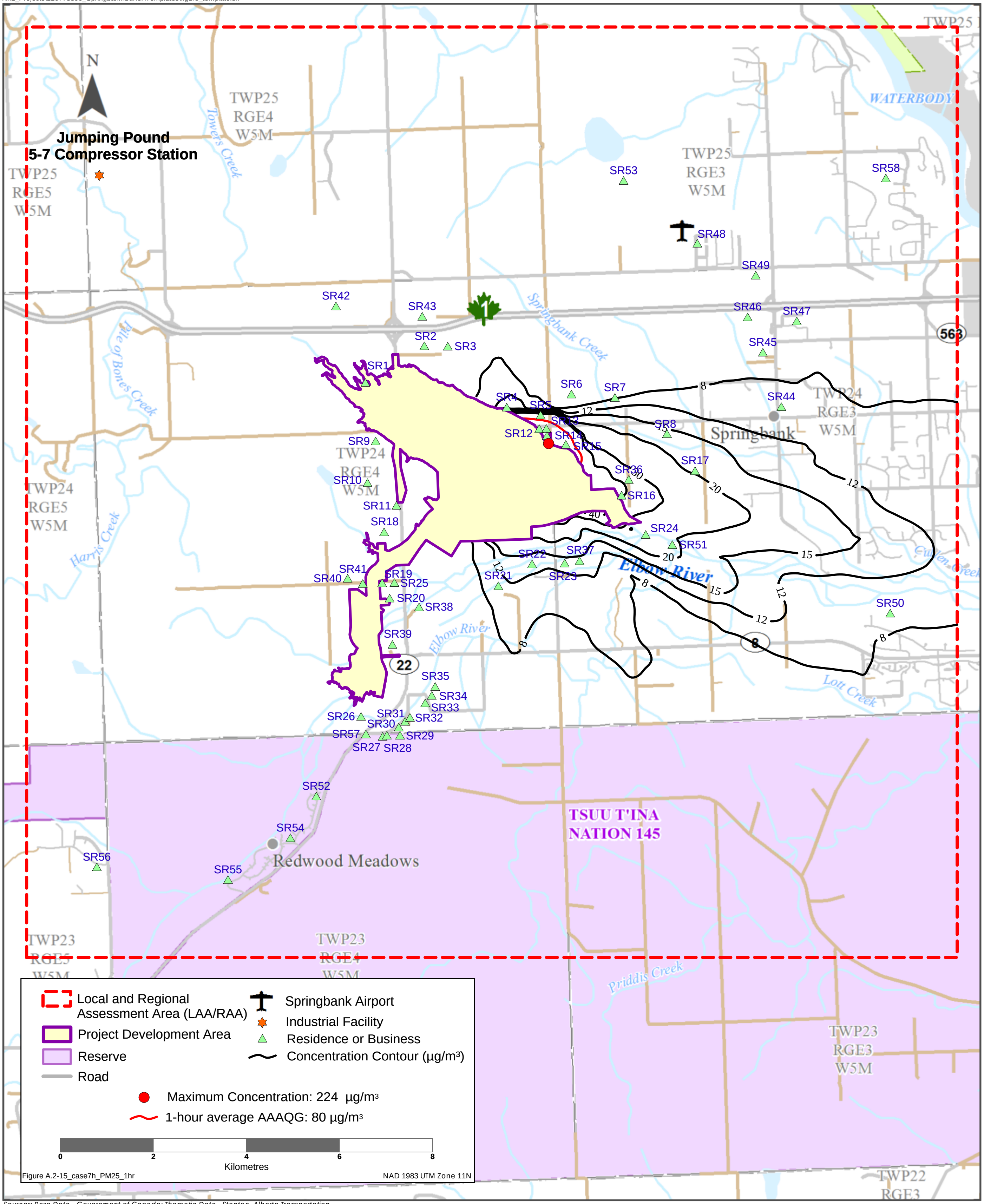

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 2, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-11

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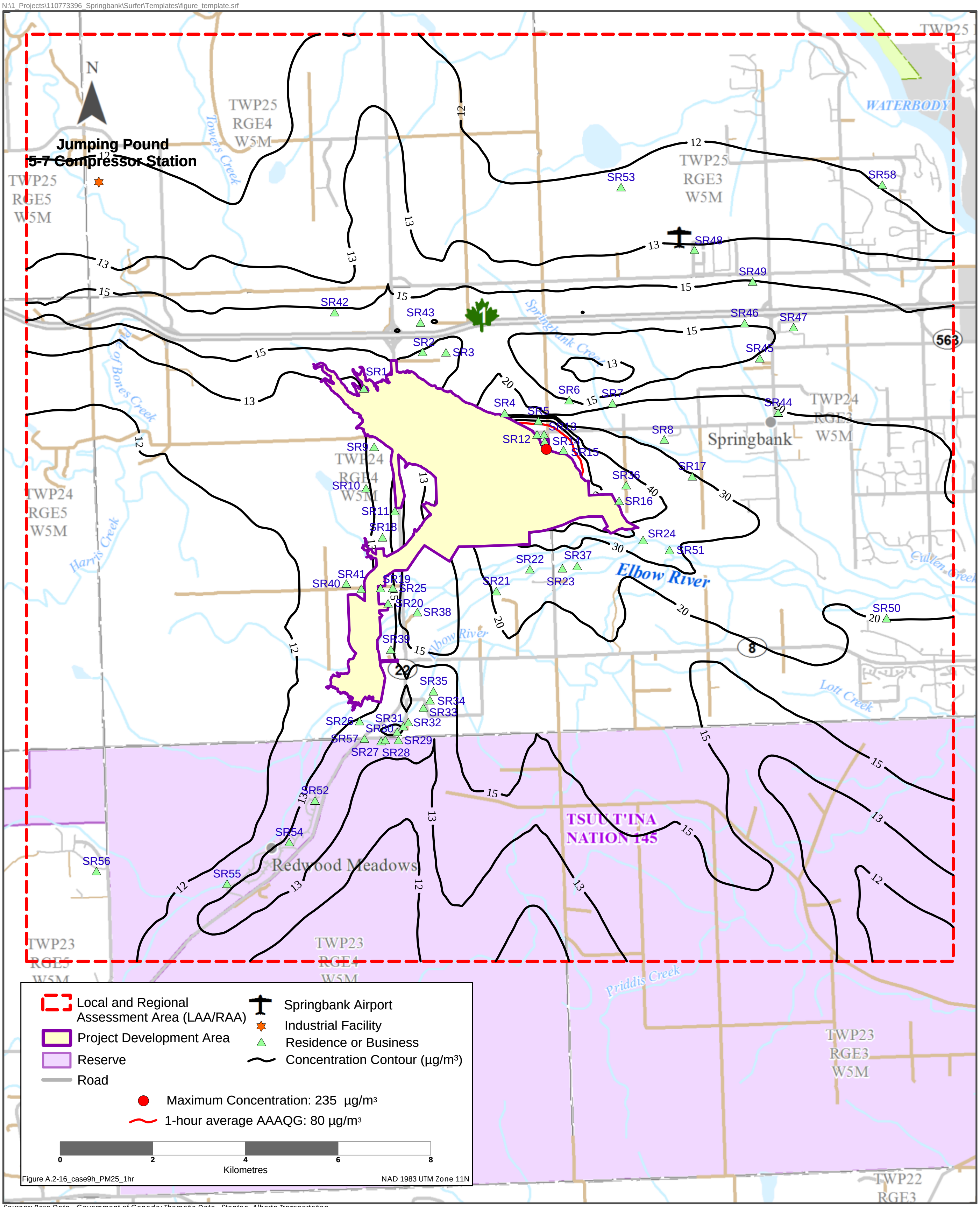


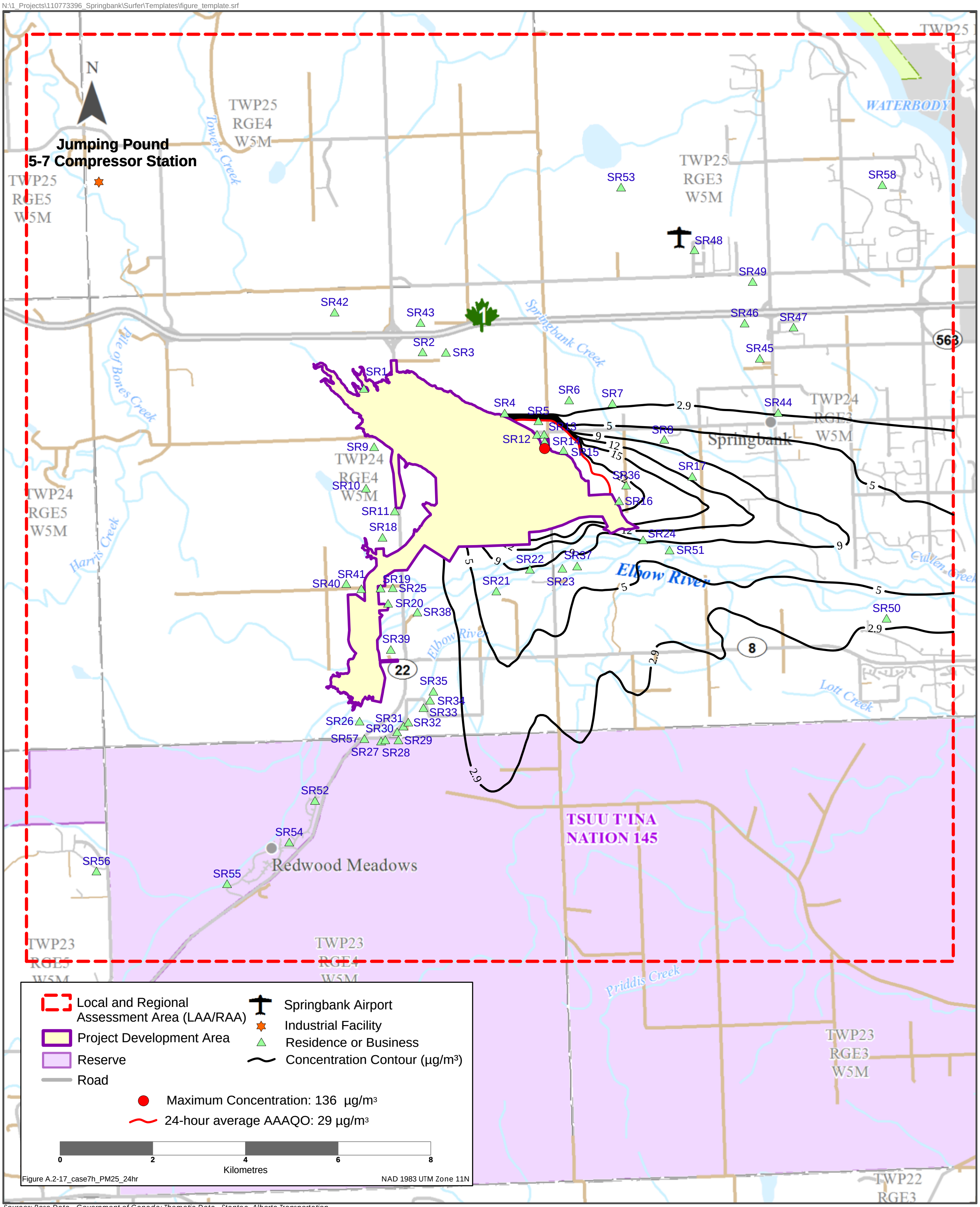
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 2, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-12



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-13

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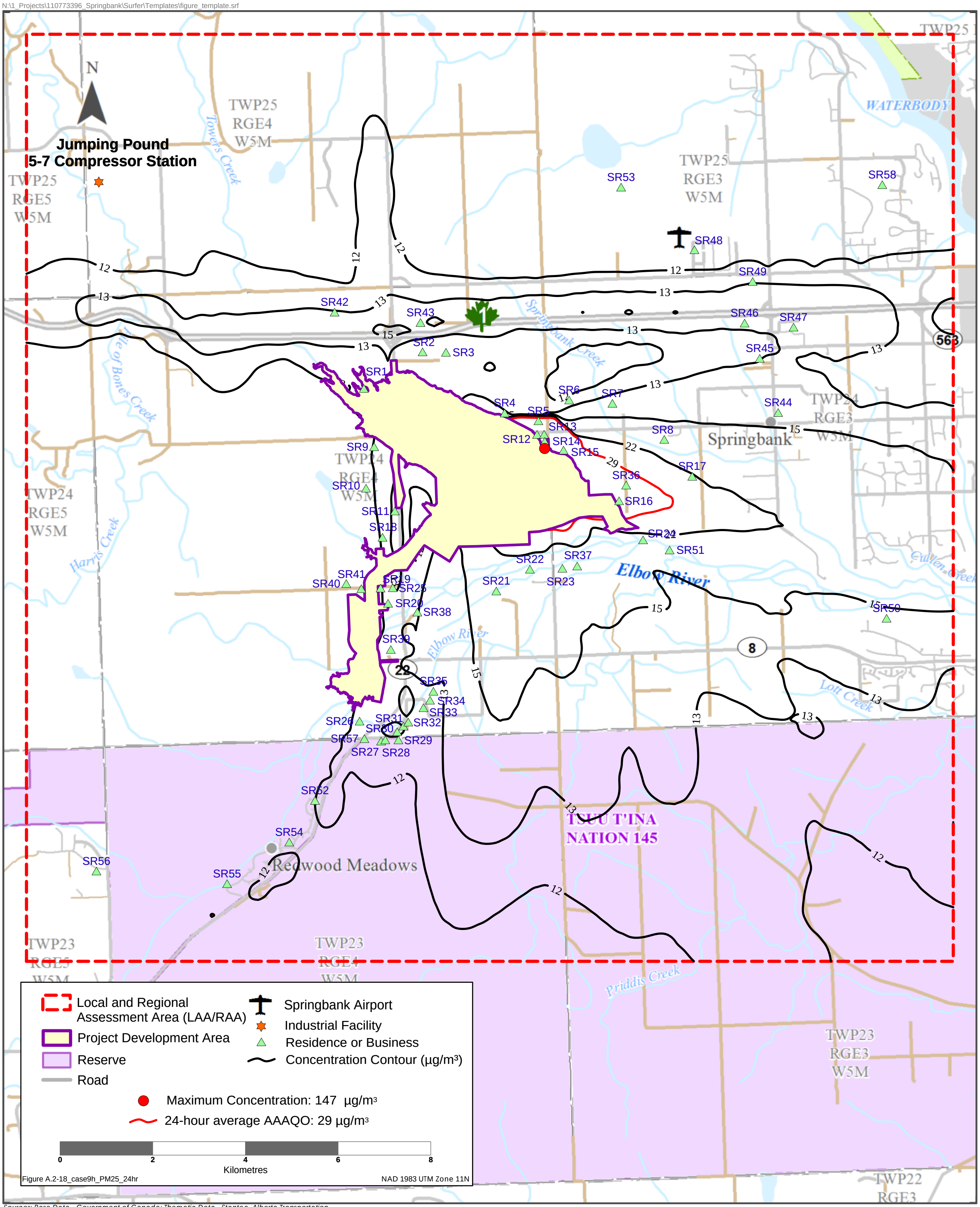


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

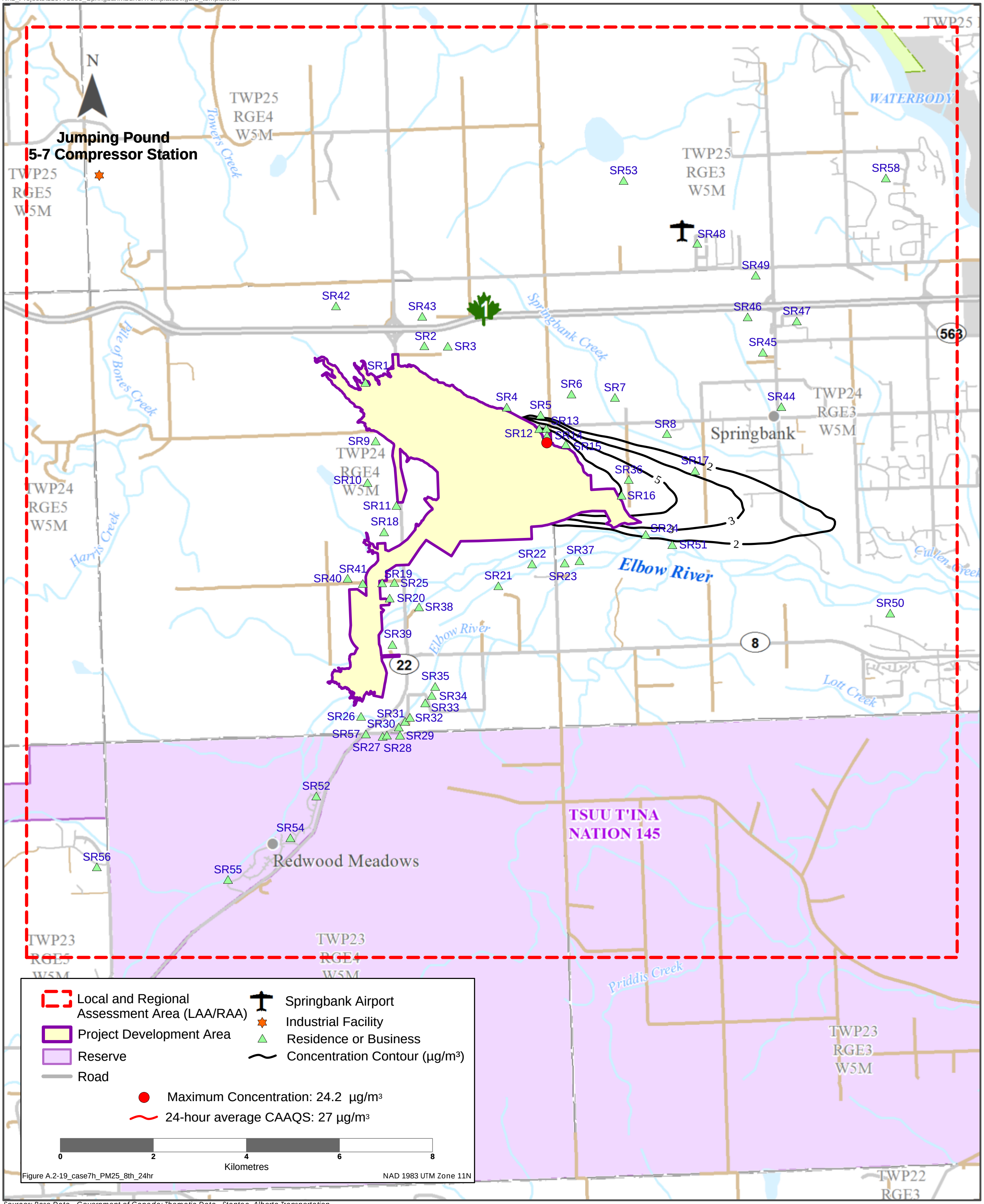
Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-14

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

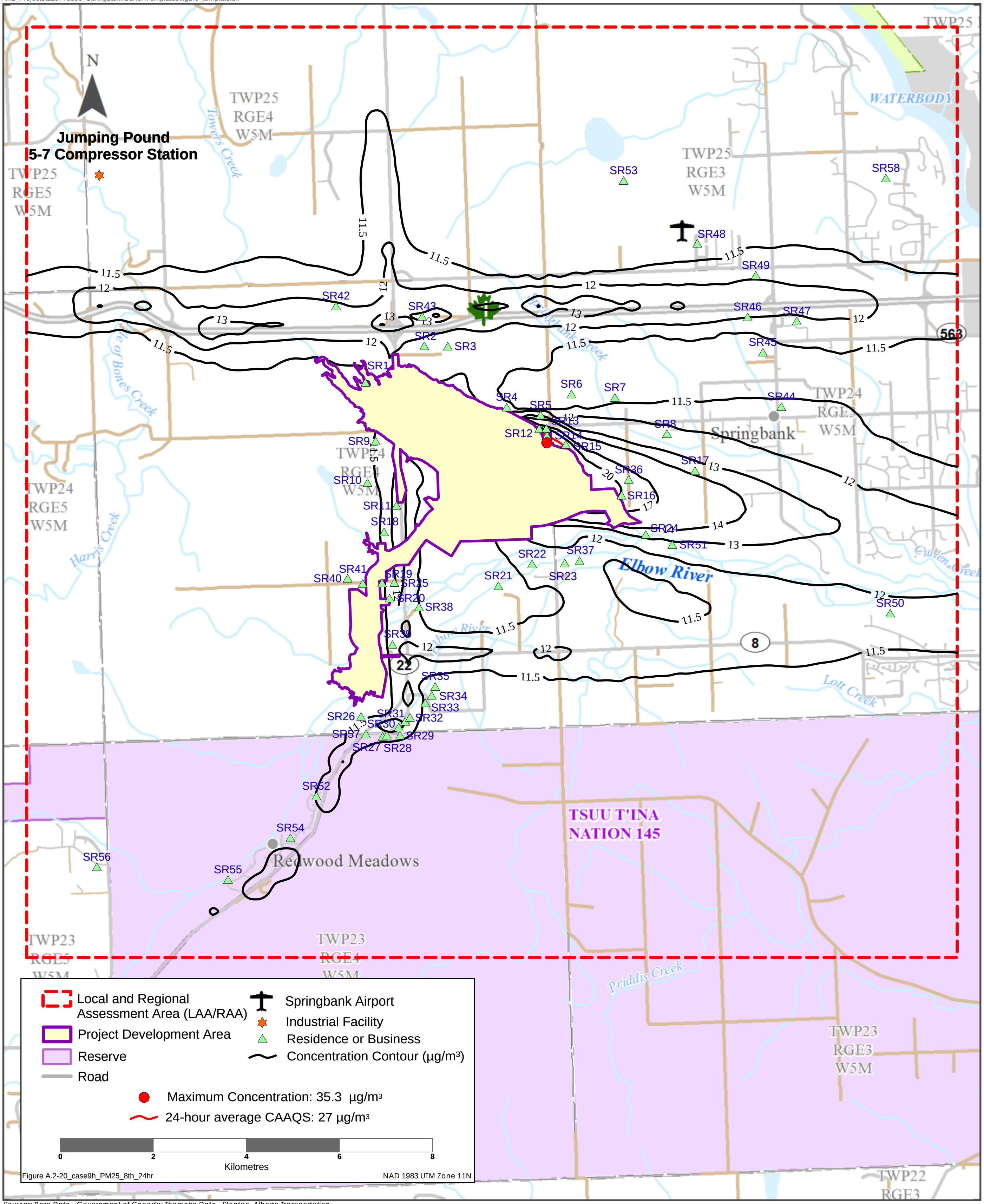
Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-15

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



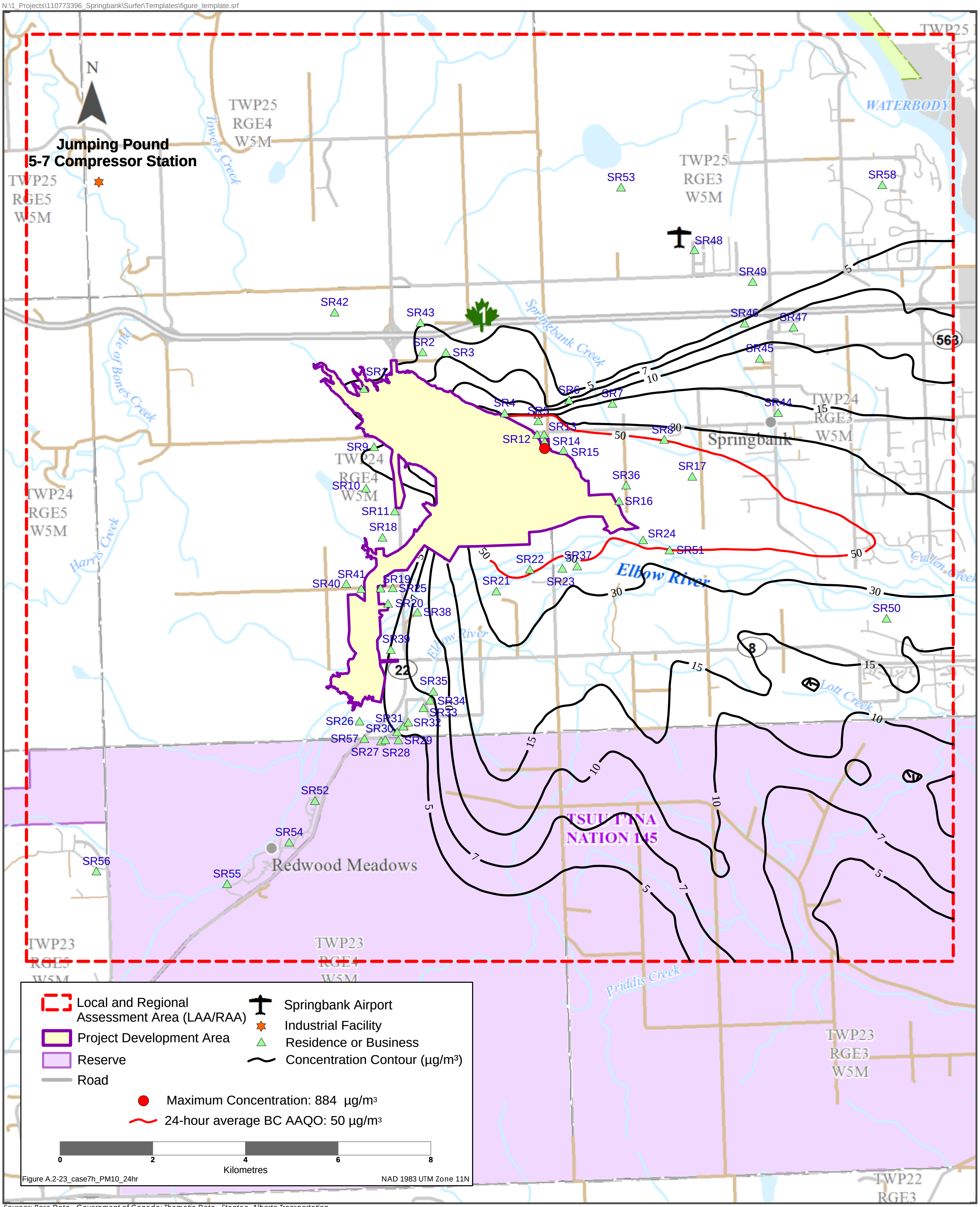
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 2, 1:200 Year Flood - Application Case)

Stantec

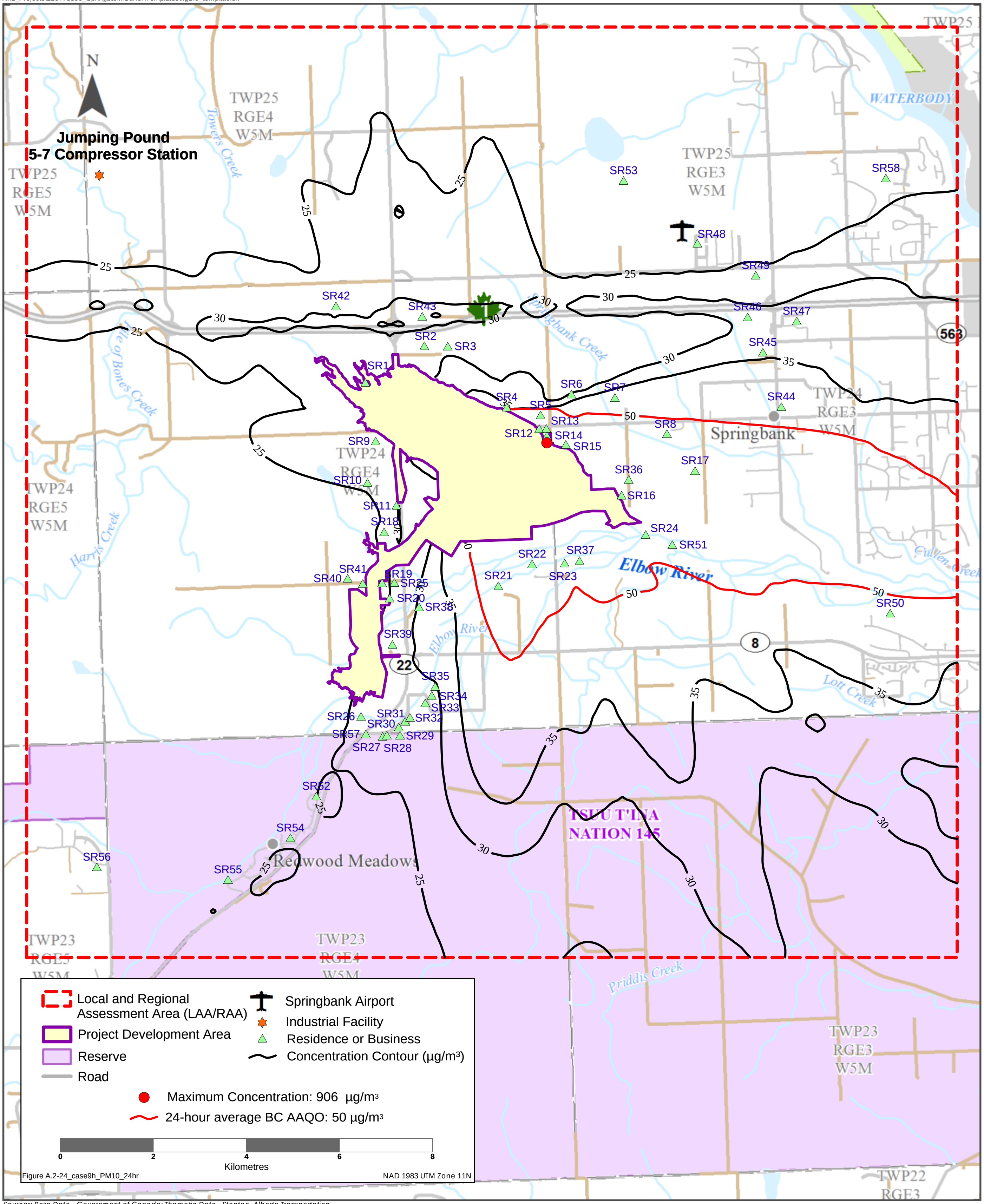
SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-16



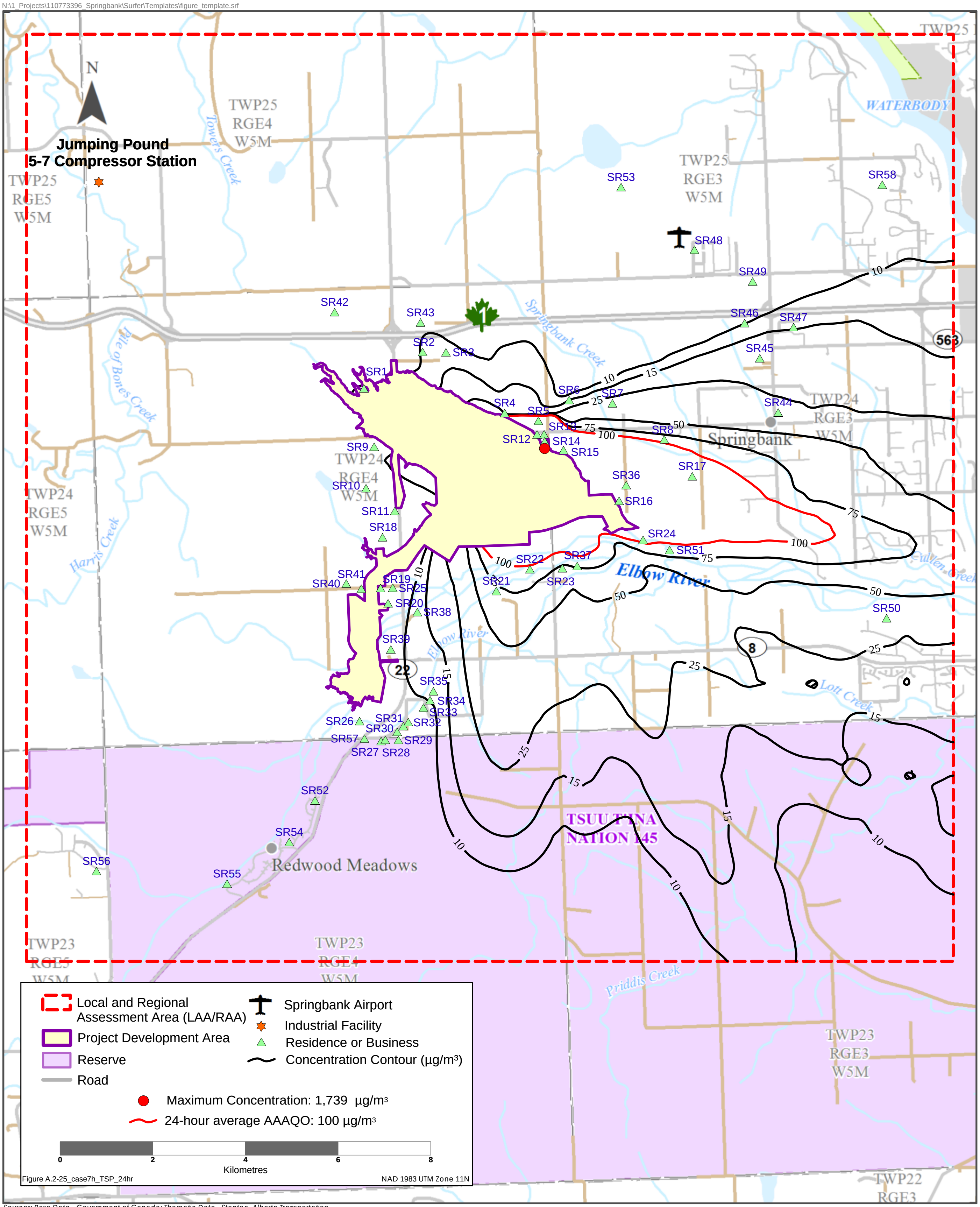
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 2, 1:200 Year Flood - Project Case)



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 2, 1:200 Year Flood - Application Case)



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 2, 1:200 Year Flood - Project Case)

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Figure A.2-19

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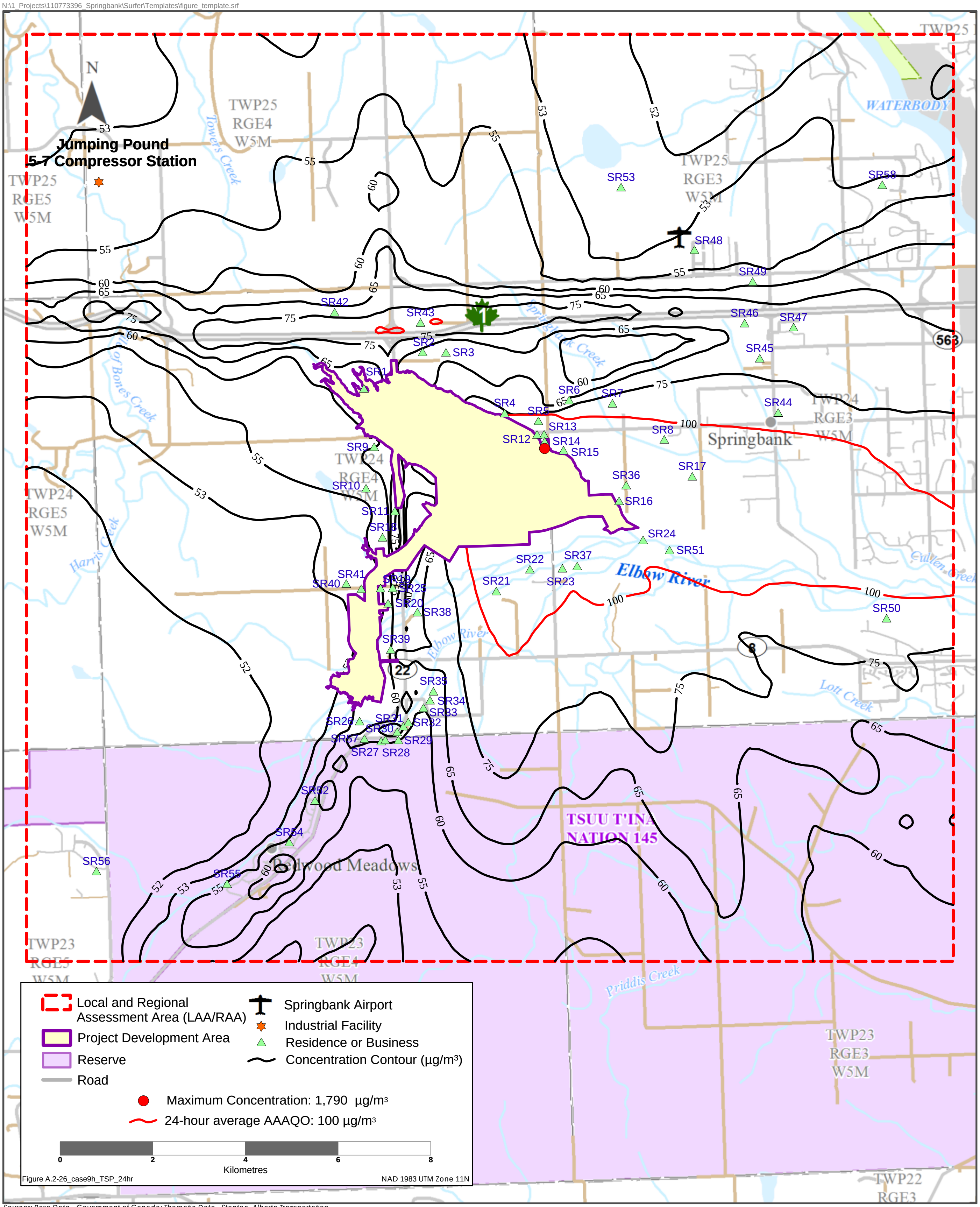

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 2, 1:200 Year Flood - Application Case)

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SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.2-20

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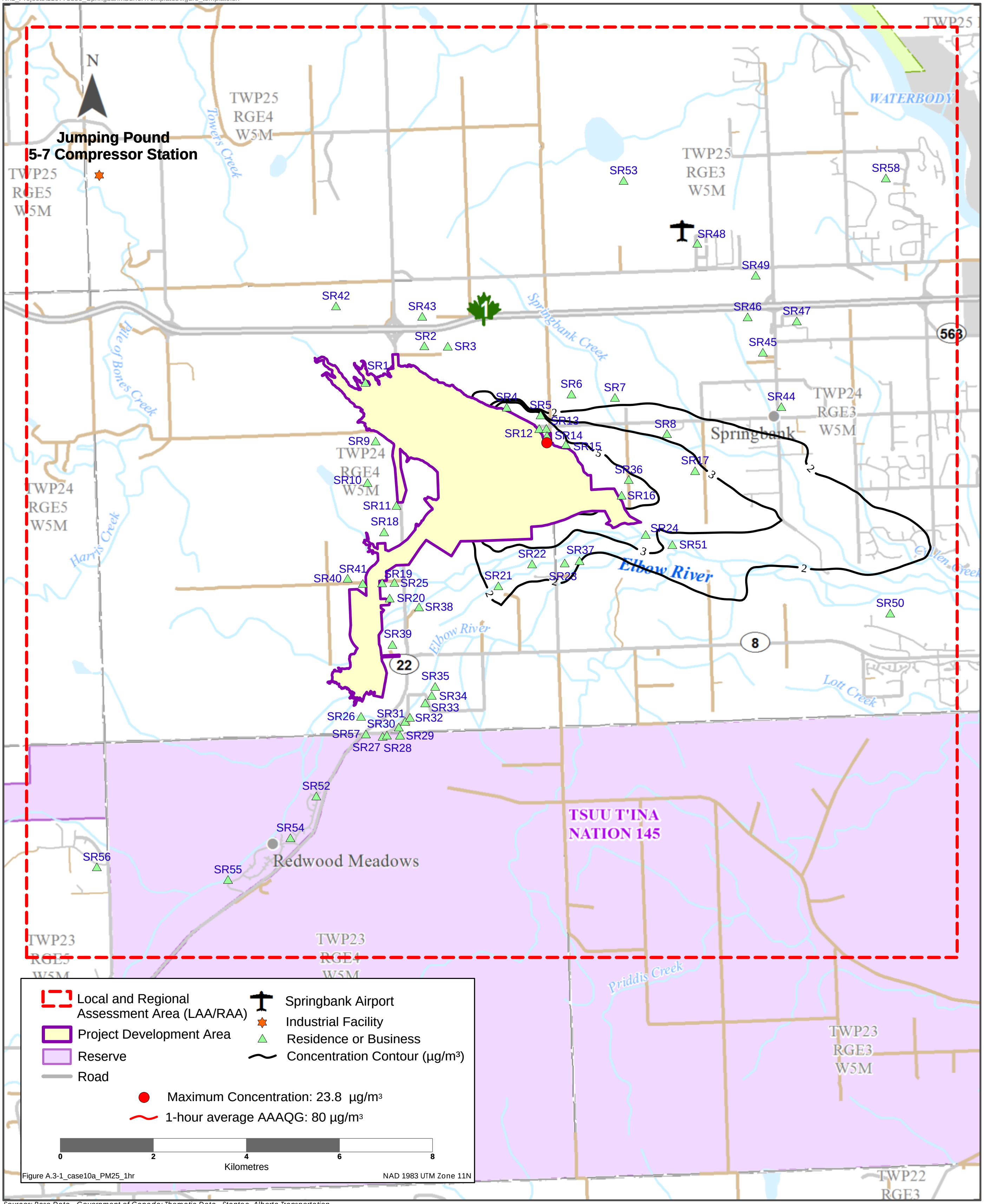

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-1

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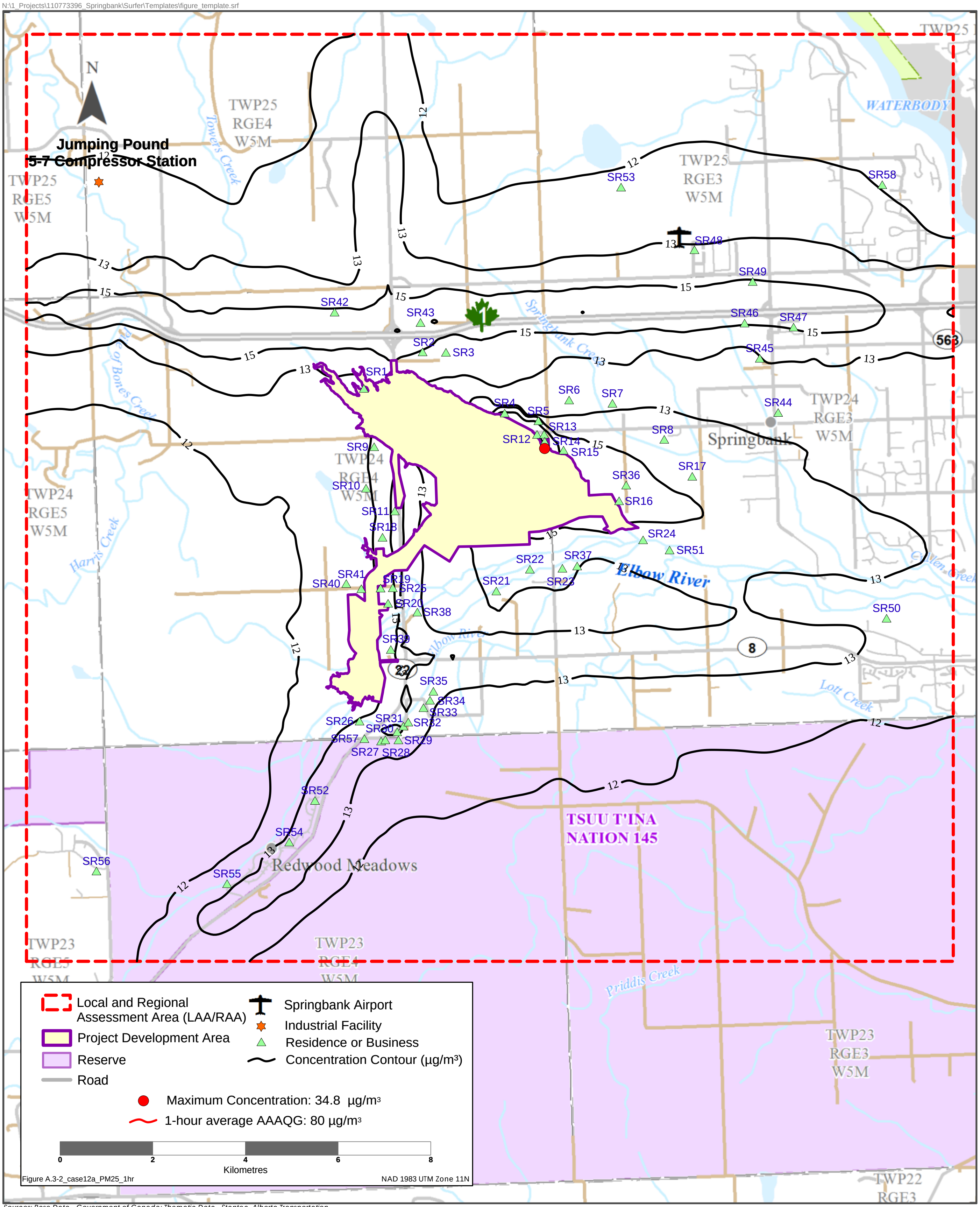

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-2

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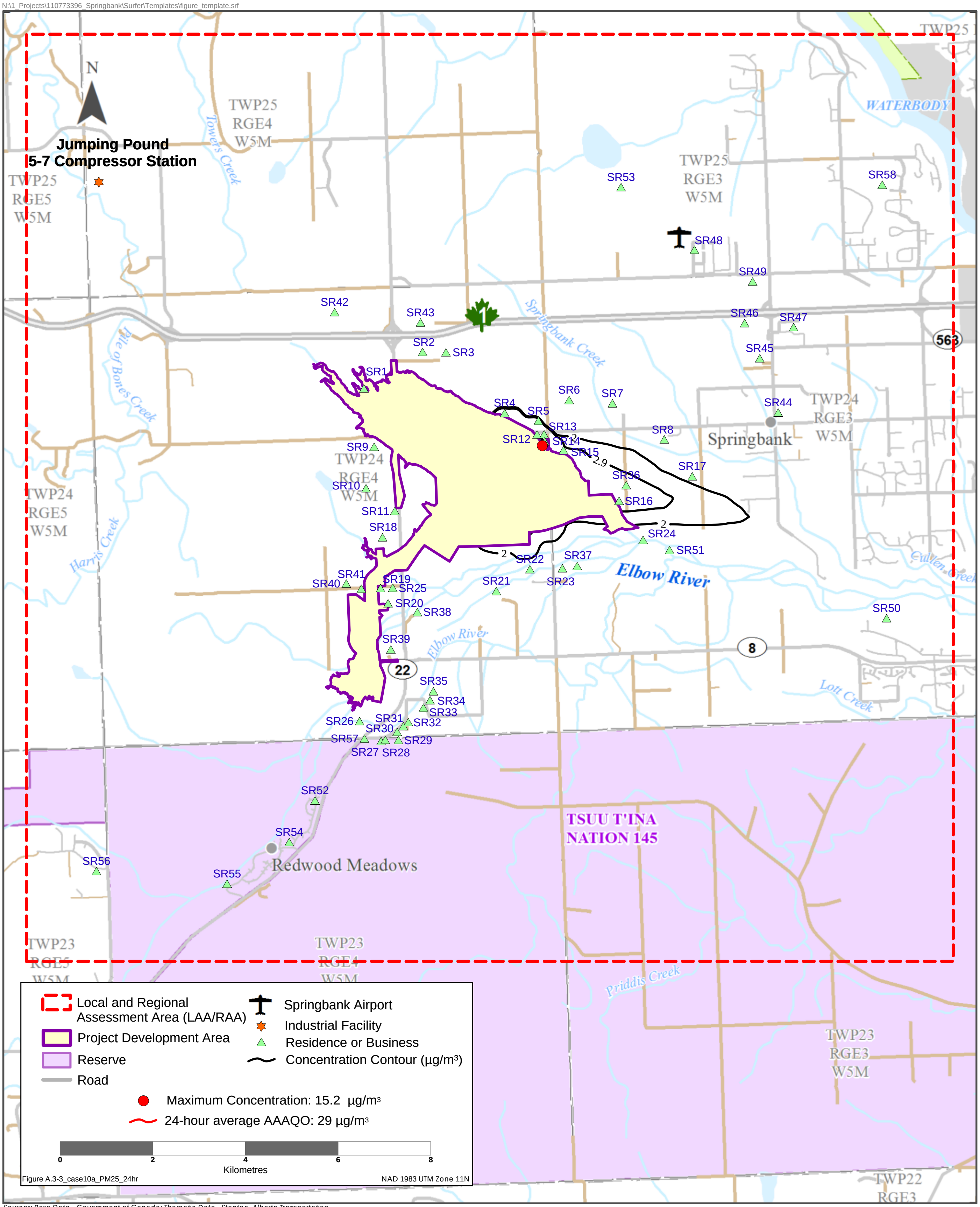

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-3

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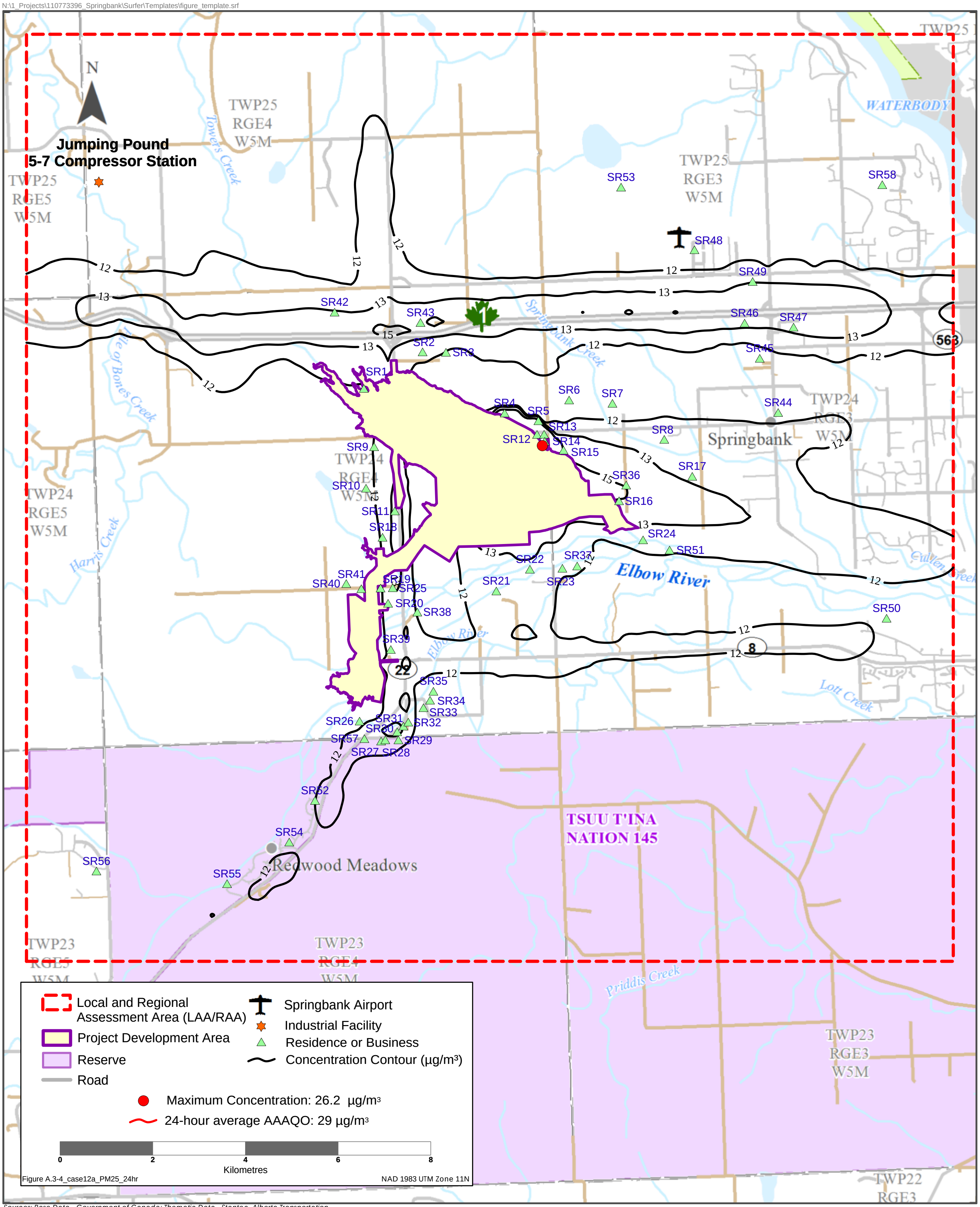

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-4

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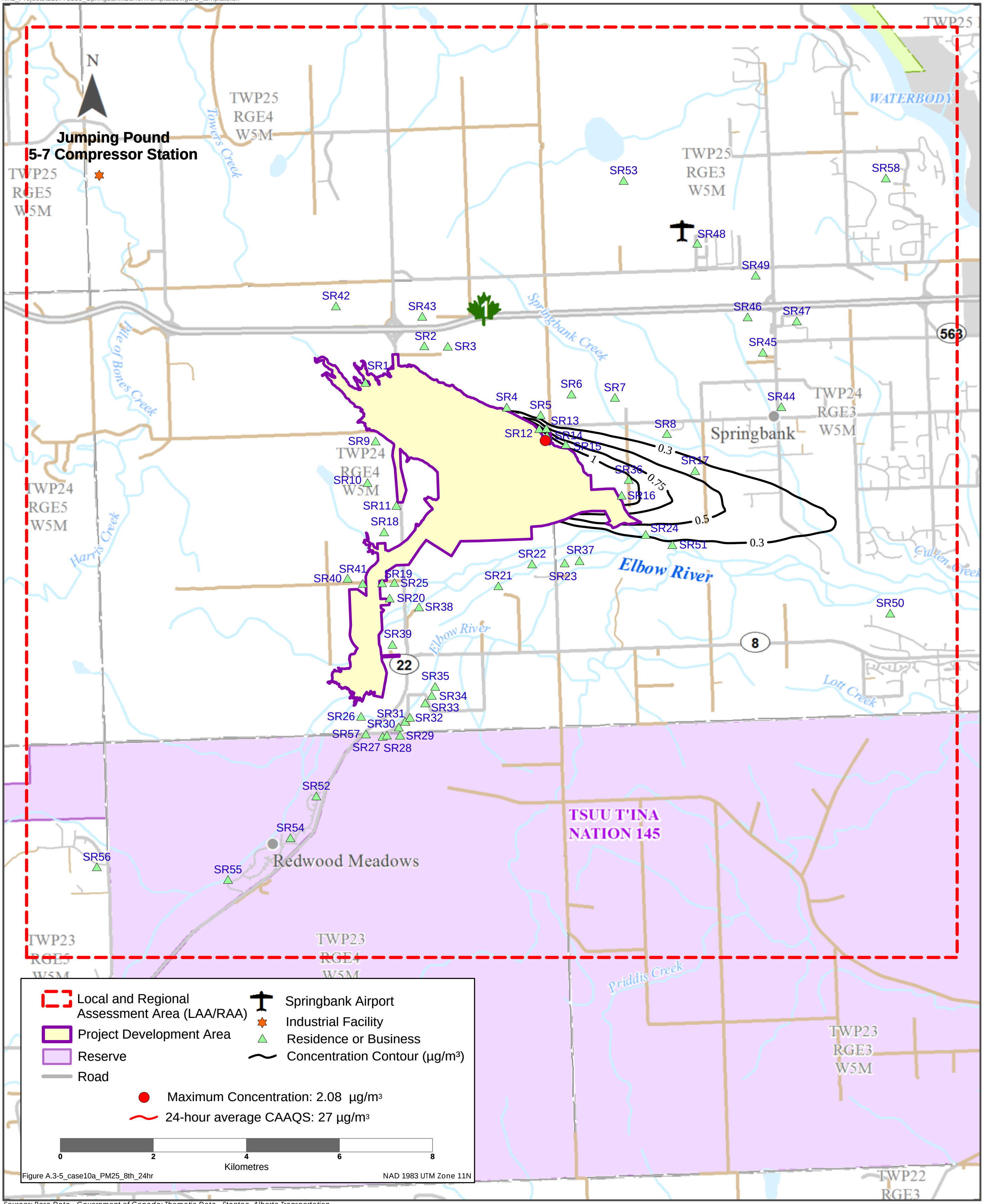

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-5

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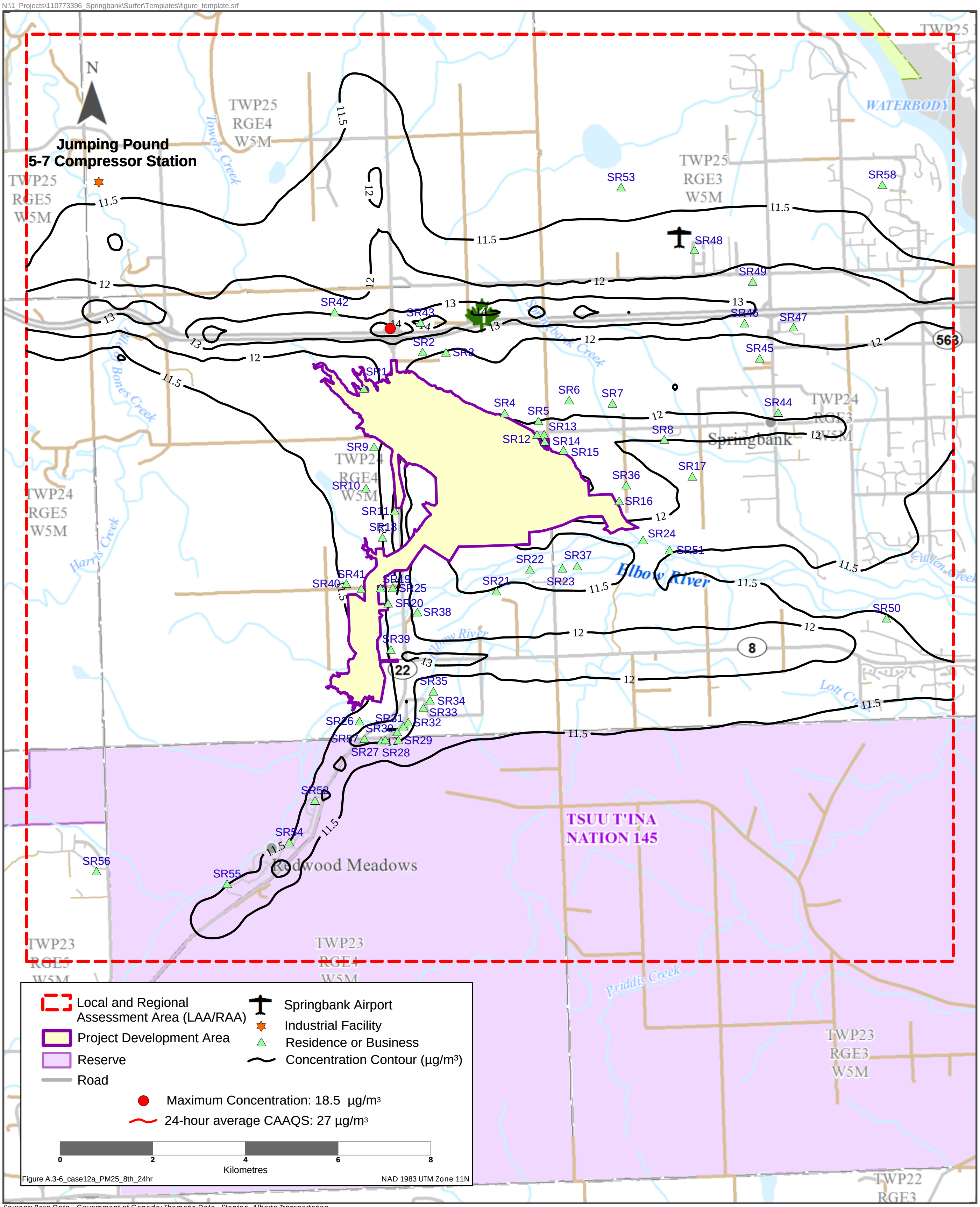
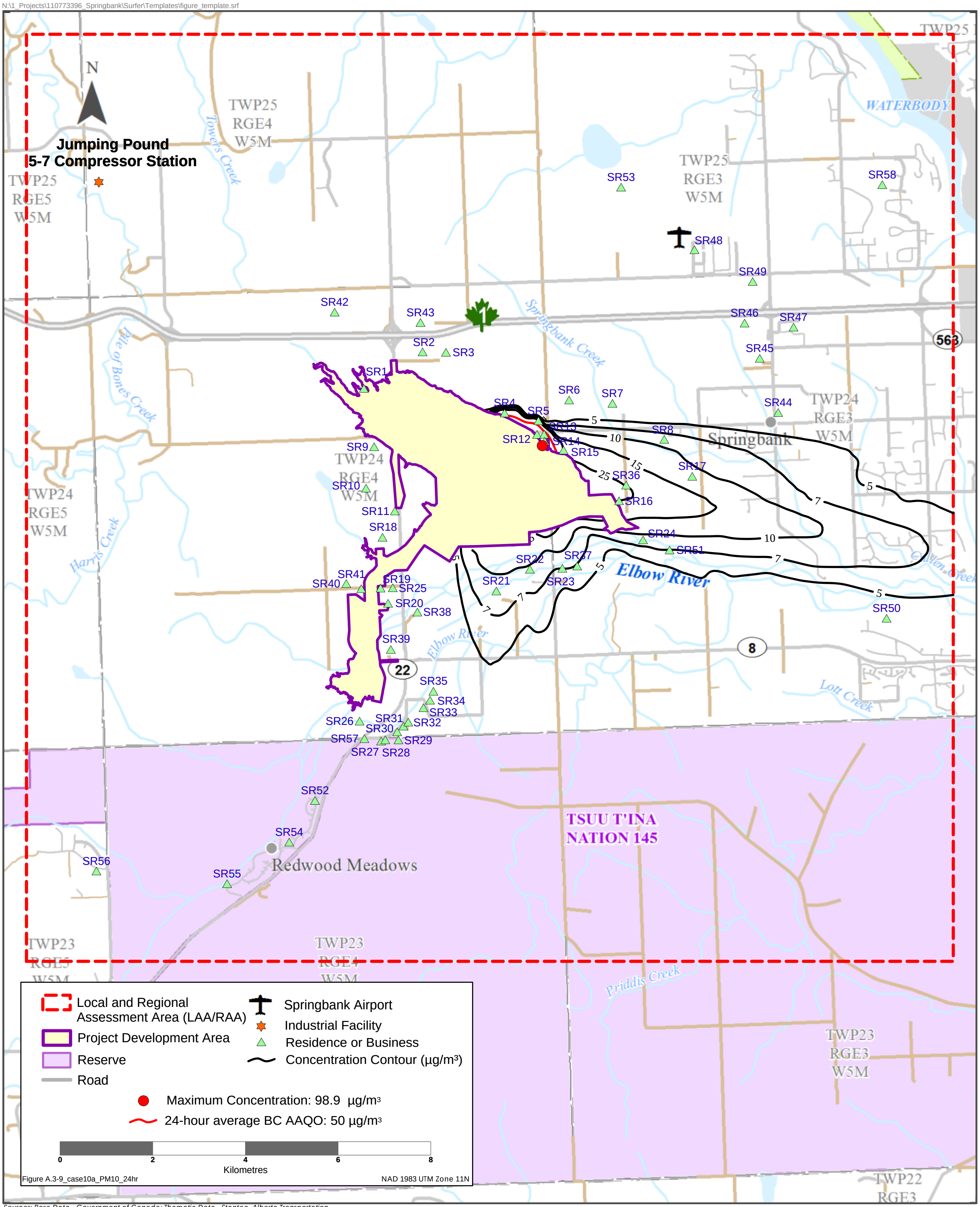


Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:100 Year Flood - Application Case)



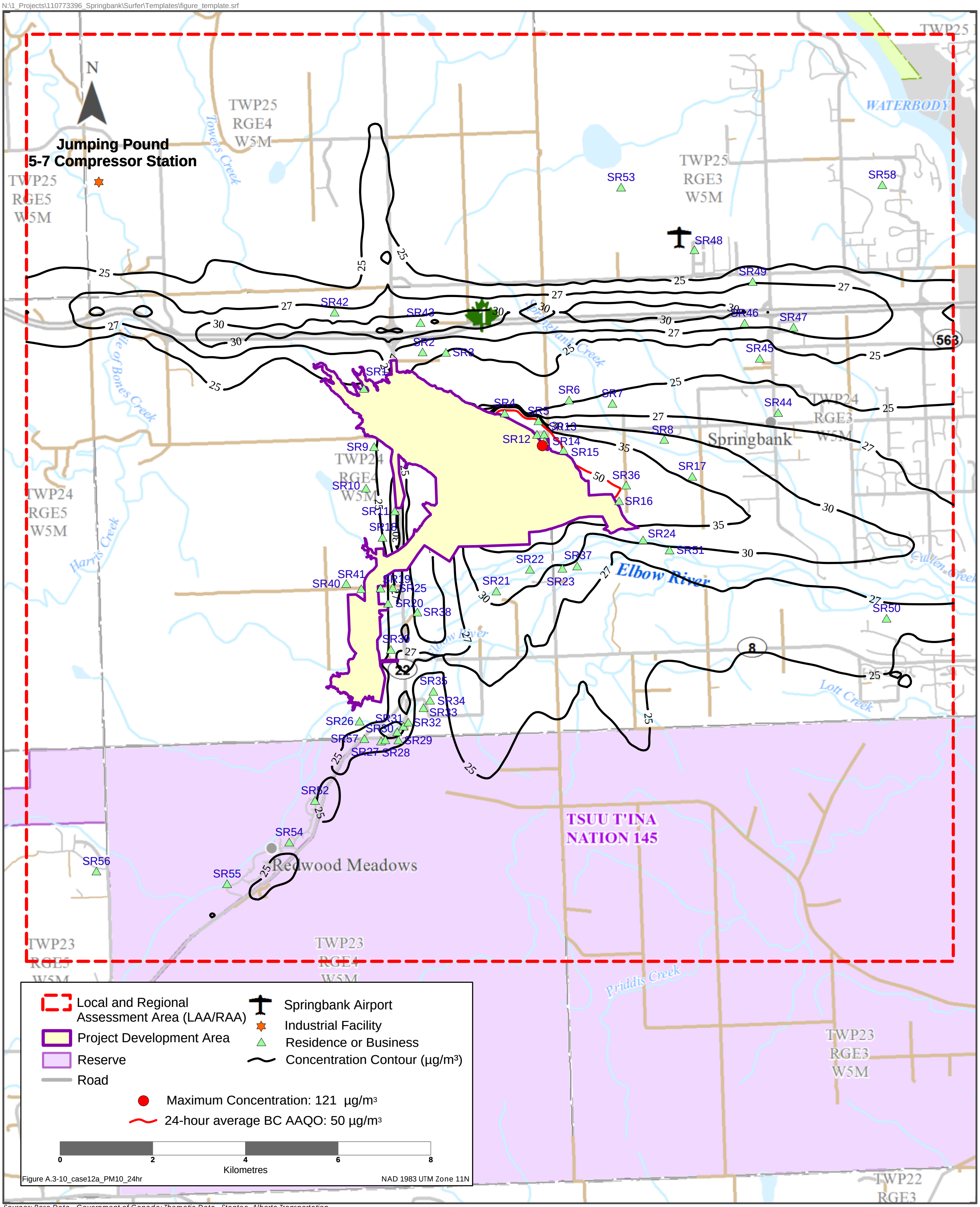
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 3, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-7



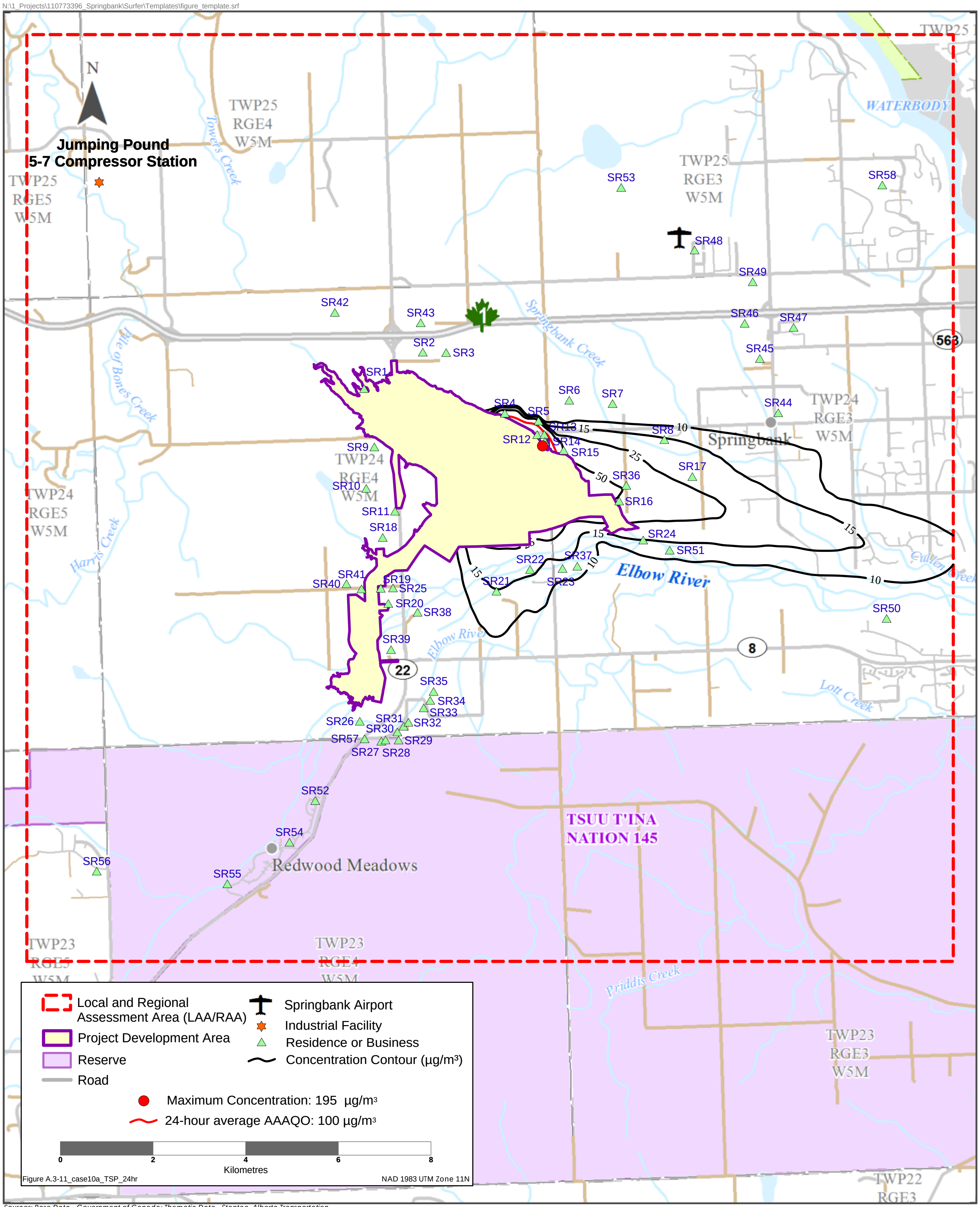
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 3, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-8



Maximum Predicted 24-hour average TSP Concentration (Case 3, Late Release, 1:100 Year Flood - Project Case)

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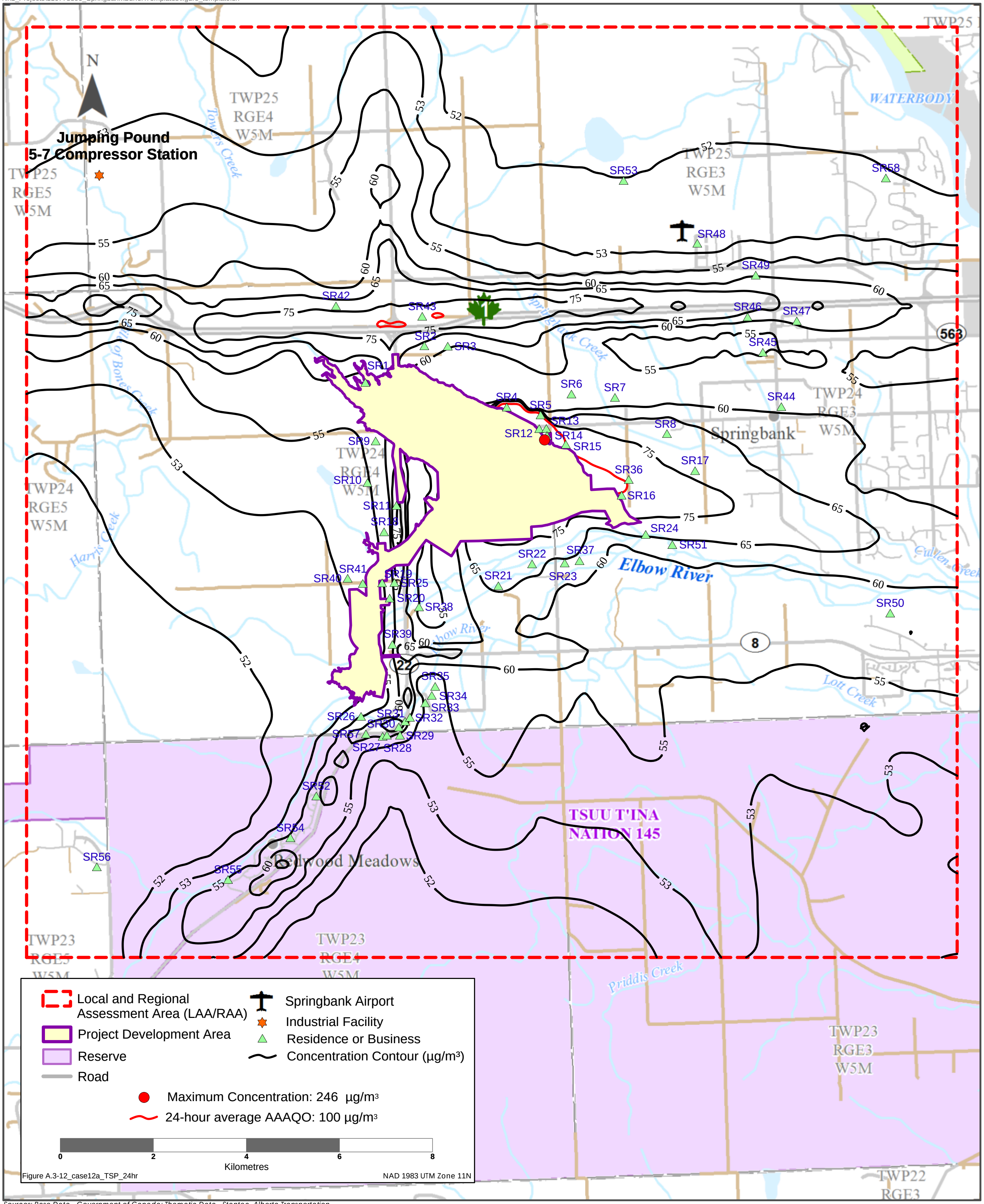

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration
(Case 3, Late Release, 1:100 Year Flood - Application Case)

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SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-10

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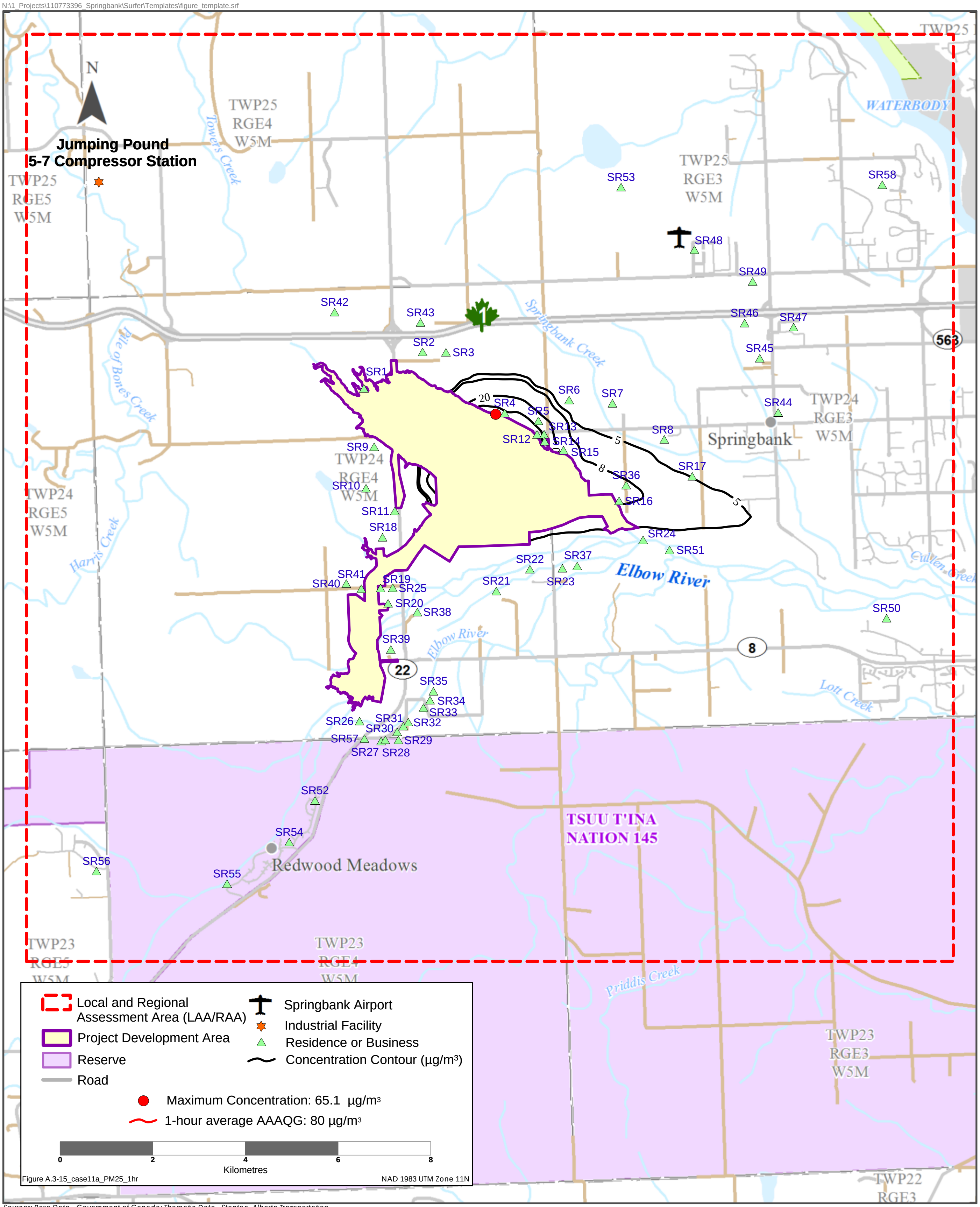

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-11

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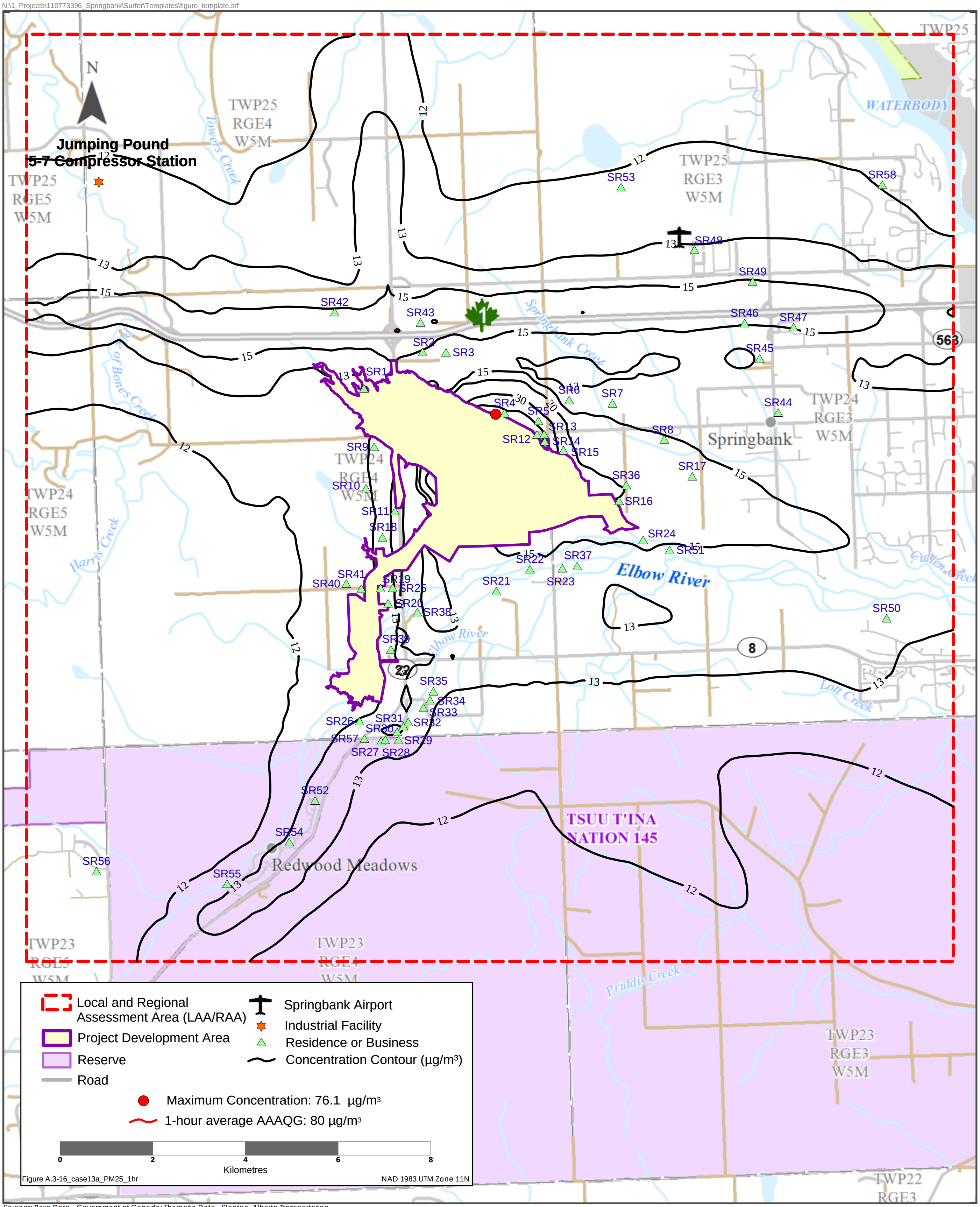

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-12

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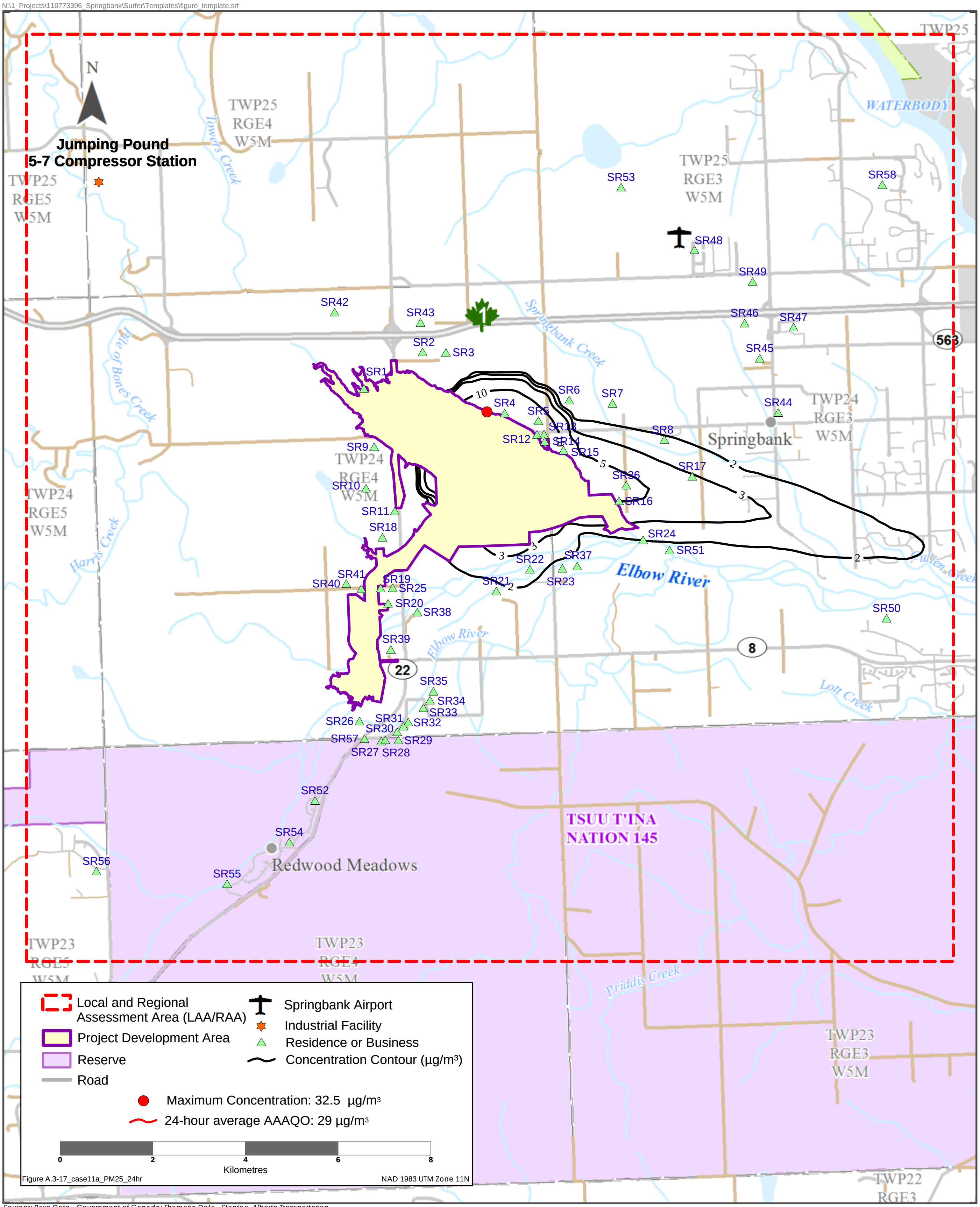

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-13

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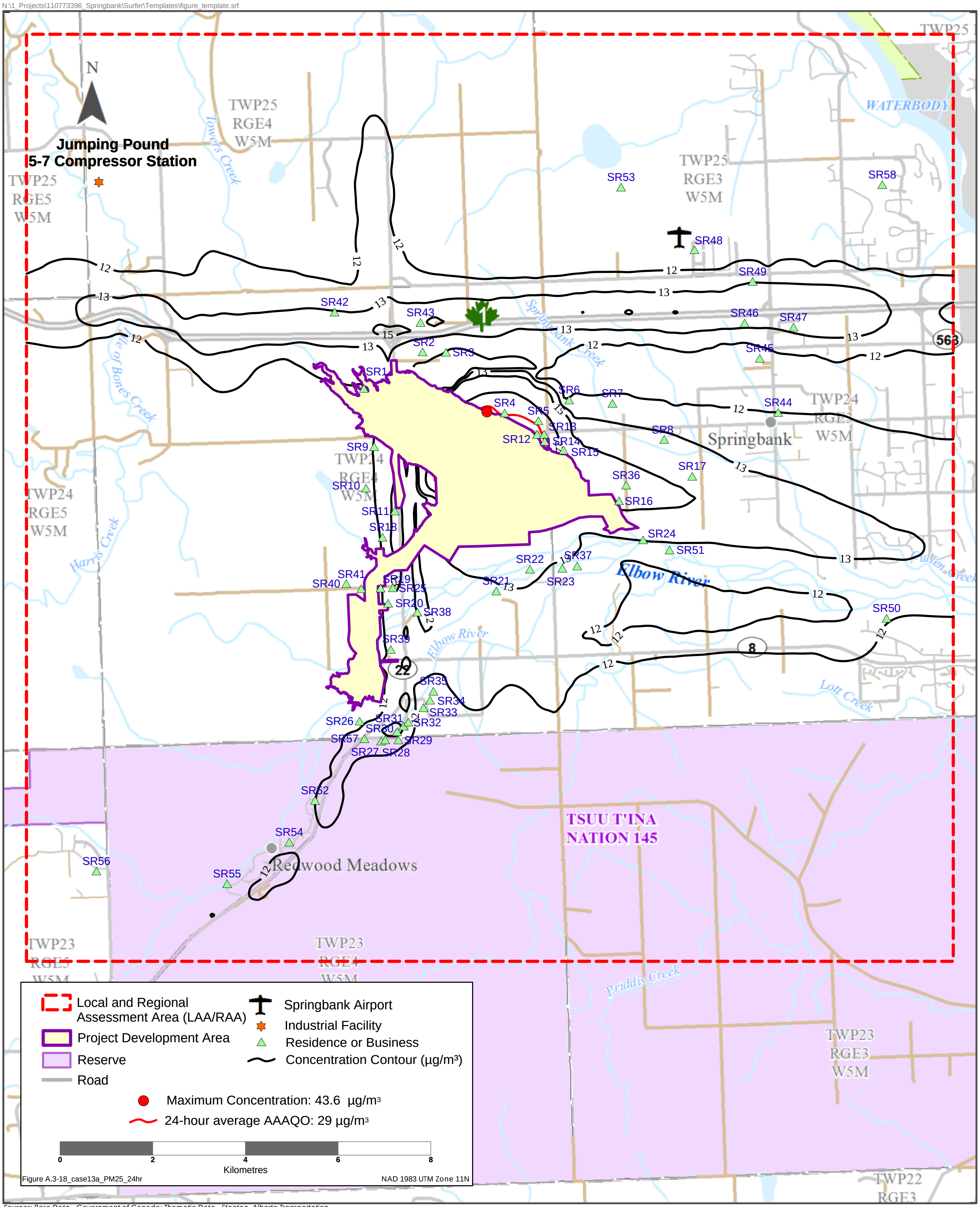


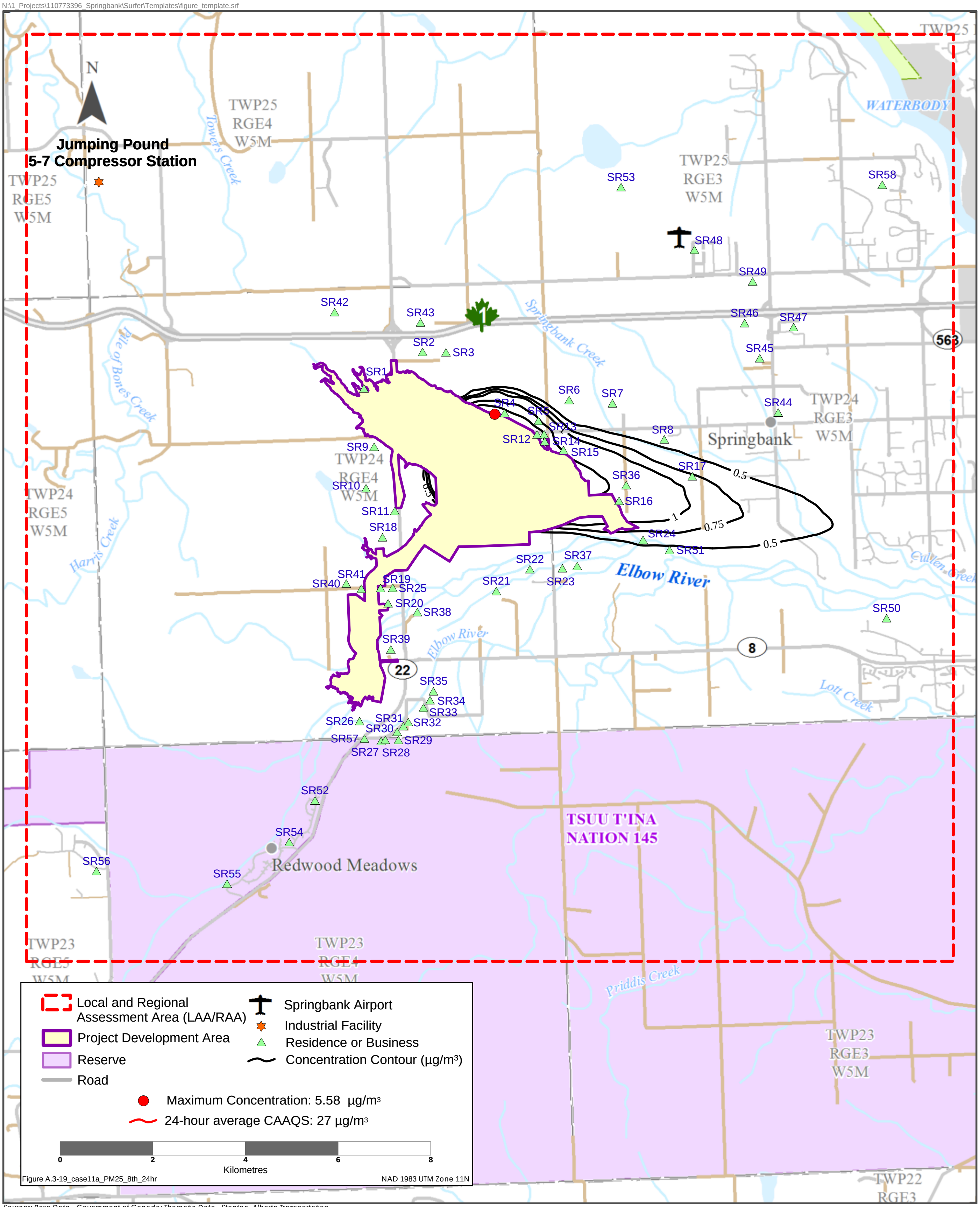
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-14



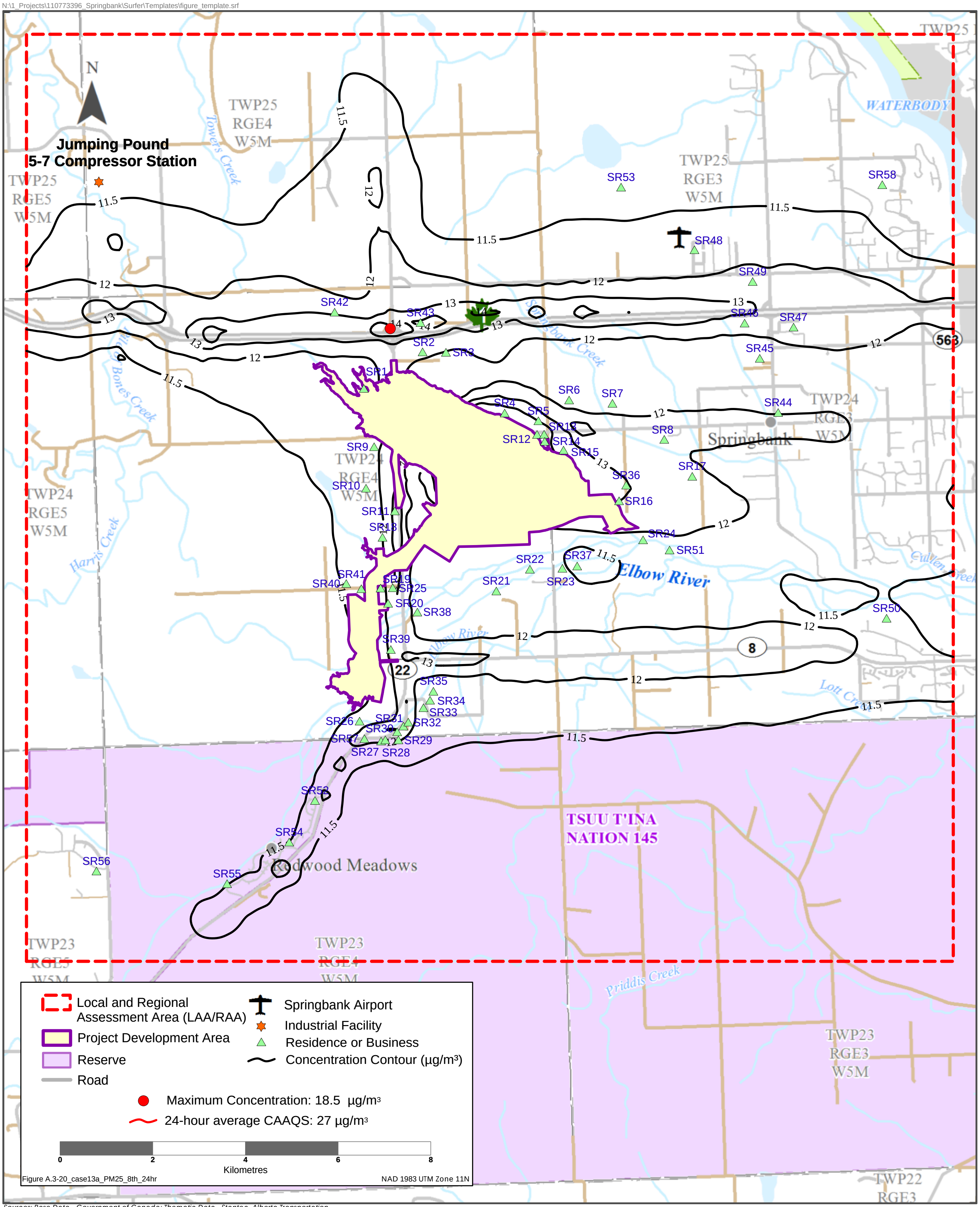
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-15



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 3, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-16

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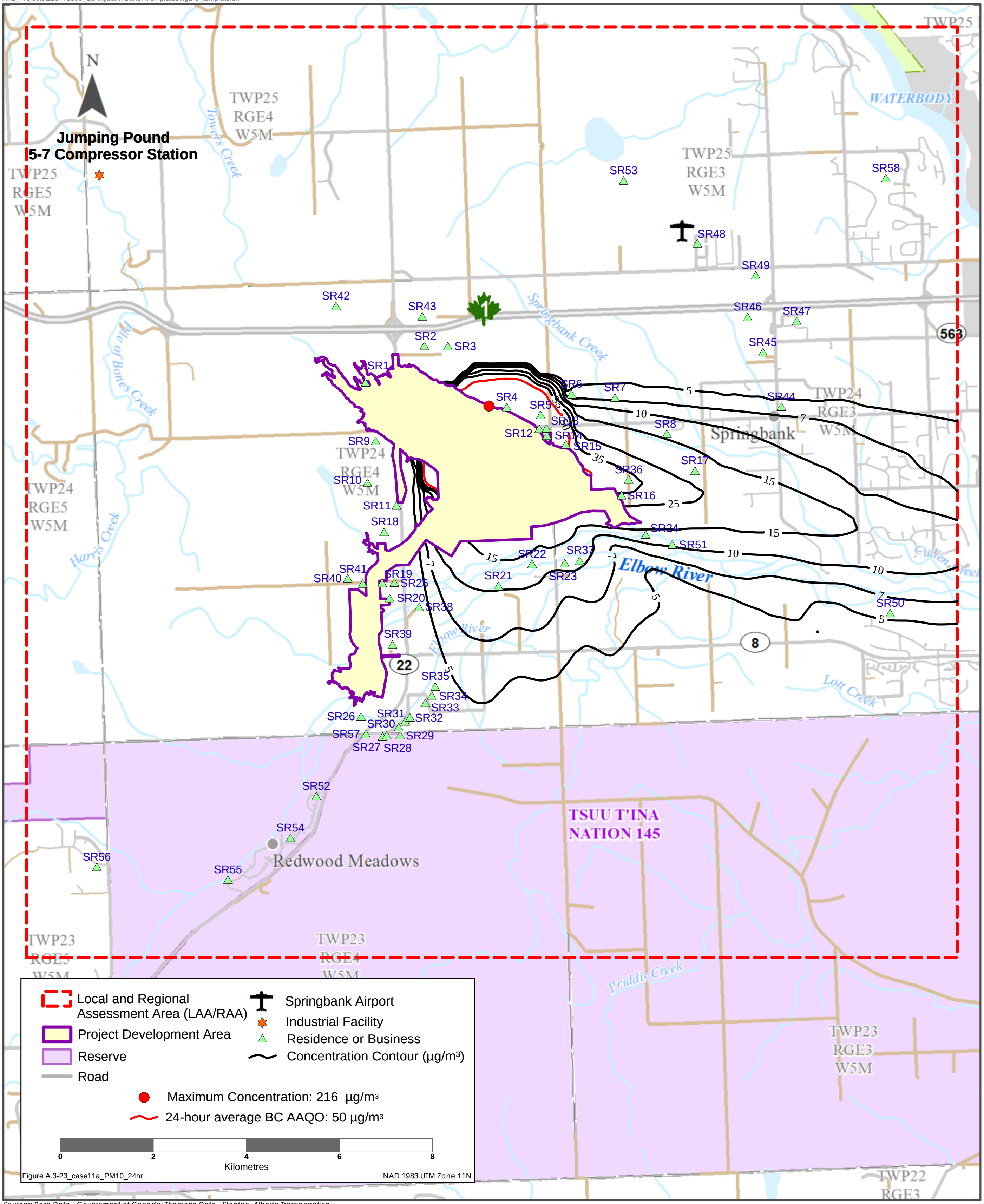

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 3, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-17

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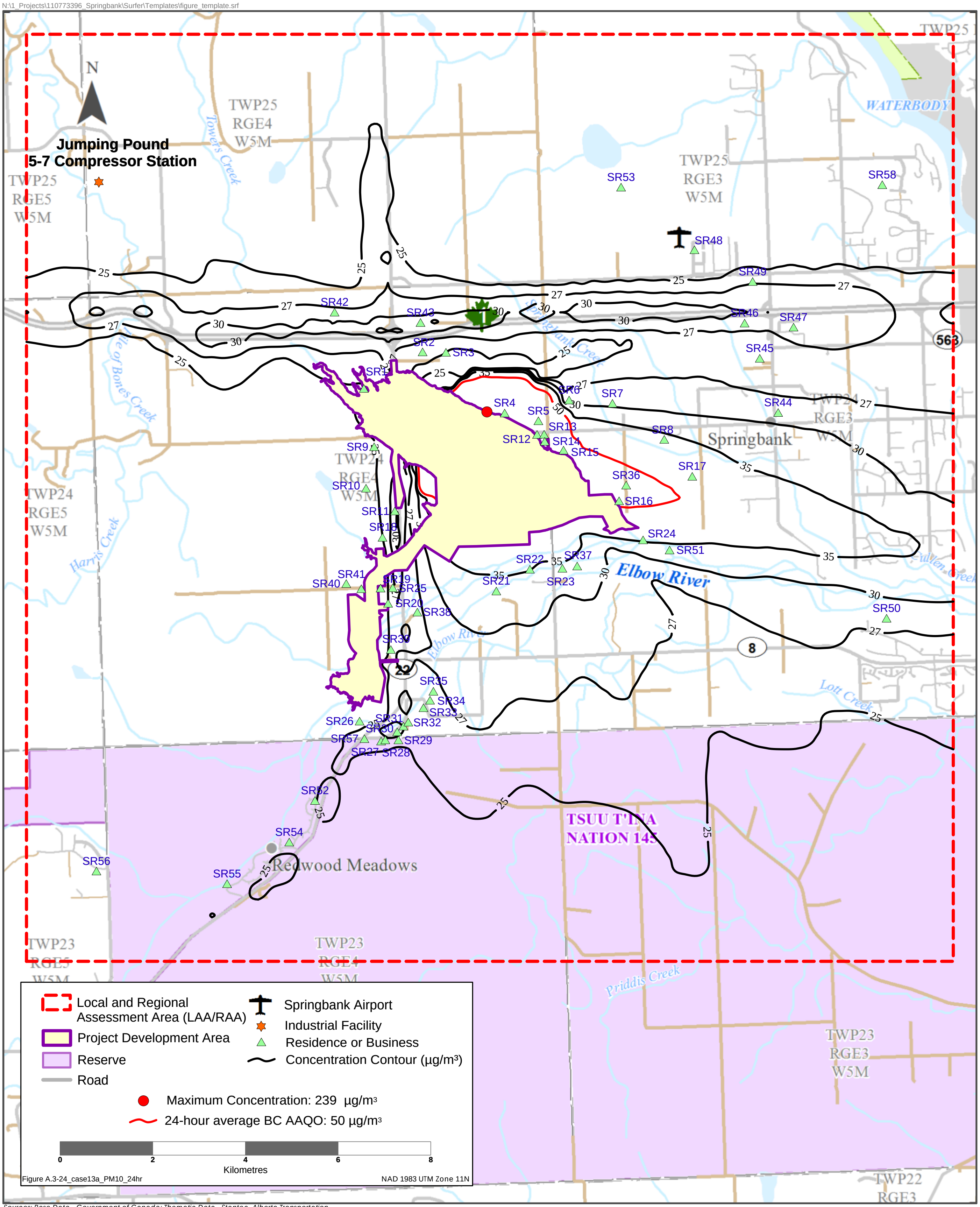

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 3, Late Release, 1:200 Year Flood - Application Case)

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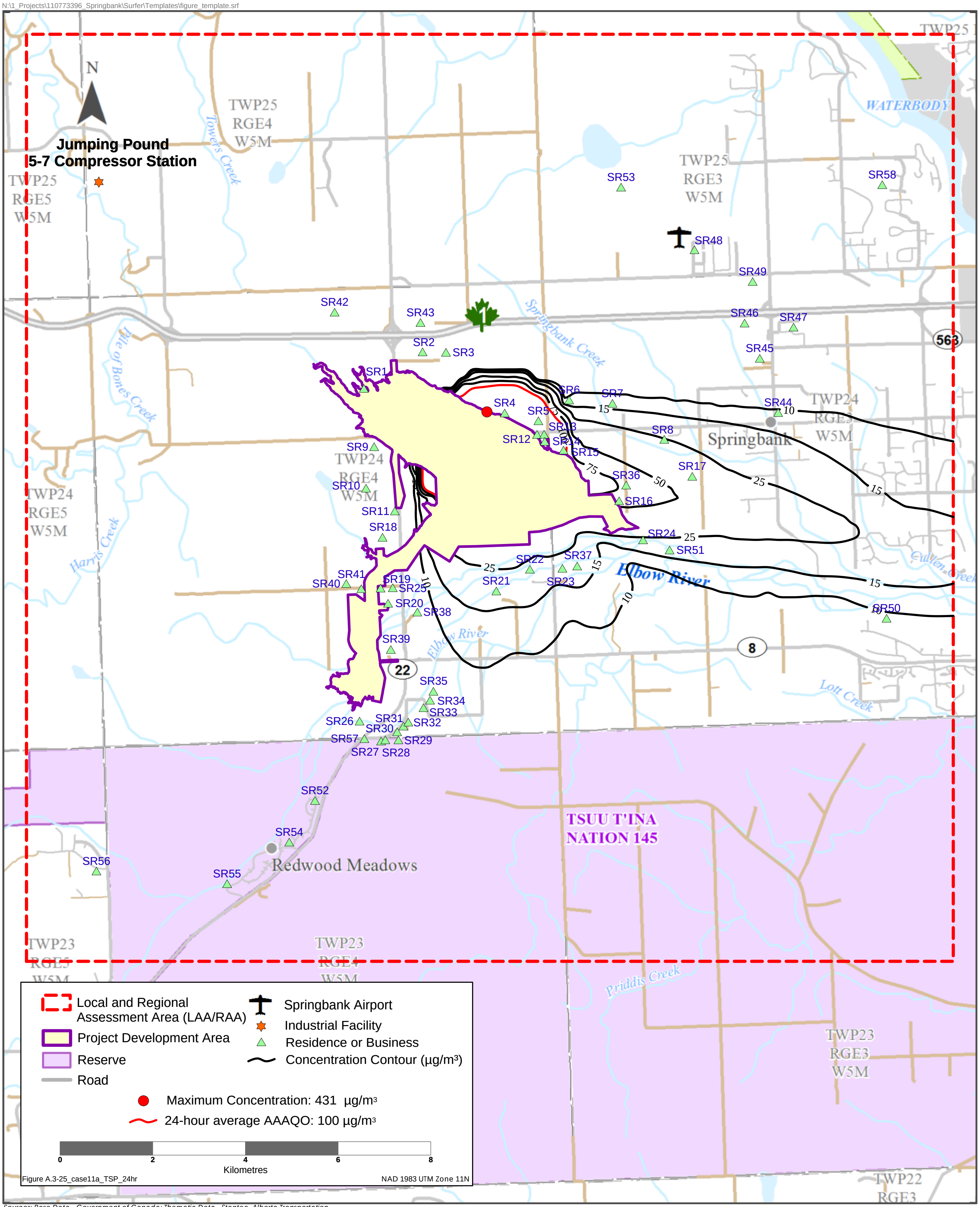

Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 3, Late Release, 1:200 Year Flood - Project Case)

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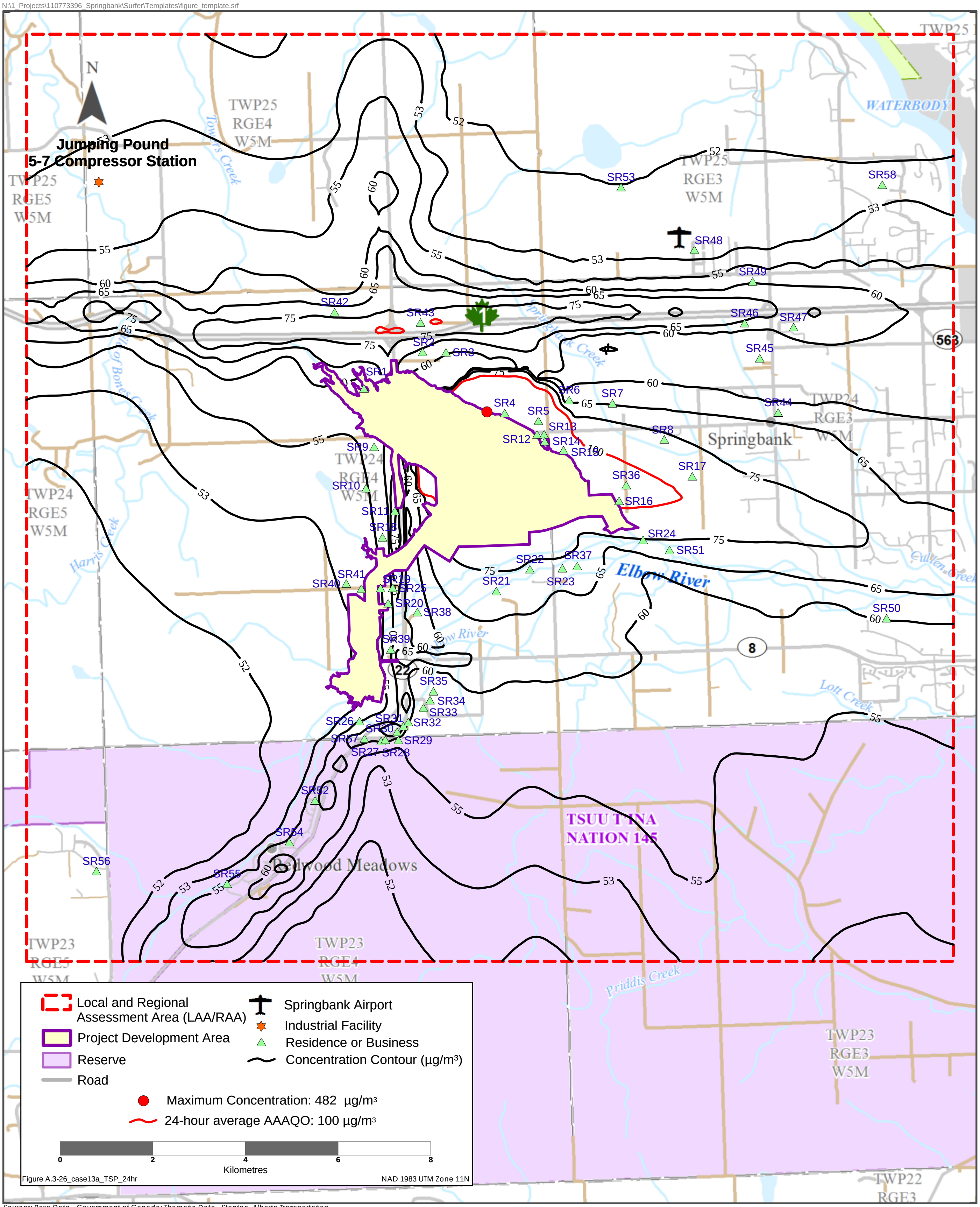


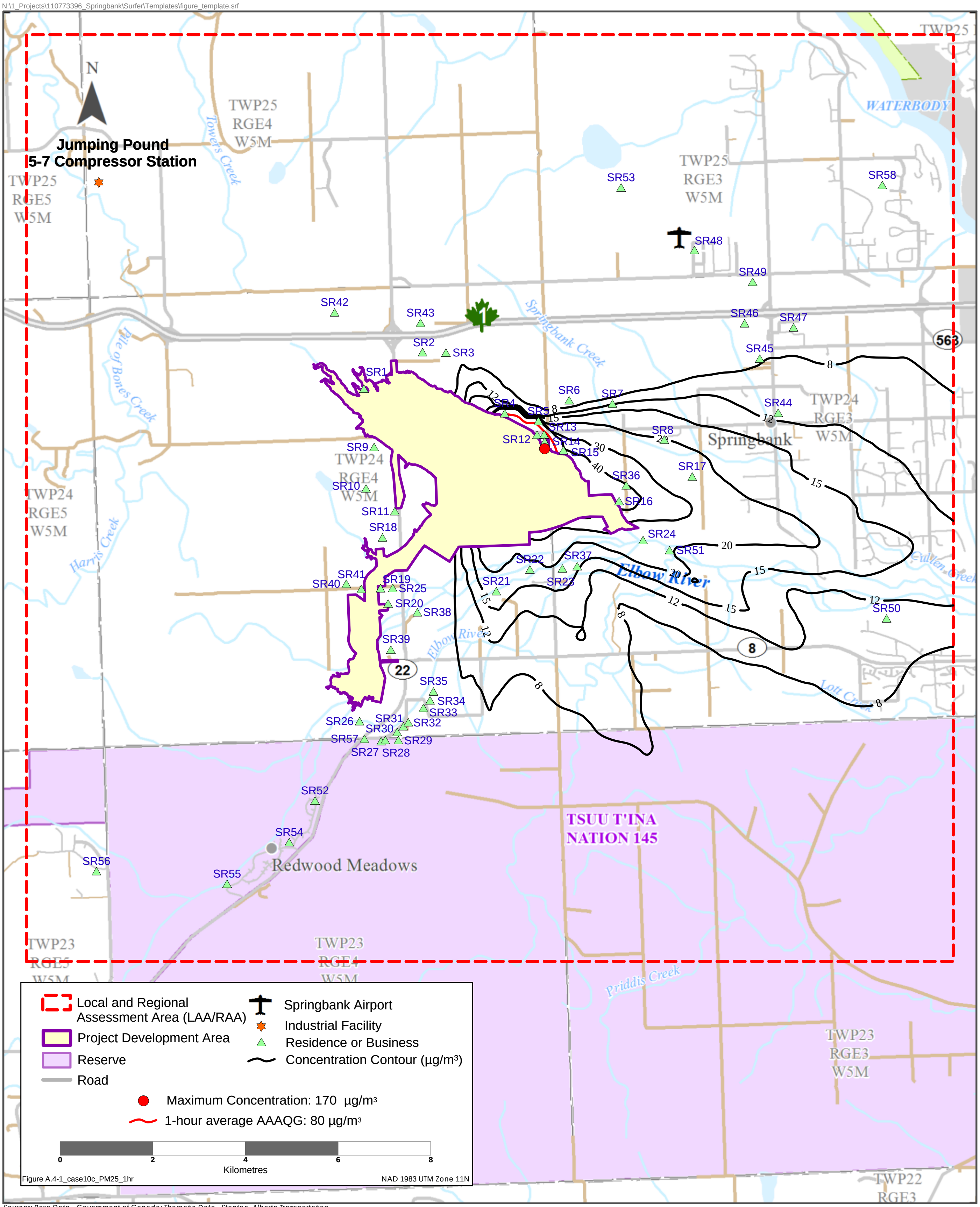
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration
(Case 3, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.3-20

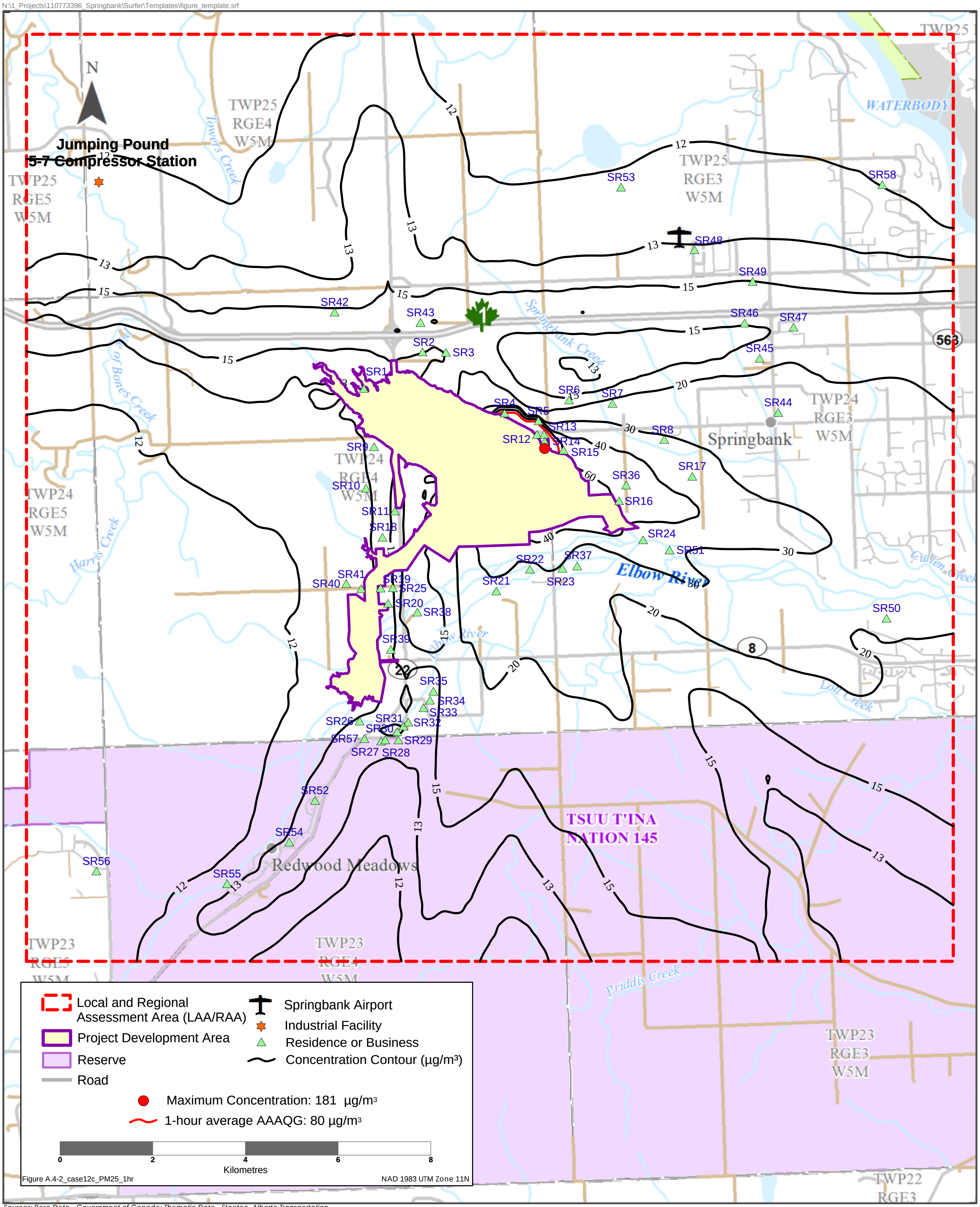


Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration
(Case 4, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-1



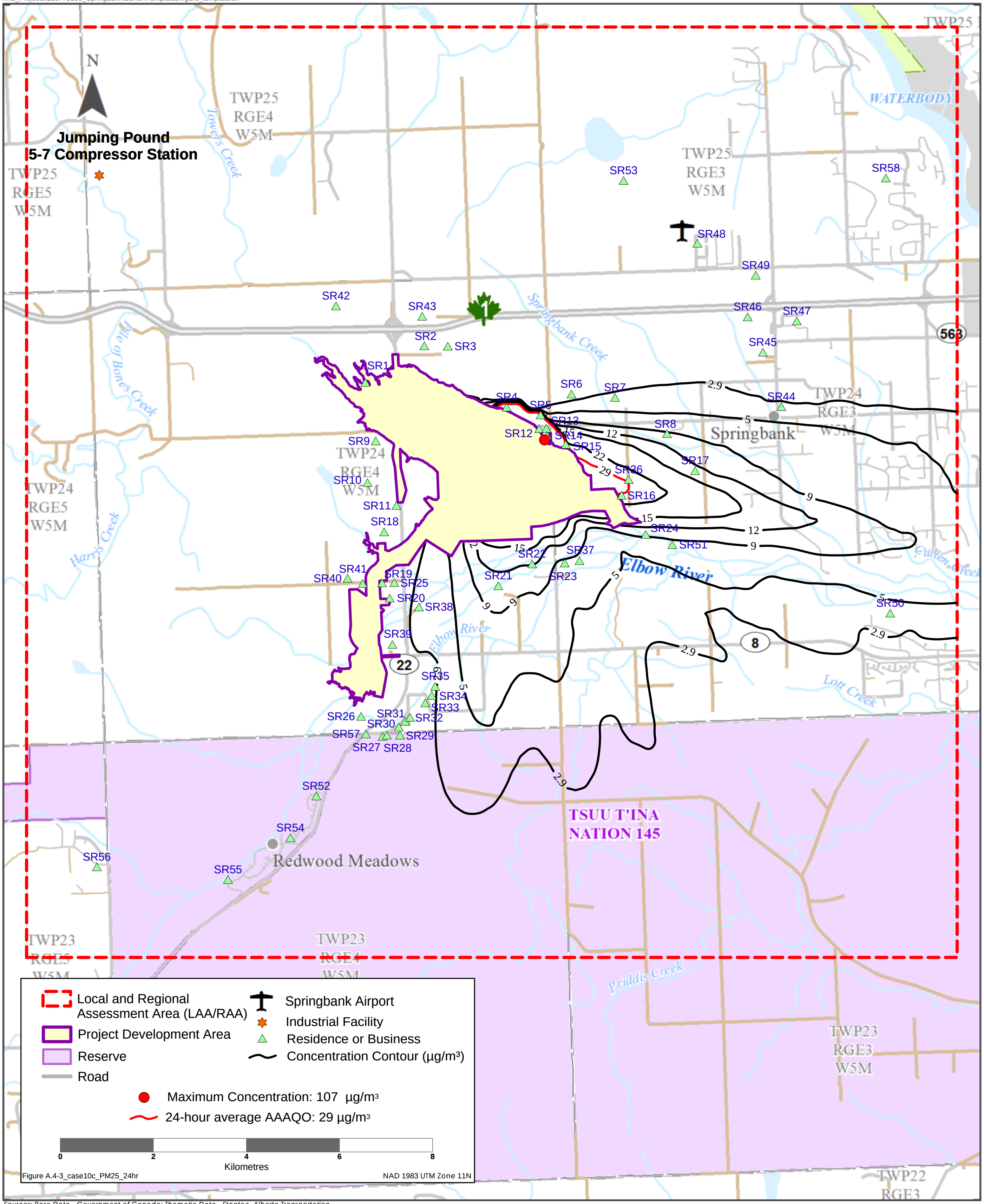
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

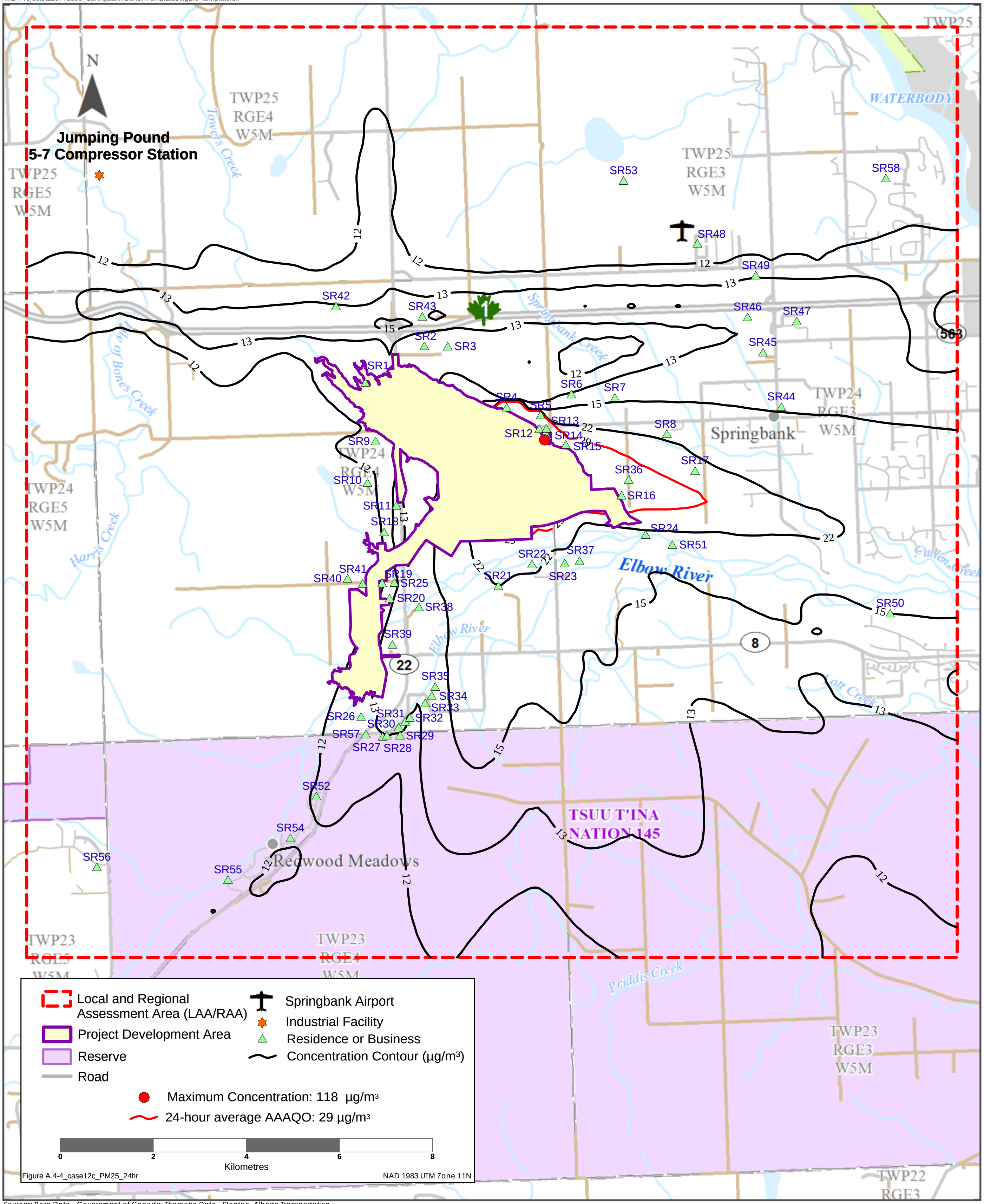
Figure A.4-2



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:100 Year Flood - Project Case)

Figure A.4-3



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

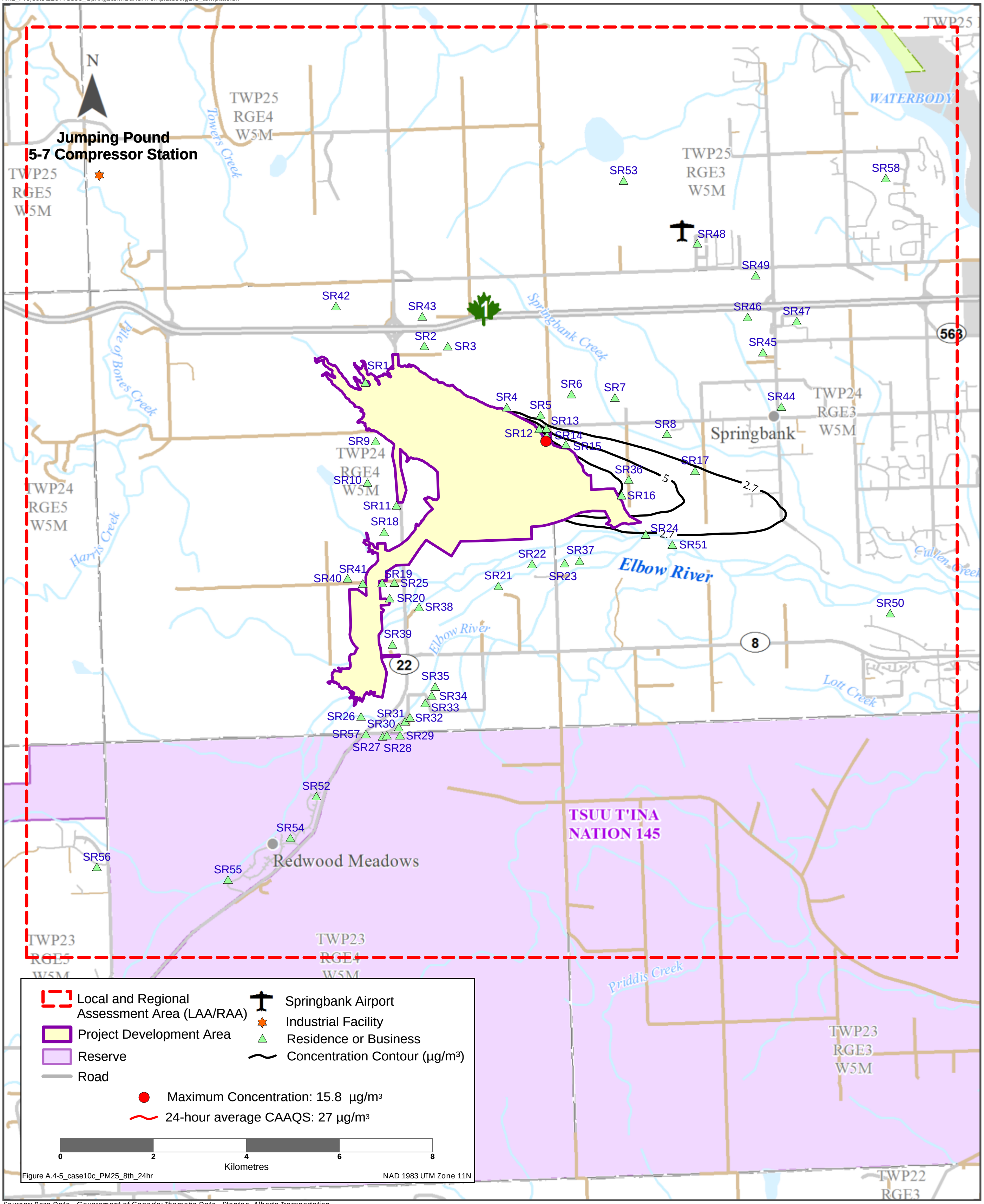
Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-4

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

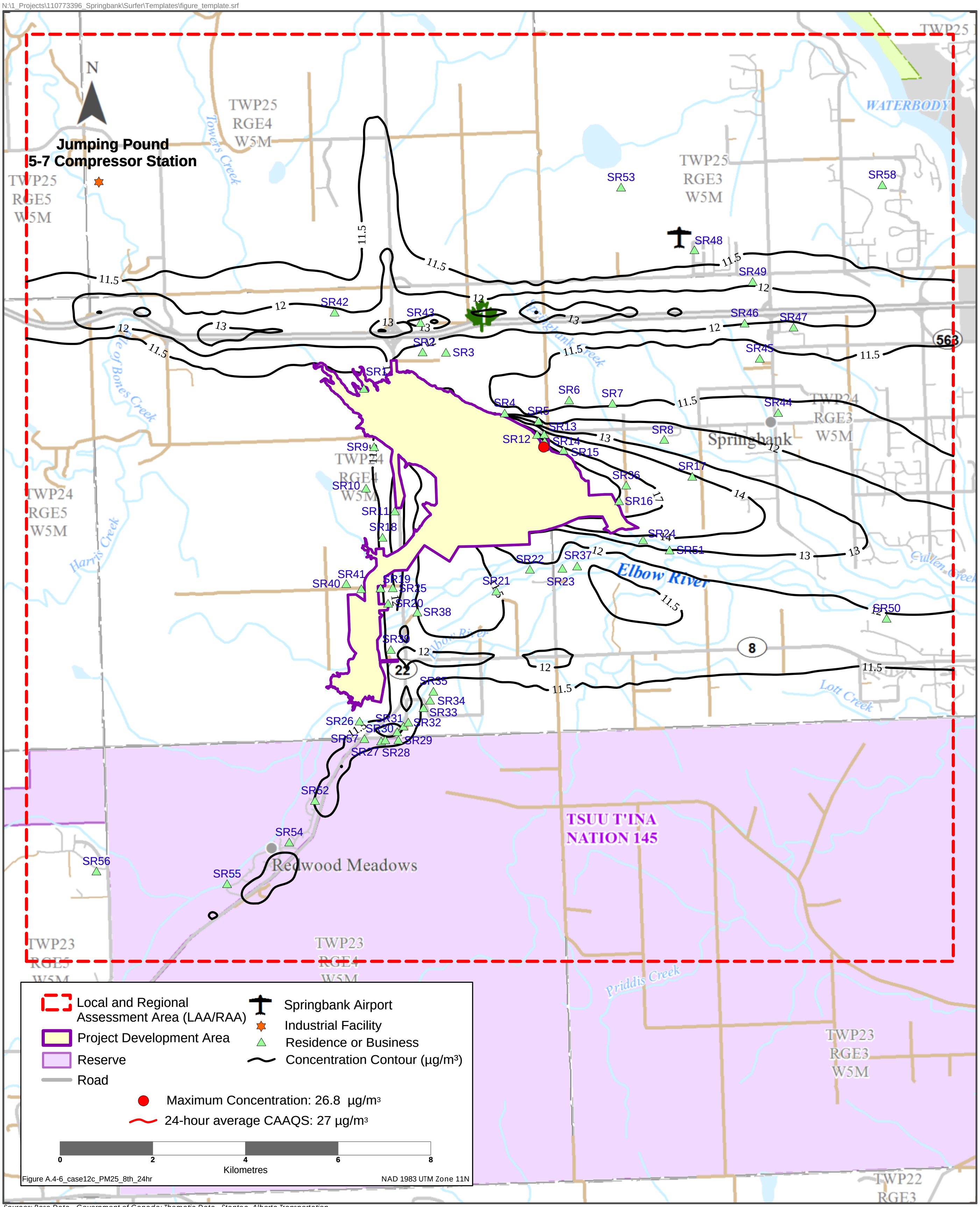
Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-5

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

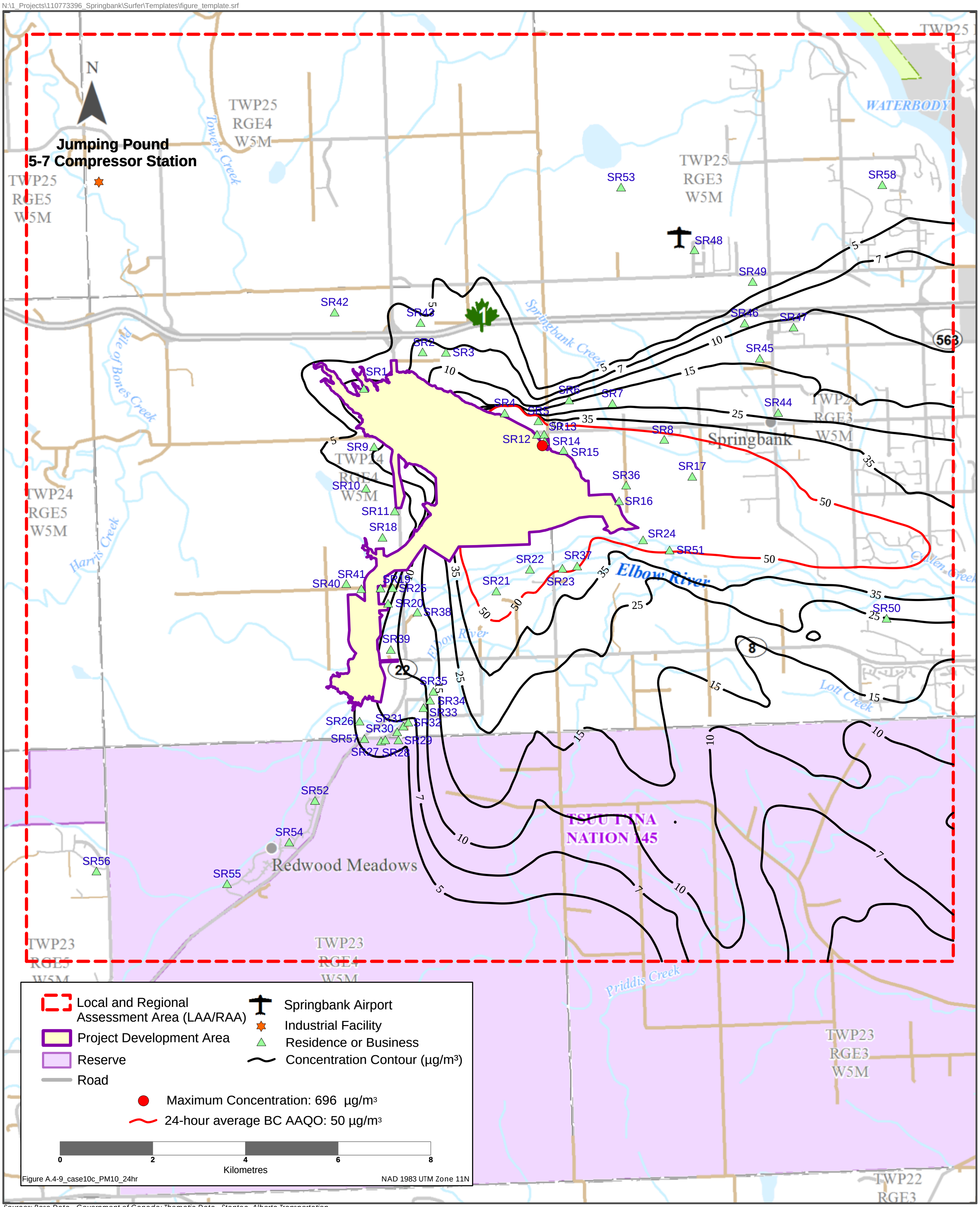
Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-6

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



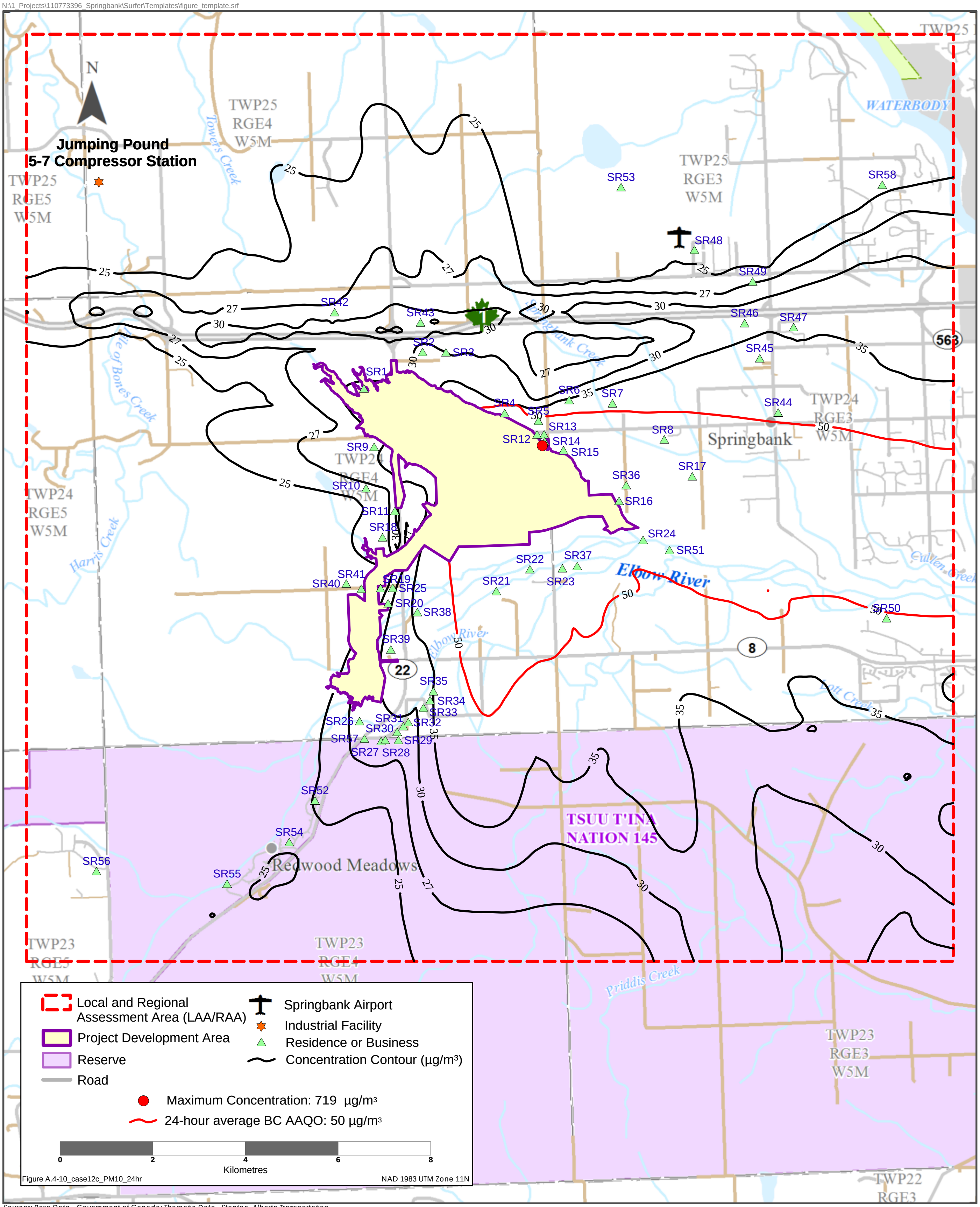
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 4, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

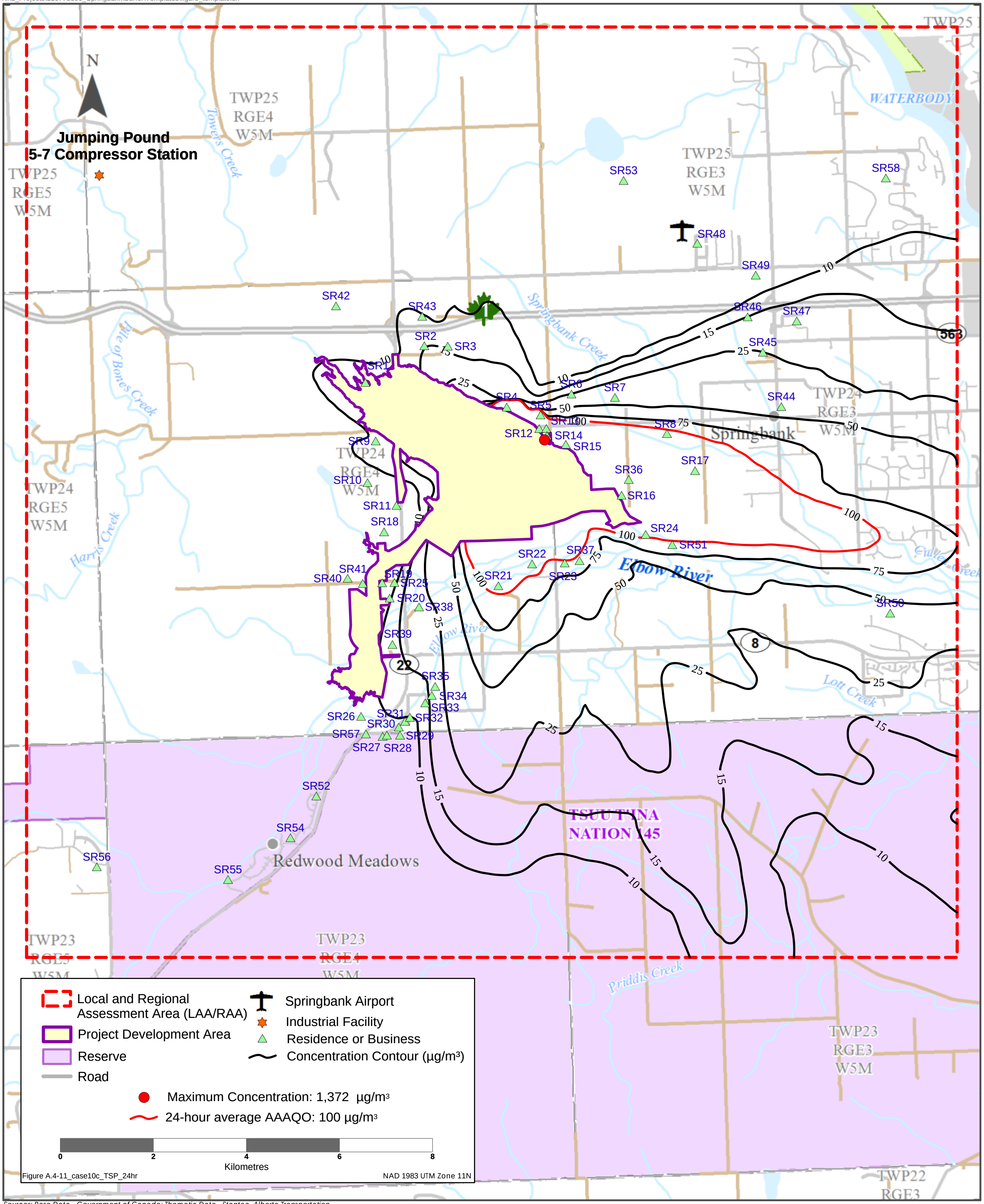
Figure A.4-7



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average PM_{10} Concentration (Case 4, Late Release, 1:100 Year Flood - Application Case)

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

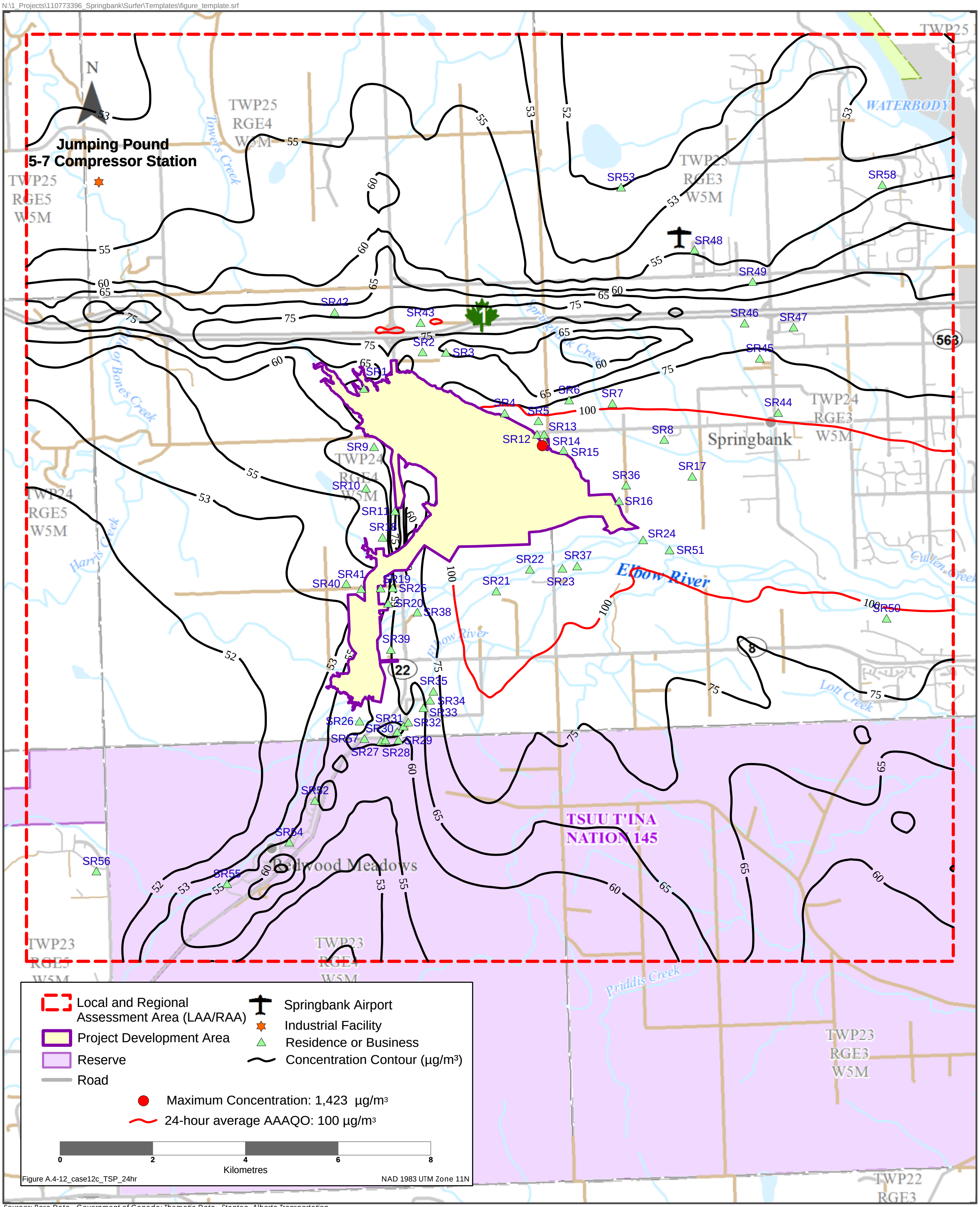
Maximum Predicted 24-hour average TSP Concentration (Case 4, Late Release, 1:100 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-9

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



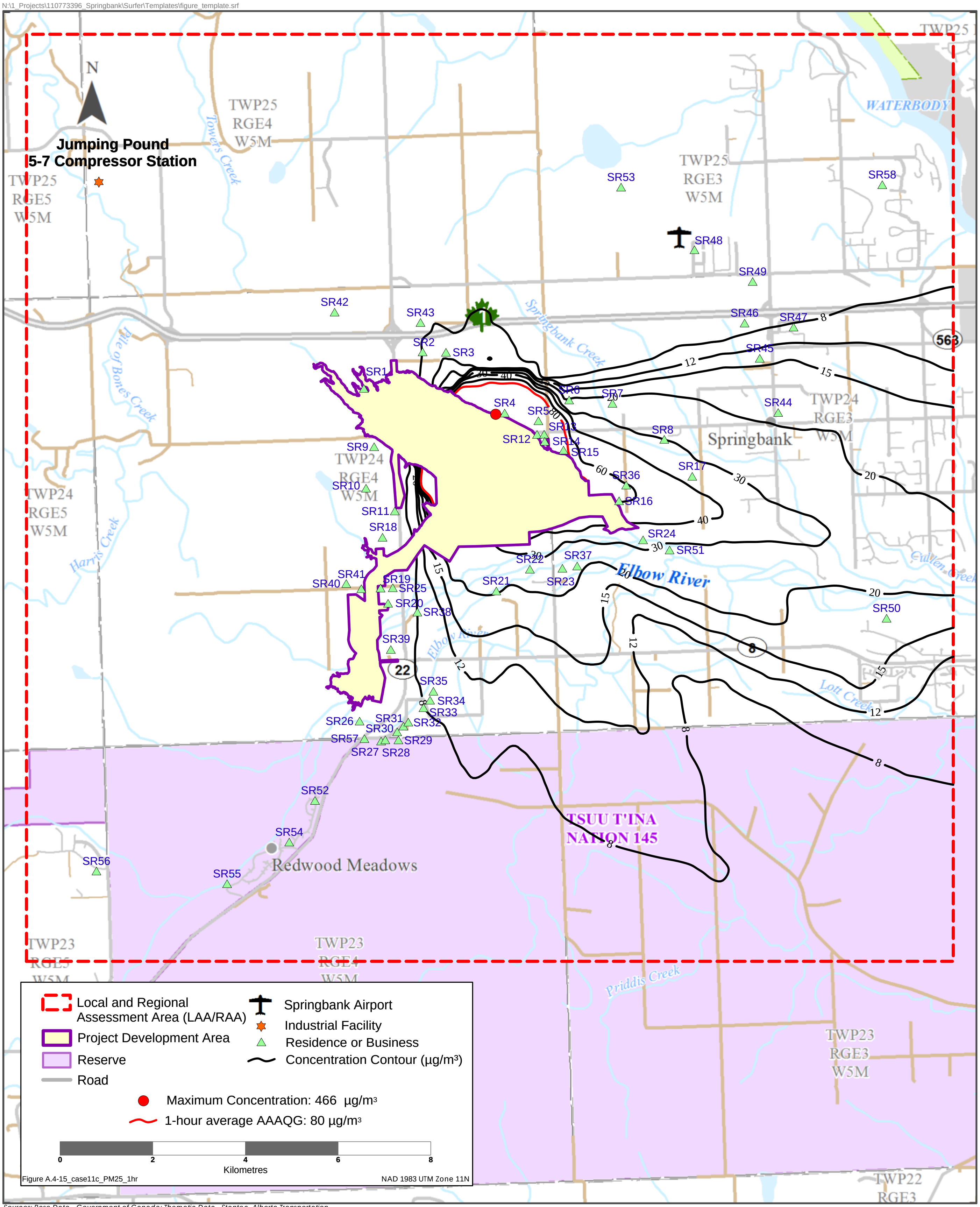
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 4, Late Release, 1:100 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-10



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

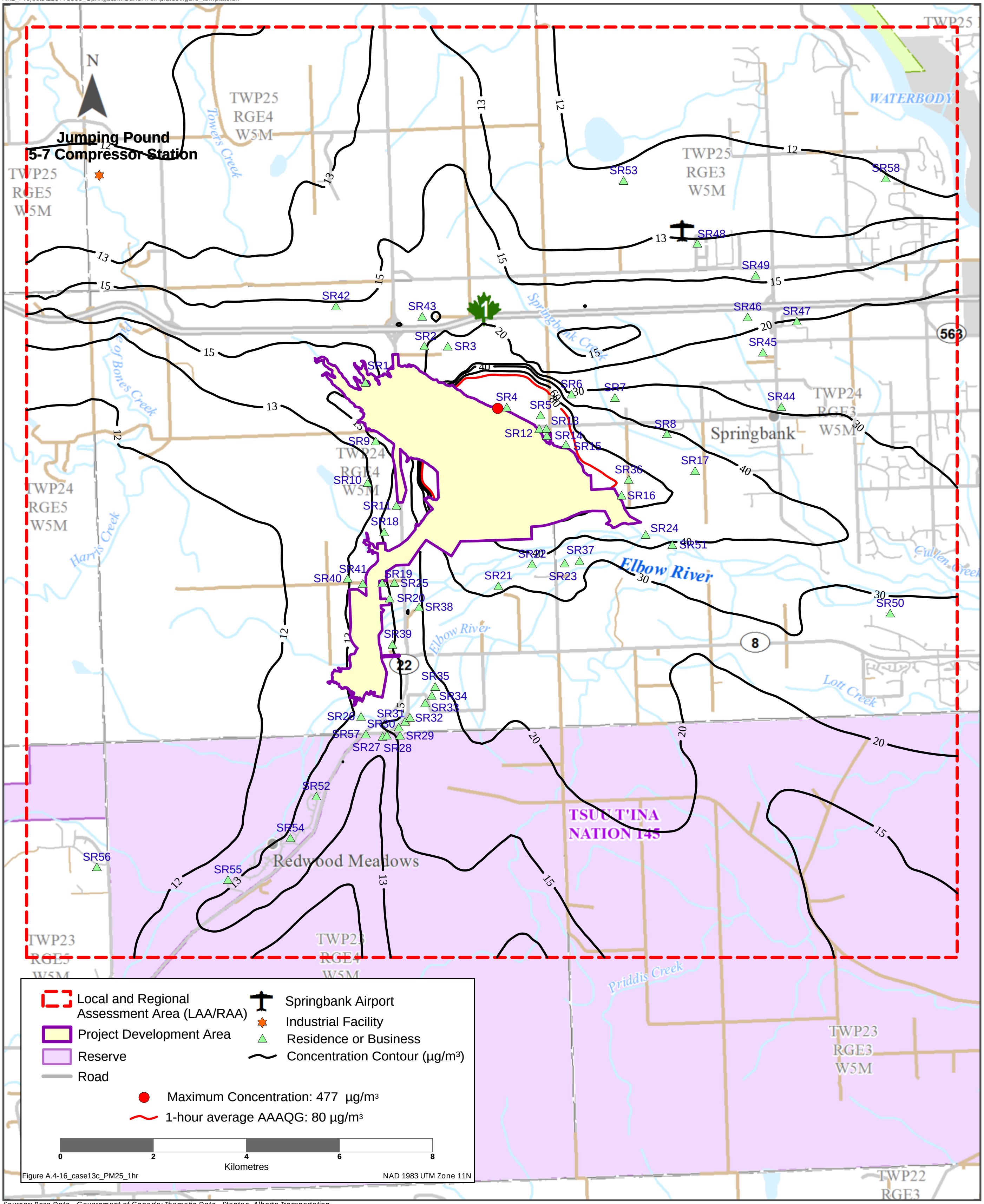
Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-11

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



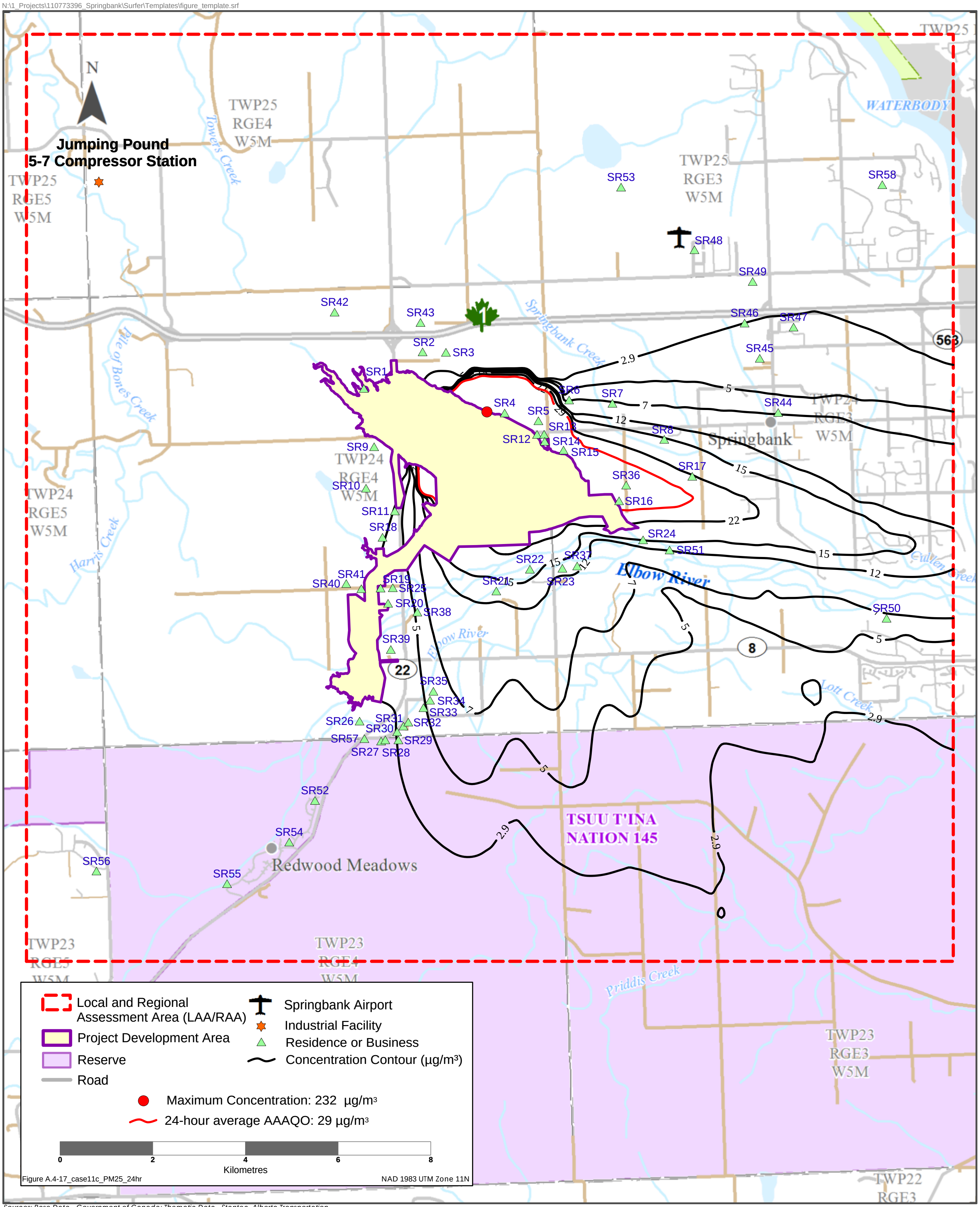
Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Predicted 9th Highest 1-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

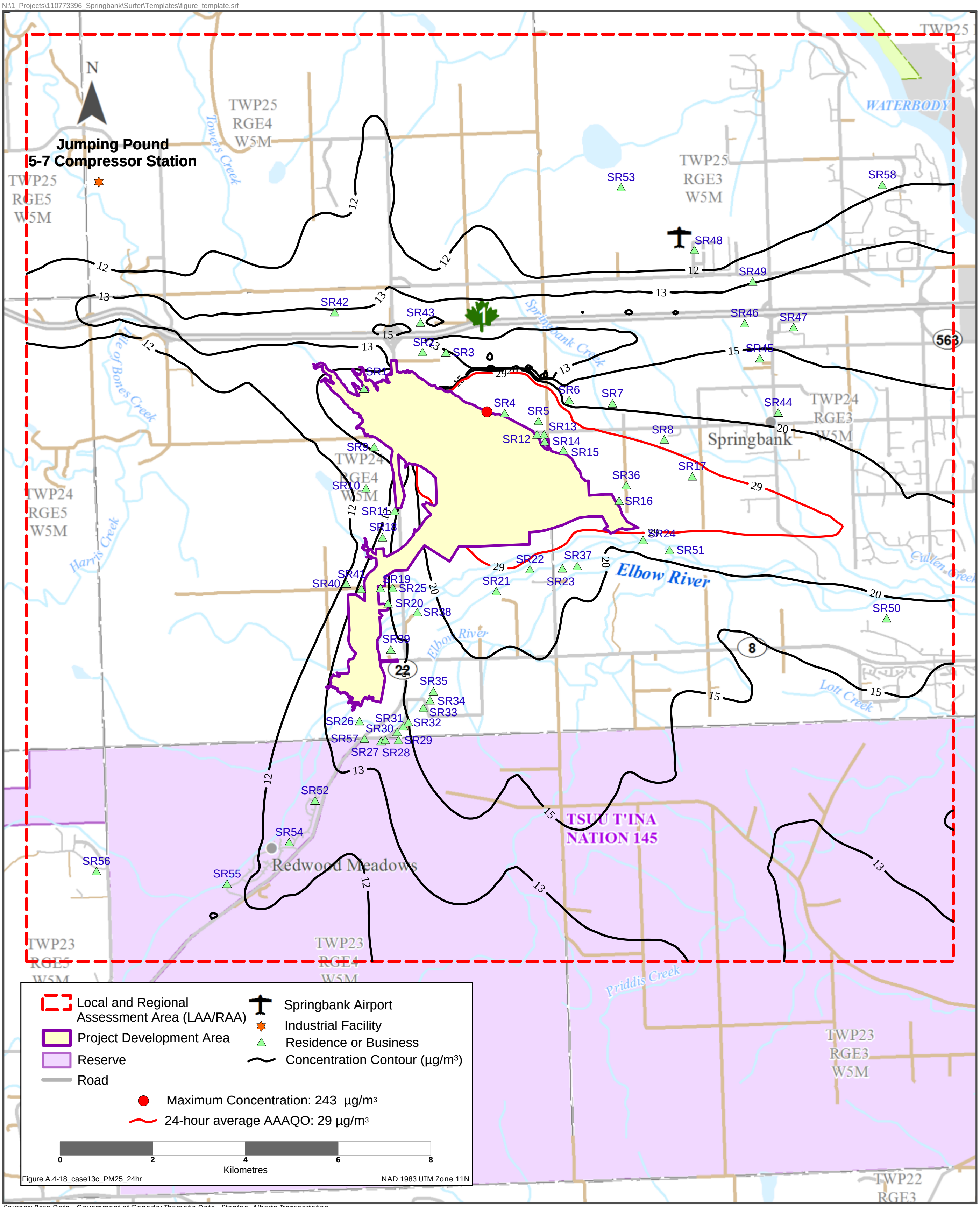
Figure A.4-12



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

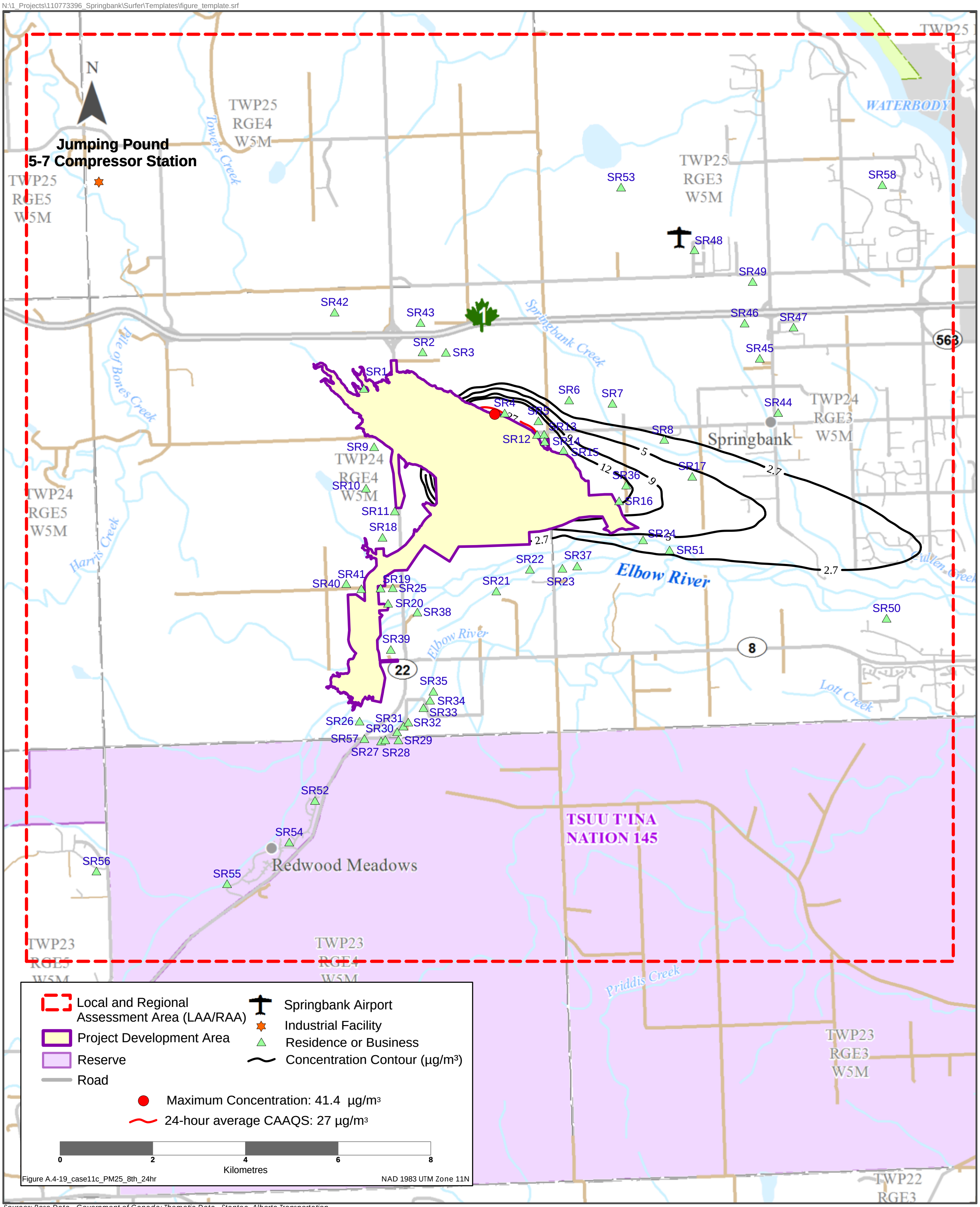
Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:200 Year Flood - Project Case)

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:200 Year Flood - Application Case)



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

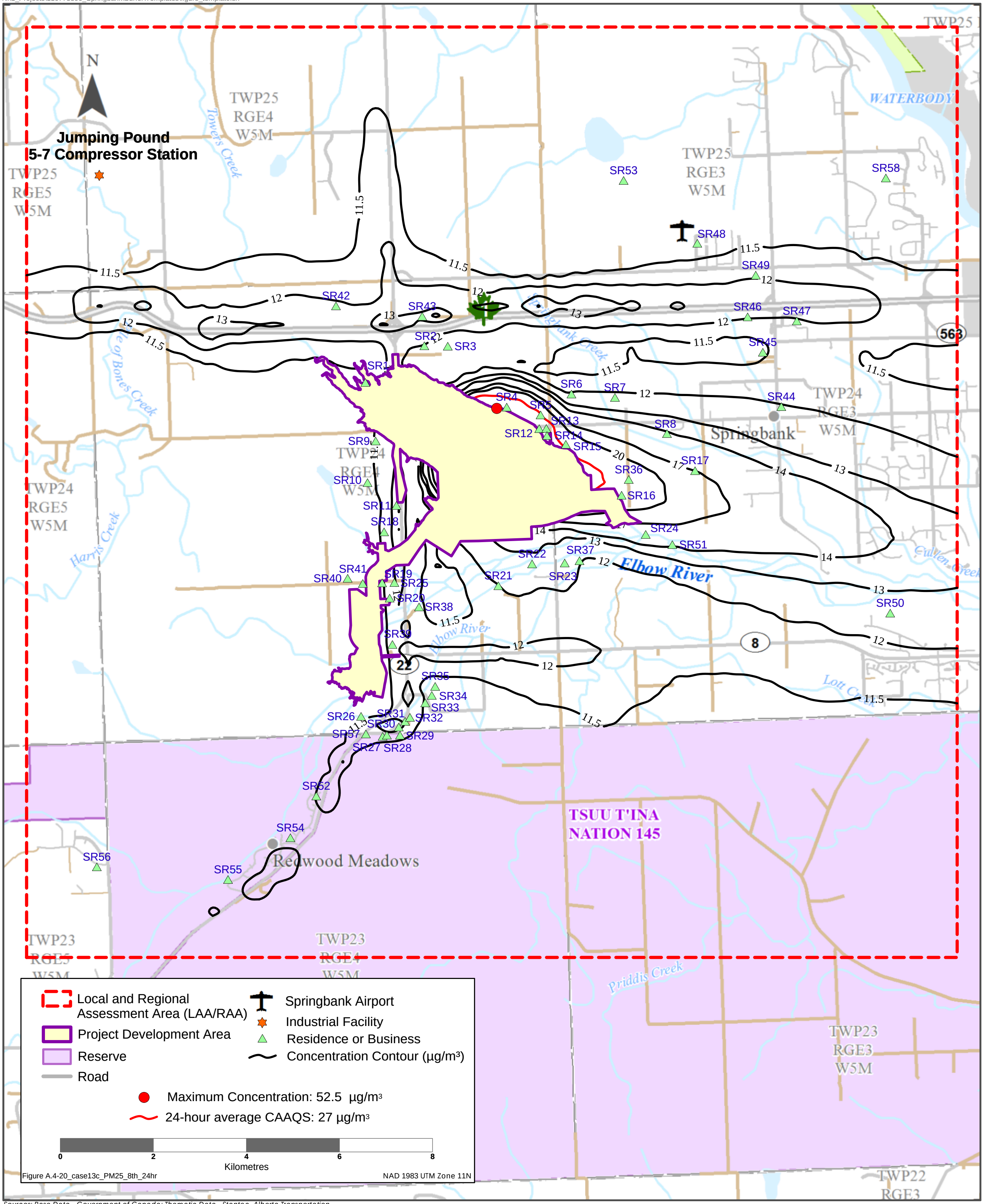
Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-15

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

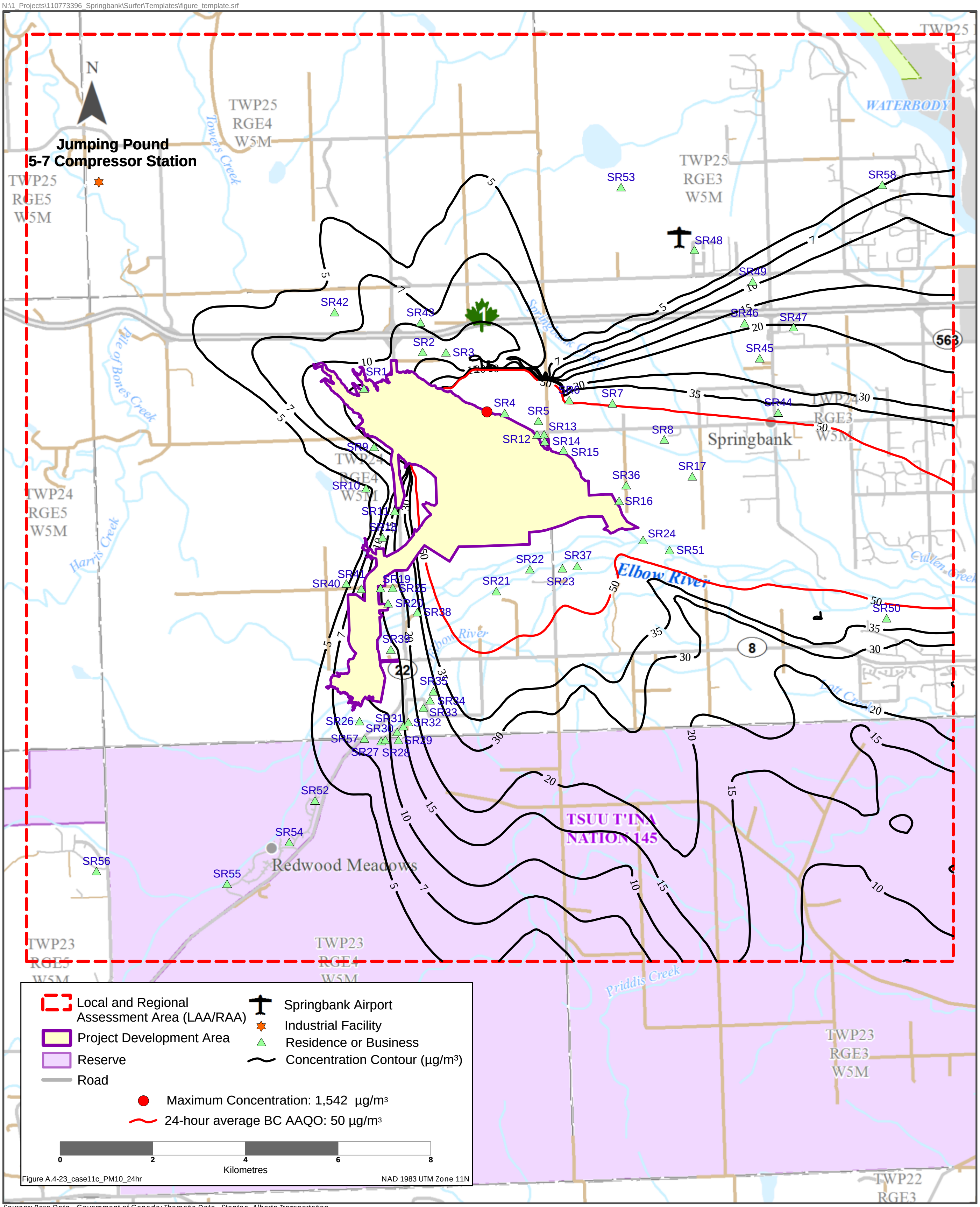
Predicted 8th Highest 24-hour average $PM_{2.5}$ Concentration (Case 4, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-16

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

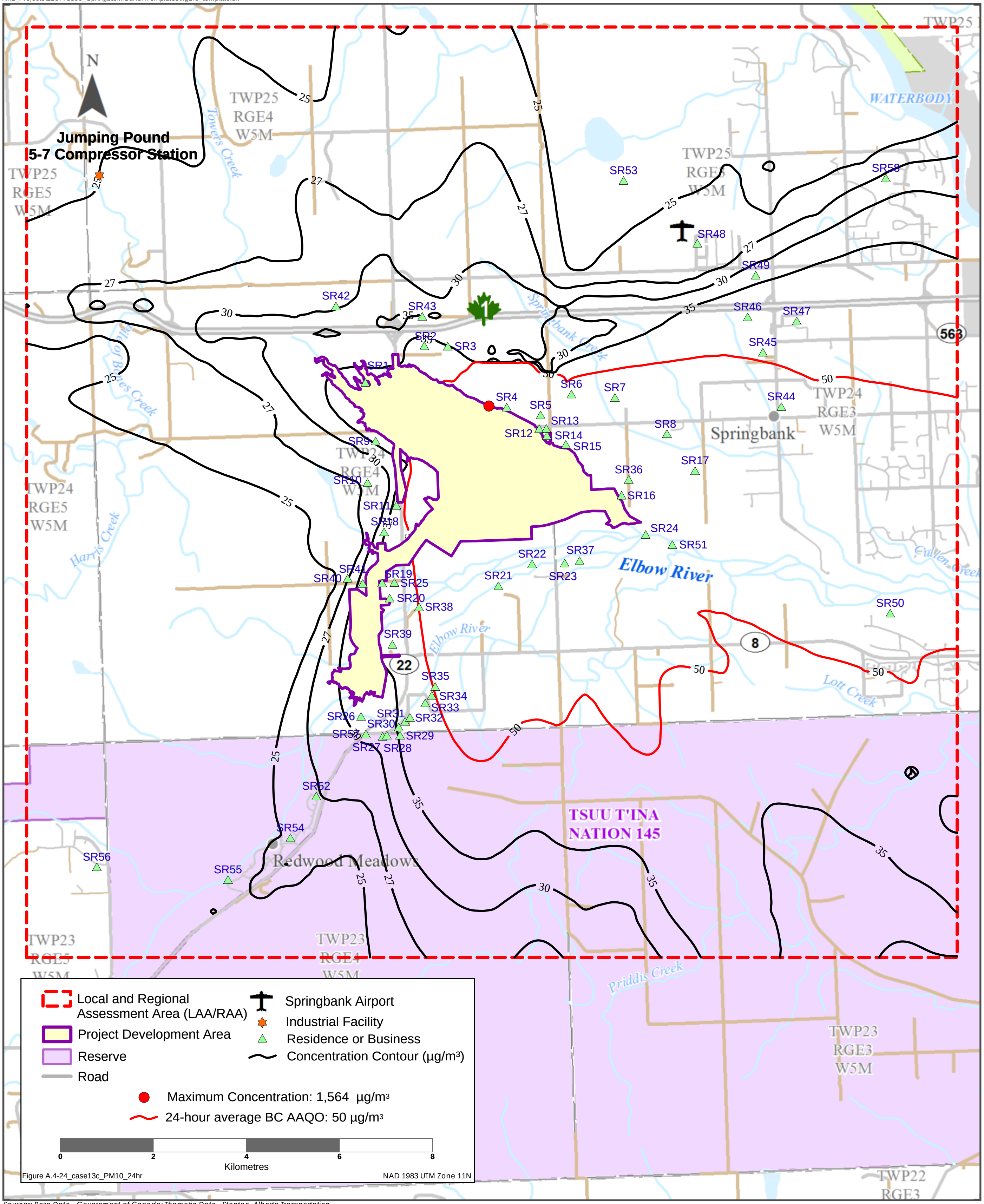
Maximum Predicted 24-hour average PM_{10} Concentration (Case 4, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-17

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

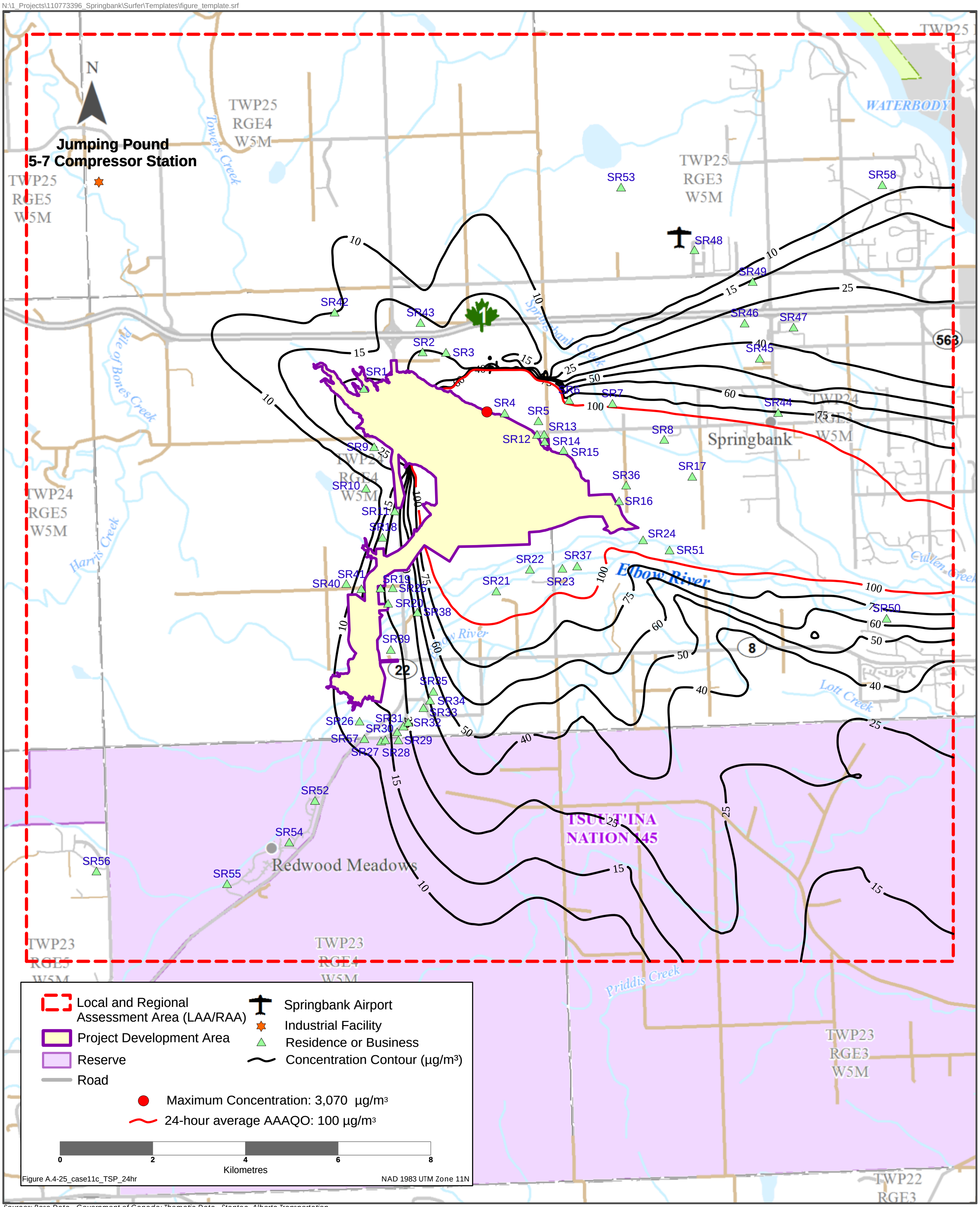
Maximum Predicted 24-hour average PM_{10} Concentration (Case 4, Late Release, 1:200 Year Flood - Application Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-18

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

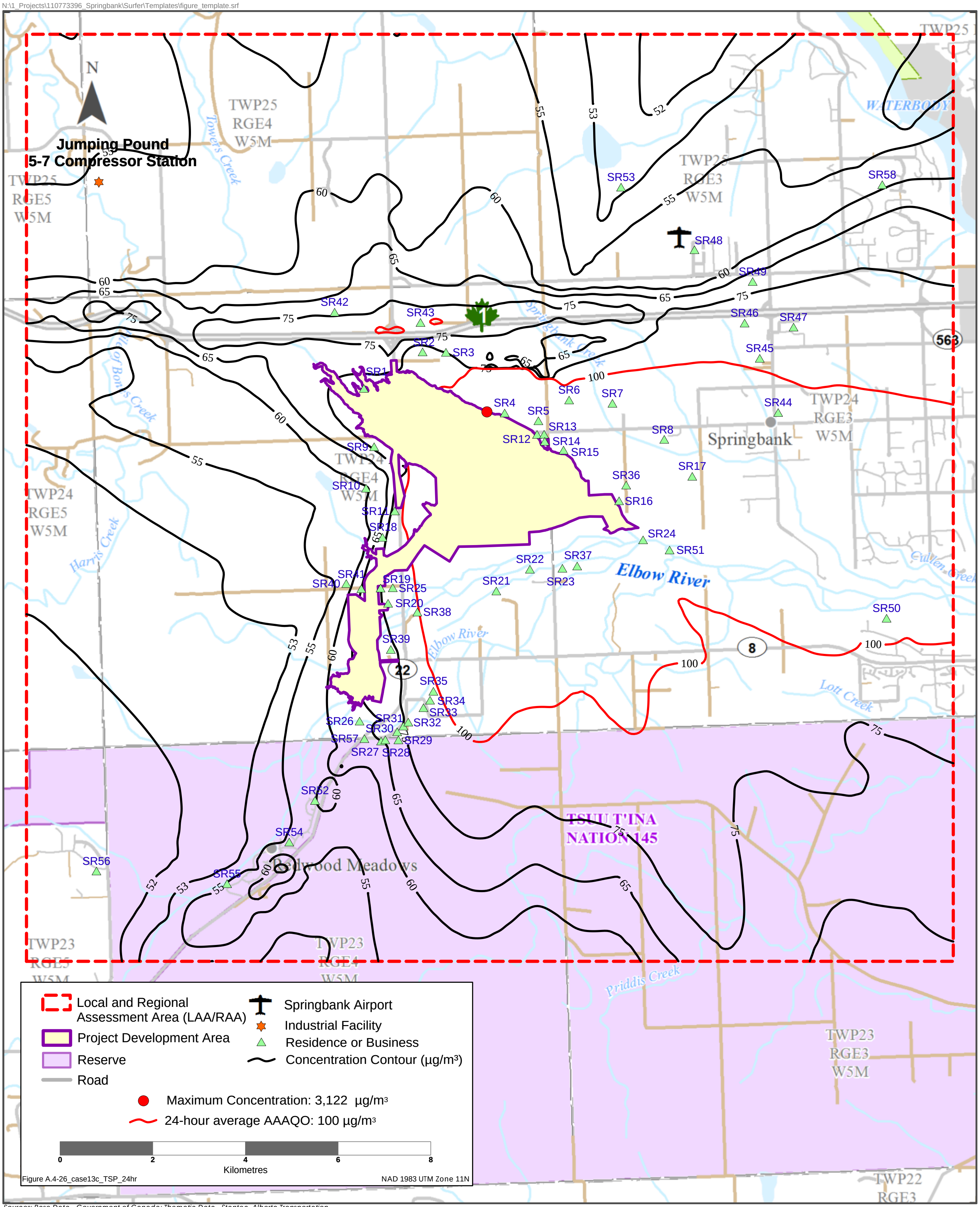
Maximum Predicted 24-hour average TSP Concentration (Case 4, Late Release, 1:200 Year Flood - Project Case)

Stantec

SPRINGBANK OFF-STREAM RESERVOIR PROJECT

Figure A.4-19

N:\1_Projects\110773396_Springbank\Surfer\Templates\figure_template.srf



Sources: Base Data - Government of Canada; Thematic Data - Stantec, Alberta Transportation

Maximum Predicted 24-hour average TSP Concentration (Case 4, Late Release, 1:200 Year Flood - Application Case)

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

ATTACHMENT B: HUMAN HEALTH RISK ASSESSMENT TABLES

Table 3-1 Exposure Ratios for 1-hour PM2.5 (Case 1)

Human Receptor Location	1-hour $PM_{2.5}$ (TRV = 80 µg/m^3)				
	Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	3.4E-01	1.7E-01	3.8E-01	3.4E-01	5.3E-01
SR01	1.7E-01	6.2E-04	9.8E-04	1.7E-01	1.7E-01
SR02	1.8E-01	2.2E-03	4.2E-03	1.9E-01	1.9E-01
SR03	1.8E-01	2.6E-03	4.9E-03	1.8E-01	1.8E-01
SR04	1.5E-01	1.2E-02	2.4E-02	1.7E-01	1.8E-01
SR05	1.6E-01	8.7E-03	1.1E-01	1.7E-01	2.7E-01
SR06	1.6E-01	2.3E-03	7.0E-03	1.6E-01	1.6E-01
SR07	1.6E-01	2.2E-03	1.3E-02	1.6E-01	1.7E-01
SR08	1.6E-01	1.6E-02	2.8E-02	1.7E-01	1.9E-01
SR09	1.7E-01	6.2E-04	1.2E-03	1.7E-01	1.7E-01
SR10	1.6E-01	1.0E-04	2.2E-04	1.6E-01	1.6E-01
SR11	2.1E-01	5.0E-05	9.0E-05	2.1E-01	2.1E-01
SR12	1.6E-01	1.7E-02	2.5E-01	1.7E-01	4.1E-01
SR13	1.6E-01	1.4E-02	2.2E-01	1.7E-01	3.9E-01
SR14	1.6E-01	1.1E-01	3.2E-01	2.6E-01	4.8E-01
SR15	1.6E-01	1.0E-01	2.5E-01	2.6E-01	4.1E-01
SR16	1.5E-01	5.2E-02	7.1E-02	2.0E-01	2.2E-01
SR17	1.5E-01	2.1E-02	3.3E-02	1.7E-01	1.9E-01
SR18	1.8E-01	1.6E-05	6.3E-05	1.8E-01	1.8E-01
SR19	1.7E-01	1.4E-05	1.0E-03	1.7E-01	1.7E-01
SR20	1.8E-01	7.2E-05	1.9E-03	1.8E-01	1.8E-01
SR21	1.6E-01	7.0E-03	1.7E-02	1.6E-01	1.7E-01
SR22	1.5E-01	1.6E-02	2.2E-02	1.7E-01	1.7E-01
SR23	1.5E-01	1.7E-02	2.3E-02	1.7E-01	1.7E-01
SR24	1.5E-01	2.9E-02	4.5E-02	1.8E-01	1.9E-01
SR25	1.9E-01	2.7E-05	1.6E-03	1.9E-01	1.9E-01
SR26	1.7E-01	4.9E-04	1.3E-03	1.7E-01	1.7E-01
SR27	1.8E-01	9.0E-04	1.6E-03	1.8E-01	1.8E-01
SR28	1.8E-01	9.0E-04	1.6E-03	1.8E-01	1.8E-01
SR29	1.8E-01	1.1E-03	1.7E-03	1.8E-01	1.8E-01
SR30	2.1E-01	1.1E-03	1.9E-03	2.1E-01	2.1E-01
SR31	2.1E-01	1.1E-03	1.9E-03	2.1E-01	2.1E-01
SR32	1.9E-01	1.4E-03	2.1E-03	1.9E-01	1.9E-01
SR33	1.7E-01	1.7E-03	2.4E-03	1.7E-01	1.7E-01
SR34	1.7E-01	1.9E-03	2.6E-03	1.7E-01	1.7E-01
SR35	1.7E-01	1.9E-03	2.6E-03	1.7E-01	1.7E-01
SR36	1.5E-01	4.0E-02	6.4E-02	1.9E-01	2.2E-01
SR37	1.5E-01	1.8E-02	2.2E-02	1.7E-01	1.7E-01
SR38	1.8E-01	6.7E-04	2.8E-03	1.8E-01	1.8E-01
SR39	1.9E-01	6.5E-04	1.9E-03	1.9E-01	1.9E-01
SR40	1.6E-01	8.0E-06	2.6E-05	1.6E-01	1.6E-01
SR41	1.6E-01	9.1E-06	1.7E-04	1.6E-01	1.6E-01
SR42	2.0E-01	5.6E-04	1.3E-03	2.0E-01	2.0E-01
SR43	2.6E-01	1.9E-03	3.6E-03	2.6E-01	2.6E-01
SR44	1.7E-01	9.1E-03	1.7E-02	1.7E-01	1.8E-01
SR45	1.6E-01	1.8E-03	5.7E-03	1.6E-01	1.6E-01
SR46	1.7E-01	4.0E-04	2.8E-03	1.7E-01	1.8E-01
SR47	1.8E-01	6.4E-04	3.1E-03	1.8E-01	1.8E-01
SR48	1.7E-01	1.7E-04	9.2E-04	1.7E-01	1.7E-01
SR49	1.9E-01	3.0E-04	9.1E-04	1.9E-01	1.9E-01
SR50	1.5E-01	1.2E-02	1.9E-02	1.6E-01	1.7E-01
SR51	1.5E-01	2.3E-02	3.5E-02	1.7E-01	1.8E-01
SR52	1.7E-01	2.0E-04	4.9E-04	1.7E-01	1.7E-01
SR53	1.6E-01	3.2E-05	1.7E-04	1.6E-01	1.6E-01
SR54	1.7E-01	1.7E-04	3.7E-04	1.7E-01	1.7E-01
SR55	1.7E-01	9.1E-05	3.0E-04	1.7E-01	1.7E-01
SR56	1.5E-01	9.0E-06	1.5E-05	1.5E-01	1.5E-01
SR57	1.9E-01	5.4E-04	1.2E-03	1.9E-01	1.9E-01
SR58	1.5E-01	5.8E-05	1.7E-04	1.5E-01	1.5E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-2 Exposure Ratios for 24-hour PM2.5 (Case 1)

Human Receptor Location	24-hour $PM_{2.5}$ (TRV = 27 µg/m^3) Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	6.8E-01	4.9E-02	1.2E-01	6.8E-01	6.8E-01
SR01	4.4E-01	6.9E-06	2.1E-05	4.4E-01	4.4E-01
SR02	4.5E-01	5.3E-05	2.6E-04	4.5E-01	4.5E-01
SR03	4.4E-01	1.6E-04	5.5E-04	4.4E-01	4.4E-01
SR04	4.3E-01	1.0E-03	1.8E-03	4.3E-01	4.3E-01
SR05	4.4E-01	2.8E-04	7.7E-03	4.4E-01	4.4E-01
SR06	4.4E-01	1.0E-04	2.8E-04	4.4E-01	4.4E-01
SR07	4.3E-01	4.9E-05	6.8E-04	4.3E-01	4.3E-01
SR08	4.4E-01	2.0E-03	4.9E-03	4.4E-01	4.4E-01
SR09	4.4E-01	4.7E-07	9.0E-07	4.4E-01	4.4E-01
SR10	4.3E-01	4.9E-07	9.2E-07	4.3E-01	4.3E-01
SR11	4.9E-01	4.6E-07	8.7E-07	4.9E-01	4.9E-01
SR12	4.3E-01	8.9E-04	6.2E-02	4.3E-01	4.9E-01
SR13	4.3E-01	8.8E-04	4.5E-02	4.3E-01	4.8E-01
SR14	4.3E-01	3.5E-03	9.2E-02	4.3E-01	5.2E-01
SR15	4.3E-01	1.2E-02	7.1E-02	4.4E-01	5.0E-01
SR16	4.2E-01	3.1E-02	4.2E-02	4.5E-01	4.6E-01
SR17	4.2E-01	6.5E-03	1.3E-02	4.3E-01	4.4E-01
SR18	4.4E-01	1.9E-07	6.6E-07	4.4E-01	4.4E-01
SR19	4.4E-01	6.8E-09	8.7E-07	4.4E-01	4.4E-01
SR20	4.5E-01	4.7E-08	8.5E-07	4.5E-01	4.5E-01
SR21	4.2E-01	1.7E-04	9.0E-04	4.2E-01	4.3E-01
SR22	4.2E-01	1.4E-03	2.6E-03	4.2E-01	4.2E-01
SR23	4.2E-01	2.1E-03	3.3E-03	4.2E-01	4.2E-01
SR24	4.2E-01	6.4E-03	1.1E-02	4.3E-01	4.3E-01
SR25	4.6E-01	1.2E-08	8.5E-07	4.6E-01	4.6E-01
SR26	4.3E-01	4.6E-07	8.2E-07	4.3E-01	4.3E-01
SR27	4.4E-01	1.6E-07	1.6E-06	4.4E-01	4.4E-01
SR28	4.4E-01	1.6E-07	1.6E-06	4.4E-01	4.4E-01
SR29	4.4E-01	1.4E-07	5.7E-06	4.4E-01	4.4E-01
SR30	4.8E-01	1.6E-07	4.2E-06	4.8E-01	4.8E-01
SR31	4.8E-01	1.6E-07	4.2E-06	4.8E-01	4.8E-01
SR32	4.6E-01	2.4E-07	1.3E-05	4.6E-01	4.6E-01
SR33	4.4E-01	5.6E-07	2.3E-05	4.4E-01	4.4E-01
SR34	4.3E-01	1.4E-06	4.2E-05	4.3E-01	4.3E-01
SR35	4.3E-01	1.4E-06	4.2E-05	4.3E-01	4.3E-01
SR36	4.2E-01	2.2E-02	3.8E-02	4.4E-01	4.6E-01
SR37	4.2E-01	2.5E-03	3.5E-03	4.2E-01	4.2E-01
SR38	4.4E-01	4.2E-07	9.8E-07	4.4E-01	4.4E-01
SR39	4.5E-01	4.6E-07	8.5E-07	4.5E-01	4.5E-01
SR40	4.3E-01	3.7E-09	2.1E-08	4.3E-01	4.3E-01
SR41	4.3E-01	3.1E-09	2.2E-07	4.3E-01	4.3E-01
SR42	4.7E-01	4.9E-06	1.9E-05	4.7E-01	4.7E-01
SR43	5.6E-01	7.9E-05	2.4E-04	5.6E-01	5.6E-01
SR44	4.5E-01	1.1E-03	2.5E-03	4.5E-01	4.5E-01
SR45	4.3E-01	3.6E-05	2.3E-04	4.3E-01	4.3E-01
SR46	4.4E-01	6.2E-06	5.1E-05	4.4E-01	4.4E-01
SR47	4.4E-01	1.4E-05	8.1E-05	4.4E-01	4.4E-01
SR48	4.4E-01	4.1E-06	1.1E-05	4.4E-01	4.4E-01
SR49	4.6E-01	3.8E-06	7.8E-06	4.6E-01	4.6E-01
SR50	4.2E-01	3.1E-03	5.1E-03	4.2E-01	4.2E-01
SR51	4.2E-01	6.3E-03	1.0E-02	4.2E-01	4.3E-01
SR52	4.3E-01	3.2E-08	5.5E-07	4.3E-01	4.3E-01
SR53	4.3E-01	1.4E-06	8.1E-06	4.3E-01	4.3E-01
SR54	4.2E-01	4.3E-09	1.4E-07	4.2E-01	4.2E-01
SR55	4.3E-01	3.8E-09	1.8E-08	4.3E-01	4.3E-01
SR56	4.1E-01	3.5E-10	1.2E-08	4.1E-01	4.1E-01
SR57	4.5E-01	4.5E-07	7.2E-07	4.5E-01	4.5E-01
SR58	4.1E-01	4.3E-08	1.3E-06	4.1E-01	4.1E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-3 Exposure Ratios for 1-hour PM2.5 (Case 2)

Human Receptor Location	1-hour $PM_{2.5}$ (TRV = 80 µg/m^3)				
	Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	3.4E-01	1.2E+00	2.8E+00	1.4E+00	2.9E+00
SR01	1.7E-01	4.8E-03	7.6E-03	1.6E-01	1.6E-01
SR02	1.8E-01	1.7E-02	3.2E-02	1.8E-01	1.8E-01
SR03	1.8E-01	2.0E-02	3.8E-02	1.7E-01	1.8E-01
SR04	1.5E-01	9.2E-02	1.8E-01	2.3E-01	3.2E-01
SR05	1.6E-01	6.6E-02	8.2E-01	2.0E-01	9.6E-01
SR06	1.6E-01	1.7E-02	5.2E-02	1.6E-01	1.9E-01
SR07	1.6E-01	1.6E-02	1.0E-01	1.6E-01	2.4E-01
SR08	1.6E-01	1.2E-01	2.0E-01	2.6E-01	3.4E-01
SR09	1.7E-01	4.6E-03	9.1E-03	1.7E-01	1.7E-01
SR10	1.6E-01	7.7E-04	1.7E-03	1.6E-01	1.6E-01
SR11	2.1E-01	3.4E-04	6.1E-04	2.0E-01	2.0E-01
SR12	1.6E-01	1.3E-01	1.8E+00	2.7E-01	1.9E+00
SR13	1.6E-01	1.1E-01	1.6E+00	2.4E-01	1.7E+00
SR14	1.6E-01	7.8E-01	2.3E+00	9.2E-01	2.5E+00
SR15	1.6E-01	7.7E-01	1.8E+00	9.1E-01	1.9E+00
SR16	1.5E-01	3.7E-01	5.1E-01	5.1E-01	6.5E-01
SR17	1.5E-01	1.5E-01	2.5E-01	2.9E-01	3.8E-01
SR18	1.8E-01	1.1E-04	4.9E-04	1.7E-01	1.7E-01
SR19	1.7E-01	1.1E-04	8.0E-03	1.7E-01	1.7E-01
SR20	1.8E-01	5.3E-04	1.5E-02	1.7E-01	1.7E-01
SR21	1.6E-01	5.2E-02	1.3E-01	1.9E-01	2.7E-01
SR22	1.5E-01	1.2E-01	1.6E-01	2.6E-01	3.0E-01
SR23	1.5E-01	1.2E-01	1.7E-01	2.6E-01	3.1E-01
SR24	1.5E-01	2.3E-01	3.5E-01	3.7E-01	4.9E-01
SR25	1.9E-01	2.0E-04	1.1E-02	1.8E-01	1.8E-01
SR26	1.7E-01	3.8E-03	1.0E-02	1.7E-01	1.7E-01
SR27	1.8E-01	6.7E-03	1.2E-02	1.8E-01	1.8E-01
SR28	1.8E-01	6.7E-03	1.2E-02	1.8E-01	1.8E-01
SR29	1.8E-01	8.2E-03	1.2E-02	1.7E-01	1.7E-01
SR30	2.1E-01	8.2E-03	1.4E-02	2.0E-01	2.0E-01
SR31	2.1E-01	8.2E-03	1.4E-02	2.0E-01	2.0E-01
SR32	1.9E-01	1.1E-02	1.6E-02	1.8E-01	1.8E-01
SR33	1.7E-01	1.2E-02	1.7E-02	1.7E-01	1.7E-01
SR34	1.7E-01	1.4E-02	1.9E-02	1.6E-01	1.6E-01
SR35	1.7E-01	1.4E-02	1.9E-02	1.6E-01	1.6E-01
SR36	1.5E-01	2.8E-01	4.6E-01	4.2E-01	6.0E-01
SR37	1.5E-01	1.4E-01	1.7E-01	2.8E-01	3.1E-01
SR38	1.8E-01	5.0E-03	2.1E-02	1.7E-01	1.7E-01
SR39	1.9E-01	4.7E-03	1.5E-02	1.8E-01	1.8E-01
SR40	1.6E-01	6.2E-05	2.0E-04	1.5E-01	1.5E-01
SR41	1.6E-01	7.0E-05	1.3E-03	1.6E-01	1.6E-01
SR42	2.0E-01	4.3E-03	1.0E-02	2.0E-01	2.0E-01
SR43	2.6E-01	1.5E-02	2.8E-02	2.5E-01	2.5E-01
SR44	1.7E-01	7.0E-02	1.3E-01	2.1E-01	2.7E-01
SR45	1.6E-01	1.4E-02	4.2E-02	1.6E-01	1.8E-01
SR46	1.7E-01	2.9E-03	2.1E-02	1.7E-01	1.7E-01
SR47	1.8E-01	4.9E-03	2.4E-02	1.7E-01	1.8E-01
SR48	1.7E-01	1.3E-03	6.9E-03	1.7E-01	1.7E-01
SR49	1.9E-01	2.3E-03	7.0E-03	1.9E-01	1.9E-01
SR50	1.5E-01	8.9E-02	1.4E-01	2.3E-01	2.8E-01
SR51	1.5E-01	1.8E-01	2.7E-01	3.1E-01	4.0E-01
SR52	1.7E-01	1.6E-03	3.8E-03	1.7E-01	1.7E-01
SR53	1.6E-01	2.4E-04	1.3E-03	1.6E-01	1.6E-01
SR54	1.7E-01	1.3E-03	2.8E-03	1.6E-01	1.6E-01
SR55	1.7E-01	6.8E-04	2.3E-03	1.7E-01	1.7E-01
SR56	1.5E-01	6.6E-05	1.1E-04	1.4E-01	1.4E-01
SR57	1.9E-01	4.2E-03	8.9E-03	1.8E-01	1.8E-01
SR58	1.5E-01	4.3E-04	1.3E-03	1.4E-01	1.4E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-4 Exposure Ratios for 24-hour PM2.5 (Case 2)

Human Receptor Location	24-hour $PM_{2.5}$ (TRV = 27 µg/m^3)				
	Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	6.8E-01	3.7E-01	9.0E-01	7.8E-01	1.3E+00
SR01	4.4E-01	4.7E-05	1.6E-04	4.2E-01	4.2E-01
SR02	4.5E-01	4.1E-04	2.0E-03	4.3E-01	4.4E-01
SR03	4.4E-01	1.2E-03	4.3E-03	4.3E-01	4.3E-01
SR04	4.3E-01	7.9E-03	1.4E-02	4.2E-01	4.3E-01
SR05	4.4E-01	2.2E-03	5.9E-02	4.2E-01	4.8E-01
SR06	4.4E-01	7.9E-04	2.1E-03	4.2E-01	4.2E-01
SR07	4.3E-01	3.7E-04	5.2E-03	4.2E-01	4.2E-01
SR08	4.4E-01	1.5E-02	3.8E-02	4.3E-01	4.5E-01
SR09	4.4E-01	3.6E-06	6.9E-06	4.3E-01	4.3E-01
SR10	4.3E-01	3.7E-06	7.1E-06	4.2E-01	4.2E-01
SR11	4.9E-01	3.6E-06	6.7E-06	4.6E-01	4.6E-01
SR12	4.3E-01	6.8E-03	4.7E-01	4.2E-01	8.8E-01
SR13	4.3E-01	6.7E-03	3.3E-01	4.2E-01	7.4E-01
SR14	4.3E-01	2.7E-02	6.9E-01	4.4E-01	1.1E+00
SR15	4.3E-01	9.0E-02	5.2E-01	5.0E-01	9.3E-01
SR16	4.2E-01	2.4E-01	3.2E-01	6.5E-01	7.3E-01
SR17	4.2E-01	4.8E-02	9.9E-02	4.6E-01	5.1E-01
SR18	4.4E-01	1.4E-06	5.1E-06	4.3E-01	4.3E-01
SR19	4.4E-01	4.7E-08	6.7E-06	4.2E-01	4.2E-01
SR20	4.5E-01	3.5E-07	6.6E-06	4.3E-01	4.3E-01
SR21	4.2E-01	1.3E-03	6.8E-03	4.2E-01	4.2E-01
SR22	4.2E-01	1.1E-02	2.0E-02	4.2E-01	4.3E-01
SR23	4.2E-01	1.6E-02	2.5E-02	4.2E-01	4.3E-01
SR24	4.2E-01	4.8E-02	8.0E-02	4.6E-01	4.9E-01
SR25	4.6E-01	9.2E-08	6.6E-06	4.3E-01	4.3E-01
SR26	4.3E-01	3.5E-06	6.3E-06	4.2E-01	4.2E-01
SR27	4.4E-01	1.2E-06	1.2E-05	4.3E-01	4.3E-01
SR28	4.4E-01	1.2E-06	1.2E-05	4.3E-01	4.3E-01
SR29	4.4E-01	1.1E-06	4.3E-05	4.3E-01	4.3E-01
SR30	4.8E-01	1.3E-06	3.2E-05	4.6E-01	4.6E-01
SR31	4.8E-01	1.3E-06	3.2E-05	4.6E-01	4.6E-01
SR32	4.6E-01	1.8E-06	9.5E-05	4.4E-01	4.4E-01
SR33	4.4E-01	4.3E-06	1.7E-04	4.2E-01	4.2E-01
SR34	4.3E-01	1.1E-05	3.2E-04	4.2E-01	4.2E-01
SR35	4.3E-01	1.1E-05	3.2E-04	4.2E-01	4.2E-01
SR36	4.2E-01	1.7E-01	2.8E-01	5.8E-01	6.9E-01
SR37	4.2E-01	1.9E-02	2.7E-02	4.3E-01	4.4E-01
SR38	4.4E-01	3.3E-06	7.6E-06	4.3E-01	4.3E-01
SR39	4.5E-01	3.5E-06	6.5E-06	4.3E-01	4.3E-01
SR40	4.3E-01	2.9E-08	1.4E-07	4.2E-01	4.2E-01
SR41	4.3E-01	2.4E-08	1.6E-06	4.2E-01	4.2E-01
SR42	4.7E-01	3.7E-05	1.4E-04	4.5E-01	4.5E-01
SR43	5.6E-01	6.1E-04	1.9E-03	5.2E-01	5.2E-01
SR44	4.5E-01	8.2E-03	1.9E-02	4.3E-01	4.4E-01
SR45	4.3E-01	2.7E-04	1.8E-03	4.2E-01	4.2E-01
SR46	4.4E-01	4.8E-05	3.8E-04	4.3E-01	4.3E-01
SR47	4.4E-01	1.1E-04	6.1E-04	4.3E-01	4.3E-01
SR48	4.4E-01	2.8E-05	7.9E-05	4.3E-01	4.3E-01
SR49	4.6E-01	2.6E-05	5.8E-05	4.4E-01	4.4E-01
SR50	4.2E-01	2.4E-02	3.9E-02	4.3E-01	4.5E-01
SR51	4.2E-01	4.8E-02	7.6E-02	4.6E-01	4.8E-01
SR52	4.3E-01	2.4E-07	4.2E-06	4.2E-01	4.2E-01
SR53	4.3E-01	1.1E-05	5.5E-05	4.2E-01	4.2E-01
SR54	4.2E-01	2.9E-08	1.0E-06	4.2E-01	4.2E-01
SR55	4.3E-01	2.6E-08	1.3E-07	4.2E-01	4.2E-01
SR56	4.1E-01	2.7E-09	8.5E-08	4.1E-01	4.1E-01
SR57	4.5E-01	3.5E-06	5.5E-06	4.4E-01	4.4E-01
SR58	4.1E-01	3.3E-07	1.0E-05	4.1E-01	4.1E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-5 Exposure Ratios for 1-hour PM2.5 (Case 3)

Human Receptor Location	1-hour $PM_{2.5}$ (TRV = 80 µg/m^3)				
	Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	3.4E-01	3.0E-01	8.1E-01	4.3E-01	9.5E-01
SR01	1.7E-01	2.1E-03	6.4E-03	1.6E-01	1.6E-01
SR02	1.8E-01	5.9E-03	1.3E-02	1.8E-01	1.8E-01
SR03	1.8E-01	7.2E-03	1.8E-02	1.7E-01	1.7E-01
SR04	1.5E-01	1.4E-01	4.1E-01	2.7E-01	5.5E-01
SR05	1.6E-01	1.2E-01	3.5E-01	2.5E-01	4.9E-01
SR06	1.6E-01	7.7E-03	3.8E-02	1.6E-01	1.8E-01
SR07	1.6E-01	2.0E-02	4.0E-02	1.6E-01	1.8E-01
SR08	1.6E-01	3.4E-02	5.2E-02	1.7E-01	1.9E-01
SR09	1.7E-01	1.6E-03	5.8E-03	1.7E-01	1.7E-01
SR10	1.6E-01	2.4E-04	6.4E-04	1.6E-01	1.6E-01
SR11	2.1E-01	2.0E-04	9.0E-03	2.0E-01	2.0E-01
SR12	1.6E-01	2.6E-01	3.8E-01	4.0E-01	5.2E-01
SR13	1.6E-01	1.6E-01	3.3E-01	2.9E-01	4.7E-01
SR14	1.6E-01	2.0E-01	3.1E-01	3.3E-01	4.4E-01
SR15	1.6E-01	7.3E-02	1.5E-01	2.1E-01	2.9E-01
SR16	1.5E-01	7.8E-02	1.1E-01	2.2E-01	2.4E-01
SR17	1.5E-01	4.1E-02	6.2E-02	1.8E-01	2.0E-01
SR18	1.8E-01	1.7E-04	6.8E-03	1.7E-01	1.7E-01
SR19	1.7E-01	2.1E-03	6.1E-03	1.7E-01	1.7E-01
SR20	1.8E-01	3.0E-03	6.4E-03	1.7E-01	1.7E-01
SR21	1.6E-01	2.9E-02	3.4E-02	1.7E-01	1.7E-01
SR22	1.5E-01	2.8E-02	4.0E-02	1.7E-01	1.8E-01
SR23	1.5E-01	2.9E-02	4.1E-02	1.7E-01	1.8E-01
SR24	1.5E-01	4.2E-02	5.3E-02	1.8E-01	1.9E-01
SR25	1.9E-01	3.3E-03	7.2E-03	1.8E-01	1.8E-01
SR26	1.7E-01	2.1E-03	3.2E-03	1.7E-01	1.7E-01
SR27	1.8E-01	2.1E-03	2.7E-03	1.8E-01	1.8E-01
SR28	1.8E-01	2.1E-03	2.7E-03	1.8E-01	1.8E-01
SR29	1.8E-01	2.0E-03	6.2E-03	1.7E-01	1.7E-01
SR30	2.1E-01	2.4E-03	5.9E-03	2.0E-01	2.0E-01
SR31	2.1E-01	2.4E-03	5.9E-03	2.0E-01	2.0E-01
SR32	1.9E-01	2.6E-03	1.1E-02	1.8E-01	1.8E-01
SR33	1.7E-01	2.8E-03	1.3E-02	1.7E-01	1.7E-01
SR34	1.7E-01	3.5E-03	1.4E-02	1.6E-01	1.6E-01
SR35	1.7E-01	3.5E-03	1.4E-02	1.6E-01	1.6E-01
SR36	1.5E-01	7.1E-02	1.1E-01	2.1E-01	2.5E-01
SR37	1.5E-01	2.7E-02	3.8E-02	1.7E-01	1.8E-01
SR38	1.8E-01	4.9E-03	9.4E-03	1.7E-01	1.7E-01
SR39	1.9E-01	3.3E-03	5.1E-03	1.8E-01	1.8E-01
SR40	1.6E-01	1.0E-04	3.5E-03	1.5E-01	1.5E-01
SR41	1.6E-01	8.7E-04	4.0E-03	1.6E-01	1.6E-01
SR42	2.0E-01	2.4E-03	4.5E-03	2.0E-01	2.0E-01
SR43	2.6E-01	4.3E-03	1.1E-02	2.5E-01	2.5E-01
SR44	1.7E-01	2.2E-02	3.6E-02	1.6E-01	1.7E-01
SR45	1.6E-01	1.0E-02	2.2E-02	1.6E-01	1.6E-01
SR46	1.7E-01	3.6E-03	1.3E-02	1.7E-01	1.7E-01
SR47	1.8E-01	3.8E-03	1.6E-02	1.7E-01	1.7E-01
SR48	1.7E-01	6.7E-04	1.6E-03	1.7E-01	1.7E-01
SR49	1.9E-01	5.2E-04	3.3E-03	1.9E-01	1.9E-01
SR50	1.5E-01	2.3E-02	3.4E-02	1.6E-01	1.7E-01
SR51	1.5E-01	3.4E-02	4.9E-02	1.7E-01	1.9E-01
SR52	1.7E-01	8.9E-04	1.7E-03	1.7E-01	1.7E-01
SR53	1.6E-01	1.8E-04	9.2E-04	1.6E-01	1.6E-01
SR54	1.7E-01	5.1E-04	1.1E-03	1.6E-01	1.6E-01
SR55	1.7E-01	4.1E-04	7.8E-04	1.7E-01	1.7E-01
SR56	1.5E-01	2.0E-05	6.5E-05	1.4E-01	1.4E-01
SR57	1.9E-01	2.0E-03	2.8E-03	1.8E-01	1.8E-01
SR58	1.5E-01	1.1E-04	5.3E-04	1.4E-01	1.4E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-6 Exposure Ratios for 24-hour PM2.5 (Case 3)

Human Receptor Location	24-hour $PM_{2.5}$ (TRV = 27 µg/m^3)				
	Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	6.8E-01	7.7E-02	2.1E-01	6.8E-01	6.8E-01
SR01	4.4E-01	4.2E-05	2.6E-04	4.4E-01	4.4E-01
SR02	4.5E-01	4.7E-04	1.5E-03	4.5E-01	4.5E-01
SR03	4.4E-01	8.3E-04	1.4E-03	4.4E-01	4.4E-01
SR04	4.3E-01	2.9E-03	1.3E-01	4.3E-01	5.6E-01
SR05	4.4E-01	4.8E-03	8.4E-02	4.4E-01	5.2E-01
SR06	4.4E-01	5.1E-04	4.5E-03	4.4E-01	4.4E-01
SR07	4.3E-01	1.2E-03	5.7E-03	4.3E-01	4.4E-01
SR08	4.4E-01	6.4E-03	1.5E-02	4.4E-01	4.5E-01
SR09	4.4E-01	1.3E-06	3.0E-05	4.4E-01	4.4E-01
SR10	4.3E-01	1.1E-06	1.3E-05	4.3E-01	4.3E-01
SR11	4.9E-01	1.2E-06	3.8E-05	4.9E-01	4.9E-01
SR12	4.3E-01	3.5E-02	1.5E-01	4.6E-01	5.8E-01
SR13	4.3E-01	2.5E-02	1.1E-01	4.6E-01	5.4E-01
SR14	4.3E-01	4.5E-02	1.1E-01	4.8E-01	5.4E-01
SR15	4.3E-01	3.6E-02	7.3E-02	4.7E-01	5.0E-01
SR16	4.2E-01	4.3E-02	6.2E-02	4.6E-01	4.8E-01
SR17	4.2E-01	1.6E-02	3.0E-02	4.4E-01	4.5E-01
SR18	4.4E-01	5.0E-07	2.7E-06	4.4E-01	4.4E-01
SR19	4.4E-01	1.1E-06	9.9E-06	4.4E-01	4.4E-01
SR20	4.5E-01	1.1E-06	5.4E-05	4.5E-01	4.5E-01
SR21	4.2E-01	1.8E-03	4.2E-03	4.3E-01	4.3E-01
SR22	4.2E-01	3.7E-03	7.7E-03	4.2E-01	4.3E-01
SR23	4.2E-01	3.8E-03	5.9E-03	4.2E-01	4.3E-01
SR24	4.2E-01	1.2E-02	2.1E-02	4.3E-01	4.4E-01
SR25	4.6E-01	1.1E-06	7.0E-05	4.6E-01	4.6E-01
SR26	4.3E-01	8.0E-07	2.1E-05	4.3E-01	4.3E-01
SR27	4.4E-01	5.6E-06	7.4E-05	4.4E-01	4.4E-01
SR28	4.4E-01	5.6E-06	7.4E-05	4.4E-01	4.4E-01
SR29	4.4E-01	2.1E-05	9.9E-05	4.4E-01	4.4E-01
SR30	4.8E-01	1.8E-05	1.0E-04	4.8E-01	4.8E-01
SR31	4.8E-01	1.8E-05	1.0E-04	4.8E-01	4.8E-01
SR32	4.6E-01	3.3E-05	1.3E-04	4.6E-01	4.6E-01
SR33	4.4E-01	5.9E-05	2.0E-04	4.4E-01	4.4E-01
SR34	4.3E-01	8.5E-05	3.0E-04	4.3E-01	4.3E-01
SR35	4.3E-01	8.5E-05	3.0E-04	4.3E-01	4.3E-01
SR36	4.2E-01	4.0E-02	6.2E-02	4.6E-01	4.8E-01
SR37	4.2E-01	3.3E-03	5.4E-03	4.2E-01	4.3E-01
SR38	4.4E-01	4.7E-06	2.0E-04	4.4E-01	4.4E-01
SR39	4.5E-01	1.3E-06	7.7E-05	4.5E-01	4.5E-01
SR40	4.3E-01	9.5E-08	2.1E-06	4.3E-01	4.3E-01
SR41	4.3E-01	1.1E-06	2.2E-06	4.3E-01	4.3E-01
SR42	4.7E-01	4.6E-05	1.8E-04	4.7E-01	4.7E-01
SR43	5.6E-01	5.0E-04	1.1E-03	5.6E-01	5.6E-01
SR44	4.5E-01	2.8E-03	6.6E-03	4.5E-01	4.5E-01
SR45	4.3E-01	3.8E-04	1.3E-03	4.3E-01	4.3E-01
SR46	4.4E-01	8.7E-05	5.9E-04	4.4E-01	4.4E-01
SR47	4.4E-01	1.5E-04	6.2E-04	4.4E-01	4.4E-01
SR48	4.4E-01	7.6E-06	2.1E-05	4.4E-01	4.4E-01
SR49	4.6E-01	7.0E-06	5.7E-05	4.6E-01	4.6E-01
SR50	4.2E-01	5.9E-03	9.8E-03	4.2E-01	4.2E-01
SR51	4.2E-01	1.2E-02	1.9E-02	4.3E-01	4.4E-01
SR52	4.3E-01	1.8E-07	1.7E-06	4.3E-01	4.3E-01
SR53	4.3E-01	7.5E-06	4.5E-05	4.3E-01	4.3E-01
SR54	4.2E-01	1.9E-08	5.4E-07	4.2E-01	4.2E-01
SR55	4.3E-01	1.4E-08	9.9E-08	4.3E-01	4.3E-01
SR56	4.1E-01	7.1E-09	1.6E-08	4.1E-01	4.1E-01
SR57	4.5E-01	1.1E-06	2.5E-05	4.5E-01	4.5E-01
SR58	4.1E-01	5.0E-07	9.1E-06	4.1E-01	4.1E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-7 Exposure Ratios for 1-hour PM2.5 (Case 4)

Human Receptor Location	1-hour $PM_{2.5}$ (TRV = 80 µg/m^3) Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	3.4E-01	2.1E+00	5.8E+00	2.3E+00	6.0E+00
SR01	1.7E-01	1.6E-02	5.0E-02	1.6E-01	1.9E-01
SR02	1.8E-01	4.5E-02	1.0E-01	1.9E-01	2.4E-01
SR03	1.8E-01	5.6E-02	1.4E-01	1.9E-01	2.7E-01
SR04	1.5E-01	1.0E+00	2.9E+00	1.2E+00	3.1E+00
SR05	1.6E-01	8.6E-01	2.5E+00	1.0E+00	2.7E+00
SR06	1.6E-01	5.7E-02	2.8E-01	2.0E-01	4.2E-01
SR07	1.6E-01	1.6E-01	3.0E-01	2.9E-01	4.4E-01
SR08	1.6E-01	2.6E-01	3.8E-01	3.9E-01	5.2E-01
SR09	1.7E-01	1.2E-02	4.3E-02	1.7E-01	1.8E-01
SR10	1.6E-01	1.8E-03	4.9E-03	1.6E-01	1.6E-01
SR11	2.1E-01	1.5E-03	7.0E-02	2.0E-01	2.1E-01
SR12	1.6E-01	1.9E+00	2.7E+00	2.0E+00	2.9E+00
SR13	1.6E-01	1.2E+00	2.4E+00	1.3E+00	2.5E+00
SR14	1.6E-01	1.5E+00	2.3E+00	1.6E+00	2.4E+00
SR15	1.6E-01	5.5E-01	1.1E+00	6.8E-01	1.3E+00
SR16	1.5E-01	5.6E-01	7.7E-01	7.0E-01	9.1E-01
SR17	1.5E-01	3.0E-01	4.6E-01	4.4E-01	6.0E-01
SR18	1.8E-01	1.3E-03	5.1E-02	1.7E-01	1.9E-01
SR19	1.7E-01	1.5E-02	4.5E-02	1.7E-01	1.8E-01
SR20	1.8E-01	2.3E-02	4.8E-02	1.8E-01	1.9E-01
SR21	1.6E-01	2.2E-01	2.6E-01	3.6E-01	3.9E-01
SR22	1.5E-01	2.1E-01	3.1E-01	3.5E-01	4.5E-01
SR23	1.5E-01	2.2E-01	3.1E-01	3.6E-01	4.5E-01
SR24	1.5E-01	3.2E-01	4.0E-01	4.6E-01	5.4E-01
SR25	1.9E-01	2.5E-02	5.4E-02	1.8E-01	1.9E-01
SR26	1.7E-01	1.5E-02	2.4E-02	1.7E-01	1.7E-01
SR27	1.8E-01	1.5E-02	2.0E-02	1.8E-01	1.8E-01
SR28	1.8E-01	1.5E-02	2.0E-02	1.8E-01	1.8E-01
SR29	1.8E-01	1.5E-02	4.6E-02	1.7E-01	1.9E-01
SR30	2.1E-01	1.7E-02	4.4E-02	2.0E-01	2.0E-01
SR31	2.1E-01	1.7E-02	4.4E-02	2.0E-01	2.0E-01
SR32	1.9E-01	1.9E-02	8.2E-02	1.8E-01	2.2E-01
SR33	1.7E-01	2.1E-02	9.8E-02	1.7E-01	2.4E-01
SR34	1.7E-01	2.6E-02	1.1E-01	1.6E-01	2.4E-01
SR35	1.7E-01	2.6E-02	1.1E-01	1.6E-01	2.4E-01
SR36	1.5E-01	5.1E-01	7.7E-01	6.5E-01	9.1E-01
SR37	1.5E-01	2.1E-01	2.9E-01	3.5E-01	4.3E-01
SR38	1.8E-01	3.5E-02	7.0E-02	1.8E-01	2.1E-01
SR39	1.9E-01	2.5E-02	3.8E-02	1.8E-01	1.8E-01
SR40	1.6E-01	7.6E-04	2.6E-02	1.5E-01	1.6E-01
SR41	1.6E-01	6.7E-03	3.0E-02	1.6E-01	1.7E-01
SR42	2.0E-01	1.8E-02	3.5E-02	2.0E-01	2.0E-01
SR43	2.6E-01	3.3E-02	8.1E-02	2.5E-01	2.5E-01
SR44	1.7E-01	1.6E-01	2.6E-01	3.0E-01	4.0E-01
SR45	1.6E-01	7.6E-02	1.7E-01	2.1E-01	3.1E-01
SR46	1.7E-01	2.8E-02	1.0E-01	1.7E-01	2.4E-01
SR47	1.8E-01	2.8E-02	1.3E-01	1.8E-01	2.6E-01
SR48	1.7E-01	5.1E-03	1.3E-02	1.7E-01	1.7E-01
SR49	1.9E-01	4.0E-03	2.6E-02	1.9E-01	1.9E-01
SR50	1.5E-01	1.6E-01	2.5E-01	3.0E-01	3.9E-01
SR51	1.5E-01	2.7E-01	3.7E-01	4.0E-01	5.1E-01
SR52	1.7E-01	6.8E-03	1.2E-02	1.7E-01	1.7E-01
SR53	1.6E-01	1.4E-03	6.8E-03	1.6E-01	1.6E-01
SR54	1.7E-01	3.9E-03	7.7E-03	1.6E-01	1.6E-01
SR55	1.7E-01	3.1E-03	5.7E-03	1.7E-01	1.7E-01
SR56	1.5E-01	1.5E-04	4.9E-04	1.4E-01	1.4E-01
SR57	1.9E-01	1.5E-02	2.1E-02	1.8E-01	1.8E-01
SR58	1.5E-01	8.5E-04	4.0E-03	1.4E-01	1.5E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-8 Exposure Ratios for 24-hour PM2.5 (Case 4)

Human Receptor Location	24-hour $PM_{2.5}$ (TRV = 27 µg/m^3)				
	Exposure Ratio (unitless)				
	Base Case	Project Case (1:100 Year Flood)	Project Case (Design Flood)	Application Case (1:100 Year Flood)	Application Case (Design Flood)
MPOI	6.8E-01	5.8E-01	1.5E+00	9.9E-01	1.9E+00
SR01	4.4E-01	3.2E-04	2.0E-03	4.2E-01	4.3E-01
SR02	4.5E-01	3.7E-03	1.2E-02	4.4E-01	4.4E-01
SR03	4.4E-01	6.4E-03	1.1E-02	4.3E-01	4.4E-01
SR04	4.3E-01	2.2E-02	9.9E-01	4.4E-01	1.4E+00
SR05	4.4E-01	3.6E-02	6.4E-01	4.5E-01	1.1E+00
SR06	4.4E-01	3.8E-03	3.5E-02	4.2E-01	4.5E-01
SR07	4.3E-01	9.2E-03	4.3E-02	4.2E-01	4.5E-01
SR08	4.4E-01	4.8E-02	1.1E-01	4.6E-01	5.3E-01
SR09	4.4E-01	9.6E-06	2.1E-04	4.3E-01	4.3E-01
SR10	4.3E-01	8.8E-06	9.8E-05	4.2E-01	4.2E-01
SR11	4.9E-01	9.1E-06	2.9E-04	4.6E-01	4.6E-01
SR12	4.3E-01	2.7E-01	1.1E+00	6.8E-01	1.5E+00
SR13	4.3E-01	1.8E-01	8.1E-01	5.9E-01	1.2E+00
SR14	4.3E-01	3.3E-01	8.1E-01	7.4E-01	1.2E+00
SR15	4.3E-01	2.7E-01	5.5E-01	6.7E-01	9.6E-01
SR16	4.2E-01	3.2E-01	4.6E-01	7.3E-01	8.7E-01
SR17	4.2E-01	1.2E-01	2.3E-01	5.3E-01	6.4E-01
SR18	4.4E-01	3.9E-06	2.1E-05	4.3E-01	4.3E-01
SR19	4.4E-01	8.5E-06	7.7E-05	4.2E-01	4.2E-01
SR20	4.5E-01	8.3E-06	4.0E-04	4.3E-01	4.3E-01
SR21	4.2E-01	1.3E-02	3.2E-02	4.2E-01	4.4E-01
SR22	4.2E-01	2.8E-02	5.9E-02	4.4E-01	4.7E-01
SR23	4.2E-01	2.9E-02	4.5E-02	4.4E-01	4.5E-01
SR24	4.2E-01	9.0E-02	1.5E-01	5.0E-01	5.6E-01
SR25	4.6E-01	8.3E-06	5.3E-04	4.3E-01	4.3E-01
SR26	4.3E-01	6.1E-06	1.6E-04	4.2E-01	4.2E-01
SR27	4.4E-01	4.3E-05	5.6E-04	4.3E-01	4.3E-01
SR28	4.4E-01	4.3E-05	5.6E-04	4.3E-01	4.3E-01
SR29	4.4E-01	1.5E-04	7.0E-04	4.3E-01	4.3E-01
SR30	4.8E-01	1.3E-04	7.4E-04	4.6E-01	4.6E-01
SR31	4.8E-01	1.3E-04	7.4E-04	4.6E-01	4.6E-01
SR32	4.6E-01	2.5E-04	9.6E-04	4.4E-01	4.4E-01
SR33	4.4E-01	4.4E-04	1.5E-03	4.2E-01	4.2E-01
SR34	4.3E-01	6.0E-04	2.3E-03	4.2E-01	4.2E-01
SR35	4.3E-01	6.0E-04	2.3E-03	4.2E-01	4.2E-01
SR36	4.2E-01	3.0E-01	4.7E-01	7.1E-01	8.8E-01
SR37	4.2E-01	2.5E-02	4.1E-02	4.3E-01	4.5E-01
SR38	4.4E-01	3.5E-05	1.4E-03	4.3E-01	4.3E-01
SR39	4.5E-01	1.0E-05	5.8E-04	4.3E-01	4.3E-01
SR40	4.3E-01	7.1E-07	1.6E-05	4.2E-01	4.2E-01
SR41	4.3E-01	8.8E-06	1.7E-05	4.2E-01	4.2E-01
SR42	4.7E-01	3.5E-04	1.4E-03	4.5E-01	4.5E-01
SR43	5.6E-01	3.9E-03	8.2E-03	5.2E-01	5.2E-01
SR44	4.5E-01	2.1E-02	4.9E-02	4.4E-01	4.6E-01
SR45	4.3E-01	2.9E-03	9.6E-03	4.2E-01	4.2E-01
SR46	4.4E-01	6.6E-04	4.5E-03	4.3E-01	4.3E-01
SR47	4.4E-01	1.2E-03	4.8E-03	4.3E-01	4.3E-01
SR48	4.4E-01	5.2E-05	1.6E-04	4.3E-01	4.3E-01
SR49	4.6E-01	4.7E-05	4.4E-04	4.4E-01	4.4E-01
SR50	4.2E-01	4.5E-02	7.5E-02	4.5E-01	4.8E-01
SR51	4.2E-01	8.8E-02	1.4E-01	5.0E-01	5.5E-01
SR52	4.3E-01	1.4E-06	1.3E-05	4.2E-01	4.2E-01
SR53	4.3E-01	5.8E-05	3.4E-04	4.2E-01	4.2E-01
SR54	4.2E-01	1.5E-07	4.0E-06	4.2E-01	4.2E-01
SR55	4.3E-01	1.1E-07	7.4E-07	4.2E-01	4.2E-01
SR56	4.1E-01	4.8E-08	1.1E-07	4.1E-01	4.1E-01
SR57	4.5E-01	8.6E-06	1.9E-04	4.4E-01	4.4E-01
SR58	4.1E-01	3.8E-06	7.0E-05	4.1E-01	4.1E-01

NOTE:
Shaded cell indicates a ER greater than 1.0

Table 3-9 Frequency of Concentrations Greater than Benchmark TRV

Human Receptor Location	1-hour $PM_{2.5}$ (TRV = 80 µg/m^3)				24-hour $PM_{2.5}$ (TRV = 27 µg/m^3)			
	Application Case (1:100 year flood)		Application Case (design flood)		Application Case (1:100 year flood)		Application Case (design flood)	
	Maximum concentration (µg/m^3)	Frequency of Concentrations Greater than Banchmark TRV[a] (h/a)	Maximum concentration (µg/m^3)	Frequency of Concentrations Greater than Banchmark TRV[a] (h/a)	Maximum concentration (µg/m^3)	Frequency of Concentrations Greater than Banchmark TRV[a] (d/a)	Maximum concentration (µg/m^3)	Frequency of Concentrations Greater than Banchmark TRV[a] (d/a)
Case 1 - Original Area of Deposited Sediment, Original Sediment Area with Fine Sediment								
SR4	12.6	0	13.4	0	11.5	0	11.5	0
SR5	12.8	0	25.4	0	11.7	0	16.9	0
SR12	12.8	0	44.9	0	11.6	0	23.6	0
SR13	12.9	0	45.5	0	11.7	0	22.2	0
SR14	23.2	0	47.9	0	45.5	0	25.2	0
SR15	24.7	0	53.6	0	16.7	0	24.1	0
SR16	14.2	0	15.4	0	13.7	0	14.6	0
SR17	12.1	0	12.7	0	11.9	0	12.6	0
SR36	13.4	0	15.0	0	13.1	0	14.5	0
Case 2 - Original Sediment Area, Increased Sediment Area with Fine Sediment								
SR4	23.6	0	29.2	0	12.4	0	11.6	0
SR5	22.6	0	114	2.2	12.2	0	54.5	0.6
SR12	25.0	0	241	21	12.5	0	100	4.6
SR13	23.7	0	246	16	12.4	0	90.0	3.4
SR14	97.8	0.8	262	26	23.9	0.2	112	6.8
SR15	108.7	1	301	16	53.3	0.4	103	4.6
SR16	33.0	0	40.7	0	30.7	0.2	37.2	1
SR17	18.9	0	23.3	0	17.8	0	22.5	0
SR36	27.0	0	39	0	26.1	0	36.2	0.8
Case 3 - Increased Area of Deposited Sediment, Original Sediment Size Assumptions								
SR4	27.5	0	64.0	0	18.3	0	26.8	0
SR5	27.2	0	56.7	0	17.0	0	27.7	0.2
SR12	33.5	0	60.5	0	23.5	0	33.9	0.4
SR13	33.4	0	60.8	0	20.2	0	26.9	0
SR14	34.8	0	50.2	0	22.0	0	28.7	0.2
SR15	14.7	0	32.2	0	14.7	0	19.6	0
SR16	15.6	0	17.1	0	14.8	0	15.9	0
SR17	13.0	0	14.5	0	12.7	0	14.2	0
SR36	15.4	0	18.0	0	14.9	0	16.9	0
Case 4 - Increased Area of Deposited Sediment, Increased Sediment Area with Fine Sediment								
SR4	129	3.2	390	30	65.0	0.2	128	0.8
SR5	127	2.0	322	24	55.4	0.2	129	6.6
SR12	172	14	348	26	99.0	2.4	173	14
SR13	171	7.4	350	21	78.9	1.0	124	10
SR14	181	11	291	17	92.9	2.6	142	10
SR15	38.2	0	163	7.0	36.8	0.8	74.3	5.6
SR16	42.1	0	53.4	0	38.1	0.8	46.3	2.6
SR17	25.8	0	34.9	0	23.9	0	33.9	0.6
SR36	40.8	0	57.0	0	38.8	1	53.7	3.2

NOTES:

[a] Frequency value represents average annual frequency above benchmark TRV based on 5 years of air dispersion modelling

Shaded cell indicates a ER greater than 1.0

Reference: **Post-Flood Operations Sediment Emission Estimates and Dispersion Model Predictions**

ATTACHMENT C: REVISED POST-FLOOD SOIL PROPERTIES

Stantec

Memo

To:	Matthew Hebert Alberta Transportation	From:	Ivan Whitson, PhD I Whitson Innovations Inc., subcontractor to Stantec Consulting Ltd.
File:	110773396	Date:	March 11, 2021

Reference: Springbank Off-stream Reservoir Revised Post-Flood Soil Properties and Related Assessment Conclusions

Based on feedback from Fisheries and Oceans Canada (DFO), the Impact Assessment Agency of Canada, and Alberta Environment and Parks (AEP) (obtained through the first round of information requests), Alberta Transportation was asked to explore the possibility of releasing water from the reservoir earlier, relative to the release timing described in the EIA. Revised modelling was undertaken in response to this request (IAAC IR4-01).

The results of the revised modeling show that the extent of sediment deposition and particle size distribution under design flood scenarios was different than modeled for the environmental impact assessment (EIA). For example, under the design flood the extent of 10 to 100 cm thick sediment is now 319 ha (early release) and 337 ha (late release) compared to 105 ha in the EIA (Volume 3A, Section 10, Table 10-11). Areas with greater than 1 m of flood sediment, however, are reduced by about 35 ha compared to the EIA. The EIA (Volume 3B: 9.2.3.1) stated that flood sediments would be dominated by sand-sized particles, with sandy loam to sand textural classes expected (confirmed with Round 1 AEP IR390), whereas the updated modelling shows a range of textural classes from sand to heavy clay as discussed below.

Although these changes in soil characteristics have the potential to affect agricultural land capability and wind erosion risk characterization the conclusions presented in the EIA and SIRs remain valid. *Effect on soil quality and quantity are expected to be high magnitude and irreversible because of the change in land capability associated with the introduction of new soil series with different physical properties. Specifically, there will be a decrease in equilibrium land capability from existing conditions to post-flood conditions (*Round 1 AEP IR390). Round 1 AEP IR393 recognized that the high magnitude and adverse changes to agricultural land capability after the design flood would be significant. In addition, Alberta Transportation has committed to monitoring of soil and revegetation success following flooding which will allow the application of mitigation measures to adaptively manage revegetation success if it is not following a desired trajectory.

The changes in sediment properties resulting from the revised modelling are summarized below.

Reference: **Springbank Off-stream Reservoir Revised Post-Flood Soil Properties and Related Assessment Conclusions**

CHANGES TO SEDIMENT PROPERTIES

Texture

The revised sediment modeling suggests that a deltaic soil pattern will develop such that soil texture and sediment thickness will vary systematically with distance from the outlet of the diversion channel and other variables related to flow dynamics (Trenhaile, 2010). Deeper sediments of coarser texture will predominate closer to the diversion channel mouth. Shallower sediments of higher clay and silt content will predominate further out from the diversion channel mouth. Soil profiles will display vertical textural stratification. The stratified textural properties will promote soil water storage in these profiles similar to the sandy deltaic soils near Fort McMurray, AB, where vertically stratified soils are able to support a diverse set of ecotypes (Huang et al., 2011; Zettl et al., 2011). As a result, for most areas of flood sediment accumulation, soil moisture storage properties will be greater than was expected in the 2018 EIA. The revised sediment description differs from the assumption that the reservoir would be an extension of the Elbow River floodplain presented in Round 1 NRCB IR81.

All soil units that characterize the design flood deposits are expected to be classified in the Regosolic order (Orthic Regosol Subgroup). The materials would be classified as C horizons and are expected to range from sand to heavy clay textural classes depending on location within the reservoir. The finer textured soils are likely easier to revegetate and manage than the areas of coarser texture.

Textural properties for the late release, design flood are presented in Figures 1 (clay), Figure 2 (silt) and Figure 3 (sand). The sand component is greatest near the diversion channel outlet (Figure 3). Clay percentage is greatest in the further extents of the reservoir (Figure 1) while silt is most concentrated in the areas between sand and clay dominance (Figure 2). The revised modelling shows a revised distribution of post flood sediment textures in the reservoir relative to the predominantly sandy textures presented in Round 1 AEP IR390.

Sediment thickness in the reservoir for the late release design flood is presented in Figure 4. Thickest deposits are nearest the diversion channel outlet while thickness generally decreases with distance away from the outlet. There are extensive areas of very thin sediment. The thresholds of importance to the soil assessment remain as 3 cm (minimum for wind erosion effects to soil) and 20 cm (minimum to consider the change to agricultural land capability). The 3 cm depth was chosen to provide a conservative estimate of soil erosion risk characterization as determined with the accepted methodology (Coote and Pettapiece, 1989).

Predicted texture properties from the revised modelling do not change the conclusions presented in the EIA and SIRs. Rather, this information will inform the revegetation plan that will be implemented following a flood and is consistent with the measures outlined in the Draft Vegetation and Wetland Mitigation, Monitoring, and Revegetation Plan.

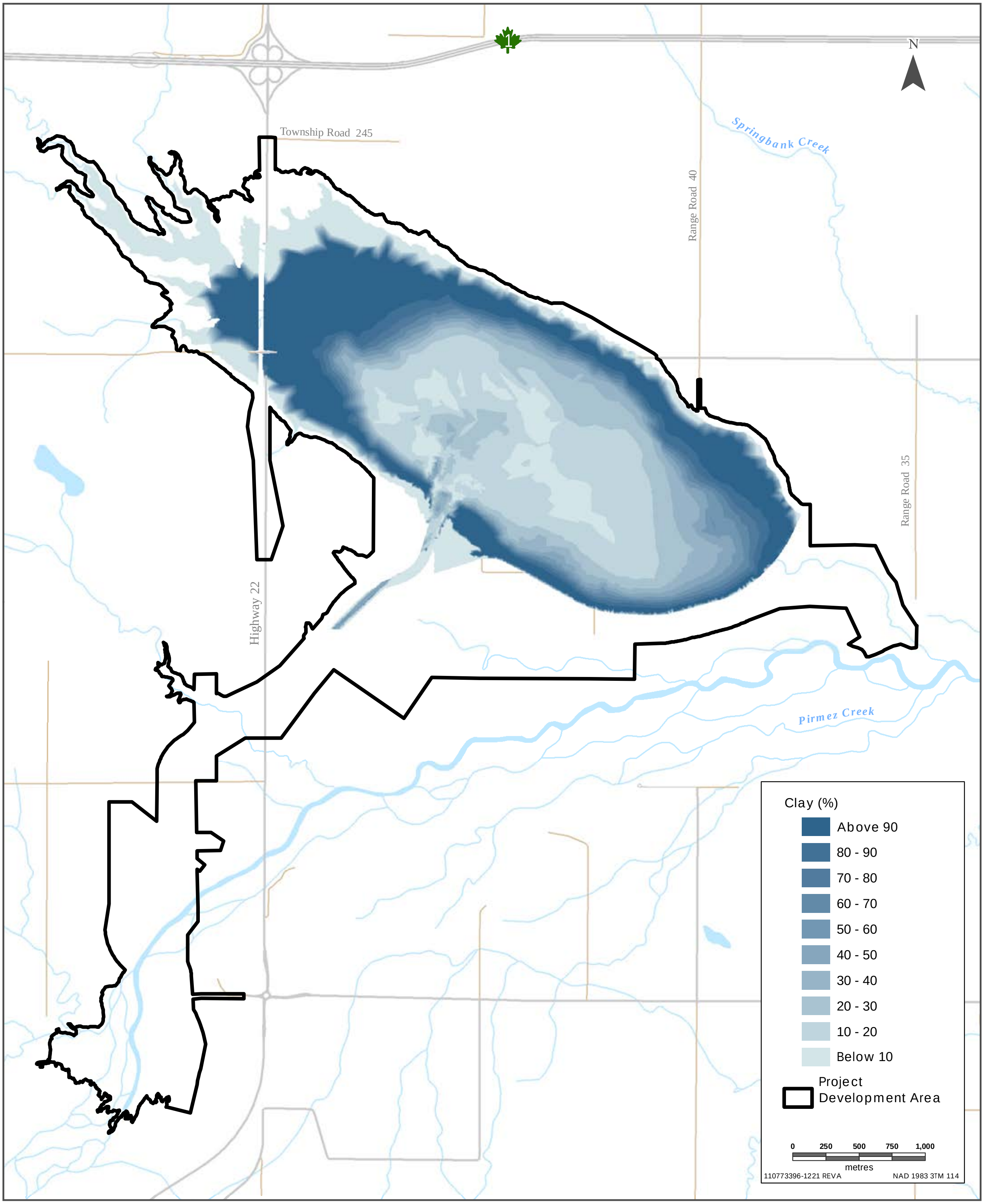
Salinity

The revised modeling of sediment properties does not change previous statements about soil salinization. Soil salinization remains a relatively low risk concern (Round 1 AEP IR392).

Calcium Carbonate

The calcium carbonate abundance presented in the EIA ranged from a maximum of approximately 40% for the Twin Bridges soils series on the Elbow River floodplain to approximately 30% in subsoils of fine textured reservoir soils (EIA, Volume 4, Appendix G, Terrain and Soils TDR). Carbonate abundance in flood sediments was expected to be similar to the soils on the Elbow river floodplain. The concentration of carbonate minerals in soil and sediments can be related to particle size, so that it might differ among sandy, silty and clayey sediments expected in the reservoir (Rostad and St. Arnaud, 1970; Ghebre-Egziabhier and St. Arnaud, 1983). Kennedy and Smith (1977), in studies of sediments in lakes near Banff, Alberta, found that carbonate minerals were more concentrated in larger particle sizes and less concentrated in smaller particles. A range of calcium carbonate concentration is expected in flood sediments. It is possible, but unlikely that carbonates might exceed the guidelines for reclamation suitability, where 70% calcium carbonate equivalent is the limit between poor and unsuitable topsoil quality (Alberta Agriculture, Food and Rural Development, 1987). This potential difference does not change the conclusions of the EIA. In addition, Alberta Transportation has committed to monitoring of soil and revegetation success following flooding which will allow the application of mitigation measures to adaptively manage revegetation success if it is not following a desired trajectory. If elevated calcium carbonate abundance is identified at levels that would affect revegetation success, Alberta Transportation has identified that appropriate mitigation measures will be applied, such as the addition of elemental sulfur to neutralize the alkaline conditions.

Figure 1 to 4. Diagrams displaying the predicted spatial variability of particle size distribution and thickness for the late release Design flood. Figure 1: fraction 1, clay%; Figure 2: fraction 2, silt%; Figure 3: fraction 3, sand%; Figure 4: sediment thickness. Note that areas of no sediment deposition in Figures 1 to 3 are displayed as <10% for that fraction.



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Sediment Deposition Clay (%) Pattern in the PDA Late Release Design Flood

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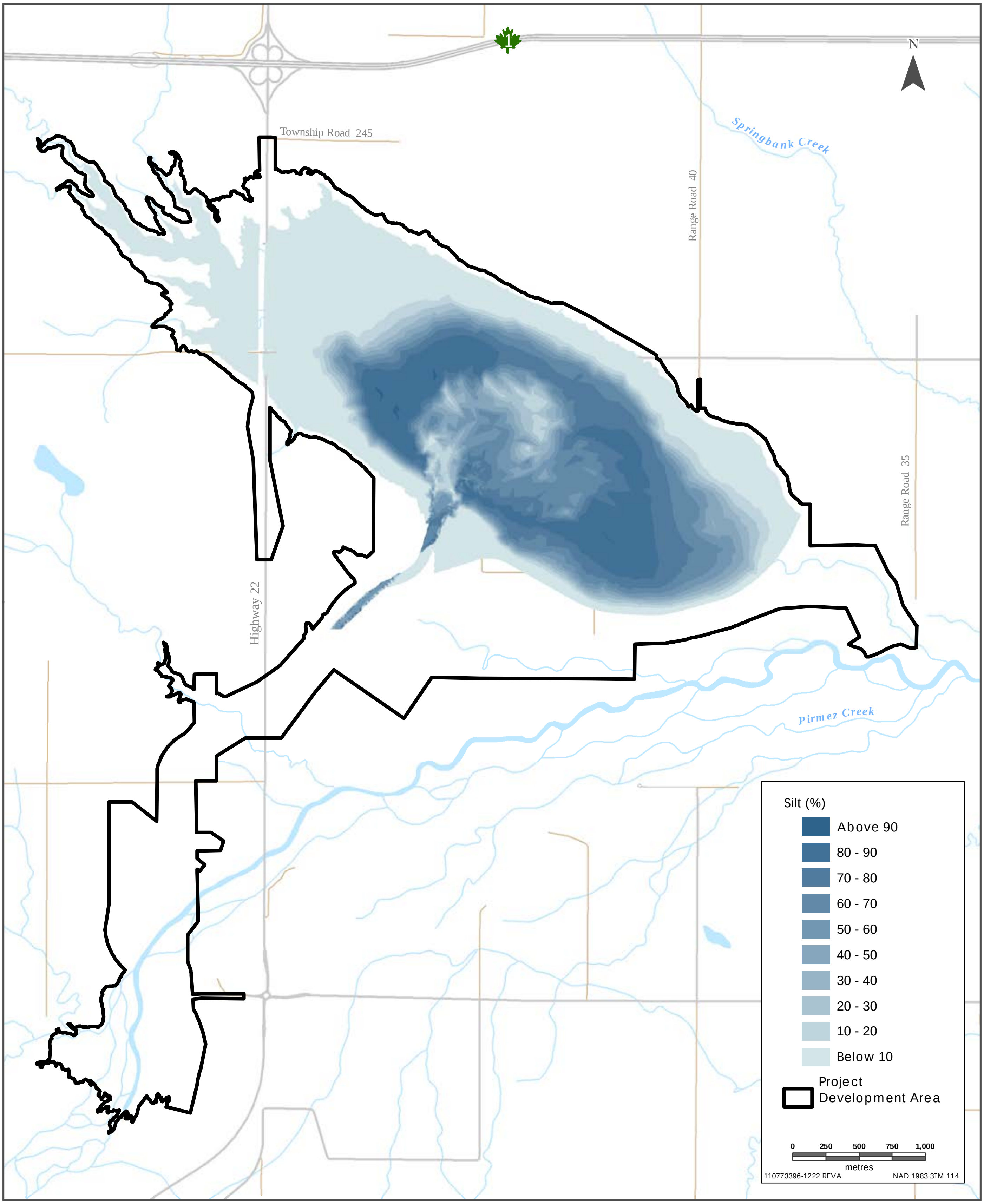
Figure 1



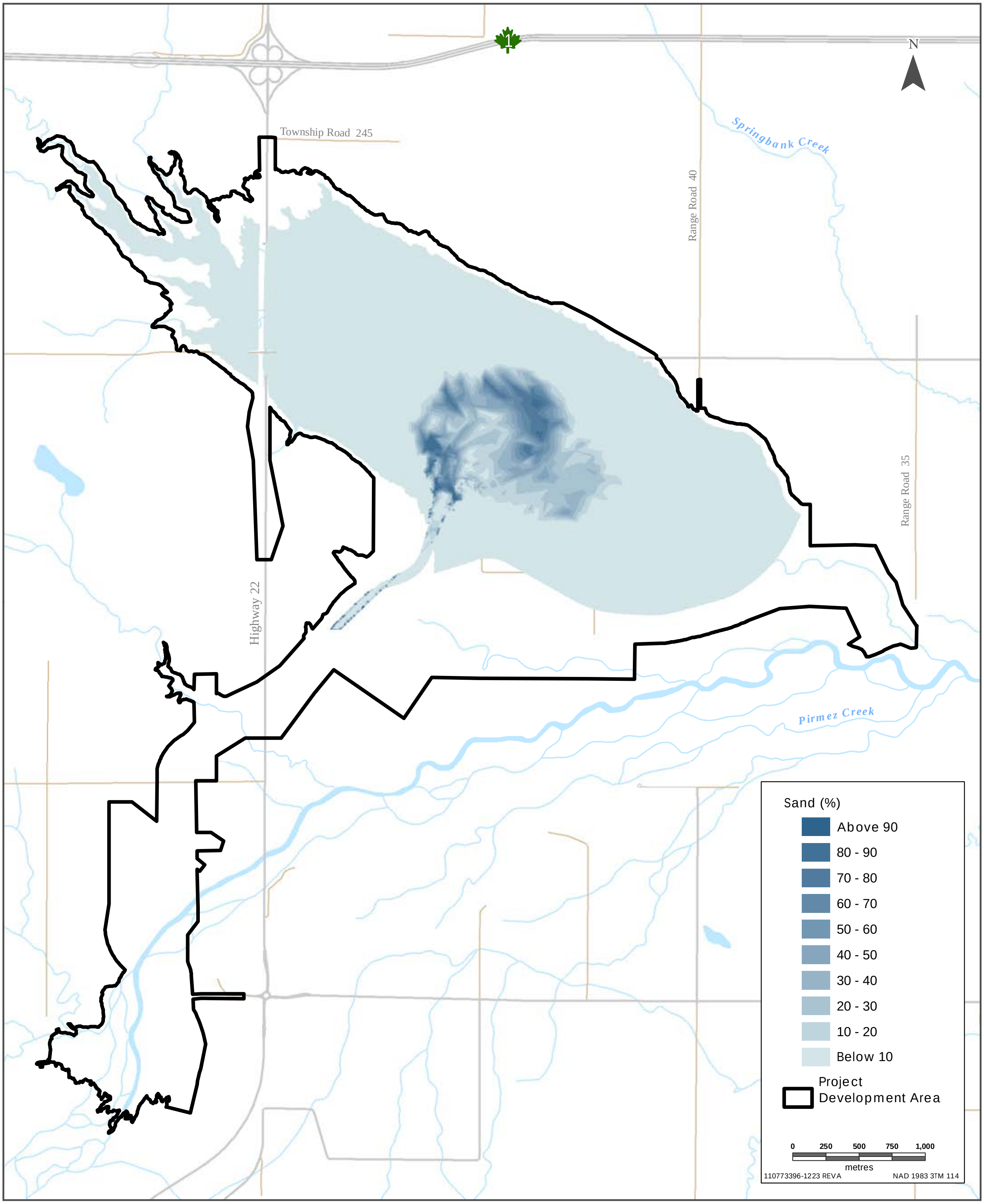
Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Sediment Deposition Silt (%) Pattern in the PDA Late Release Design Flood

Stantec

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 2



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Sediment Deposition Sand (%) Pattern in the PDA Late Release Design Flood

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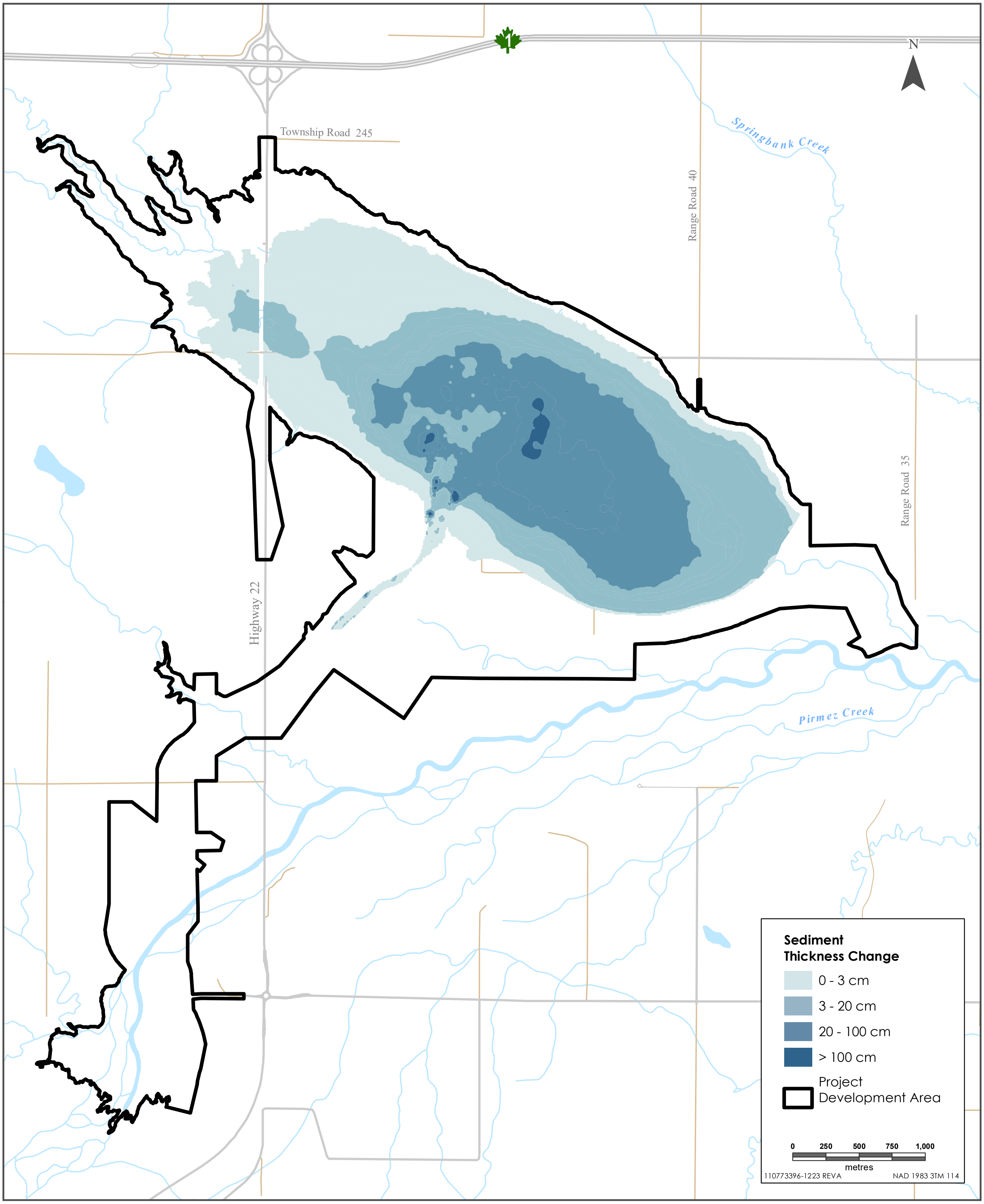
ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 3



Sources: Base Data - Government of Alberta, Government of Canada, Thematic Data - Stantec Ltd.

Sediment Deposition Thickness Change Pattern in the PDA Late Release Design Flood

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ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT ENVIRONMENTAL IMPACT ASSESSMENT

Figure 4

REVISED SOIL CHARACTERIZATION

The EIA identified 5 soil units based on the sediment deposited in the reservoir, Soil units were identified by evaluating spatial variability in clay, silt and sand percentage and sediment depth. Based on the updated sediment modelling, textural characteristics and depths, these soil units have been updated to inform any required mitigation and revegetation planning. Six updated conceptual soil types were identified for the area of flood deposition (Table 1) based on the updated modelling. Limits of soil units were based on percent clay, percent sand, and sediment thickness (Table 1). For instance, unit C1 consists of soils that have 50% sand content or greater, less than 20% clay content, and are thinner than 0.2 m.

Physical properties of flood sediment will vary more than described in NRCB Round 1 IR390. Although the six new expected soil units have been characterized by average particle size distribution within each group (Table 1), textural classes are likely to be spatially variable, as indicated in Figures 1 to 3. Textural classes in the sediment under the revised modeling will likely include sand, loamy sand, sandy loam, loam, clay loam, silt loam, silty clay loam, clay, silty clay and heavy clay. Areas of sandy texture will tend to be deepest, areas of clayey sediment will tend to be shallowest, and silty soils will be intermediate in thickness.

All units are assumed to have moderately well to well drained conditions. While it is likely that depressional and lower slope positions will develop imperfect to poorly drained soil conditions, these have not been evaluated at this point in time. Moisture conditions will be evaluated as part of revegetation efforts and will inform revegetation activities.

Table 1 Characteristics of revised post-flood soil units

Unit	Unit Limits	%Clay	%Silt	%Sand	Thickness (m)
		Average			Median
C1	%sand>=50; %clay<20; thickness<0.2 m	9	23	67	0.13
C2	%sand>=50; %clay<20; thickness 0.2 m <= C2 < 1.0 m m	8	21	71	0.38
C3	%sand>=50; %clay<20; thickness: > 1.0 m	2	15	83	1.52
M1	%sand<50; %clay<30; thickness<0.2 m	19	70	11	0.08
M2	%sand<50; %clay<30; thickness>0.2 m	15	73	11	0.32
F1	%sand<50; %clay>=30; thickness<0.2 m	73	26	1	0.04
Inclusions	Not evaluated; these are areas of the sediment plume that do not fall within the class limits of soil units C1, C2, C3, M1, M2 and F1.	Not characterized	-	-	various

SOIL INTERPRETATIONS

Land Capability

The units with median thickness greater than 20 cm were evaluated for agricultural land capability (Table 2) (soil profile only) to be consistent with the EIA (See EIA, Volume 3B, Section 9, Table 9-5). Units C2 and M2 were both rated as class 4. Unit C3 was rated as class 7, similar to the DEP4 unit from the 2018 EIA. Overall, the ratings for the flood sediment soil units are not as low as in the EIA.

The change in spatial distribution of agricultural land capability for the late release, design flood has not been updated so an updated version of EIA, Volume 3A, Section 9, Table 9-6 (and Figure 9-5) has not been provided; however, it is likely that the reduction in extent of LCC class 2 will be greater than in the EIA. As indicated above, under the design flood the extent of 10 to 100 cm thick sediment is now 319 ha (early) and 337 ha (late) compared to 105 ha in the EIA (Round 2 IAAC IR4-01, Table 1-10).

The change in sediment texture is positive for capability ratings but the change in extent (area) of sediment is negative for capability. Overall, there is likely a reduction in the extent of area of agricultural land capability class 2 because of the increased area of flood sediment, however the changes do not affect the conclusions presented in the EIA and SIRs.

Table 2 LCC as a Function of Flood, by Soil Unit

Soil Unit	Agricultural Land Capability Class[1]		
	Climate Rating	Profile Rating	
		Maximum Effect[2]	Equilibrium Effect[2]
C1	3H	-	-
C2	3H	6	4
C3	3H	7	7
M1	3H	-	-
M2	3H	7	4
F1	3H	-	-

NOTES:

[1] Consistent with methods used in EIA, Volume 3B, Section 9, Table 9-5 (exhibit 48). Not calculated for Units C1, M1 and F1 because soil thickness in these less than 20 cm.

[2] Maximum effect occurs for a short period after reservoir drainage and accounts for both reversible (soil saturation, anoxia) and irreversible soil effects. Equilibrium effect accounts only for irreversible soil changes (particle size change and pH change).

Soil Drying

The sediment depicted for the late release model for the design flood is expected to dry at more spatially variable rate than was forecast in the EIA. The variability of soil texture in the flood sediment may result in complex patterns of soil drainage that were not evident in the EIA where the sediment was expected to be isotropic with respect to vertical water movement. The revegetation plan under development will account for the influence of soil moisture on the application of mitigations.

There are no substantial changes to the rates of drying of other (non-sediment) soils displayed in EIA, Volume 3B Table 9-3. The EIA showed soil submergence to vary from 5 to 67 days, and soil drying to restore aerobic soil conditions within a few weeks to months for the design flood (Effects were further discussed in NRCB Round 1 IR 387). The overall period of inundation under the early/late release would vary from as little as about 2 days (1:10, early) to as many as about 92 days (1:100 late) (Round 2 IAAC IR4-01, Table 1-1) which is not materially different than the EIA.

Wind Erosion Risk

The wind erosion risk of the new soil units has been evaluated using the same conservative assumptions used previously (EIA, Volume 4, Appendix G, Attachment 9A) and that were presented in EIA, Volume 3B, Figure 9-2. Wind erosion risk in this context looks at soil detachment and localized transport. Risks were based on a wind speed of 76 km/h and soils were assumed to be free of vegetation and crop residue and at wilting point moisture content. Under these conditions, erosion risk of the updated post-flood soil units range from moderate to severe (Table 3), compared to the EIA where all flood sediment soil units had a wind erosion risk of severe. The reduction in areal extent of sandy flood sediments and the increase in area of silty and clayey sediment will decrease the soil erosion risk at post-flood.

Alberta Transportation has committed to identifying and managing areas of erosion risk through the use of tackifiers or other applicable mitigation measures. As a result, the results of the updated modelling do not change the conclusions of the EIA.

Table 3 Wind erosion risk for post-flood new reservoir soil units

Soil Unit	Wind Erosion Risk (no mitigations)
C1	Severe
C2	Severe
C3	Severe
M1	Moderate
M2	Moderate
F1	High

Reference: Springbank Off-stream Reservoir Revised Post-Flood Soil Properties and Related Assessment Conclusions

SUMMARY

Although the changes in soil characteristics have the potential to affect agricultural land capability and wind erosion risk characterization, the conclusions presented in the EIA and SIRs remain valid. In addition, Alberta Transportation has committed to monitoring of soil and revegetation success following flooding which will allow the application of mitigation measures to adaptively manage revegetation success if it is not following a desired trajectory.

Ivan R. Whitson Digitally signed by Ivan R. Whitson Date: 2021.03.11 17:38:34 -07'00'

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