Technical Memorandum

Prepared For:	City of Chilliwack	**Date:**	December 14, 2016
Prepared By:	Waterline Resources Inc.	**File No.:**	2137-16-006
Subject:	Summary of Water Related Information for the City of Chilliwack		

BACKGROUND

Trans Mountain Pipelines ULC (Trans Mountain) has been requested by the National Energy Board (NEB) to address concerns of communities regarding protection of municipal water sources. This technical memo summarizes the publicly available information in relation to the municipal water supply and nearby water resources at the City of Chilliwack. This document includes:

- A map showing the municipal water wells used to supply water to the City of Chilliwack (Figure 1);
- A map showing the aquifers present at the City of Chilliwack (Figure 2);
- A map showing shallow groundwater flow direction and municipal water supplies (Figure 3); and
- A detailed map showing shallow groundwater flow directions near the proposed pipeline route and the City of Chilliwack well field (Figure 3a).

MUNICIPAL WATER SUPPLY SUMMARY

A search of the water wells and water supplies registered to the city of The City of Chilliwack is presented on Figure 3. In addition, the City of Chilliwack has identified the water wells presented on Figure 3A as used for municipal supply.

SUMMARY OF INTERVENER REQUEST GROUNDWATER RELATED ISSUES

Intervener Requests (IRs) for groundwater related issues within the City of Chilliwack are summarized in Table 1.

SUMMARY OF TRANS MOUNTAIN COMMITMENTS TO THE CITY OF CHILLIWACK

Groundwater related commitments which Trans Mountain has made to the City of Chilliwack are summarized in Table 2.

Table 1: Summary of Groundwater Related Intervener Requests

Number	Source	Question	Answer
IR 1.27a	Fraser Valley Regional District	Please provide detailed hydrological studies and bioinventories of all potentially affected watercourses where groundwater table manipulation is being considered in the Fraser Valley Regional District.	In Table B.1 of Appendix B, in the Groundwater Technical Report Volume 5C-3 in Volume 5C, (Waterline Resources Inc., December 2013) provides an inventory of potential shallow groundwater areas as well as unconfined aquifers. Construction dewatering activities in non-aquifer conditions (i.e. a fine grained, low permeability setting) will result in the diversion of relatively low volumes of water and limited hydraulic influence away from the dewatered trench. In aquifer conditions (i.e. coarse grained, high permeability setting) dewatering activities have the potential to require handling larger volumes of water and having hydraulic influence that reaches farther from the dewatered trench. The inventory of issues and mitigations summarized in Table B.1 (referred to above) and Table 4.1-11 in the Groundwater Technical Report (referred to above) focused recognition of potential shallow groundwater issues to areas also with shallow or unconfined aquifer conditions. The potential effects of dewatering during construction activities and the associated recommended mitigation measures are included in Item 4.4, Table 7.2.3-2 in Volume 5A of the Application. Section 8.3 of the Pipeline Environmental Protection Plan, Volume 6B, also lists potential mitigation measures associated with dewatering the trench. Volumes 5B and 5C of the Application contain the biophysical and socio-economic technical supporting studies to support the assessment in Volume 5A, of which detail related to hydrological and bio-inventory assessment is included. Examples of these technical reports include the following: • A study of the Route Physiography and Hydrology (BGC Engineering Inc., November 2013) is presented in Appendix I of Volume 4A; • Stream classifications and fisheries assessments for watercourses are provided in Technical Report 5C-7 in Volume 5C, Fisheries (British Columbia) Technical Report (Triton Environmental Consultants Ltd., December 2013); and • Inventory and study of wetlands are provided in Technical Report 5C-8 in Volume 5C, Wetland Evaluation Technical Report (TERA Environmental Consultants, December 2013).
IR 1.4a	Michael Hale	What are the estimated effects if there were a major spill into an aquifer that is the source for a community's drinking water, such as the Sardis-Vedder Aquifer (Chilliwack) or the Abbotsford-Sumas Aquifer (Abbotsford).	Section 6.2.2.1 in Volume 7 of the application ""Without treatment or physical removal, oil would be a long-term source of groundwater contamination if it contacted the water table. For this reason, spill response efforts aim to reduce potential for groundwater contamination by removing pooled oil and affected surface materials as quickly as possible, and as deeply as needed to remove contamination so that aquifers are not affected." With this focus on timely clean-up activities, impacts to aquifers can be minimized. With respect to the Sardis-Vedder aquifer, the pipeline traverses north and down-gradient of the capture zone of existing City of Chilliwack municipal wells according to available aquifer modelling (AMEC 2007). Surface spill risk analysis shown in Appendix C (Page 89 of 97), Volume 7 indicates that surface releases along the pipeline in this area would tend to continue downslope generally to the north and away from the municipal wells in this area.
IR 1.4b	Michael Hale	What are the potential effects of undetected leaks seeping into drinking water sources?	Section 3.0 of Volume 7.0 of the Application discusses the oil spill risk assessments completed for the project and sections 7.0 and 8.0 of Volume 7.0 addresses the potential effects of pipeline releases. More specifically, section 6.2.2.1 addresses soil and groundwater and the emphasis placed on spill prevention and spill response.
IR 1.2.11	Pro Information Pro Environment United People Network	Does your groundwater analysis of 300 meters from the pipeline corridor take the spill risk scenarios in Volume 7 Pages 30 to 45 into consideration	The risk assessment referenced in Volume 7, Section 3.0 includes Oil Outflow analysis in Appendix B, and Overland and Stream Flow Modeling of Potential Full-Bore Rupture in Appendix C. The analysis provides input to the risk assessment and includes the identification of High Consequence Areas (HCAs) impacted by potential spill volumes. These HCAs include water wells, aquifers, wells, canals, rivers and streams and will result in an elevated risk determination based on the increased consequence associated with the environmental receptors.
No. 1.8.2	Pro Information Pro Environment United People Network	Trans Mountain also mention the possibility of flooding at the drill site that could hinder HDD drilling, and state “Under such circumstances, either open cut or HDD may require special measures to mitigate or prevent affects caused by groundwater inflows. ”Please explain in detail what Trans Mountain mean by “special measures”	Section 8.4 of the Pipeline Environmental Protection Plan (Volume 6B) presents a suite of mitigation measures that are commonly implemented during the backfilling process after the pipeline has been installed in the trench. Examples of special measures for open-cut construction include the installation of sub-drains and trench breakers, for controlling the flow of groundwater along the pipe. For a horizontal directional drill (HDD), special measures might include active depressurization of the aquifer during drilling to reduce or eliminate groundwater inflows or pressure grouting to seal off annular space between the casing and the edge of the borehole (Section 8.7.3 of Volume 6B) to eliminate the hydraulic connection to other units. Detailed geotechnical investigations are being carried out to identify these potential problems with the intent that an HDD drill profile would be designed to avoid the potential problem. In the unlikely event where groundwater flow into the bore ultimately reaches ground surface at the drill rig site, this would be collected into settling tanks or ponds and treated and disposed of as required in the Environmental Protection Plan. Special measures would include the collection and treatment and disposal of the excess water, as well as grouting of the bore to seal any flow. In addition a new drill alignment will be considered along with implementing the design contingency plan.
IR 1.I_g	Water Wealth Project	Please explain how this mitigation might be carried out in the event of a pipeline leak in the area of the aquifer serving City of Chilliwack community wells.	In the referenced Table 4.1-1 on page 4-3, of the Groundwater Technical Report 5C-3, Volume 5C, potential mitigation of groundwater-related issues number 6 states “Re-establish or replace a potable water supply as required should a registered or known water well located within 30m of the construction right-of-way be damaged (i.e., diminishment in quantity and/or quality) during pipeline installation.” Through this mitigation, Trans Mountain is committed to ensuring the continuity of water supply. In Section 6.2.2.1, Volume 7, Trans Mountain acknowledged that "Without treatment or physical removal, oil would be a long-term source of groundwater contamination if it contacted the water table. For this reason, spill response efforts aim to reduce potential for groundwater contamination by removing pooled oil and affected surface materials as quickly as possible, and as deeply as needed to remove

Number	Source	Question	Answer
			contamination so that aquifers are not affected." With this focus on timely clean-up activities, impacts to aquifers can be minimized. With respect to the Sardis-Vedder aquifer, the pipeline traverses north and down-gradient of the capture zone of existing City of Chilliwack municipal wells according to available aquifer modelling (AMEC, 2007). Overland and Stream Flow Modeling of Potential Full-Bore Ruptures included in Volume 7, Appendix C (Page 89 of 97) indicates that surface releases along the pipeline in this area would tend to continue downslope generally to the north and away from the municipal wells in this area. In the event that a pipeline release somehow impacted aquifer conditions around one of the City of Chilliwack community wells, Trans Mountain would commit to work with the City of Chilliwack to identify surplus capacity from other wells in the system, while suitable replacement alternatives were established and implemented.
IR 2.10a	Province of British Columbia	How can it be said that the pipeline traverses down-gradient of the capture zone for the City of Chilliwack community wells	In the area of Chilliwack, the proposed revised pipeline corridor deviates to the north from the existing pipeline as well as the originally proposed pipeline corridor. With respect to the Sardis-Vedder aquifer, the existing pipeline is located along the northern limits of the capture zone of existing City of Chilliwack municipal wells according to available aquifer modelling (AMEC 2007). The proposed revised pipeline corridor traverses north and down-gradient of the capture zone of existing City of Chilliwack municipal wells (AMEC 2007). Groundwater flows from areas of higher pressure to areas of lower pressure. The flow of groundwater in the vicinity of the Chilliwack water supply wells is to the north from the Vedder River toward the wells and the proposed pipeline corridor. Pumping water from these supply wells induces a hydraulic (or pressure) gradient toward the wells. Most of the water coming toward the wells comes from the south in the direction of the Vedder River. Some of the water will come from the north, but available modelling (AMEC, 2007) suggests this local well capture does not extend as far as the proposed pipeline corridor. In addition, local surface topography in the vicinity of the proposed pipeline alignment decreases to the north, such that surface drainage in the vicinity of the pipeline is also down-gradient of the municipal wells. The context applied here reflects that the proposed pipeline corridor is down-gradient of the municipal wells from both a surface topography and groundwater flow perspective. Reference: AMEC Earth and Environmental. 2007. City of Chilliwack Sardis Aquifer 60-Day Capture Zone Figure 1.
IR 2.10b	Province of British Columbia	Please explain the statement that “surface releases along the pipeline in [the area near the City of Chilliwack community wells] would tend to continue downslope generally to the north and away from the municipal wells in the area”.	Please refer to the response to Province of BC IR No. 2.10a. The spill modelling (in Volume 7, Appendix C (Page 89 of 97) Filing ID A3S4W5) suggested that spilled fluids in the Chilliwack area closest to the municipal wells would flow northward from the proposed revised pipeline corridor following local topography. This direction is away from the municipal wells and their associated capture zones, as indicated in Reference (i). The capture zone modelling completed by AMEC (2007) identifies the zone of groundwater that is captured by the pumping wells. Because the boundary of the capture zone lies outside the proposed pipeline corridor, groundwater from beneath the corridor would not likely be captured by the pumping wells. Reference: AMEC Earth and Environmental. 2007. City of Chilliwack Sardis Aquifer 60-Day Capture Zone Figure 1.
IR 2.10c	Province of British Columbia	Has Trans Mountain assessed the potential consequences of Project related groundwater contamination of a community? If not, why not?	Trans Mountain has not completed a formal assessment for the Project, but realizes a release from the pipeline system could significantly impact communities in various ways. In response to Province of BC IR No. 2.12 Trans Mountain commits to engage with communities regarding possible installation of groundwater monitoring wells. During these engagements Trans Mountain anticipates that potential consequences of groundwater contamination will be discussed along with a review of the maintenance policies, systems, programs, procedures, practices, and activities to prevent pipeline releases as noted in Province of BC IR No. 2.12.
IR 2.10d	Province of British Columbia	If Trans Mountain has assessed the potential consequences of Project related groundwater contamination on a community, has a mitigation plan been developed to address such effects? If yes, please provide a copy of such plan. If not, why not?	Please see the response to Province of BC IR 2.10c.
IR 2.I.c	WaterWealth	KMC describes the pipeline as being on a down gradient from City of Chilliwack municipal wells. Does this refer to the surface topography or subsurface hydraulic gradient?	Groundwater flows from areas of higher pressure to areas of lower pressure. The flow of groundwater in the vicinity of the Chilliwack water supply wells is to the north from the Vedder River toward the wells and the proposed pipeline corridor. Pumping water from these supply wells induces a hydraulic (or pressure) gradient toward the wells. Most of the water coming toward the wells comes from the south in the direction of the Vedder River. Some of the water will come from the north, but available modelling (AMEC, 2007) suggests this local well capture does not extend as far as the proposed pipeline corridor.

Number	Source	Question	Answer
			In addition, local surface topography in the vicinity of the proposed pipeline alignment decreases to the north, such that surface drainage in the vicinity of the pipeline is also down-gradient of the municipal wells. The context applied here reflects that the proposed pipeline corridor is down-gradient of the municipal wells from both a surface topography and groundwater flow perspective. References: AMEC Earth and Environmental. 2007. City of Chilliwack Sardis Aquifer 60-Day Capture Zone Figure 1.
IR 2.I.d	WaterWealth	If hydraulic gradient was used, what was the hydraulic gradient information based on? Did it take into account seasonal changes in precipitation and water table fluctuations?	The hydraulic gradient data was derived from interpreted flow patterns based on actual groundwater data, and corresponding modelling efforts (AMEC, 2007). These interpretations and efforts were determined through knowledge of water levels in water monitoring or supply wells and through modelling of these data. The hydraulic gradient may change in magnitude seasonally depending on precipitation. Greater precipitation may result in higher hydraulic gradients in the subsurface. However, it is rare to change the direction of groundwater flow without changes to the environment. For example, extracting water from the ground induces a hydraulic gradient toward the well which may be a different direction than was naturally present. References: AMEC Earth and Environmental. 2007. City of Chilliwack Sardis Aquifer 60-Day Capture Zone Figure 1.
IR 2.I.g	WaterWealth	Please explain the limitations and potential for error in relying on surface contamination models to determine vulnerability of an aquifer to contamination from a pipeline buried at the depths of the TMEP	The trench containing the pipeline will have a depth of approximately 2 m (1.8 to 2.2m) depending on local conditions. Thus the upper surface of the pipeline is very near ground surface. As such, surface contamination models would provide good estimates of the vulnerability of an aquifer, particularly an unconfined aquifer, to contamination from a pipeline. Since water table conditions typically mirror surface topography, expected shallow groundwater flow often reflects local topographic conditions. Trans Mountain acknowledges that surface pathway flow predictions are not a definitive indication of potential subsurface contaminant fate. However, situations where subsurface contaminant migration pathways differ from surface drainage pathways would typically be restricted to those situations where more complicated hydrogeologic conditions prevail (e.g. aquitards and confining layers separate shallow contaminant sources from deeper underlying aquifers), and such deviation would not typically be expected for shallow unconfined water table settings.

Table 2: Summary of Groundwater Related Commitments to the City of Chilliwack

Date Commitment Was Made	Commitment Description	Commitment Status	Project Stage for Implementation of Commitment
2014.12.15	Trans Mountain will review construction execution plans with the City of Chilliwack with particular focus on activity near the aquifer.	Scoping	Prior to Construction
2014.12.04	HMM to show water table on alignment drawings as requested by City.	Scoping	Prior to Construction
2015.09.25	City to provide information requested in draft memo. In addition, Waterline requested water chemistry for monitoring and supply wells listed in Item 4 of the memo.	Scoping	Prior to Construction
2015.09.25	KMC commented that the additional valve to the east of the Sardis-Vedder aquifer, near Silverthorne Road, does not impact DRA risk modelling results. City agreed to review and confirm if valve is required	Scoping	Prior to Construction

CERTIFICATION

This document was prepared under the direction of a professional geologist, geoscientist or engineer registered in the Province of British Columbia.

Waterline Resources Inc. trusts that the information provided in this document is sufficient for your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Respectfully submitted,

Waterline Resources Inc.

Reviewed By:

Joel Defoe, P. Geo. (AB)
Hydrogeologist

David van Everdingen, P. Geo.
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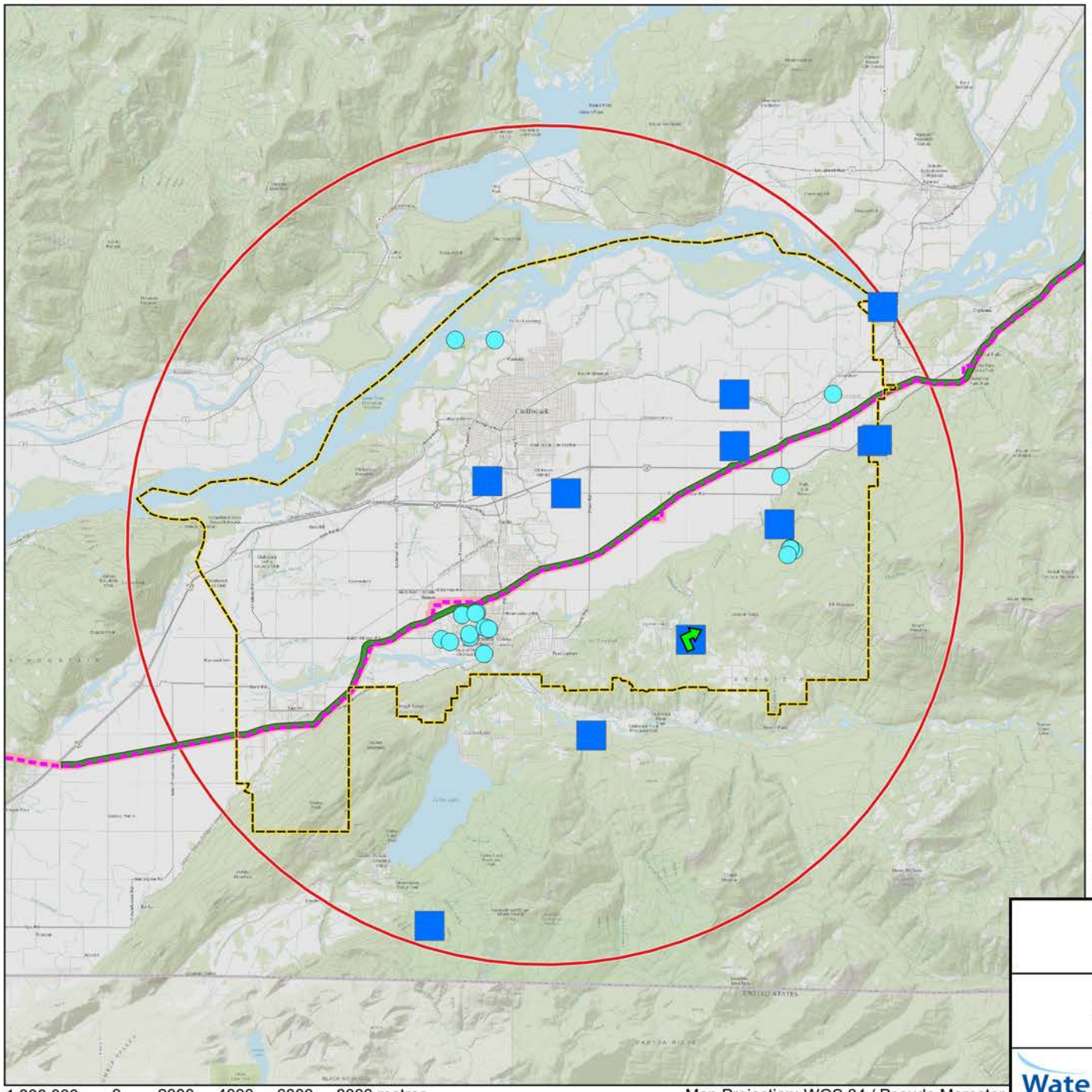


N

Legend

- Municipal Water Wells

Municipal Spring Licenses

- Current
- Abandoned/Other

Municipal Surface Water Licenses

- Current
- Municipal Boundary
- Proposed Pipeline Centre Line
- Existing Pipeline Centre Line
- 150 m Buffer
- 14.0 km Search Radius

Basemap: Esri World Topo

1:300,000 0 2000 4000 6000 8000 metres

Map Projection: WGS 84 / Pseudo Mercator

Reference:

BCGOV ENV Water Protection and Sustainability Branch, 2016. Ground Water Wells (Spatial View). DataBC Data Catalogue, accessed Nov 16, 2016; Data BC, BCGOV FLNRO Water Management Branch

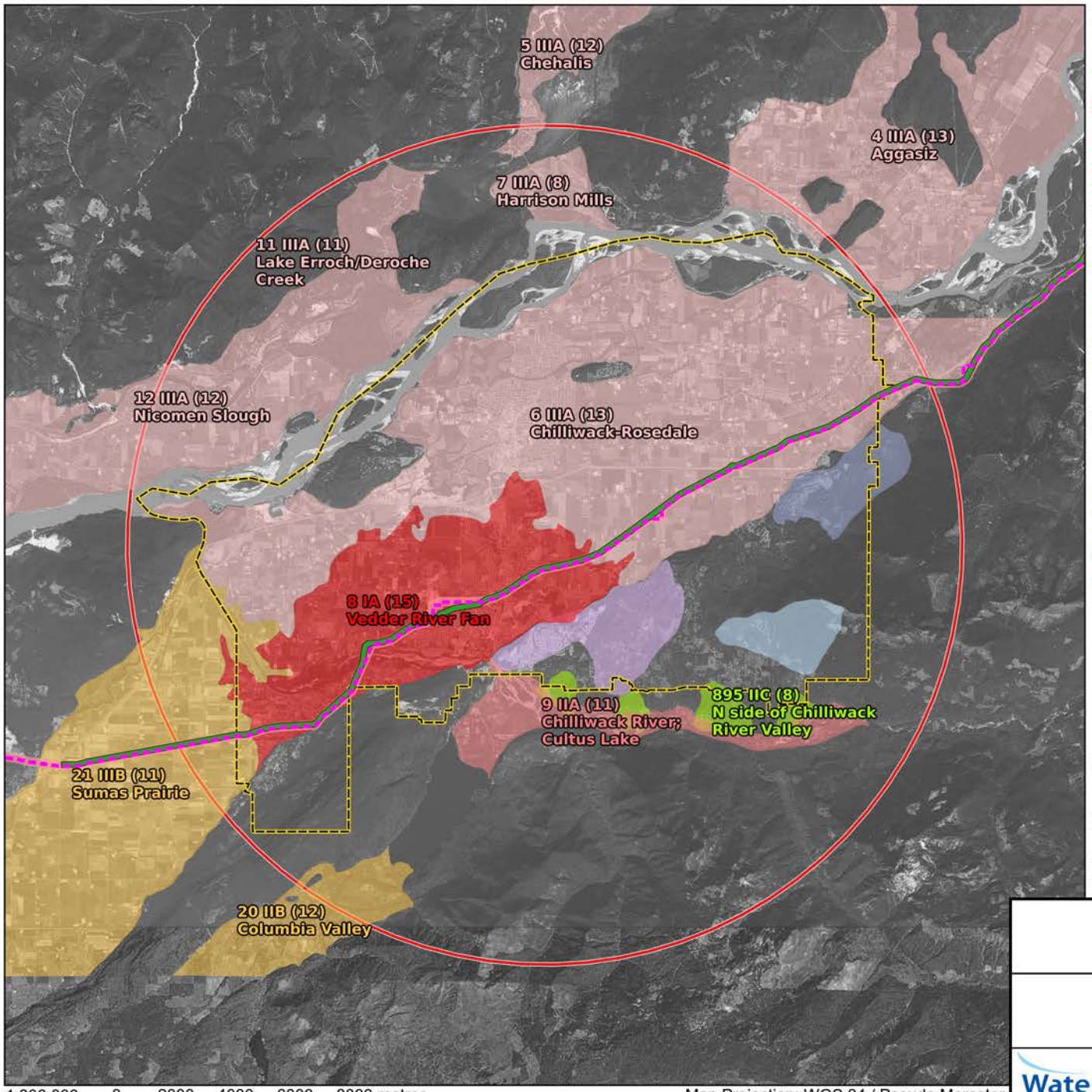
City of Chilliwack, BC

MUNICIPAL WATER SUPPLIES

Waterline

Prepared By:	J. Musulak
Project:	2137-16-006
Compiled By:	J. Musulak
Date Issued:	2016-Dec-14
Date Revised:	--

FIGURE 1



N

Legend

- Proposed Pipeline Centre Line
- Existing Pipeline Centre Line
- 150 m Buffer
- Municipal Boundary

Overburden Aquifers

- IA
- IIA
- IIB
- IIC
- IIIA

Bedrock Aquifers

- IIC
- IIIB
- IIIC
- 14.0 km Search Radius

Basemap: Esri World Imagery

Reference:

BCGOV ENV Water Protection and Sustainability Branch, Ground Water Aquifers, downloaded 2013-04-15.

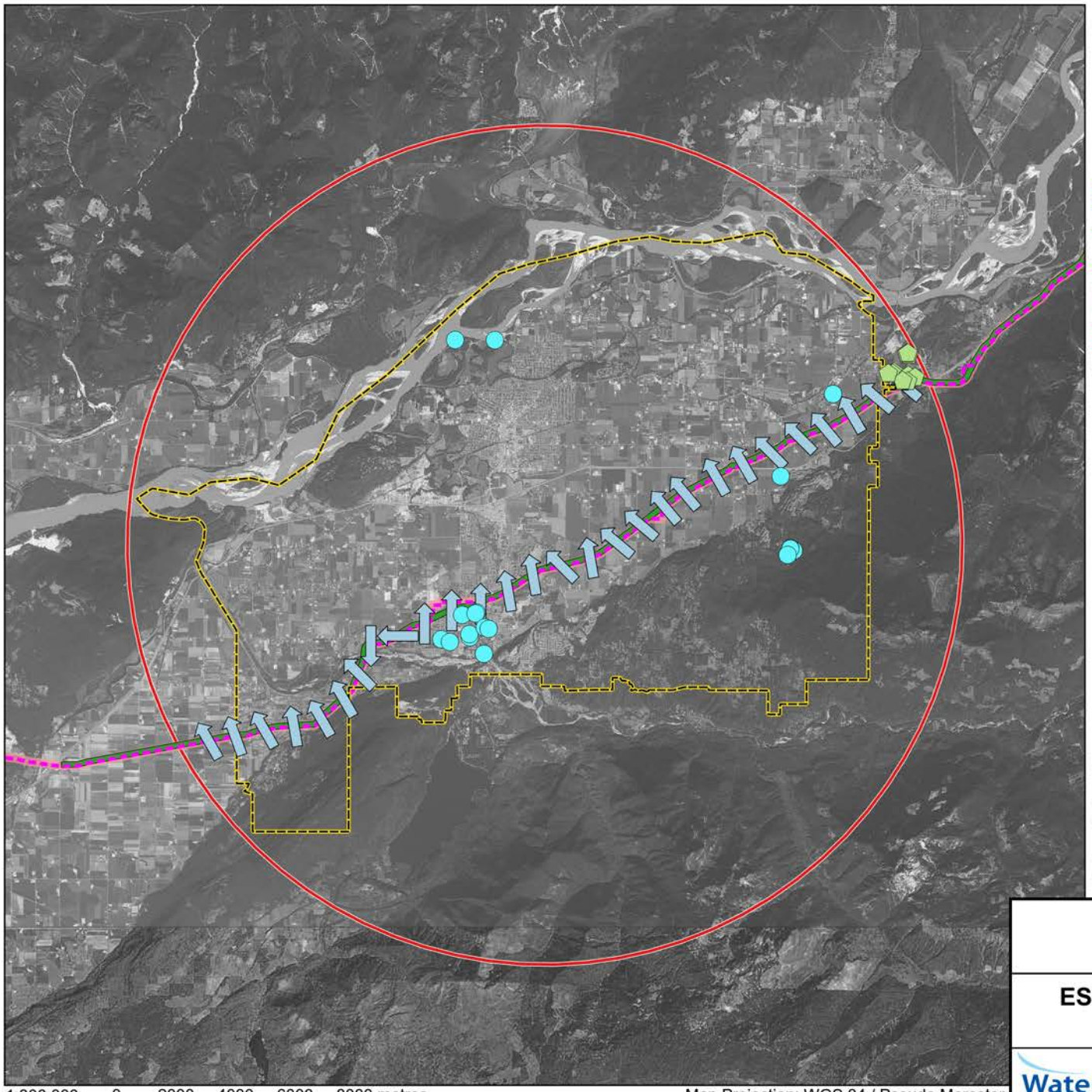
City of Chilliwack, BC

AQUIFERS

Waterline

Prepared By:	J. Musulak
Project:	2137-16-006
Compiled By:	J. Musulak
Date Issued:	2016-Dec-14
Date Revised:	--

FIGURE 2



Reference:

City of Chilliwack, Sardis Aquifer 60 Day Capture Zone (AMEC, Dec. 2007).

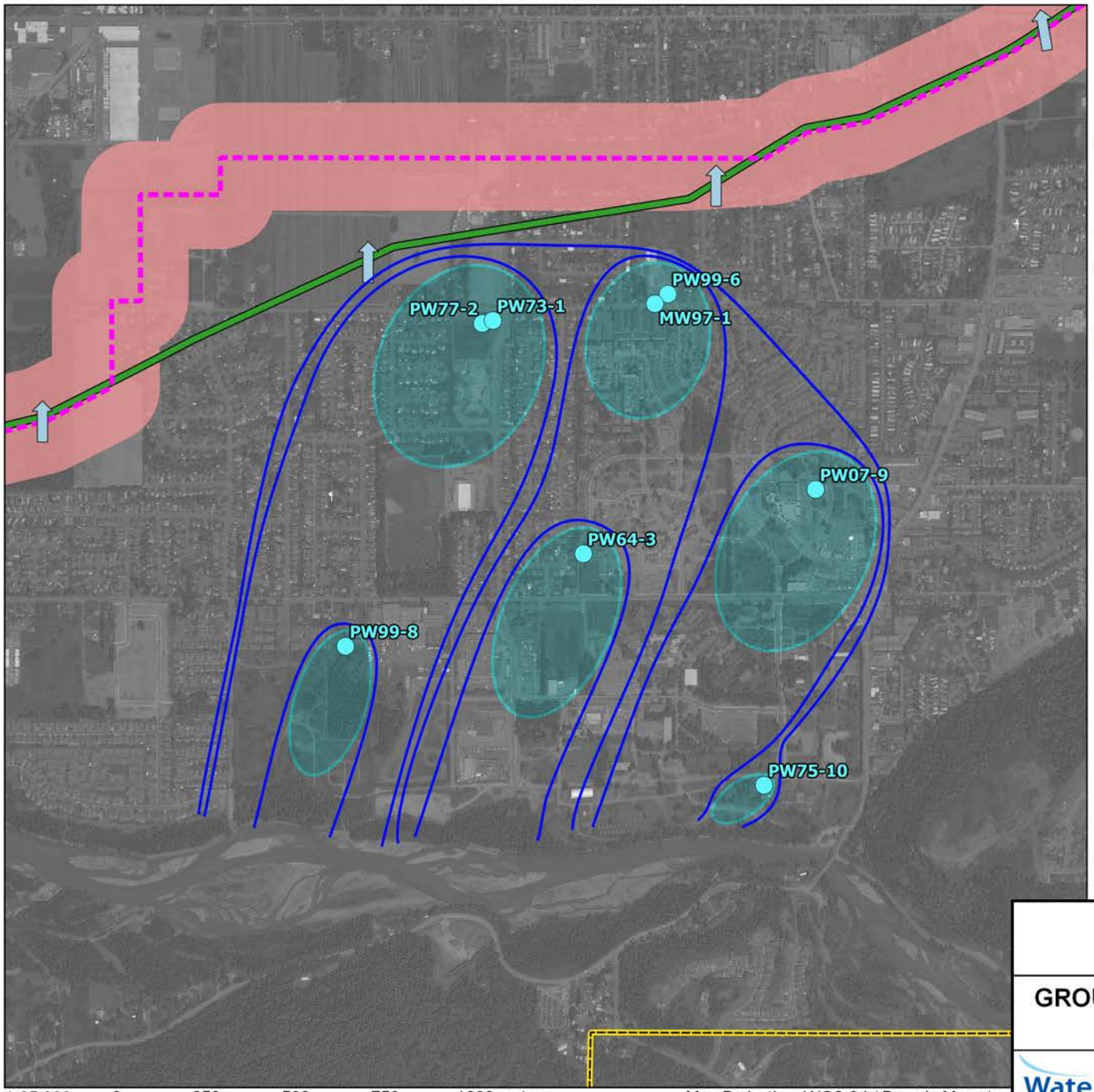
City of Chilliwack, BC

ESTIMATED GROUNDWATER FLOW DIRECTION

Waterline

Prepared By:	J. Musulak
Project:	2137-16-006
Compiled By:	J. Musulak
Date Issued:	2016-Dec-14
Date Revised:	--

FIGURE 3

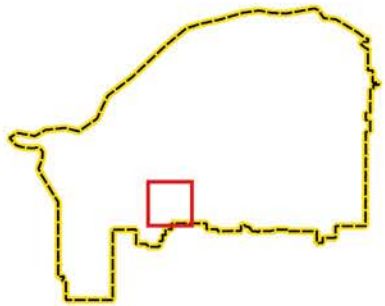


N

Legend

- Municipal Water Supply Wells
- Sardis Aquifer 60 day traveltime
- Capture Zone
- Estimated Groundwater Flow Direction
- Proposed Pipeline Centre Line
- Existing Pipeline Centre Line
- 150 m Buffer
- Municipal Boundary

Basemap: Esri World Imagery



Reference:

City of Chilliwack, Sardis Aquifer 60 Day Capture Zone (AMEC, Dec. 2007).

1:25,000 0 250 500 750 1000 metres

Map Projection: WGS 84 / Pseudo Mercator

City of Chilliwack, BC

GROUNDWATER FLOW DIRECTION AND WATER SUPPLIES

Waterline

Prepared By:	J. Musulak
Project Number:	--
Compiled By:	J. Musulak
Date Issued:	2016-Dec-12
Date Revised:	--

FIGURE 3A

Meeting Summary

Date: February 5, 2016

Location: City of Chilliwack Office

Start Time: 2.30pm

Duration: 1 hour

Subject: City of Chilliwack Technical Working Group #5

Project Number: 334890

Project Title: TMEP

Document: 334890-PM-313-S0-0247

Revision: A

Attendees:	Rod Sanderson (City)	Suzy Hunter (HMM)
	Paul Hill (KMC)	Jonathon Lingham (HMM)
Distribution:	Attendees, Bill Nooyen (KMC), Lexa Hobenshield (KMC), Adam Neale (HMM), Bruce Balson (HMM), Ashley Stuckless (HMM), ROC@kindermorgan.com	
Recorded by:	SH	

Item:	Discussion Summary / Action Description:	Action By / Due Date:
1	Additional valve for Sardis-Vedder aquifer	
	HMM tabled a sketch showing aerial view of area surrounding the intersection of Vedder Road and South Sumas Road. HMM advised that the closest viable location to Silverthorne Road suitable for installation of an additional valve was on Kinkora Golf Course or the land parcel immediately to the east of Kinkora.	
	Aerial view entitled 'Valve Site Options – Chilliwack Aquifer Revision A 18 January 2016' attached.	
	City advised that they did not have any specific concerns with either of the proposed locations but requested that HMM confirm that the proposed locations were outside of the capture zone.	
	ACTION - HMM to confirm that the proposed locations were outside of the capture zone.	HMM – SH
2	City Review of Preliminary Crossing Drawings	
	City tabled a hard copy of the crossing data table previously provided to TMEP via email.	
	ACTION - HMM to review draft table.	HMM – JL
	ACTION - City to provide updated table in native format.	City – RS
	ACTION - City to advise width of road allowance for each road crossing	City – RS
	ACTION – HMM to produce crossing drawings for municipal utilities which are not within roadways.	HMM - JL
3	Geotech program for Horizontal Directional Drilling (HDD)	HMM – SH
	HMM provided a brief summary of the geotech program in Chilliwack to be carried out to confirm the viability/preferred route of the HDD and alternative trenchless methodologies.	
	ACTION - City to advise City requirements for post drilling restoration of the boreholes within the aquifer	RS-City
	ACTION – HMM to confirm depths of the geotech investigations.	HMM - SH
4	Previous minutes not reviewed.	Info
5	SH to contact RS to schedule next meeting.	HMM-SH

Meeting Summary

Date: December 4, 2015

Location: City of Chilliwack Office

Start Time: 2.30pm

Duration: 1 hour

Subject: City of Chilliwack Technical Working Group #4

Project Number: 334890

Project Title: TMEP

Document: 334890-PM-313-S0-0229

Revision: A

Attendees:	Rod Sanderson (City) Tara Friesen (City) Bill Nooyen (KMC) via phone Paul Hill (KMC)	Adam Neale (HMM) Jonathon Lingham (HMM) Suzy Hunter (HMM)
Distribution:	Attendees, Lexa Hobenshield (KMC), Kristjana Hawthorne (KMC), Ashley Stuckless (HMM), Bruce Balson (HMM), ROC@kindermorgan.com	
Recorded by:	SH	

Item:	Discussion Summary / Action Description:	Action By / Due Date:
1	Horizontal Directional Drilling (HDD) discussion	
	HMM had provided conceptual HDD alignment drawings, for BC Hydro ROW alignment and alternative alignment, via email in advance of the meeting.	
	City acknowledged the value to the community of not using open cut trench in this area, however concerns were raised on the depth of the drilling and the proximity to the aquifer. City raised concerns regarding identification and quick response to spills occurring at proposed HDD depth.	
	KMC described integrity program.	
	City asked if shallower trenchless methodologies could be investigated. HMM advised that HDD was the most proven trenchless methodology but that typically HDD depth would be at least 10m. HMM also advised that additional site investigation e.g. boreholes would be required to confirm feasibility of HDD and alternative trenchless methodologies. The City is supportive of geotech investigation to confirm viability/preferred route and advised no concerns regarding drilling boreholes for this purpose.	
	ACTION – HMM to provide proposed borehole locations prior to carrying out additional SI	HMM – SH
	ACTION - HMM to investigate shallower methodologies and advise Chilliwack of findings when available.	HMM - SH
	ACTION - HMM to show water table on alignment drawings as requested by City.	HMM - JL
2	Sample drawings	
	HMM tabled sample crossing drawings.	
	Utility locations shown are still indicative and will be confirmed via daylighting.	
	City requested that the methodology for how the crossing will be completed within the road allowance be shown on the drawing.	
	City asked the drawings are marked 'For Permit'.	
	City requested a single drawing for road and water/sewer utility crossings within the road allowance.	

	City requested drawings are submitted in batches c/w coversheet showing drawing list and key plan.	
	ACTION – HMM to update drawings as described above	HMM - JL
3	Additional valve for Sardis-Vedder aquifer	
	HMM advised that the additional valve was currently proposed to be located at Prest Road to optimise slight reduction in outflow volumes. City re-iterated request to have valve added at or near to Silverthorne Road to be as close to the aquifer as possible.	
	ACTION – HMM to issue project decision register to locate valve at or before Silverthorne Road (as close as possible).	HMM - SH
4	Tzeachten alignment	
	KMC advised that Tzeachten discussion were progressing. City requested that they are advised of any developments as soon as possible.	
5	Road Crossings	
	HMM advised the current intention was to bore road crossings in Chilliwack. City advised that as a minimum, roads with traffic volume in excess of 10,000 cars per day and/or 4 lanes or greater should be crossed with trenchless methods.	
6	NEB timeline	
	HMM advised that the NEB recommendation to cabinet has been delayed by 4 months to May 20, followed by a 90 day review period prior to CPCN decision. TMEP are assessing the impact of this delay to the overall schedule.	
7	**Next meeting date : end of January 2016**	
	SH to contact RS mid-January to confirm/schedule.	HMM-SH

Meeting Summary

Date: October 28, 2015
Location: City of Chilliwack offices
Start Time: 3pm
Duration: 1 hour
Subject: Technical Working Group #3

Project Number: 334890
Project Title:
Document: 334890-PM-313-S0-0208
Revision: A

Attendees:	Rod Sanderson (City) Tara Friesen (City) Bill Nooyen (KMC) via phone Paul Hill (KMC)	Adam Neale (HMM) Jonathon Lingham (HMM) Suzy Hunter (HMM) via phone
Distribution:	Attendees, Lexa Hobenshield (KMC), Kristjana Hawthorne (KMC), Ashley Stuckless (HMM), ROC@kindermorgan.com	
Recorded by:	SH	

Item:	Discussion Summary / Action Description:	Action By / Due Date:
1	BC Hydro ROW	
	City advised they would take a neutral stance regarding the existing route versus the alternate route. City had hoped that backyard construction could be avoided with the alternate route, but HMM study shows this is not the case due the setback from the power lines stipulated by BC Hydro.	
	ACTION – City to send formal response to BN outlining their position on routing	City - RS
	ACTION - KMC to action the Lands team to confirm permission to survey from residents on P1 Alternate Alignment	KMC
	ACTION – KMC to advise City of outcomes KMC internal meeting on October 30th	KMC
	ACTION - HMM to provide sketches of trenchless scenarios for City to review and provide feedback	City – TF
2	Routing within Aquifer	
	Data received from City on October 27. City indicated that the modelling of the capture zones includes allowances for future usage.	
	City advised that they have experience of push/pull drilling under Highway 1, but not within the aquifer capture zone.	
	City confirmed that valve is to be added to the east of the Sardis-Vedder aquifer. City expected to have valves on either side of the water course.	
	ACTION - HMM to confirm specific location of added valve.	HMM - SH
3	South Sumas Road and Vedder Road crossings	
	HMM tabled routing drawings. Proposed methodology is open cut with traffic management for South Sumas Road and bore for Vedder Road. City mentioned that open cut road crossings may be considered for roads with low traffic volumes as long as traffic management plan allows for local traffic to be accommodated for the duration for the works. Daytime lane closures may be considered for daylighting utilities.	

	ACTION - City to consider drawings and methodology and provide feedback.	City
4	Action items from previous minutes	
	Item 2, bulletpoint 5: City to advise of any previous experience of geofabric in bottom of trench within capture zone.	
	Update – City advised that they had no prior experience for this specific purpose but they would expect TMEP to adopt industry best practice.	
	ACTION – HMM to follow up with construction team regarding prior experience	HMM – JL
	Item 5: Alignment through Tzeachten First Nation Reservation (IR13)	
	Update – Info session being held October 28, 2015.	
	ACTION – BN to advise City of any relevant outcomes	KMC - BN
	Item 7: City comments received on sample crossing drawings.	
	ACTION – HMM to provide response to questions.	HMM – JL
5	HMM proposed tabling crossing drawings in future TWG meetings for City review. City requested that drawings are sent in batches (5-10 drawings) in advance of each meeting.	
	ACTION – HMM to send drawings prior to next TWG	HMM - JL
6	**ACTION** - HMM to develop list of requests made in City's Letter of Comment to NEB dated Aug 18, 2015 and provide status	HMM - SH
7	City clarified that any works on the Heritage Trail must have appropriate restoration after construction.	
8	Delay in NEB decision was discussed. NEB recommendation now expected May 2016, not January 2016.	
9	**Next meeting date : End of November.**	
	ACTION - SH to contact RS mid November to agree timing	HMM - SH

BC Hydro/Chilliwack Routing Options

October 28, 2015

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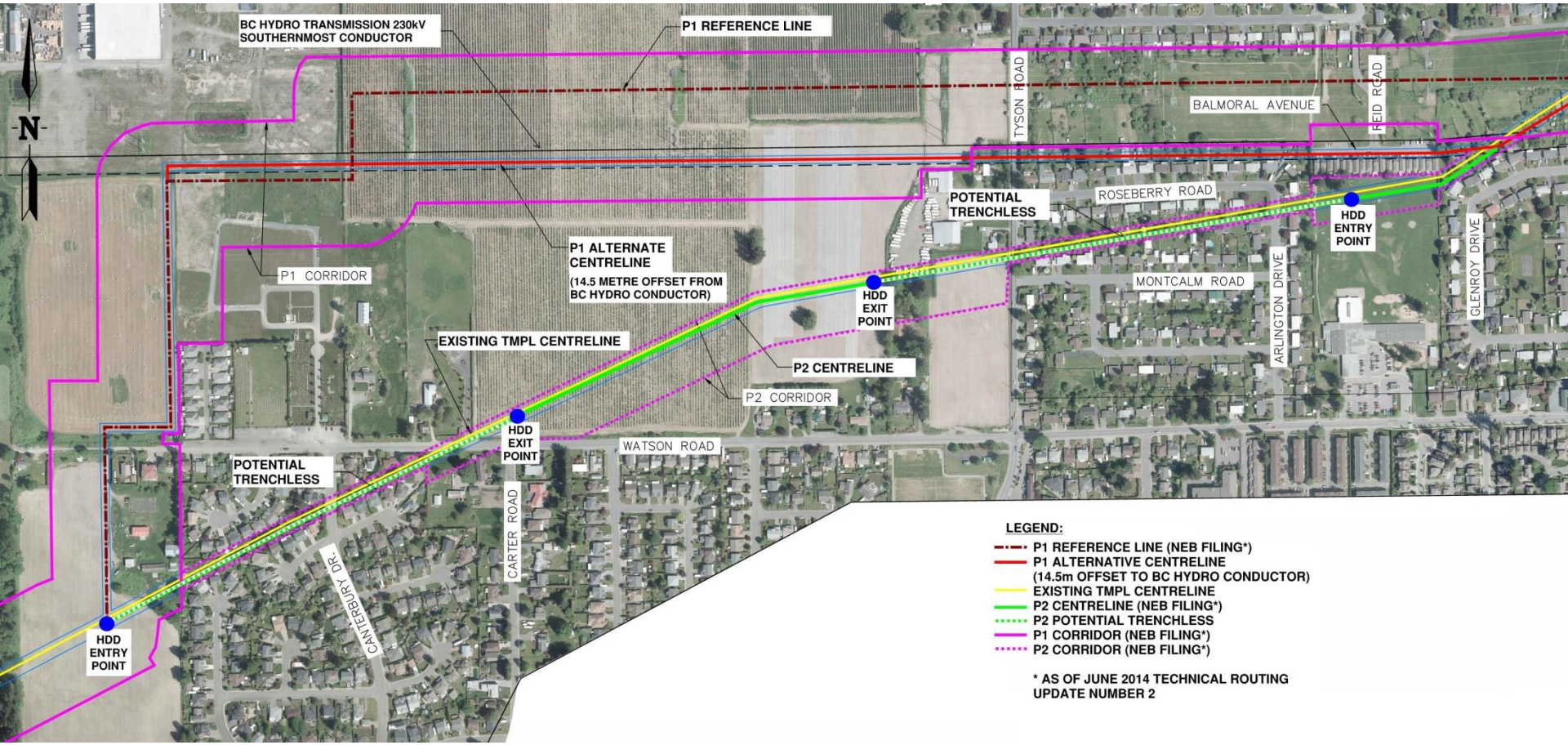
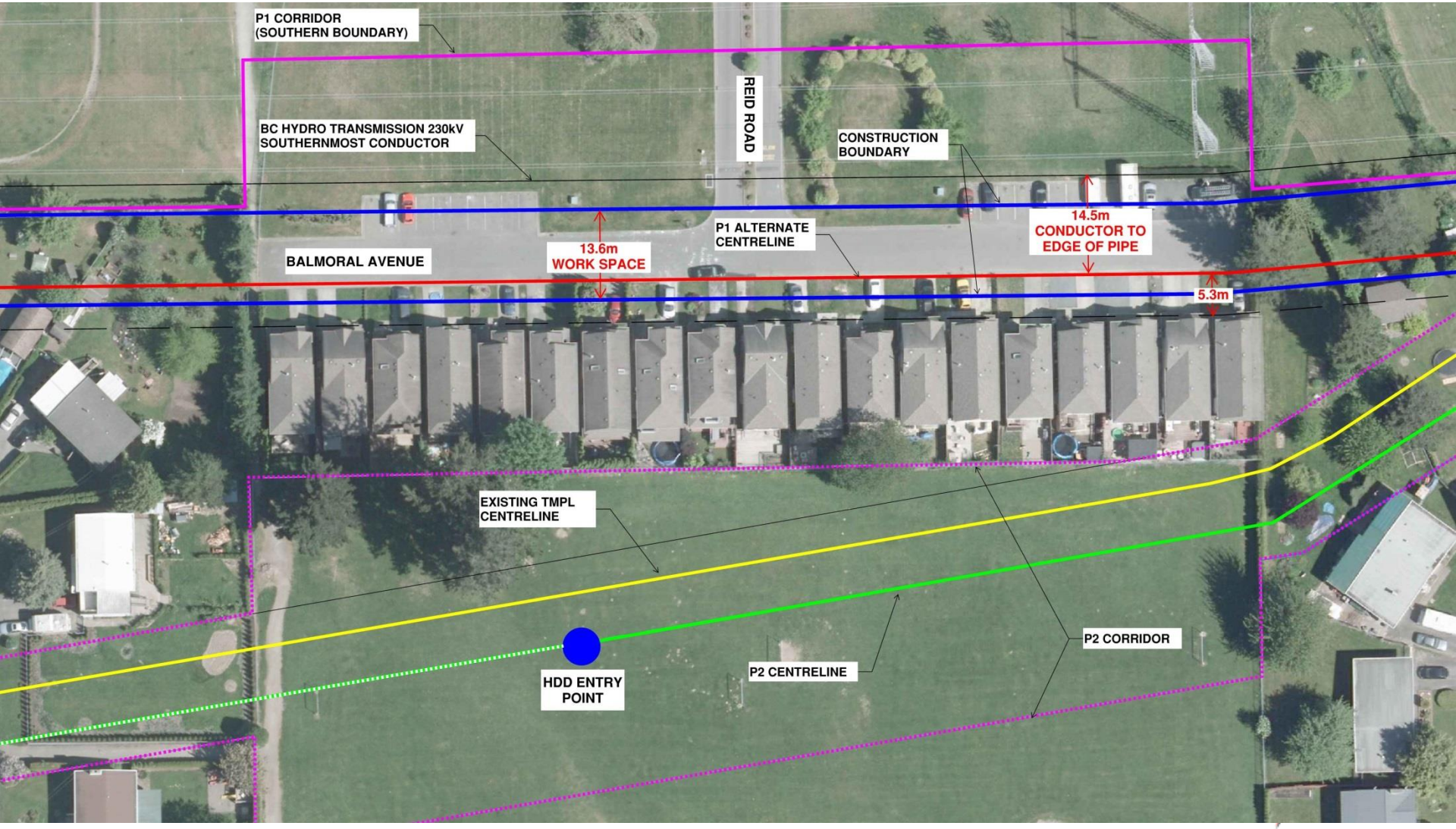
ENGINEERING

OVERVIEW – ROUTE OPTIONS

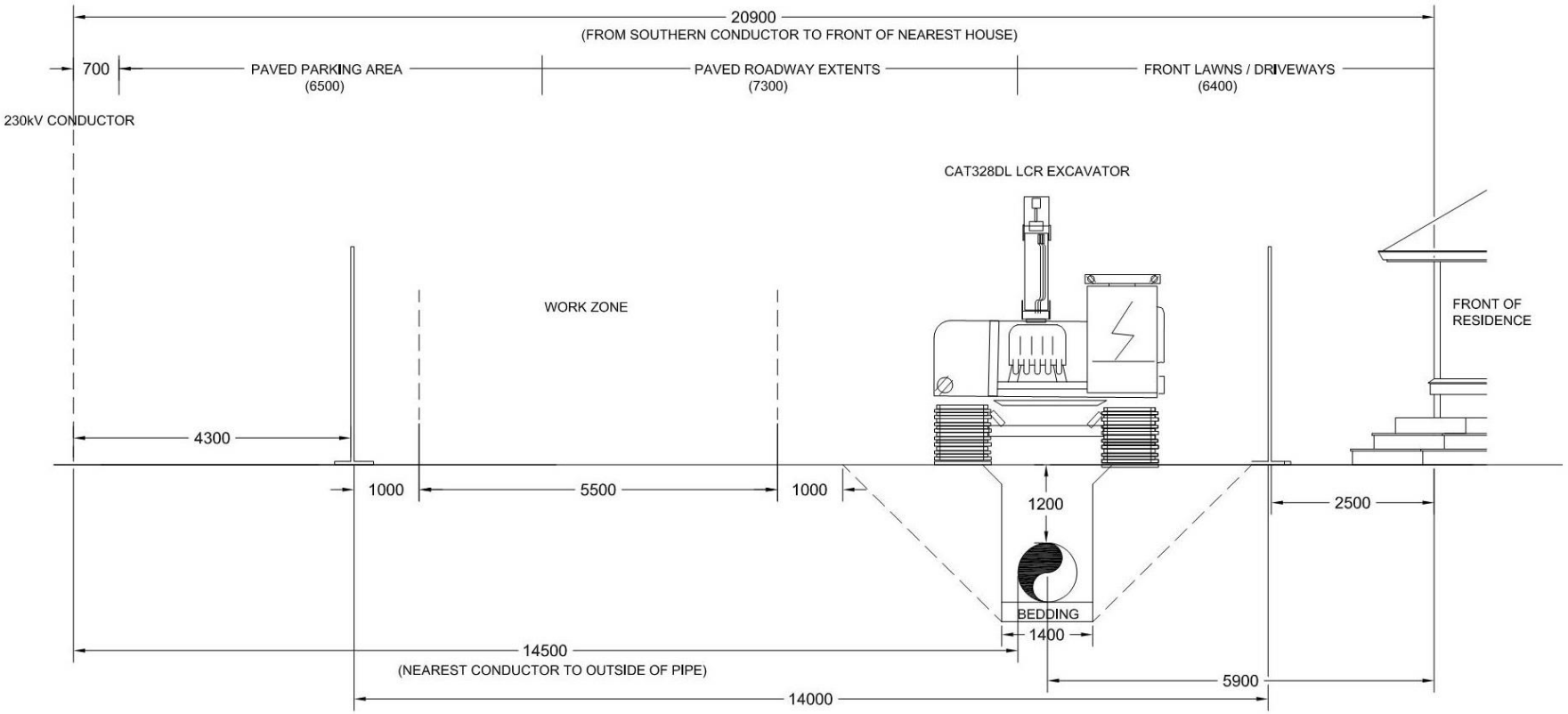


P1 ALTERNATE OPTION

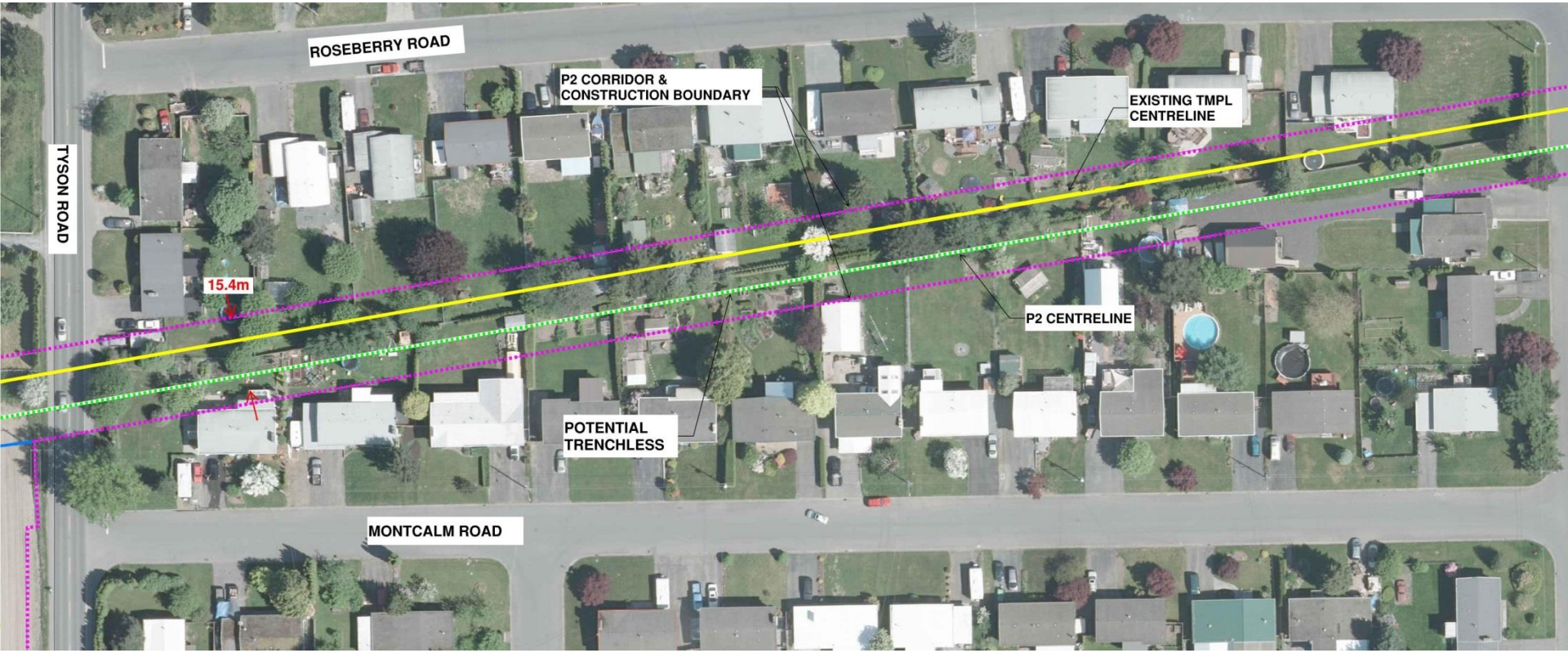


P1 ALTERNATE OPTION

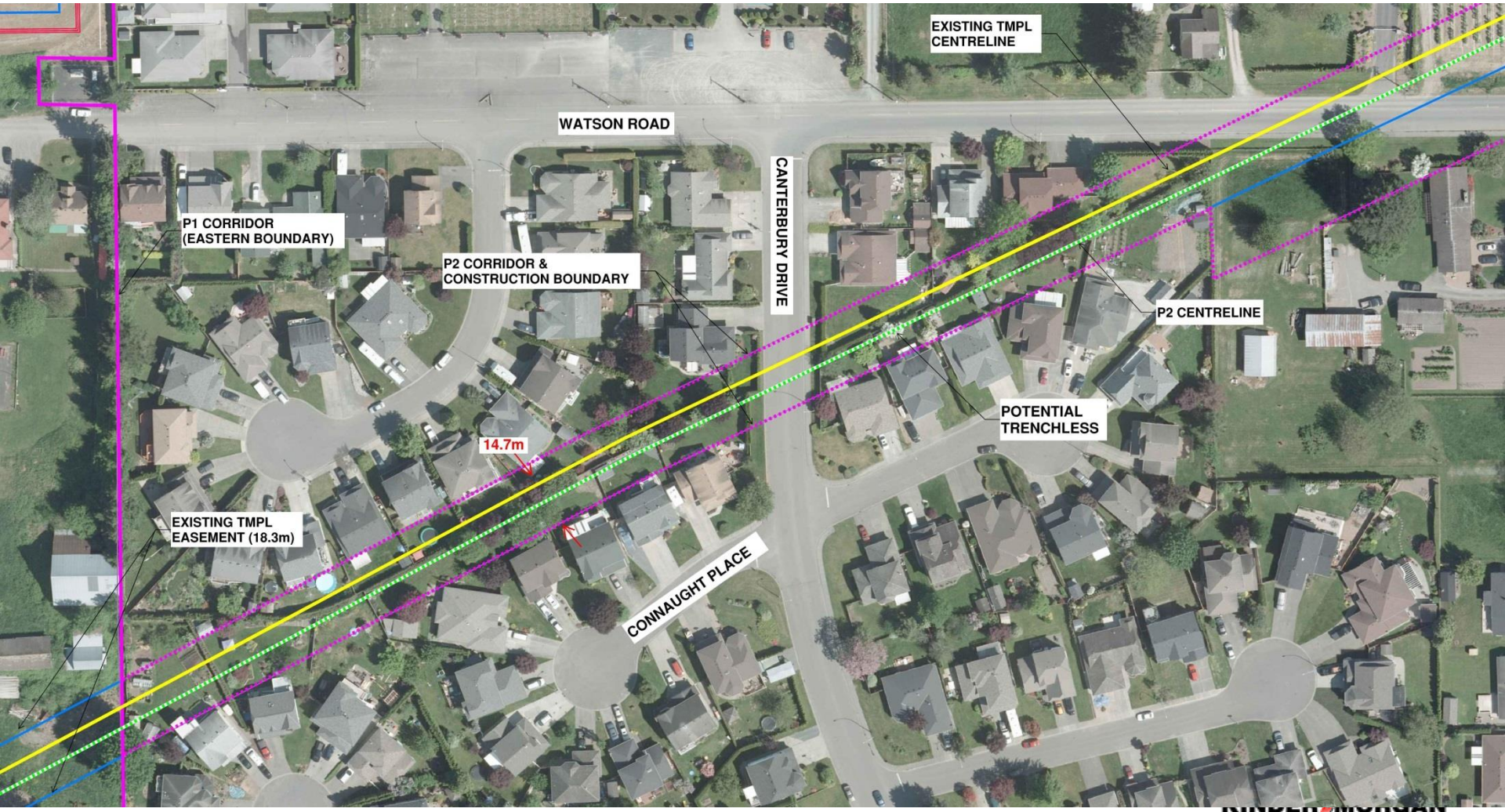
P1 CONSTRUCTION SECTION



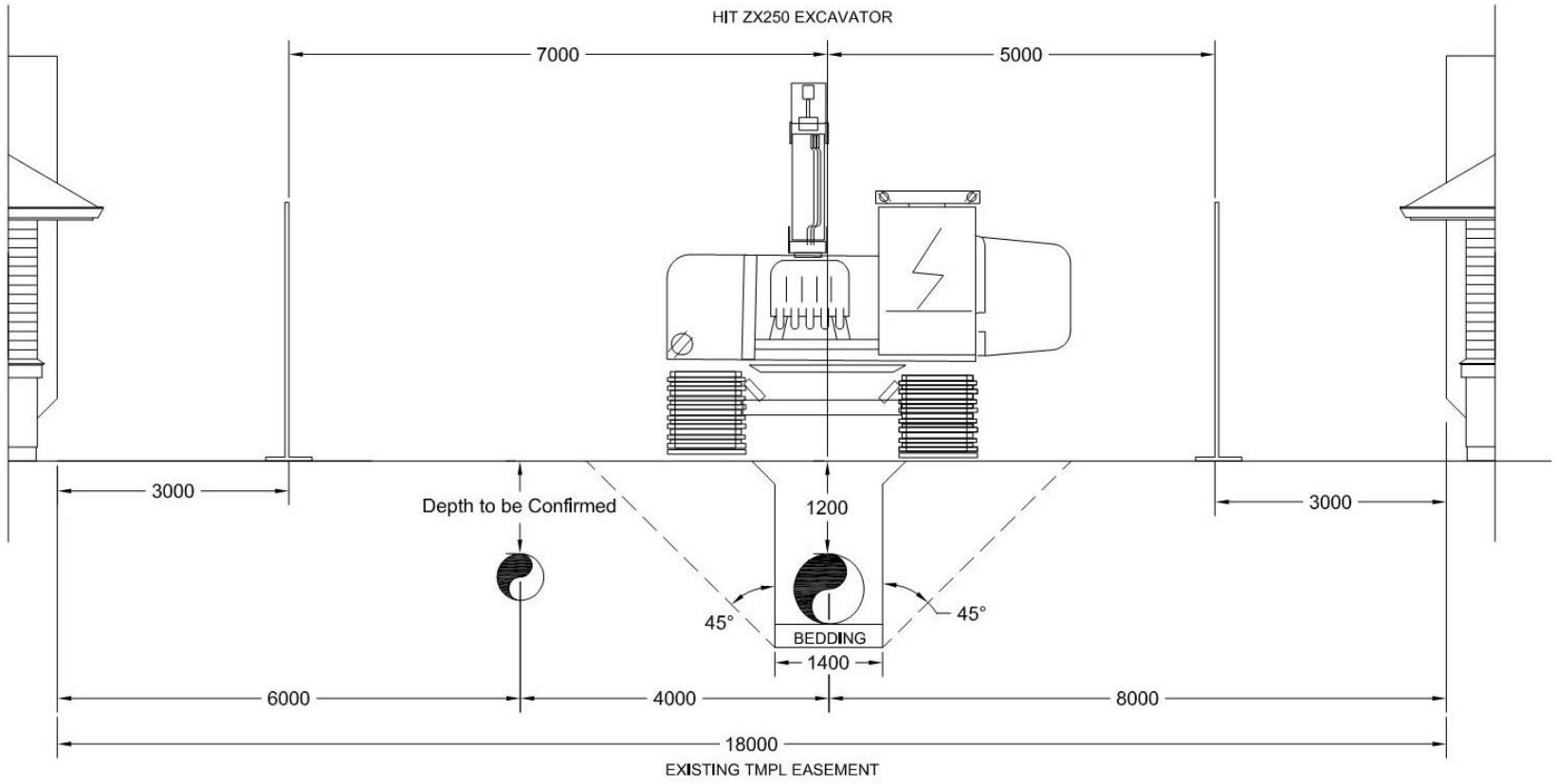
P2 OPTION


ROSEBERRY ROAD
P2 CORRIDOR &
CONSTRUCTION BOUNDARY
EXISTING TMPL
CENTRELINE
TYSON ROAD
15.4m
P2 CENTRELINE
POTENTIAL
TRENCHLESS
MONTCALM ROAD

P2 OPTION


EXISTING TMPL CENTRELINE
WATSON ROAD
CANTERBURY DRIVE
P1 CORRIDOR (EASTERN BOUNDARY)
P2 CORRIDOR & CONSTRUCTION BOUNDARY
P2 CENTRELINE
POTENTIAL TRENCHLESS
14.7m
EXISTING TMPL EASEMENT (18.3m)
CONNAUGHT PLACE

P2 CONSTRUCTION SECTION



Stakeholder Consultation

BC Hydro

- Engagement with BC Hydro began mid-2014
- Following multiple delays, BC Hydro initiated Field Resistivity testing to support modeling between their two 500kV circuits
- First draft report issued May 27th 2015 (4 months behind originally promised date)
- Report indicated the P1 Reference Line was unacceptable (preference for P2 Route)
- BC Hydro indicated that between the 500kV and 230kV is also unacceptable
- BC Hydro was then asked to model the pipeline to the south of their 230kV conductors
- Revision 1 of the report was issued July 6th 2015, showing that with adequate mitigation the alignment could be placed just within their easement (easement boundary is located 21.34m to the south of the 230kV conductor)
- Due to being extremely close to residents, BC Hydro was asked to model the pipeline closer with “unlimited” mitigation

Stakeholder Consultation

BC Hydro (Continued)

- BC Hydro responded September 9th 2015 to state that the closest possible distance (due to safety concerns) is 14.5m from the 3rd conductor – this option is shown as the P1 Alternate Centreline on the following slides
- Continuing to work with BC Hydro Transmission on crossings
- Distribution crossing review has begun, but still remains a risk
- Project Management and cost reporting from BC Hydro has been unacceptable; lobby to remove Project Manager was denied

City of Chilliwack

- Initially, it was the City of Chilliwack's preference for the P1 Reference Line Route for TMEP due to utilizing the BC Hydro Green Belt corridor, resulting in less construction impact to residents
- BC Hydro has removed the P1 Reference Line as an option, and has countered with a minimum 14.5m offset south of the 230kV conductor (with mitigation)
- Currently, the City of Chilliwack is neutral with regards to the P1 Alternate Route and the P2 Route, as both will involve construction impacts to residents

Constructability

GENERAL CONSTRUCTABILITY

- The P1 Alternative Route (14.5m offset from BC Hydro 230kV conductor) and the P2 Route (utilizes existing Trans Mountain easement) are both constructible utilizing open cut methodologies with restricted work space and reduced production rates. Landowner concerns with proximity to houses would likely drive to trenchless solution (HDD, Direct Pipe).
- Both routes will involve using security fencing placed within 3m of residential houses

MAJOR TRENCHLESS

- The P2 Route currently has two Horizontal Directional Drills (HDDs) currently being explored, and shown in the Overview slide . To determine the feasibility of these HDDs, further geotechnical investigation will need to be undertaken
- HDD for the P1 Route would also require HDD investigation and feasibility assessment
- Due to being within the extents of a major Chilliwack Aquifer, additional considerations and input will need to acquired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LANDS

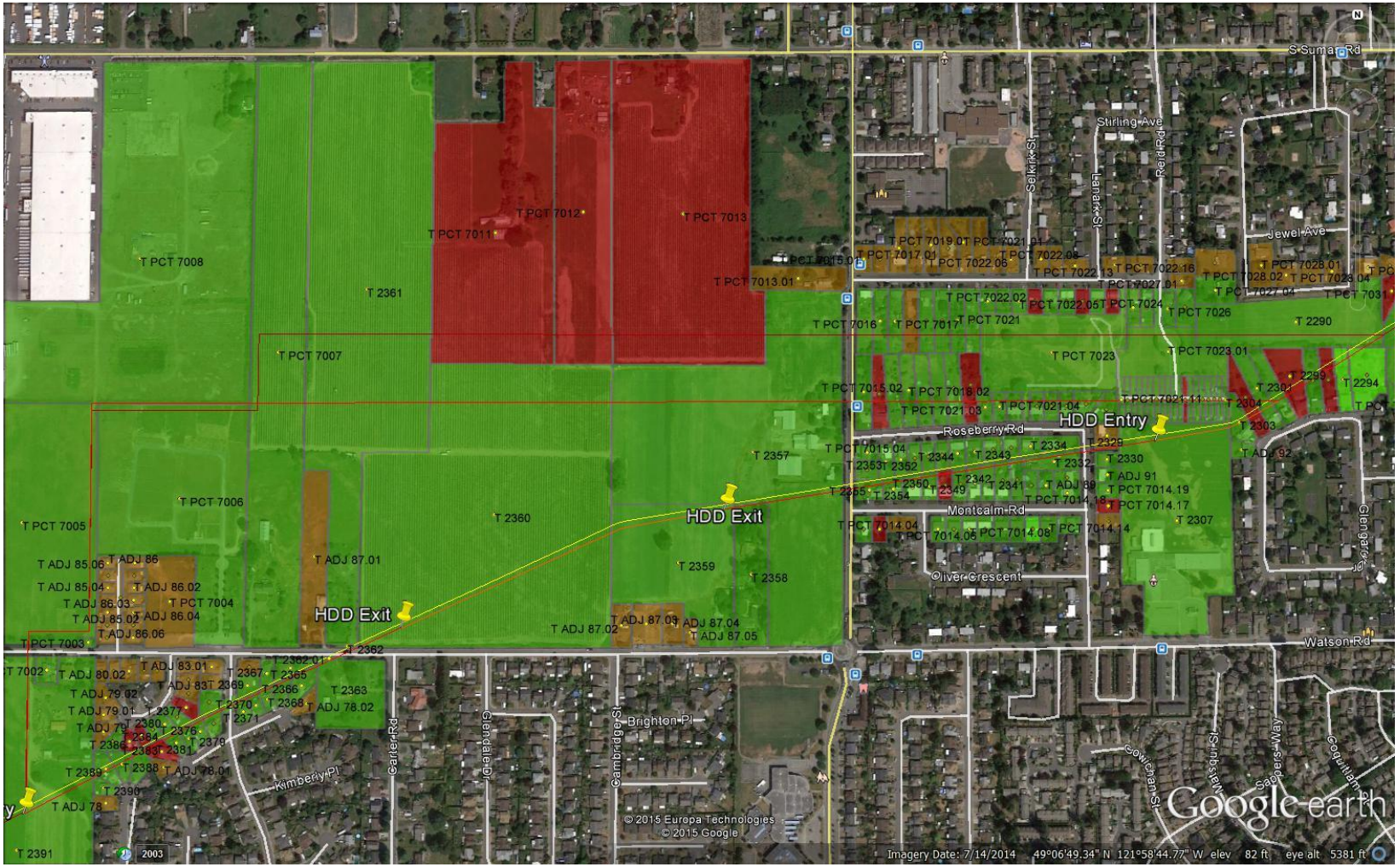
Lands Consultation Update

- P1 Hydro Corridor:
  - All landowners received NEB Notice to Participate (Oct-Nov 2012)
  - Survey consent requested – 3 refusal with original alignment, 4 refusals with revised alignment
    - Requests for survey were based upon TMEP inside the BC Hydro Corridor
    - Expect opposition to increase with new alignment closer to homes
- P2 TMPL Corridor:
  - All landowners received NEB Notice to Participate (Oct-Dec 2012)
  - Survey consent requested – 6 refused
  - Refusals: opposed to TMEP, safety, past tree removals
  - ½ of the existing TMPL easements are single line and would not apply to TMEP.
- Minimal contact with property owners since March-August 2013.

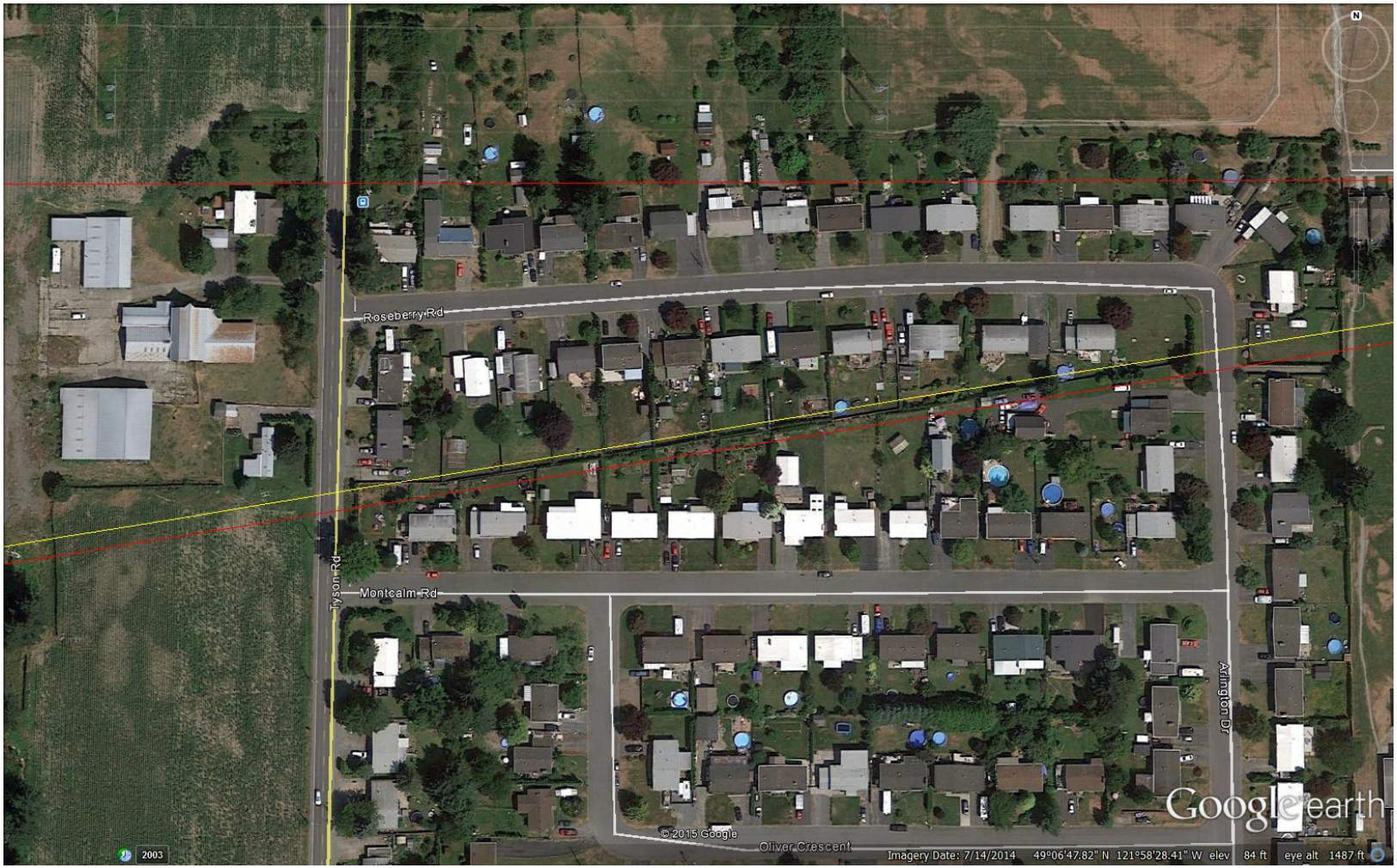
Property Impacts

Corridor	Properties within Corridor	Homes within 20 m of pipe centerline
P1 – Hydro Corridor	20	8
P1 – Revised Hydro	47	44
P2 – TMPL Corridor	43	47
Corridor	**Survey Consent (inside BC Hydro Corridor)**	**Survey Refusals**
P1 – Hydro Corridor	17	3
P1 – Revised Hydro	41	6
P2 – TMPL Corridor	38	5

Land Survey Access Status



Properties Within 20m of TMEP



STAKEHOLDER ENGAGEMENT AND COMMUNICATIONS

Stakeholder Engagement - Analysis

- Stakeholders in Chilliwack have been engaged since 2012 however has not been extensive and we have not been actively present in the broader community since March 2014
- Since Spring 2013, mapping displayed during consultation showed the preferred and alternate corridors for routing in Chilliwack; the focus however has not been on routing
- Although invites extended to broader community, only direct engagement in affected neighbourhoods was with Watson Elementary school (February 2014)
- Feedback received from Chilliwack stakeholders to date focused on:
  - environmental aspects such as protecting aquifer
  - perceived land/property de-valuation
  - pipeline safety and emergency response planning

Stakeholder Engagement - Chilliwack

Nov 2012	Open House	Advertised event to scope issues, no routing options provided
Jun 2013	Routing Workshop	By invite routing workshop with stakeholders representing community interests (no identified attendees specific to affected neighbourhoods)
Feb 2014	Meeting with Watson Elementary Principal	Provide project overview and damage prevention/public awareness
Mar 2014	Routing Workshop	By invite routing workshop with stakeholders representing community interests (no identified attendees specific to affected neighbourhoods)
Mar 2014	Public Information Session	Advertised event, routing maps available
2015	Digital Engagement (webinars, weekly e-newsletter, website)	Construction related information provided to Fraser Valley residents
2015	Telephone Town Hall	Construction related information provided to Fraser Valley residents
Misc	Presentations	Chilliwack interest groups: Chambers, Rotaries, Probus
Ongoing	Meetings with local government	To exchange information on all aspects of project, including technical details via TWGs

Mitigation & Risks

- Recommend additional engagement to minimize risk and ensure stakeholders are fully aware of our preferred route:
  - Would ensure we can meet Condition 9 (Tzeachten IR routing)
  - Meets community expectations & protects KMC/Trans Mountain brand
  - Ensures residents in affected neighbourhoods are aware of our plans, have opportunity to ask questions and seek clarification
  - Given the strong opponent community in Chilliwack: Home of Water Wealth & Pipe Up *(Pipe Up focus on concerns about routing through schools)* it is important that we continue to be transparent

Proposed Next Steps

- Ongoing discussions with City of Chilliwack to obtain feedback on routing & construction aspects
- Neighbourhood specific engagement:
  - Prior to neighbourhood engagement: Land Team advise landowners of routing decisions
  - Q1 2016: Meeting with Principals of Vedder Middle & Watson Elementary schools, Chilliwack School District to provide routing and construction update
  - Q1 2016: Updates to provincial and federal elected officials in Chilliwack
  - Q2 2016: By invite neighbourhood update session to provide routing update and construction information to affected neighbourhoods; follow-up with online opportunity to provide feedback on construction aspects

REGULATORY

Regulatory

- Alternative route P2 removed from NEB alternatives through IR 3.017 in Feb 2015
- Alternative P1 pushed outside of Study Corridor with BC Hydro mandated 14.5 m offset
- Both P1 and P2 require consultation and Variance application, with start date after NEB Report and Recommendations
- NEB Condition 56 requires report for mitigation of segments of pipeline within 10 m of hydro conductor. Must include how TMEP reached agreement with BC Hydro.

Meeting Summary

Date: September 25, 2015

Location: City of Chilliwack Office

Start Time: 1.30pm

Duration: 1 hour

Subject: City of Chilliwack Technical Working Group #2

Project Number: 334890

Project Title: TMEP

Document: 334890-PM-313-S0-0173

Revision: A

Attendees:	Rod Sanderson - City of Chilliwack, Deputy Director of Engineering	David van Everdingen – Consultant to KMC
	Bill Nooyen - KMC (via phone)	Jonathon Lingham – HMM
	Kristjana Hawthorne - KMC (via phone)	Suzy Hunter – HMM
	Margaret Mears - KMC	
Distribution:	Attendees , Adam Neale (HMM), Lexa Hobenshield (KMC)	
Recorded by:	S. Hunter	

Item:	Discussion Summary / Action Description:	Action By / Due Date:
1	Minutes from last meeting not reviewed.	
2	Sardis-Vedder Aquifer	
	City of Chilliwack proposed that discussion of Letter of Comment be deferred to the next TWG. HMM to add to agenda for next meeting.	SH
	HMM tabled draft memo responding to City of Chilliwack's letter dated July 6.	
	• KMC commented that the additional valve to the east of the Sardis-Vedder aquifer, near Silverthorne Road, does not impact DRA risk modelling results. City agreed to review and confirm if valve is required.	City
	• City to provide information requested in draft memo. In addition, DvE requested water chemistry for monitoring and supply wells listed in Item 4 of the memo.	City
	• City requested that memo plus cover letter are submitted formally.	SH/KMC
	• The design considerations listed in Item 4 of the draft memo were not reviewed. City to review and provide feedback.	City
	• Geofabric discussion was tabled and is to be added to agenda for next TWG. City to advise if fabric has previously been used in trench bottom for other work through capture zone.	SH/City
	• BN committed to using biodegradable hydraulic fluid for the pipeline section from the western limit of Watson Road to the western property line of 45560 South Sumas Road.	
	• City assumes best management and engineering practices will be used by TMEP.	
3	Ground water monitoring	
	Tara Friesen leads this effort for the City. Tara to attend next TWG if possible to discuss GW monitoring in more detail.	

4	Commitment Tracking List KMC's intention is that the tracking list is a live document, with monthly updates.	
5	Alignment though Tzeachten First Nation Reservation Negotiations are progressing well, with no hold points anticipated	
6	Alternate route in BC Hydro ROW HMM tabled sketches showing alternate route for TMEP within BCH ROW. BCH require that TMEP provide a minimum 14.5m clearance from the southern conductor on the 230kV line. This setback distance is in addition to other AC mitigation measures that TMEP would be implementing. City to comment on acceptability of this alignment within BC Hydro ROW versus paralleling existing TMPL.	City
7	Sample crossing drawings HMM tabled sample crossing drawings. City to review and advise comments.	City
8	Future meetings City agreed to regular monthly meetings to be set up individually due to scheduling constraints. HMM to send meeting requests as required. Permitting and Traffic Management to be discussed in future meetings. **Next meeting – end of October**	SH

Correspondence

From: Hawthorne, Kristjana
Sent: Wednesday, March 08, 2017 3:59 PM
To: 'Blain, David'
Cc: Hobenshield, Lexa
Subject: RE: Information requested by the City of Chilliwack

David,

The statement was written to take into account both feedback we received from the City and other stakeholders. We take feedback from the City seriously and place high value on your feedback when making Project decisions. From our ongoing discussions, including emails and written correspondence, we heard from the City that of the two construction methodologies presented for consideration, open-trench from the City's perspective was preferred over HDD which would place the pipe close to the water intake levels.

Your email of January 26, 2017 to Lexa states:

- …when the pipe was to be shallow, they represented reasonable risk management. A deep pipe in the water table represents a whole different level of concern.
- …from the City's perspective 1-2 months of construction risk or disruption is better than 100 years of having to worry about the pipeline causing a problem

To address the City's concerns about operations once the pipeline goes into service, our technical consultant, Waterline prepared a Technical Memo based on the assumption of open-trench construction, to outline what would happen in the event of a release from operating the pipeline. The Technical Memo does not discuss, nor was it intended to discuss, the merits between open-trench or HDD technology or the impact of those construction methodologies on the aquifer.

Trans Mountain hires technical experts who are certified in their chosen fields to provide professional, unbiased, and technically sound advice. They have a responsibility to provide technical recommendations that are safe for the environment and the public. Trans Mountain would not have proposed HDD as a potential construction methodology if we were unsure that the risk to the aquifer could be minimized.

Trans Mountain takes protection of the aquifer seriously and we are confident that our mitigation measures will protect the aquifer. We look forward to seeing you at the information session this evening.

Regards, Kristjana

From: Blain, David [mailto:blain@chilliwack.com]
Sent: Wednesday, March 08, 2017 8:48 AM
To: Hawthorne, Kristjana
Cc: Hobenshield, Lexa
Subject: RE: Information requested by the City of Chilliwack

Kristjana

We discussed the Trans mountain pipeline at Council yesterday (the video of the session will be available on our website). Now I would like to discuss messaging about the pipeline route and construction.

Your modified letter still states "After reviewing feedback from the City and considering stakeholder feedback, Trans Mountain plans to construct using open-trench methodology over the aquifer area from Vedder Road to Unsworth Road." Bluntly, this still reads that that the open cut construction is something that the City wants to see happen instead of the deep tunneling. It is not just stakeholder feedback, your own specialist, Steve Foley from Waterline, has provided a report explaining why deep construction is a threat to the drinking water wells.

I would be interested in discussing how this will be presented tonight, I can be reached at my direct line 604-793-2841.

Regards.

David Blain, M.A.Sc., MBA, P.Eng. | Director of Planning and Engineering
P: 604.793.2907 | F: 604.793.2756 | E: blain@chilliwack.com

City of Chilliwack
8550 Young Road, Chilliwack, BC
Canada V2P 8A4
www.chilliwack.com

From: Hawthorne, Kristjana [mailto:Kristjana_Hawthorne@kindermorgan.com]
Sent: Wednesday, March 01, 2017 9:32 AM
To: Blain, David
Cc: Poos, Peter (Contractor); Sanderson, Rod
Subject: RE: Information requested by the City of Chilliwack

Good morning David,
Please see attached the revised letter to address City's concerns. We have been responsive to the City's requests for information and appreciate the positive working relationship. and look forward to continued good relationship and coordinated efforts with the City as we move towards construction. Following our meeting on February 15, 2017, we offered the opportunity for edits to the letter in writing, but the edits we received did not include the identified paragraph. We have made further edits to the letter to satisfy the City's concerns. It would be appreciated if any future feedback from the City is coordinated.

If you wish to discuss this further, please call me at 604.-790-5537.

Regards,

From: Blain, David [mailto:blain@chilliwack.com]
Sent: Tuesday, February 28, 2017 2:33 PM
To: Hawthorne, Kristjana

Cc: Poos, Peter (Contractor); Sanderson, Rod
Subject: RE: Information requested by the City of Chilliwack

[This email message was received from the Internet and came from outside of Kinder Morgan]

Kristjana

I am going through the material now. With respect to the response letter on page 2 fifth paragraph it continues to state that open cut is the City's stated preference. As discussed in our meeting we cannot allow this stand without response. We don't "prefer" open cut, the deep option is completely unacceptable so the surface option is the lesser evil. This is confirmed by your hydrogeologist, Steve Foley in his technical memorandum.

Obviously I don't expect you to refer to your option as the "lesser evil" but leaving it as being the City's choice is also unacceptable. Please have the paragraph revised to reflect that your technical analysis indicates that this is the best protection for the aquifer.

I am available to talk this afternoon if necessary. My deadline for completion of the staff report is noon tomorrow.

Thank you.

David Blain, M.A.Sc., MBA, P.Eng. | Director of Planning and Engineering
P: 604.793.2907 | F: 604.793.2756 | E: blain@chilliwack.com

City of Chilliwack
8550 Young Road, Chilliwack, BC
Canada V2P 8A4
www.chilliwack.com

From: Hawthorne, Kristjana [mailto:Kristjana_Hawthorne@kindermorgan.com]
Sent: Tuesday, February 28, 2017 1:52 PM
To: Blain, David
Cc: Sanderson, Rod; Poos, Peter (Contractor); Toth, Greg
Subject: Information requested by the City of Chilliwack

David,
Please see attached the requested information from Trans Mountain in advance of the City's staff report to Mayor and Council on March 7th.

Attached please find:

- Response to City of Chilliwack Letter dated January 25, 2017
- Response to City of Chilliwack regarding Vedder River mitigation
- Technical Memo - Sardis Vedder Aquifer
- Sardis Vedder Aquifer Handout

If you have any questions regarding the enclosed, I can be reached at 604-790-5537 or by return email.

Kristjana Hawthorne, ABC
Stakeholder Engagement Specialist, Trans Mountain Expansion Project
P: 604.790.5537 | **E:** kristjana_hawthorne@kindermorgan.com
Twitter: @TransMtn | @Kristjana_H

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Kinder Morgan Canada Inc.
2844 Bainbridge Avenue, PO Box 84028 Bainbridge, Burnaby, BC V5A 4T9
Toll Free: 1-866-514-6700 | **E:** info@transmountain.com | **W:** transmountain.com

Trans Mountain Expansion Project
Email: info@transmountain.com | Phone: 1.866.514.6700 | Website: www.transmountain.com

February 28, 2017

David Blain
Director, Engineering and Planning
City of Chilliwack
8550 Young Road
Chilliwack, BC, V2P 8A4

Dear Mr. Blain,

Re: Vedder River, Browne Creek and Adjacent Dyke Pipeline Crossing Mitigation

At its meeting with Trans Mountain on the 15th of February, the City of Chilliwack requested further information on the proposed pipeline crossing methodology of the Vedder River and its adjacent tributaries and off-channel habitats. In particular, additional information was requested on the mitigation at these locations, given recent revisions to the trenchless crossing methodology for the Vedder River and its immediately adjacent tributaries.

In response to this request, Trans Mountain has prepared this letter, which details the existing fish habitat potential, crossing methods, and site-specific mitigation measures to be implemented for these watercourses.

PROPOSED CROSSING METHODS

A Horizontal Directional Drill (HDD) was initially proposed by Trans Mountain for the trenchless crossing of the Vedder River. However, geotechnical investigation revealed that sub-surface ground conditions are not conducive to an HDD. The revised trenchless crossing methodology now is a new technology called DirectPipe™. DirectPipe™ methodology has maximum length limitations for 36 inch pipe. As such, the overall length of the Vedder River trenchless crossing will be shorter than that initially proposed using an HDD method.

The entry point for the trenchless crossing remains unchanged and will be located north of the north Dyke (KP 1100.1) (Figure 1). The pipe will then extend underneath Peach Creek (BC-716), the Vedder River (BC-717), and Hopedale Slough (BC-781), and exit approximately 100 m south of Hopedale Slough (KP 1100.6) within an existing open area. From this point to the south side of Browne Creek (approximately KP 1100.8) an open-cut trenched method will be used. The crossing of Browne Creek will use an isolated crossing method during the Least Risk Window of August 1 to September 15, if flowing at the time of construction. Browne Creek is subject to seasonal flows and may be dry during this time. The south dyke (KP 1100.85) will be crossed using a guided horizontal auger bore method. The locations of the watercourse crossings proposed and construction footprint are shown in Figure 1.

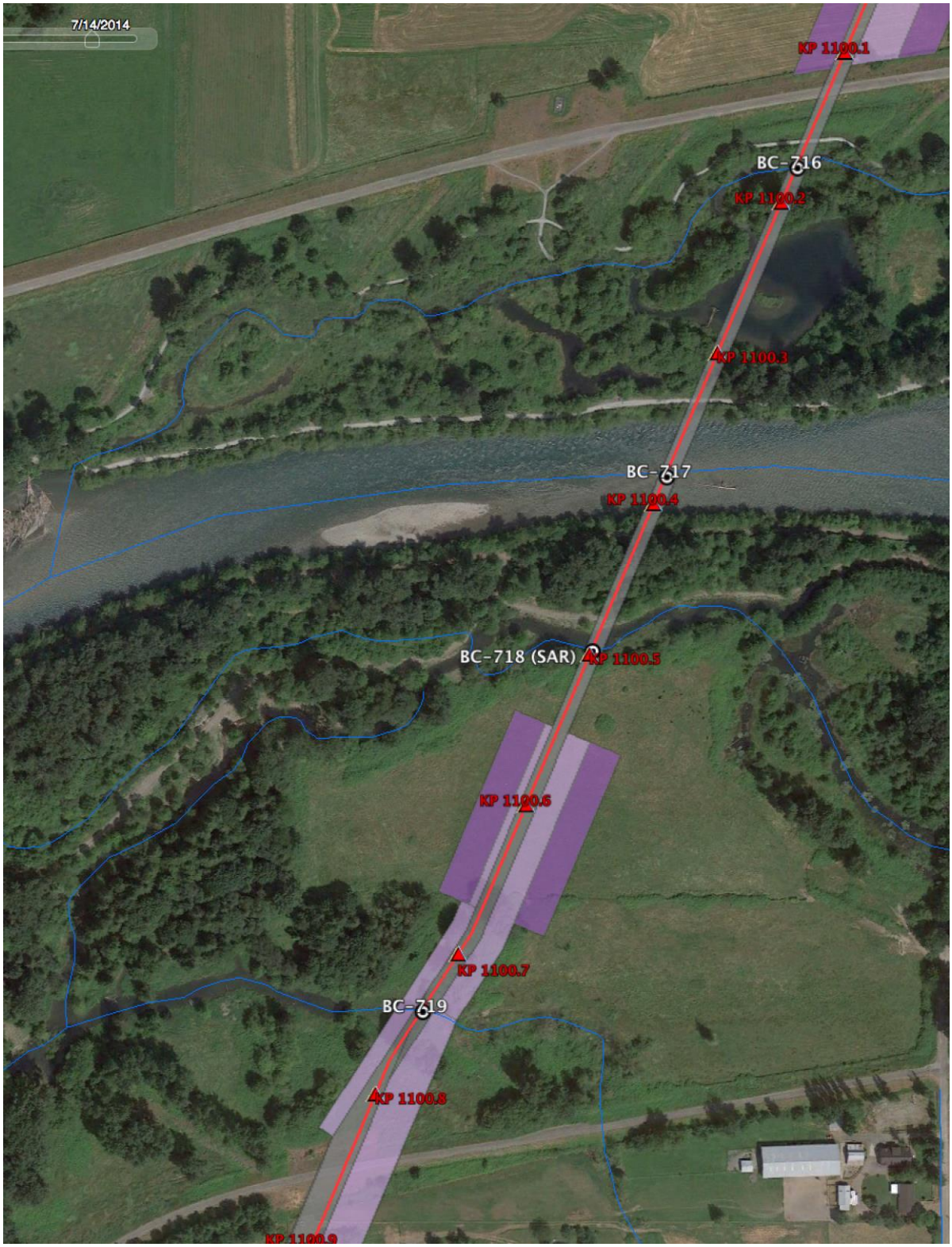

Figure 1. *Location of proposed construction footprint and watercourse crossings (BC-716, Peach Creek; BC-717, Vedder River; BC-718, Hopedale Slough; BC-719, Browne Creek).*

MITIGATION AND RECLAMATION

Vedder River, Peach Creek, and Hopedale Slough

The proposed DirectPipe™ crossing of Peach Creek (BC-716), the Vedder River (BC-717), and Hopedale Slough (BC-718) will completely avoid all bed and banks and off-channel areas, as the pipe will be subsurface for the entirety of its length. All existing roads, dykes, and rotary trails will also be undisturbed.

Hopedale Slough is considered critical habitat for the *Species at Risk Act* (SARA) Listed Salish Sucker (DFO 2016). As per NEB Condition 75, which requires a trenchless crossing method at all watercourses containing Critical Habitat or Proposed Critical Habitat for Salish Sucker, habitat within Hopedale Slough will not be disturbed by the proposed DirectPipe™ trenchless crossing.

Key Mitigation

- Use of a trenchless crossing method;
- DirectPipe™ does not require the high pressures encountered with traditional HDD methods, so minimizes the potential loss of hydraulic fluid release to surface (instream);
- A Qualified Environmental Professional (QEP) will be present on site and water quality will be monitored for the duration of each watercourse crossing.

Browne Creek

The crossing method for Browne Creek (BC-719) is an isolated trenched method with a fish salvage and water quality monitoring, inside the precautionary Least Risk Window of August 1 – September 15. Browne Creek is a low-gradient watercourse with good off-channel rearing and overwintering habitat for juvenile salmonids (coho salmon, coastal cutthroat, and rainbow trout). Browne Creek has connectivity to Hopedale Slough during high flow conditions. However, it is subject to seasonal flows, and has been documented to be dry or intermittent at the pipeline crossing location during the summer months (Appendix A: Photo 1-4). Furthermore, Salish Sucker are extremely unlikely to inhabit Browne Creek during the summer, and it is identified as potential overwintering habitat only.

The lower reach of Browne Creek, particularly where it is wider and deeper near its confluence with Hopedale Slough, is considered to provide potential overwintering habitat for Salish Sucker (Pearson 2015) but is not critical habitat. Spawning potential is low for both salmonids and SSU, given high percentages of fines/organics and a lack of riffles. The riparian habitat at the crossing consists of mature deciduous trees, interspersed with open grassy sections with evidence of heavy cattle use observed.

Mitigation measures will ensure there are no residual instream impacts. Channel bed and banks will be reclaimed and stabilized, and off-channel wetland areas will be restored to a similar condition that existed prior to construction. The following site-specific mitigation and reclamation measures will be implemented at Browne Creek and its fringe wetland habitat:

Key Mitigation

- The isolated trenched crossing of Browne Creek will occur during the summer, when the channel will likely be dry/intermittent or have little to no flow. Any flow encountered can be easily handled, with low potential for downstream sediment transport.
- Proposed construction timing inside the Least Risk Window (August 1 - September 15) will avoid critical spawning/incubation periods for salmonids, including Salish Sucker which have a spawning period of March 1 - July 1.
- A precautionary fish salvage will be conducted following isolation, if flowing.
- Water quality will be monitored, if flowing, and a QEP will be present on site for the duration of the crossing.
- A clear-span crossing structure will be used for the pipeline drag section across the channel. Bridge footings will be setback sufficiently from the banks of Browne Creek including portions of the fringing wetland habitat.
- Temporary erosion and sediment control measures will be implemented to control sediment runoff into Browne Creek prior to final clean-up and the establishment of permanent erosion and sediment control measures.
- Excavated/stripped soil in off-channel areas will be salvaged, stored separately to prevent admixing, then backfilled in the reverse order it was removed, and re-contoured as needed. Erosion control blankets and/or coir logs will be installed as needed.
- Instream habitat will be restored and enhanced, as approved by the Environmental Inspector (EI) and QEP. Specifically,
    - Coir fabric wraps and brush layering will be used to enhance fish habitat; and,
    - Large woody debris will be salvaged (if present) and returned to instream areas at the completion of instream works.
- Riparian areas will be reclaimed, as approved by the EI and QEP; specifically,
    - Existing willow, alder, and other similar vegetation will be salvaged and transplanted into the immediate banks of the watercourse; and,
    - Additional root wads and large woody debris (if available) will be installed in disturbed riparian areas to stabilize soils, reduce sedimentation, and accelerate woody vegetation recovery.

Additional Mitigation

It is acknowledged that recent restoration and habitat enhancement has taken place in the Browne Creek area. The construction footprint will avoid these restoration sites, leaving them

unaltered. Lastly, Trans Mountain has made a commitment to use only biodegradable hydraulic fluid in machinery working directly instream or aquifer areas.

CLOSURE

This letter has been prepared for Trans Mountain, to inform the City of Chilliwack about the crossing methods, existing fish habitat, and mitigation measures for the crossing of the Vedder River and adjacent tributaries, including habitat considered critical habitat or potential overwintering habitat for the SARA Listed Salish Sucker. Use of a DirectPipe™ method across the Vedder River, Peach Creek and Hopedale Slough, in conjunction with the site-specific mitigation measures for the Browne Creek isolated trenched crossing, will minimize the risk of serious harm to fish and fish habitat at these locations.

Sincerely,

Peter Poos
Director, Engineering
Trans Mountain Expansion Project

CC: Rod Sanderson, Deputy Director Engineering, City of Chilliwack
Greg Toth, Director Pipeline Construction, TMEP
Kristjana Hawthorne, Stakeholder Engagement & Communications, TMEP

REFERENCE

[DFO] Fisheries and Oceans Canada. 2016. Recovery Strategy for the Salish Sucker (*Catostomus* sp. cf. *catostomus*) in Canada. Species at Risk Act Recovery Strategy Series, Fisheries and Oceans Canada, Vancouver. ix + 64 pp.

Pearson, M. 2015. Guidelines for Capture, Handling, Scientific Study, and Salvage of the Salish Sucker (*Catostomus* sp.). Report prepared for Fisheries and Oceans Canada. Vancouver, British Columbia. ii + 29 pp.

Appendix A

Browne Creek Site Photos

Photo 1. View upstream at proposed crossing location, during high flow conditions (February 2016)

Photo 2. View downstream at proposed crossing location, during high flow conditions (February 2016)

Photo 2. View upstream at proposed crossing location, during low flow (dry) conditions (July 2013).

Photo 3. View downstream at proposed crossing location, during low flow (dry) conditions (July 2013)

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DRAFT Technical Memorandum

Prepared For:	Kinder Morgan Canada (KMC)	**Date:**	February 28, 2017
Prepared By:	Steve Foley, M.Sc., P.Geo., Principal Hydrogeologist	**File No.:**	2137-17-003
Subject:	Sardis-Vedder Aquifer Conceptual Model City of Chilliwack – Relation to the Trans Mountain Expansion Project (TMEP)		

CONCEPTUAL HYDROGEOLOGICAL MODEL

The Vedder River alluvial fan was formed as an unconsolidated deposit shaped by flowing water (Figure 1). The variability of the energy within an alluvial fan depositional environment has the potential of sorting and depositing coarse grained, higher permeability material interbedded with fine grained, lower permeability material. This creates a stratified, heterogenous, anisotropic, bulk deposit. High permeability strata within the fan complex form highly transmissive aquifers such as the systems developed beneath the City of Chilliwack. The depth to the water table, or thickness of the unsaturated zone, varies across the fan complex depending on local topography. In the upper reaches of the Vedder River fan complex, the unsaturated zone can exceed 10 m in thickness.

The fan complex would not be considered a single, massive aquifer, but rather a series of overlapping aquifers that are highly stratified and parted by lower permeability material. The primary Vedder River alluvial fan aquifer layers are extremely conductive, characterized by transmissivity values exceeding 10,000 m^2/day. Although the aquifers are considered unconfined and pore pressures have generally equilibrated across the section, the stratification of the bulk deposit creates anisotropic media whereby the horizontal hydraulic conductivity characterizing the aquifer material exceeds the vertical hydraulic conductivity of the bulk deposits. In addition, the ratio between vertical hydraulic conductivity and horizontal hydraulic conductivity varies spatially throughout the entire fan complex. Although unconfined or semi-confined aquifer systems are considered more vulnerable to surface contamination when compared to confined aquifers, the anisotropy of the bulk deposit and the intrinsic properties of high permeable dynamic aquifers such as the Sardis-Vedder Aquifer, are considered their greatest protection.

These properties have allowed cities, such as the City of Chilliwack, to be built on top of the aquifer systems, while not compromising the integrity of the municipal groundwater supplies. Similar to the geology character, well capture within this system is also stratified, whereby the capture zone geometry is controlled by the three dimensional intrinsic properties of the alluvial fan deposits. This concept is largely ignored by analytical approaches to two-dimensional source well capture zone

analysis presented in plan view. Even more advanced numerical techniques can not fully simulate the complexity of the spatial variability of this system.

In highly transmissive aquifers exploited by municipal source wells where production screens are installed in deeper permeable zones, the primary capture zone is drawn deeper into the porous media and the effects dissipate upward across the layered sequence, potentially limiting capture from shallow permeable zones. Under these conditions, shallow groundwater near the water table may evade capture by municipal wells entirely (Figure 2). This condition provides a level of protection for the municipal water supply from shallow contamination that could be sourced from surface activity. In this respect, shallow groundwater within the plan view footprint of a capture zone is not necessarily drawn into the production well, rather it will continue to flow down gradient, away from the active source wells, towards the point of discharge.

In the Sardis-Vedder Aquifer, the natural gradient (sloping water table or sloping piezometric surface) is driven from the high ground at the apex of the Vedder River alluvial fan located south of the City of Chilliwack municipal well fields, to the north, through the fan apron, towards the Fraser River (Figure 1). This natural gradient is the driving force that elongates the municipal well capture zones, extending up-gradient toward the Vedder River source.

The geometry of a capture zone will be modified up through the stratigraphic section, depending on the spatial variability of the hydraulic properties of the anisotropic, porous media. At the downstream edge of a capture zone, there is a vertical stagnation line which behaves as a flow divide where groundwater is drawn towards the well on the well side of the line, and groundwater flows away from the well on the downstream side of the line (Figure 2). The pressure distribution in higher permeability zones, where flow to the well is focussed, controls most of the capture, and forms the largest footprint of the capture zone. The footprint of the capture zone may be reduced in the shallow zones as pressure dissipates up through the section (Figure 2). Under these conditions, although the flow of shallow groundwater along the natural flow path can become distorted as it enters the pumping well cone of depression that extends to surface, the natural gradient can prevail, allowing shallow groundwater to escape well capture and continue moving down gradient towards the discharge area. This concept is illustrated schematically in the Figures 1 and 2.

TMEP PIPELINE MONITORING

The TMEP pipeline routing across the Sardis-Vedder Aquifer is proposed as a shallow buried utility within the existing pipeline right-of-way, down-gradient of the operating municipal wells. This places the pipeline in the unsaturated zone, or dry soils above the water table (Figure 2). The conceptual model as described above, demonstrates that the municipal groundwater supplies are protected from shallow groundwater contamination where capture does not extend up to the water table from the active aquifer zone (Figure 2). This hypothesis is indirectly confirmed through the maintenance of the integrity of the municipal water supply over 50 years of development and operation, during a transition period from agricultural land use to urbanization.

In the unlikely event that product is released from either the existing pipeline or the newly installed pipeline, and has the capacity to penetrate the thick unsaturated zone, the light non-aqueous phase liquid (NAPL) will hang up on top of the water table and dissolve slowly across the groundwater phreatic surface (Figure 2). By following the conceptual model presented above, dissolved phase contamination sourced from the NAPL outside the shallow water table capture zone can be carried down gradient, away from the deeper manifestation of well capture in the active aquifer layers, and have no impact on the municipal wells (Figure 2).

Through a better understanding of the Sardis-Vedder Aquifer conceptual hydrogeological model, Trans Mountain strongly believes that management of the section of pipeline that crosses the alluvial fan, down-gradient of the City of Chilliwack municipal wells, must be focussed on preventing releases from occurring through leak prevention strategies and in-trench leak detection. Trans Mountain will continue to allocate extensive resources to its pipeline integrity program, which is used to identify and repair anomalies in the pipe before leaks occur. A computational pipeline monitoring (CPM) system is used in combination with other monitoring methods, such as surveillance patrols, regular in-line inspections using smart pigs and smart ball tools (acoustical leak detection technology), Control Centre Operator (CCO) monitoring using the supervisory control and data acquisition (SCADA) system, and scheduled line balance calculations.

The pipeline integrity program is designed to overcome the limitations of focusing pipeline leak detection through the use of traditional groundwater monitoring piezometers. Piezometers are passive monitoring wells completed with short screens. These monitoring devices are designed to sample small pore volumes and rely on the natural gradients in an aquifer to detect leaks. The limitations of groundwater monitoring using piezometers are linked to the unpredictability of the location and timing of a contaminant release along liner infrastructure, such as a pipeline, railway or roadway. In addition, the three-dimensional, complex nature of the aquifer system places a great deal of uncertainty in resolving subsurface flow and capture, such that monitoring piezometers can not be effectively located.

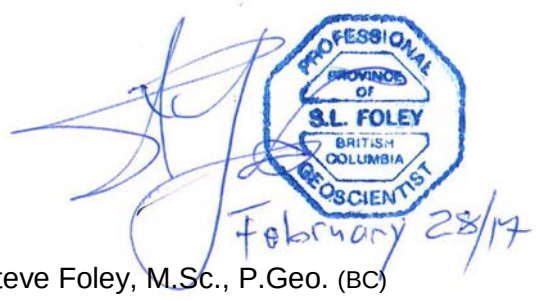
CERTIFICATION

This document was prepared under the direction of a professional geoscientist registered in the Province of British Columbia.

Waterline Resources Inc. trusts that the information provided in this document is sufficient for your requirements. Should you have any questions or concerns, please do not hesitate to contact the undersigned.

Respectfully submitted,

Waterline Resources Inc.
APEGA Permit to Practice No. P07329



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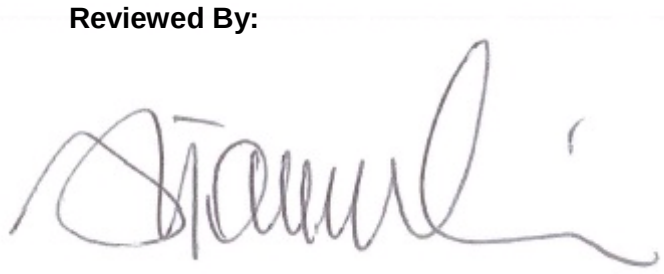

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