REQUEST FOR PROPOSAL

BRITISH COLUMBIA

RFP NUMBER: RMB-HIDC-01

HIGHWAY INVENTORY DATA COLLECTION

Authorized representative

gie

Our Signature, Our Commitment

BRITISH COLUMBIA

Request for Proposals

2017-2018 Highway Inventory Data Collection

Ministry of Transportation and Infrastructure

RFP Number: RMB-HIDC-01

Issue date: February 7, 2017

Closing Time: Proposals must be received **before** 2:00 PM **Pacific Time** on: Wednesday, February 22, 2017

DELIVERY OF PROPOSALS:

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(1) include a copy of this cover page that is signed by an authorized representative of the Proponent; or

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Ministry of Transportation and Infrastructure
Rehab and Maintenance Branch
4th Floor - 940 Blanshard Street
Victoria BC V8W 3E6
Attention: Rachel Fox

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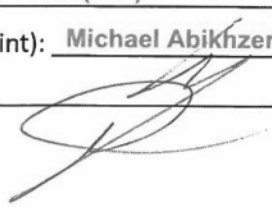
a) The Proponent has carefully read and examined the entire Request for Proposals;

b) The Proponent has conducted such other investigations as were prudent and reasonable in preparing the proposal; and

c) The Proponent agrees to be bound by the statements and representations made in its proposal.

PROPONENT NAME (please print): 841 8748 Canada Inc. (GIE)

NAME OF AUTHORIZED REPRESENTATIVE (please print): Michael Abikhzer

SIGNATURE OF AUTHORIZED REPRESENTATIVE: 

DATE: 21-02-17

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1 EXPERIENCE

1.1 THE FIRM

GIE, founded in 1996, with over twenty-one (21) years of experience and more than 300,000 miles of highway asset inventory data collection and pavement evaluation and over 75 similar projects, ranks among North American leaders in the field of asset and pavement management services. In fact, GIE's activities span a wide range of automated field survey services including condition data collection, pavement distress surveys, analysis and interpretation, right-of-way and road asset inventory, GPS coordinates, GIS, network condition rating, reporting and realistic custom design multi-annual maintenance plan and budgets.

GIE operates throughout North America. For instance, s.21
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Our project team's experience and expertise and our automated services are deployed through the use of vehicles equipped with the most recent and powerful state-of-the-art technologies in order to provide our clients with very reliable and very precise user-friendly results.

GIE's track-record, professional capability and proven experience in asset data collection and pavement evaluation and management has been GIE's niche for the past 21 years

Our proposed team has performed as of to-day over 300,000 miles of automated asset and pavement data collection, analysis, interpretation, reporting and multiannual plan preparation.

GIE is fully familiar with state-of-the-art software and cutting-edge technologies currently used on our on-board equipment vehicles operated by seasoned inspectors/drivers, surveyors and technicians and supported by seasoned analysts and professional engineers.

GIE - CANADA OFFICE
150 Graveline, Montreal, Quebec
H4T 1R7, Canada

GIE - USA OFFICE
724, S, Spring Street, #304
Los Angeles, California, 90014 USA

1.2 PAST EXPERIENCE

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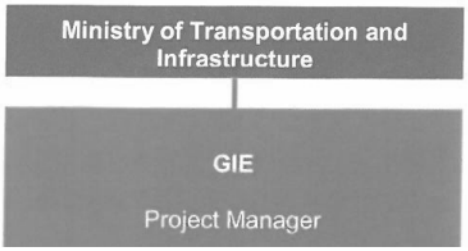
1.3 PROJECT TEAM MEMBERS

The following chart contains the roles, titles, experience and names of each of the project team members. All team members will be assigned full time to this project:



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1.4 PROJECT MANAGER

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1.5 SUPPORT STAFF

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2 METHODOLOGY / DATA QUALITY

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2.2 WORK PLAN

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HIGHWAY INVENTORY DATA COLLECTION SYSTEM

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3 TIMELINE

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APPENDIX III
MANDATORY DOCUMENTS

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Certificat d'enregistrement

Nous attestons par la présente que **QUASAR** *a enregistré le système de management de la qualité de:*

841 8748 Canada Inc. (GIE)

150 Graveline, Montréal, QC H4T 1R7

en vertu de la norme sur le système de management de la qualité:

ISO 9001:2015

Enregistrement initial	Date d'émission	Date d'échéance	Numéro du certificat
October 1, 2010	**September 30, 2016**	**September 30, 2019**	**Q105402**

Portée: Services d'ingénierie dans les domaines du génie du bâtiment, du génie de l'environnement; services de laboratoire en géotechnique des sols et matériaux ainsi que services d'auscultation et gestion des pavages.

QUASAR
Systèmes de management

SCC Accredited
CB-MS
OCSM
Accrédité CCN

Registraire

Registered by
Enregistrée par

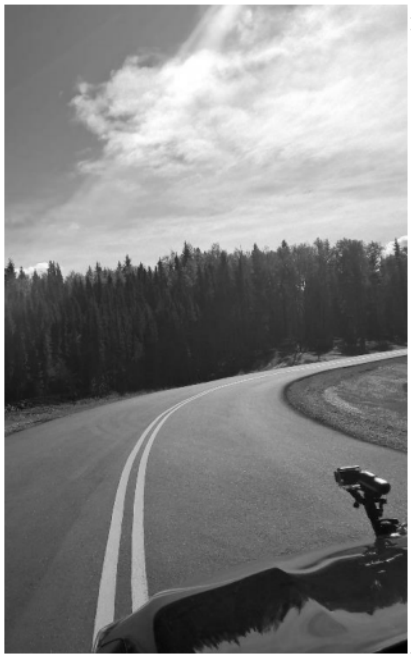
CWB QUASAR CWBI

Les modalités régissant l'enregistrement et l'utilisation de ce certificat sont définies dans le contrat signé entre QUASAR et le détenteur.
Communiquez avec le détenteur du certificat pour obtenir plus d'information sur le champ d'application et les limites de l'enregistrement.

3400F-SMQ/2014-09 **QUASAR**, une division du Groupe CWB, 8260 Park Hill Drive, Milton (Ontario) Canada L9T 5V7, tél. : 1-800-844-6790, téléc. : (905) 542-1318, site Web : www.cwbgroup.org.

GIE GROUP
150, Graveline Street, Montreal (Quebec) CANADA H4T 1R7
T : **514 284-6085** • 1 800 443-7166 **F** : 514 284-5229
www.gieinc.ca

- Building Science
- Environmental Engineering
- Geotechnical and Materials Engineering
- Pavement Evaluation and Management



Prepared for:

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

Proposal Submission

2017 – 2018 Highway Inventory Data Collection

RFP No. RMB-HIDC-01 | Wednesday, February 22, 2017 | 2:00 PM

Submitted by:

McElhanney

McElhanney Consulting Services Ltd.

12 – 556 North Nechako Road
Prince George, BC V2K 1A1

Contact: Brendon Masson, PEng
Engineering Division Manager
Phone 778-693-2194
Email: bmasson@mcelhanney.com

2341-90087-00

OQM | Organizational Quality Management Program

Certified ISO 9001:2008

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Request for Proposals

2017-2018 Highway Inventory Data Collection

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PROPONENT NAME (please print): McELHANNEY CONSULTING SERVICES

NAME OF AUTHORIZED REPRESENTATIVE (please print): L. WHITEHEAD.

SIGNATURE OF AUTHORIZED REPRESENTATIVE:

DATE: 21 FEB/2017

Contents

Tables

Figures

1. Introduction

McElhanney has a reputation of developing practical solutions for its clients. We know our role, take ownership of our work, and understand how our work has a lasting impact in the communities where we work.

When one thinks about transportation asset management, one generally thinks about higher cost assets such as bridges, pavement, and traffic control devices. The “other stuff” on the highway is commonly referred to as being “street furniture” or “ancillary infrastructure” and the management of these assets typically falls on maintenance staff / contractors to manage, repair, and replace.

One of the key features of a properly implemented asset management system, formal, or informal is the need to be accountable to the owner and user. The first step to accountability is to gain a better understanding of what you are managing and simply count and track everything you are responsible for. It is our understanding that the primary purpose of this assignment is help establish, and manage maintenance contracts across the province. Every asset counted has a value, a maintenance cost, and a replacement value; consequently, having an accurate and defendable account of all assets is critical.

Our team has recently delivered innovative solutions on several asset inventory / management projects across western Canada for both government and non-government clients. Table 1 highlights our understanding of the issues, and our proposed solutions. We understand that there is a general migration of data from the consultant to the owner and the collection of good data initially pays dividends later.

Table 1 Key Issues and Features

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2. Experience

2.1. Corporate Information

McElhanney has a very strong network of offices throughout British Columbia. We will leverage these assets during the execution of the work.

McElhanney Consulting Services Ltd. (McElhanney) is a wholly employee-owned organization. Our goal is to provide personalized services supported by a multidisciplinary team of specialists and professionals. Our range of expertise and network of branch offices permit us to meet the individual needs of clients, no matter the project size.

Established in 1910, McElhanney provides a wide range of services in engineering, survey, project and construction management, environmental assessment, landscape architecture, and community planning. Our ISO 9001:2008-certified firm now has s.21

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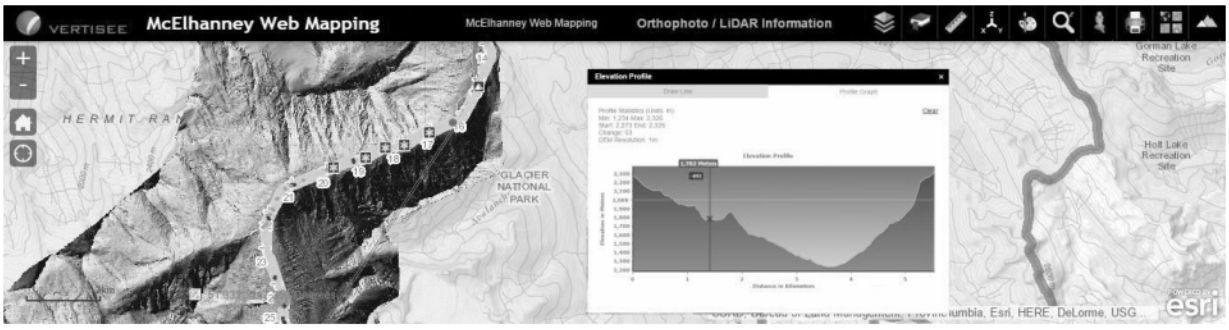
McElhanney has also developed Vertisee, an award-winning web-based mapping platform built on top of the industry-standard ESRI ArcGIS Server *Figure 1*. It integrates the power of GIS with common, easy-to-use maps, simplifying data access to create a project-by-project solution for end users. Vertisee provides the ability to share spatial geographic information across multiple platforms in a user-friendly interface, and can be updated in real-time. We commonly use Vertisee for asset management projects, especially of this scale.

Figure 1: Vertisee's web application.



2.2. Firm's Past Experience

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2.3. Project Team

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Figure 2: Organizational Chart

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3. Project Area

The Province of BC is approximately 945,000km^2 in size with the majority of the population living in the bottom 1/3rd of the Province (*Figure 3*). The use of scanned data for data collection direction relates to the relative population density of the region we are working in (higher use of Integrated GPS/GIS mapping in areas with lower population densities). Some highlights of the project include:

- A total road length of 11,375km to be assessed
- Excludes Alaska Highway
- Mix of urban/rural highways
- Mix of divided and undivided highway
- Includes collection on Haida Gwaii and Vancouver Island
- Includes data collection of Highway 1, 7, 10, 11,13, 15,17(A),91(A),99 in the Lower Mainland
- Includes Highway 1, 14, and 17 in Victoria
- Includes mountainous highways and significant grades
- Remote highways including Highway 37 and 37A

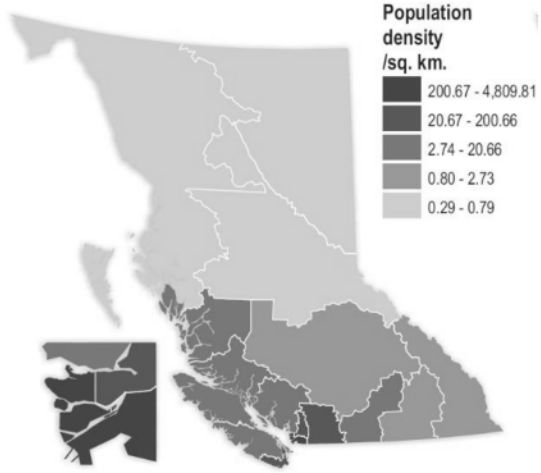

Figure 3 Population Density (BC Atlas of Wellness 2nd Edition)

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Figure 4: Office Locations

4. Methodology

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5. Project Schedule

McElhanney has reviewed the project scope of work and, and propose commencing asset collection immediately upon award. s.21

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6. Fee Estimate

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Appendix A – Resumes

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Appendix B – Project Sheets

McElhanney

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SarPoint Engineering

Proposal for:

2017-2018 Highway Inventory Data Collection
RFP #RMB-HIDC-01

Ministry of Transportation and Infrastructure
Rehab and Maintenance Branch
4th Floor - 940 Blanshard Street
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Attention: Rachel Fox

RFP No. : RMB-HIDC-01

RFP Closes at: 2:00 pm PST
on February 22, 2017

1. Table of Contents

2. Executive Summary

Further to the received RFP we are pleased to present the following proposal for the 2017 – 2018 Highway Inventory Data Collection for the Ministry of Transportation and Infrastructure throughout the province of British Columbia. This proposal will outline our understood scope of work and the technical tasks that are required to complete the final deliverables for the specified project. This proposal will also go into further detail regarding SarPoint's innovative mobile terrestrial laser scanning (MTLS) and a discussion of how this technology can be applied in the determination of the geospatial location and attribute information of the outlined assets, in addition to providing a safe medium to gather all the required data. SarPoint's approach will also be able to provide additional information that can be utilized in innovative ways to support engineering design and improve subsequent construction project management.

SarPoint is the leading provider of laser scanning services in Western Canada, and is a pioneer in the collection and processing of survey-grade data from mobile scanning platforms. SarPoint has received recognition for its work in publications such as the Calgary Herald, as well as professional groups such as the Consulting Engineers of Alberta. In 2011, SarPoint was the first company in the world to purchase the VMX-450 Mobile Scan system, which is specifically designed to capture survey-grade datasets to support municipal and transportation engineering projects.

SarPoint's unique engineering-grade mobile mapping system allows for the collection of high-density, high-accuracy 3D point data, along with accurately georeferenced digital photography. Laser-based point cloud data is collected *while moving* by a module installed on top of a vehicle such as a truck, railcar or boat. Four specially-calibrated cameras mounted on the module capture photography at specified intervals which allows for point colorization and asset identification. In addition, 360° panoramic photography is collected to produce a "google-street view" visualization of the area mapped.

Overall, collection of 3D data via mobile laser scanning will allow for rapid data collection of topographic features. Since the entire data set will be accurately georeferenced, the assets can be easily extracted thus creating an unambiguous survey record. The provision of panoramic photography in these areas will allow for the features of interest to be reviewed at any time by all stake holders.

3. Proponent Overview

SarPoint Engineering Ltd. is an Alberta-based geomatics engineering company with offices located in Calgary and Edmonton, Alberta. SarPoint is registered as a Surveyors Corporation with the Alberta Land Surveyors' Association (ALSA), the Association of British Columbia Land Surveyors (ABCLS), and the Association of Canadian Land Surveyors (ACLS). Additionally, SarPoint maintains a Permit to Practice with the Association of Professional Engineers and Geoscientists of Alberta (APEGA) and Association of Professional Engineers and Geoscientists of British Columbia (APEGBC). Table 1 outlines SarPoint's current key qualifications and affiliations with regards to professional associations and safety memberships. Copies of these documents can be made available upon request.

Table 1 - Summary of Key Qualifications

Office Locations	Calgary and Edmonton	
Corporate Memberships	*Alberta Land Surveyors Association*	*Permit #P218*
	Association of Canada Lands Surveyors	*License #255*
	Association of British Columbia Land Surveyors	*Permit #P211-2016*
	Association of Professional Engineers and Geoscientists of Alberta (APEGA)	*Permit #P11357*
	Consulting Engineers of Alberta	
	College of Alberta Professional Foresters	
	Canadian Land Reclamation Association	
Safety Memberships	*Alberta Construction Safety Association*	*5732*
	Workers Compensation Board of Alberta	*6434496*
	SafeWork BC	*797281*
	Workers Compensation Board of Saskatchewan	*A306514*
Safety Pre-Qualifications	*ISNetWorld – 400-142695*	*A or Green rating*
	PICS Auditing – 22715	*Green Flag*
	ComplyWorks – 1090961	*Green Status*
	CanQual	*Green Status*

SarPoint Engineering Ltd. recognizes that effective project management relies on open and consistent communication between all parties involved. For this reason, all SarPoint projects have a *lead focal*, who

is responsible for liaising with clients with regards to project scope, execution, progress and delivery. SarPoint has successfully applied this model to several projects involving municipalities in the past, and continues to enjoy an effective relationship with stakeholders within various departments, including provision of ongoing training and consultation on geomatics projects.

A typical project communication plan is shown on Figure 1.

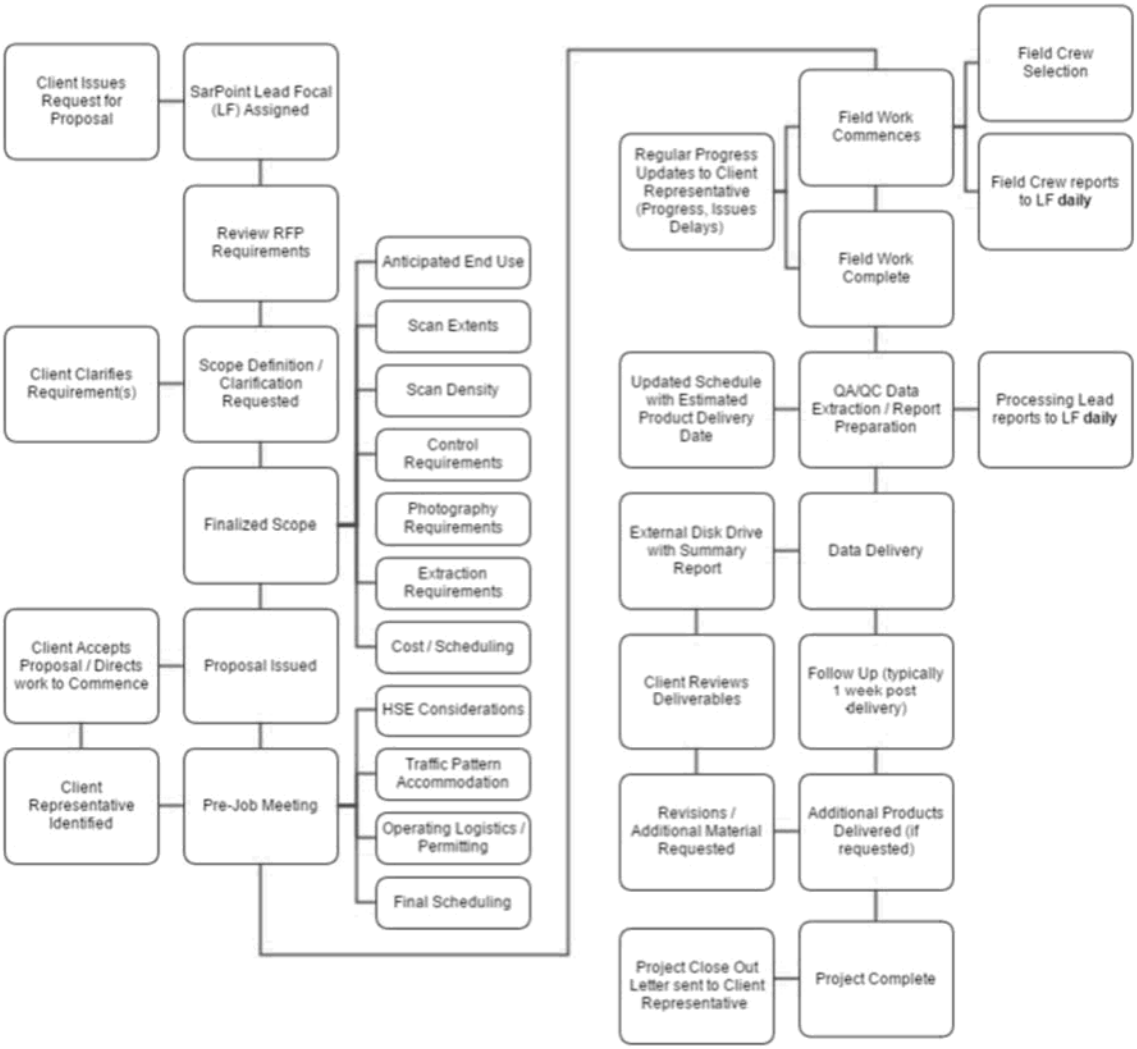

Figure 1. Typical MTLS Project Communication Plan

Note that notifications may take the form of email correspondence or verbal conversation. In the case of verbal conversation, follow up correspondence summarizing details discussed will be provided by the

SarPoint lead focal. However, in all cases, communication will occur directly between the Client Representative and the SarPoint lead focal.

If any unexpected delays occur during field collection and/or subsequent processing, the SarPoint lead focal will immediately inform the Client Representative, along with an action plan outlining how the delay will be mitigated, and an updated project completion schedule.

4. Key Personnel

Listed below are the details of several key personnel involved in MTLS data collection and processing workflow. Please refer to Appendix A for complete resumes of each individual.

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5. References

PROJECT REFERENCES

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PROJECT REFERENCES

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6. Proposed Project Timeline and Cost Assessment

Based upon the RFP document, SarPoint has understood the following initial 2017-2018 work scope, which is summarized in Table 2 and illustrated in Figure 2.

Table 2 - Summary of 2017-2018 Workscope

Delivery Group	Service Area	Requested Delivery Date	Approximate Centreline KM
1	2, 3, 4, 9, 12, 15, 24, 27	May 31, 2017	2806
2	6, 13, 26	January 1, 2018	1088
3	5, 8, 23	February 1, 2018	764
4	10, 16, 19, 22	March 1, 2018	1968
5	7, 14, 17, 18	April 1, 2018	1807
6	21, 28	May 1, 2018	1150

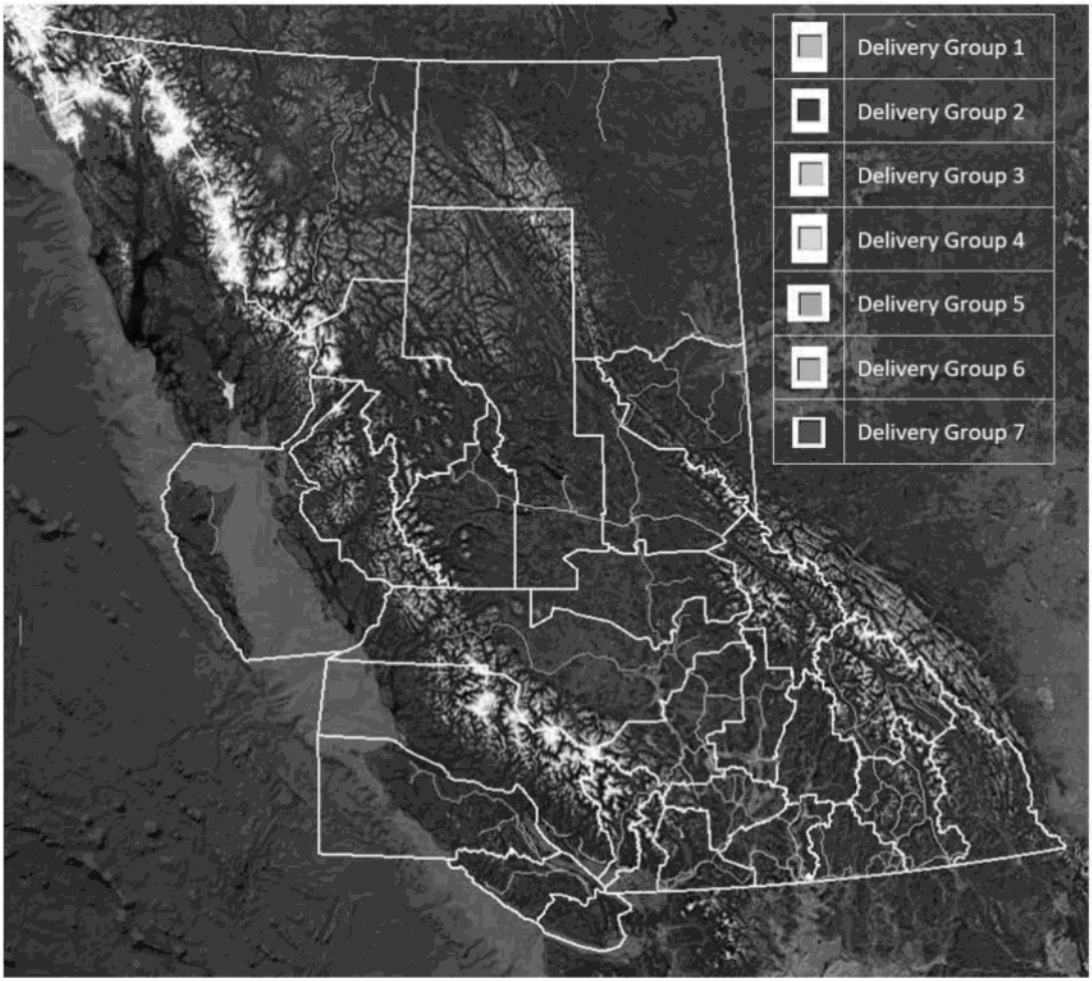

Figure 2 - MoTI Service Areas and Delivery Groups

Based upon our review of the required scope of work for each area, Table 3 from the RFP document has been completed with the proposed delivery dates. Please note that the dates below assume that the initial field work can commence on March 1, 2017.

Table 3 - Summary of Data Delivery Dates for Specific Service Areas.

Service Area	Date	Service Area	Date	Service Area	Date
1 - South Island	January 30, 2018	**11 - East Kootenay**	January 30, 2018	**21 - South Peace**	December 23, 2017
2 - Central Island	May 31, 2017	**12 - Selkirk**	May 31, 2017	**22 - North Peace**	November 30, 2017
3 - North Island	May 31, 2017	**13 - Okanagan Shuswap**	October 31, 2017	**23 - Nechako**	October 31, 2017
4 - Howe Sound	May 31, 2017	**14 - Nicola**	December 15, 2017	**24 - Lakes**	May 31, 2017
5 - Sunshine Coast	October 31, 2017	**15 - Thompson**	May 31, 2017	**25 - Bulkley Nass**	January 30, 2018
6 - Lower Mainland	October 31, 2017	**16 - South Cariboo**	November 30, 2017	**26 - Skeena**	October 31, 2017
7 - Fraser Valley	December 15, 2017	**17 - Central Cariboo**	December 15, 2017	**27 - North Coast**	May 31, 2017
8 - South Okanagan	October 31, 2017	**18 - North Cariboo**	December 15, 2017	**28 - Stikine**	December 23, 2017
9 - Kootenay Boundary	May 31, 2017	**19 - Fort George**	November 30, 2017		
10 - Central Kootenay	November 30, 2017	**20 - Robson**	January 30, 2018		

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7. Methodology and Data Quality Overview

SarPoint's mobile collection ability is a key advantage that allows topography and asset information to be collected rapidly and safely, without requiring a person to traverse busy road ways and other areas of potential hazard. Data is collected up to 100 meters on either side of the vehicle. For the volume of roadways where asset capture is required, it has been determined that the achievable accuracy without placing control every 150 metres along the roadway will be ± 30 cm in areas where the average building

height does not exceed 3 stories, and ± 1 m where the average building height exceeds 3 stories. It is believed that this accuracy meets the needed balance of production rate and quality assurance to guarantee repeatability of this data capture process. If it is deemed that a high level of accuracy is required, SarPoint can implement further controls to provide a ± 5cm accuracy. Unlike conventional surveys, data collected is extremely dense, usually comprising of one point collected every 1-3 cm. This allows for exceptionally detailed 3D point clouds to be created.

Figure 3. Multiple views of typical scan cloud and georeferenced photos

The extreme detail afforded by mobile scanning has an additional advantage in terms of later *data mining*. A typical issue in conventional surveying is that it is realised after the field visit that additional features are required, or it is not precisely clear what features were observed during the original field visit. In the case

of mobile scan data, the data already exists in the cloud and can be extracted and reviewed offsite. This can be used for later projects, such as determining the height of all overpasses along the route or areas where powerline crossings occur. All this data can be easily extracted for the initial data collection catalogue whenever the information is required, without the need field work.

In addition, mobile mapping provides a critical advantage for audit and review purposes, which is a direct benefit for the purpose of locating *all* of the existing assets along the corridors and resolving areas of conflict. Since 360° photography is collected during operation, an unbiased, complete record of the environment at the time of the scanning is collected. This is often useful when backup information to support a conclusion is required at a later time. Data can be viewed by multiple participants in SiteVisit360™, as well as overlay CAD files, for example an attributed node for a cattle guard.

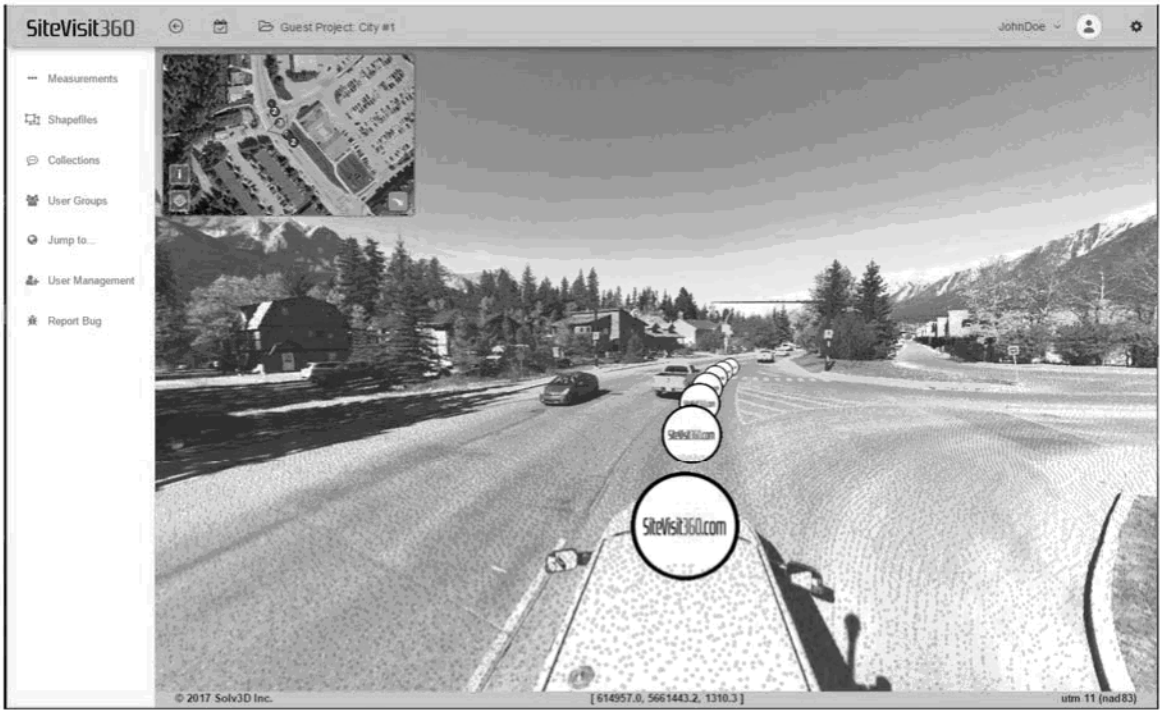

Figure 4. Sample view of scan data and panoramic photography of Street Trees in SiteVisit360™

To summarize, the key features of mobile data collection with the SarPoint system are as follows:

- Rapid data collection. Data is collected at the speed of vehicle travel. This allows data collection without interrupting the flow of regular traffic, minimizes disruptions to operations and minimizes personnel exposure to hazards.

- Accurate three-dimensional data. Three-dimensional point accuracy is 30 cm (1s) under normal operating situations.
- Dense data collection. Point spacing in cloud is at 1-3 centimetre level, which allows great detail to be captured.
- Simultaneous, georeferenced photography collection. 360°, high-resolution photography is collected while driving, allowing analysts to simultaneously use photography and point cloud data.
- Complete data set comprises a thorough baseline capture of the area of interest, which may allow for dispute resolution at later dates.
- Data set allows very realistic modelling and rendering of road ways and assets for visualization, safety and emergency response purposes.

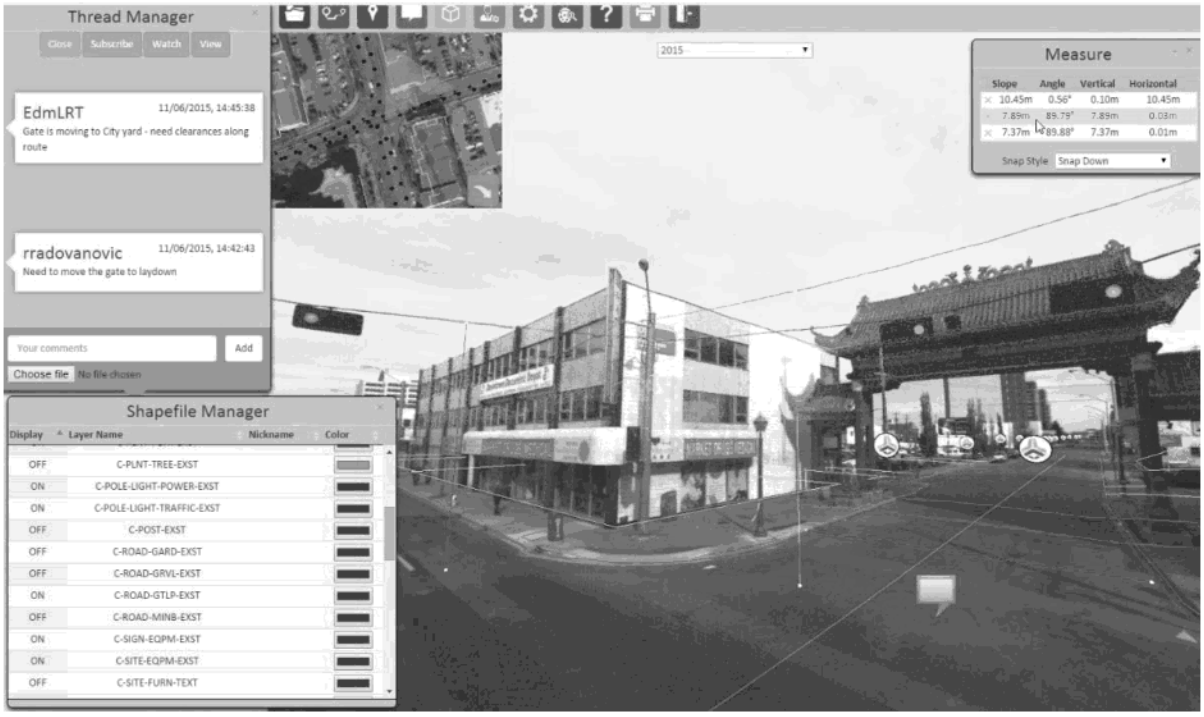

Figure 5. Sample view of scan and panoramic photography via SiteVisit360™

Additionally, SarPoint will provide a five-user demonstration license of SiteVisit360™ for a period of two months directly following the initial data delivery, which allows browsing of collected scan data, generated CAD files and panoramic imagery in a Google Street-view style interface. A typical screen shot of the interface is shown in Figure 5.

A key benefit of utilizing mobile mapping technology is that Traffic Accommodation issues are minimized. Scan data and photography will be collected from a vehicle travelling with traffic at posted speed limits. As a result, interference with normal operations in minimized, and social or economic impacts on users of the space are limited.

8. Technical Process Outline

The SarPoint Mobile Terrestrial Laser Scanning system is based upon the Riegl VMX-450 laser scanner and was specifically designed for the collection of survey-grade 3D laser scan data. Additional modifications by SarPoint allow the system to effectively capture panoramic imagery to support GIS-applications and visualization. Hardware and software components described in the following sections 8.1 and 8.2.

8.1 Hardware

Mobile Scanner System

Vehicle:	Dedicated Dodge Ram 3500 pickup, customized with hydraulic lift to raise/lower scanning system
Laser scanners:	2 x Riegl VQ-450 laser scanners. Scanners are capable of measurement at a range of 140 m, and are capable of measuring over 20 targets per pulse.
Navigation:	Applanix POS LV 120 integrated IMU/GNSS system
	Trimble GNSS (integrated into Applanix Pos System). Capable of GPS / GLONASS measurement.
	Integrated wheel-mounted Distance Measurement Instrument (DMI)
Cameras:	4 x 5 mpx CS6 planar cameras with 80x65° field of view
	1 x Ladybug 5 360° spherical camera
Base GNSS Station	Leica GS14, capable of measuring GPS / GLONASS
	Pacific Crest Transmitter Radio for broadcasting RTK corrections

	(Note, additional base station information, such as CORS/PLEADIES/DART will be used for geo-referencing of primary base station via post-processing of RINEX files)
	Secondary base station: Leica 1200GG, capable of measuring GPS/GLONASS
Rover GNSS Station	Leica GS14, capable of measuring GPS / GLONASS with built in RTK radio
	(Note, rover GNSS used to capture control information)
Total Station	Leica TS30, robotic/reflectorless 0.5" instrument (for capturing control information)

Ancillary Survey Equipment including tripods, Leica 360° reflectors + tribrachs, pogo stick, surveyor signage, traffic cones and PPE.

8.2 Software

Baseline Post-Processing:	WayPoint GrafNet
	Leica Geomatics Office 8.3
Trajectory Processing:	Applanix PosPac
Laser Scan Processing:	Riegl RiProcess w/ RiPrecision Adjustment Module (for initial point cloud creation, visualization, and adjustment)
	PointGrey RevCapPro (360° panorama processing)
	rapidlasso LasTools (for las file manipulation/gridding/thinning)
	SarPoint SPLasTools (las file QA/QC, automated feature and control point extraction, DEM construction, point classification, KMZ file production, AVI production)
	AppliedImagery QTViewer (for las file viewing)

Deliverable Production: s.21

Rigorous Quality Assurance and Quality Control measures are critical in ensuring the validity of collected MTLS data sets. In particular, since data sets consist of large amounts of point data, with no individual accuracy values attached to a given point, QA/QC of the entire point cloud is crucial prior to data delivery to the client.

SarPoint's QA/QC methodology focuses on analyzing the MTLS error budget, and assessing accuracies at multiple points along the field collection and office processing stages. In particular, the following items are checked for validity:

1. Project pre-planning: Will the data collected be fit-for-purpose?
2. Georeferencing assumptions: How do we know our reference system is correct?
3. Laser Accuracy: How do we know ranges measured by the lasers are correct?
4. Trajectory Accuracy: How do we ensure the trajectory of the scan system is correct?
5. Point Cloud Accuracy: How do we validate the resulting point cloud, including manipulations due to map projections / geoids / adjustment?

A brief overview of the QA/QC processes for each of the above elements is provided below in sections 8.3 and 8.4. SarPoint creates a detailed "Project Processing Checklist" to ensure all data collection / processing is rigorously validated prior to data delivery. A detailed overview of the workflow process throughout the project is provided in section 8.6 – Summary of Technical Process.

8.3 Quality Assurance

SarPoint's Quality Assurance process seeks to ensure that scan data collected will be fit for purpose upon collection. The following items are critical in the QA process:

1. Routine calibration of scan equipment. SarPoint maintains a calibration site in Edmonton, AB that consists of 200 m of roadway with a high density of surveyed features. The alignment is re-scanned on a quarterly basis to ensure internal calibration parameters of the scanner system remain correct. In particular, camera orientation parameters are re-calibrated whenever mounting changes.
2. Pre-project meeting to establish scope of project including end-use of data
    a. Establishment of required point density / accuracy and resulting collection speed
    b. Determination of local control available
    c. Determination of map projection / geoid to be used
    d. Logistical / permitting issues that will affect data capture
3. Project pre-planning to assess required survey control and distribution of GNSS base stations, or available of Real-Time Network.
4. Project pre-planning to assess location / density of scan validation points and type of point (see Section 7.4 for full description). Validation points are used both to adjust the collected point cloud in poor GPS conditions, as well as to validate the finalized processed cloud.
5. Project scheduling to ensure data is collected under conditions without rain or snow. If necessary, validation/control surveys are conducted during inclement weather to maintain production.
6. Project scheduling to ensure scan data is collected during periods of good satellite constellation (PDOP < 6, min 6 GPS satellites for duration) and use of space weather forecasting to avoid collection during solar events.
7. Project scheduling to ensure camera data is collected under good lighting conditions with minimal lens glare.
8. Proper project pre-planning and simulation as per section 8.6, Step 1 – Establishment of Project Scope, to ensure quantities such as swath overlap, validation point distribution, scan density and accuracy will meet specifications.
9. Proper data collection training for all field personnel used in data capture and the use of checklists to document data capture conditions and processing.

10. A minimum of two reference stations operate during scan data collection to ensure data can still be processed in the event of a base station failure or data corruption.

8.4 Quality Control

During data collection and subsequent processing, SarPoint Quality Control procedure establishes a number of "checkpoints" at which data integrity is validated. Details of this QC procedures are provided in section 8.6, however the most important elements are listed below:

1. Evaluation of network adjustment results when multiple base stations are required for long corridor projects. In particular, comparison of base line results to those derived from NRCAN Precise Point Positioning Service is completed as a blunder detection step (in particular concerning correct input of antenna heights).
2. Evaluation of reported scanner trajectory accuracy and identification of areas where theoretical 3D accuracy of trajectory exceeds 30 cm. Trajectory areas exceeding this tolerance are noted for particular evaluation against surveyed validation points.
3. Evaluation of collected scan densities. After initial scan processing, multiple patches throughout the area-of-interest are evaluated for scan density by calculating the number of points residing within a typical 1 m^2 patch.
4. Relative accuracy evaluation by comparison of pass-to-pass correspondence. Prior to scan cloud adjustment, the pass to pass separation at validation points is evaluated to ensure scan separation is less than required scan accuracy. Areas where scan separation exceeds scan accuracy (i.e. tunnels, under multiple, sequential overpasses) are flagged for particular evaluation against surveyed validation points. Use of corner-type features allows for horizontal and vertical scan separation evaluation.
5. Absolute accuracy evaluation by comparison of final, processed scan cloud to surveyed validation points. After project pre-planning described in 7.3, validation points are established and surveyed in the scan area (see 7.6 Step 2 for detailed description of validation point types). Automated detection routines allow extraction of the corresponding points in the LAS file and direct comparison of horizontal and vertical coordinates at these points.
6. Review of all deliverables by lead focal prior to delivery. The review verifies that all QC measures have been completed and that the data is fit-for-purpose and meets all client requirements.

8.5 General Notes

Current availability of scan system is such that typical projects of 5 days duration or less can be commenced within two weeks maximum upon notice of award of project. Longer projects can be scheduled on a project-by-project basis at the time of proposal creation.

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8.6 Summary of Technical Process

This section summarizes the actual processes employed in collection and processing of MTLS data sets. The process is broken down into individual sub-processes with flowcharts showing workflows as applicable. Note that specific hardware models and software versions used are described in sections 8.1 and 8.2.

Step 1. Establishment of Project Scope.

In this step, project scope is defined to ensure successful outcomes. In particular, the following items are established:

- Georeferencing required (map projection, geoid model).
- Scan density required.
- Scan accuracy required (survey / GIS grade).
- Photography required (spacing, planar, panoramic).
- Area-of-Interest, including additional possible areas-of-interest for acquisition.
- Features to be extracted.

Once project scope is defined, an execution plan is developed that addresses the following issues:

GNSS base station locations: Two reference stations are always simultaneously operating when scan data is being collected to ensure redundancy in the

event of a base station failure. For this project, we propose using the available RTN in addition to blunder checks using the Geo BC Active Control Monuments.

Availability of local control: Ties to local control points (i.e. ISA Monuments, RTN Network) are performed to allow comparison of collected data to pre-existing legacy data. For the required accuracy, the RTN network will be utilized.

Establishment of validation points: Validation points are placed throughout the scan area depending on accuracy requirements.

Standoff Distance / Scan Width: As standoff distance from laser scanner to target increases, the accuracy of the resulting point cloud degrades, and point density is reduced. SarPoint filters data on horizontal surfaces at greater than 30 m from the scanner to ensure point accuracy and density is within specifications.

Pulse Repetition Rate: Increasing the pulse repetition rate increases point density along a scan line, but results in higher file sizes. SarPoint collects data at 1.1 million points a second by default, preferring to thin delivered point clouds at the final stage.

Scan Rate: The VMX-450 system collects data at a rate of 400 lines / second.

Collection Speed: Point Density is directly correlated to platform speed, pulse repetition rate, scan rate and standoff distance. At 60 km/hr, point density of 500 points / m^2 at standoff distance of 25 m from the platform is typical for a single pass. In addition, photography exposure time must be reduced as collection speed increases to avoid image blur.

Scan Pattern : A typical scan pattern as collected by the VMX-450 system is shown below and is a function of scan rate (lines/second) and pulse repetition rate (pulse/second along line) . Note that due to the 30^o offset between the two laser scan heads, the scan pattern

of cylindrical objects is slightly greater than 180° of arc. The spacing shown below is at a standoff distance of 10 m from the vehicle as it is travelling at 30 km / hr. Typical worst case point spacings along the direction of vehicle motion is 1 point per 5 cm. Point spacings along the scan line are typically on the order of 1 point per 2 cm at maximum range.

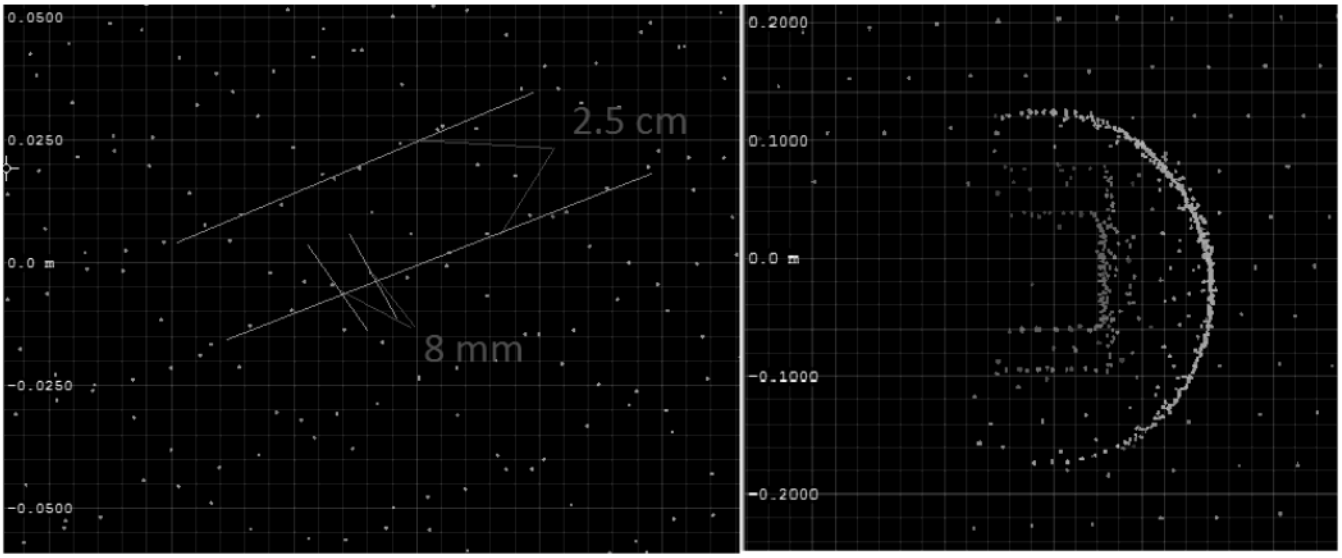

Figure 6. Example of Scan Pattern

Scan Angle: Data is collected at 360° scan angle about the individual scan heads. As a result, overhead wires and the undersides of overpasses are captured.

Returns per shot: The Riegl VMX-450 system is a full-waveform system that is capable of measuring over 20 targets per shot. In real-world applications, the number of targets per pulse is depending on the density of vegetation the pulse passes through. Typical values are 2-5 targets in grass up to 30 cm. Minimum resolvable distance between targets is on the order of 2 cm.

Number of Passes: A minimum of two passes along a given corridor is typically completed to provide redundancy and allow adjustment of scan clouds. Additional passes may be completed if concerns about trajectory accuracy in an area exist (i.e. under an overpass)

Sidelap (pass overlap): A minimum of 15 m overlap between passes is required to be considered a multiple pass.

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Photo Spacing: Typically, one photo is taken every 5 m along a trajectory. This allows for seamless photo overlap at a standoff distance of 2.5 m from the vehicle.

Step 2. Establishment of Validation Points

Validation points are typically established prior to scanning although in the case of photo-identifiable planar patches such as street markings, validation points may be surveyed after scanning (this allows for the possibility of opportunistic data capture, followed by validation once the data is actually required).

In the case of validation points surveyed by RTK, the following procedures are employed:

Step 3. Collection of Scan Data and Georeferenced photography.

Collection of scan data and georeferenced photography is relatively straight-forward using the VMX-450 system. However, the following procedures must be observed:

1. Scanning to occur during periods of suitable GNSS constellation (min 6 satellites GPS, PDOP less than 6)
2. Distance Measurement Instrument (DMI) always to be used when collecting urban data.
3. Dynamic Alignment of IMU to be completed using RTK corrections from base station.
4. Base station must appear in the scan data. This is a crucial validation on the georeferencing of the processed scan cloud.
5. Two base stations must be simultaneously operating during capture in the event of the failure of one base station, or corruption of data collected at one base station.

Step 4. Post-processing of Base Station Locations and Validation Points.

Upon completion of the scan collection, base station positions must be calculated to support processing of collected scan data and to determine validation point coordinates. This involves the following process:

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In the event that total station observations are used to establish validation points, total station observations are processed using a network-adjustment technique with internally developed software. Blunder detection is performed to identify/remove suspect observations and a network processing report is archived.

Step 5. Scanner Trajectory Processing

Once coordinates of all base stations and validation points have been computed, the trajectory of the scanner is computed using PosPac. The following guidelines are used in processing:

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Step 6. Initial Scan Processing

Once trajectories have been computed and exported, the initial scan cloud is created using RiProcess to extract raw scan data and georeference it using the trajectory information.

At this point, quantities such as point density are verified throughout the project by sampling 1 m^2 patches.

Page 119 to/à Page 120

Withheld pursuant to/removed as

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1. Vehicle Trajectory: Export of the XYZ position and orientation of the vehicle at 0.1 s increments as a csv file.
2. 3D scan cloud: Scan cloud data is exported as a LAS 1.3 format file. The following supplementary fields within the data file are filled :
    a. Pass Number
    b. Point classification – corresponding to ASPRS classification including 0 (not classified), 2 (ground), 7 (noise)
    c. RGB point color (if required)

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9. DGN / DWG file of extracted features.
10. LandXML file of bare earth DEM.

Appendix A - Corporate Resumes

Page 123 to/à Page 126

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Request for Proposals

2017-2018 Highway Inventory Data Collection

Ministry of Transportation and Infrastructure

RFP Number: RMB-HIDC-01

Issue date: February 7, 2017

Closing Time: Proposals must be received **before** 2:00 PM **Pacific Time** on: Wednesday, February 22, 2017

DELIVERY OF PROPOSALS:

Proposals must be in English and must be submitted using the submission method described below, and must either:

(1) include a copy of this cover page that is signed by an authorized representative of the Proponent; or

(2) otherwise identify the RFP, identify the Proponent and include the signature of an authorized representative of the Proponent that confirms the Proponent's intent to be bound.

Submission Method: Proponents should submit three (3) signed hard-copies of their proposal and one (1) complete signed copy of the Proposal on CD, DVD or USB storage device (flash drive) in current Adobe PDF or Microsoft Office Compatible format. Proposals must be submitted by hand or courier to:

Ministry of Transportation and Infrastructure
Rehab and Maintenance Branch
4th Floor - 940 Blanshard Street
Victoria BC V8W 3E6
Attention: Rachel Fox

Proposals must be received before the Closing Time to be considered.

A proposal is deemed to incorporate the Confirmation of Proponent's Intent to Be Bound below, without alteration.

CONFIRMATION OF PROPONENT'S INTENT TO BE BOUND:

The enclosed proposal is submitted in response to the referenced Request for Proposals, including any Addenda. By submitting a proposal the Proponent agrees to all of the terms and conditions of the RFP including the following:

a) The Proponent has carefully read and examined the entire Request for Proposals;

b) The Proponent has conducted such other investigations as were prudent and reasonable in preparing the proposal; and

c) The Proponent agrees to be bound by the statements and representations made in its proposal.

PROPONENT NAME (please print): Tetra Tech Canada Inc.

NAME OF AUTHORIZED REPRESENTATIVE (please print): Gerard Kennedy, Senior Vice President, Transportation

SIGNATURE OF AUTHORIZED REPRESENTATIVE: 

DATE: February 22, 2017

Tetra Tech
Contact: David Firbank, Project Manager
Email: David.Firbank@tetratech.com

Proposal for 2017-2018 Highway Inventory Data Collection

RFP RMB-HIDC-01

FEBRUARY 22, 2017
CONFIDENTIAL
FILE: PTRN.INFR03029

TETRA TECH

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Tetra Tech Canada Inc.
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APPENDICES

1.0 TETRA TECH KNOWLEDGE AND EXPERIENCE

1.1 Introduction

In response to the Request for Proposals (RFP RMB-HIDC-01) issued by British Columbia Ministry of Transportation and Infrastructure (the Ministry) for the 2017-2018 Highway Inventory Data Collection, Tetra Tech Canada Inc. (Tetra Tech) is pleased to submit this response document. Our proposal will show that Tetra Tech is the right choice for the Ministry in achieving the objective of this project, updating the highway feature information that forms part of the Province's Corporate Highway and Resource Information System (CHRIS).

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1.2 Corporate Background

1.2.1 Consultant Profile

Tetra Tech provides a broad range of engineering and scientific consulting services to the transportation, energy, mining, and development sectors throughout Western Canada.

Formerly known as EBA Engineering Consultants Ltd. that was originally founded by Dr. Elmer Brooker in 1966, the multidisciplinary company has since grown, now providing services to domestic and foreign markets. Our clients are served by 800 employees comprised of engineers, scientists, technologists, and support staff operating from 15 offices located throughout British Columbia, Alberta, Saskatchewan, Yukon, the Northwest Territories, and Ontario, with our head office in Edmonton, Alberta. In 2010, EBA Engineering Consultants Ltd.'s holding company was acquired by Tetra Tech Inc. of Pasadena, CA. s.21

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TETRA TECH CORE VALUES

- ✓ *Our Reputation is Paramount*
- ✓ *We Believe in the Individual*
- ✓ *We Succeed as a Team*
- ✓ *We Each Take Ownership For What We Do*
- ✓ *We Innovate*
- ✓ *We Improve our Communities*

A values-based consulting engineering and sciences company, Tetra Tech focusses on the transportation, mining, energy, and development sectors and is registered with the Association of Professional Engineers and Geoscientists of British Columbia. Over the last 40 years, we have grown to provide a diverse range of consulting services in Western and Northern Canada. A strong belief in our core values drives us to be a world-class team in everything we do, and to support the development and careers of our employees, while improving the communities in which we work. We are proud of our ability to create and deliver better solutions to our clients.

1.2.2 Consultant Qualifications and Experience Performing Similar Services

Tetra Tech has provided automated non-destructive pavement data collection services to the transportation industry since 1992. Our mandate to collect and provide accurately referenced quality data was the foundation on which our pavement data collection services were developed. Tetra Tech has the technology resources, including software and electrical engineering, to complete this inventory data collection assignment and the experienced resources to ensure the quality and value of the data.

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Growing consistently since inception, the core staff of the Transportation Infrastructure Technologies group has been with Tetra Tech for more than 15 years.

Our data collection experience has been gained from a user's perspective. We recognize that the integrity of the collected data is critical for operation and maintenance decisions made by our clients, pavement engineers, asset managers, or others. The foundation of Tetra Tech's data collection services is our ability to collect accurately referenced quality data on a timely basis. s.21

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Understanding client data needs permits incorporating innovative practices and techniques and, when appropriate, added value services. As is demonstrated in this proposal, Tetra Tech will continue to improve the quality and value of road corridor data collection through innovation, as well as the efficient and cost-effective delivery of properly referenced and accurate data.

The following table highlights some of the data collection projects completed by Tetra Tech s.21
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1.3 Corporate References

Detailed information for some of our corporate references and projects similar in nature to the scope outlined in the RFP is provided in the following section.

1.3.1 Project History / Highlights of Relevant Projects

The following table lists four completed data collection projects with technical requirements and scopes similar to the scope of the Ministry's inventory data collection assignment. Each relevant project description includes a brief description of our role and responsibilities. These projects were successfully completed by Tetra Tech's Transportation Infrastructure Technologies group, including many of the key staff included in the delivery of 2016-2017 BC Pavement Surface Condition Surveys.

Table 1.1: Proponent Project Team References

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2.0 PROJECT TEAM

Tetra Tech proposes a highly qualified, established, and experienced project team to successfully provide all of the required deliverables for this assignment to the utmost satisfaction of the Ministry. Our project team consists of staff located in Western Canada and Washington State with extensive experience in roadway corridor data collection, LiDAR and ROW imagery data extraction, and asset management.

Some of the fundamental keys to the success of this assignment are in the qualifications and experience of the project team members, a clear and dependable structure. s.21

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Feature

Tetra Tech proposes a highly qualified and established team to provide all required deliverables for this assignment

Benefit to the Ministry

All key project team members have successfully worked together to deliver similar data collection programs

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The key project personnel have in many times worked together to deliver large pavement data collection and pavement management projects for local and provincial governments. s.21

s.21 Tetra Tech's data collection services have been developed on our team's ability to collect quality data, referenced accurately, and the adherence to project schedules. All post-processing, analysis, QA/QC, and reporting operations will be accomplished using Tetra Tech's in house staff.

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Tetra Tech's Quality Management System (QMS) principles (based on ISO 9001 standards) will be incorporated into every aspect of this project to help meet the Ministry's objectives. The QMS trains employees in diverse and discipline-specific work methods and procedures with the intent of developing a quality driven culture to effectively and consistently deliver reliable solutions.

An Organization Chart is provided below and is followed by an overview of our proposed key project team members, along with their roles, years of experience, and similar past applicable experience (Table 2.1).

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Table 2.1: Project Personnel

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3.0 METHODOLOGY

3.1 Project Understanding

The Ministry is interested in updating the numbered highway inventory asset information that forms part of CHRIS. This update will be derived from the LiDAR and ROW Imagery data collected as part of the Ministry's existing 2016/2017 RPMS Pavement Surface Condition Surveys contract, and additional data collection surveys to be conducted for the priority Service Areas during the spring of 2017. The asset Inventory Types, and related Attributes for each feature of interest, are as defined in the 'RPMS Data Collection Contractor Inventory Type Details - PreRenewal Collection, 2-February-2017 (copy attached). s.21

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3.2 Data Collection

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Pavement Surface Profiler 7000

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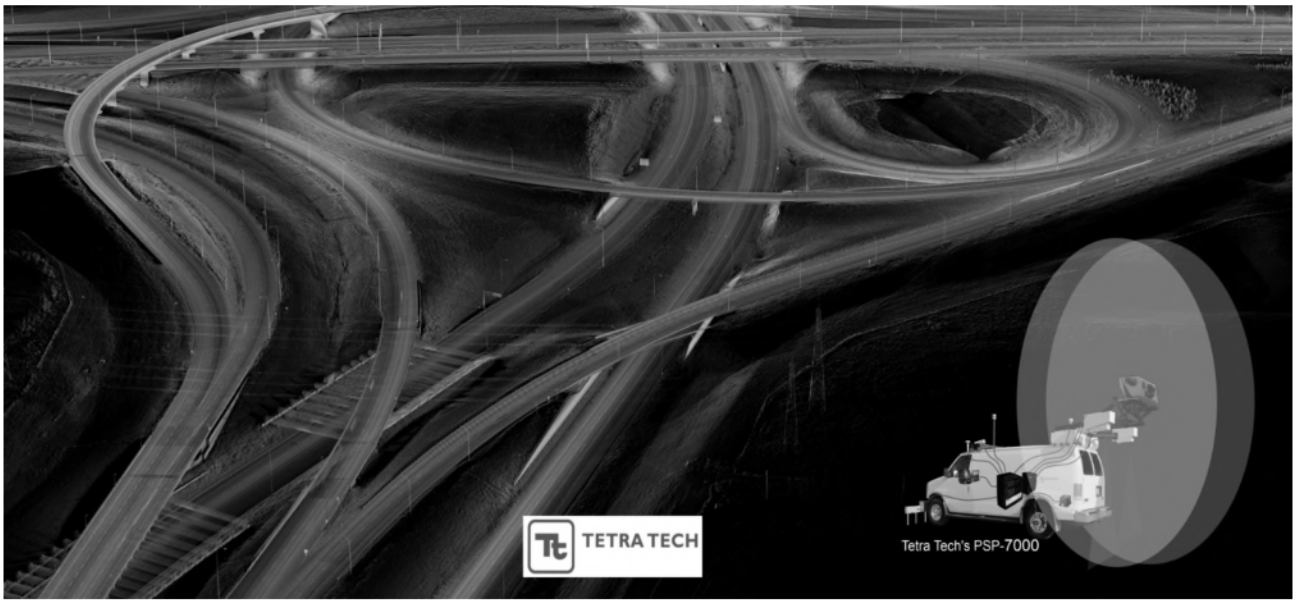

LiDAR Point Cloud

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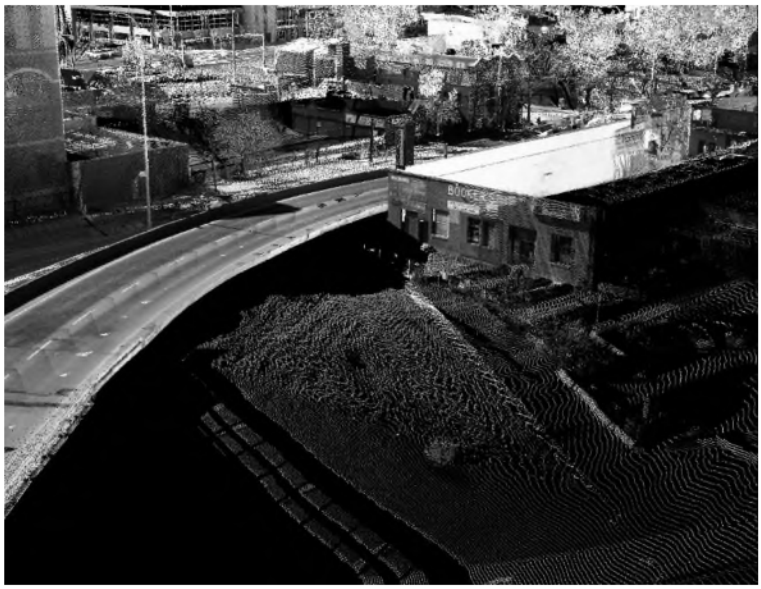

LiDAR Point Cloud Colorized Using PSP Digital Images

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3.2.1 Geo-Referenced Data

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3.3 Inventory Assessment

The roadway features of interest for extraction and characterization during this assignment are detailed in the '*Inventory Type Details - PreRenewal Data Collection, 2-Februaruy-2017'* manual.[s.21]

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3.4 Tetra Tech Quality Control

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3.5 Proposed Deliverables

3.5.1 Data Files

- Updated excel workbook as per sample provided in Appendix D in the RFP.
- A separate workbook will be provided for each Service Area.

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4.0 SCHEDULE

As indicated by the Ministry, all datasets from the eight service areas identified for priority delivery are to be collected, processed, and delivered by May 31, 2017 based on a contract award in mid-March. s.21

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Service Area	s.21	Inventory Delivery Date	Service Area	s.21	Inventory Delivery Date
1 – South Island		June, 2018	**15 – Thompson**		May 31, 2017
2 – Central Island		May 31, 2017	16 – South Cariboo		March, 2018
3 – North Island		May 31, 2017	17 – Central Cariboo		April, 2018
4 – Howe Sound		May 31, 2017	18 – North Cariboo		April, 2018
5 – Sunshine Coast		February, 2018	19 – Fort George		March, 2018
6 – Lower Mainland		January, 2018	20 – Robson		June, 2018
7 – Fraser Valley		April, 2018	21 – South Peace		May, 2018
8 – South Okanagan		February, 2018	22 – North Peace		March, 2018
9 – Kootenay Boundary		May 31, 2017	23 - Nechako		February, 2018
10 – Central Kootenay		March, 2018	**24 – Lakes**		May 31, 2017
11 – East Kootenay		June, 2018	25 – Bulkley Nass		June, 2018
12 – Selkirk		May 31, 2017	26 - Skeena		January, 2018
13 – Okanagan Shuswap		January, 2018	**27 – North Coast**		May 31, 2017
14 - Nicola		April, 2018	28 - Stikine		May, 2018

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5.0 PRICE ESTIMATE

Tetra Tech's bid unit price is presented below as an "all-in" per Center-line Kilometre (CL-km) rate. It includes the costs required for data collection, processing and asset extraction. The proposed unit rate is based upon a network of approximately s.21 This network length is based on review of the shapefile provided and the information provided in the Addenda QandA Summary #2 with respect to network lengths. Tetra Tech is willing to work with the Ministry to determine the unit rate for any additional services.

Table 5.1: Unit Price – 2017 and 2018 Highway Inventory Data Collection

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6.0 CLOSURE

We trust this proposal meets your present requirements. If you have any questions or comments, please contact the undersigned.

Tetra Tech Canada Inc.

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/ktd

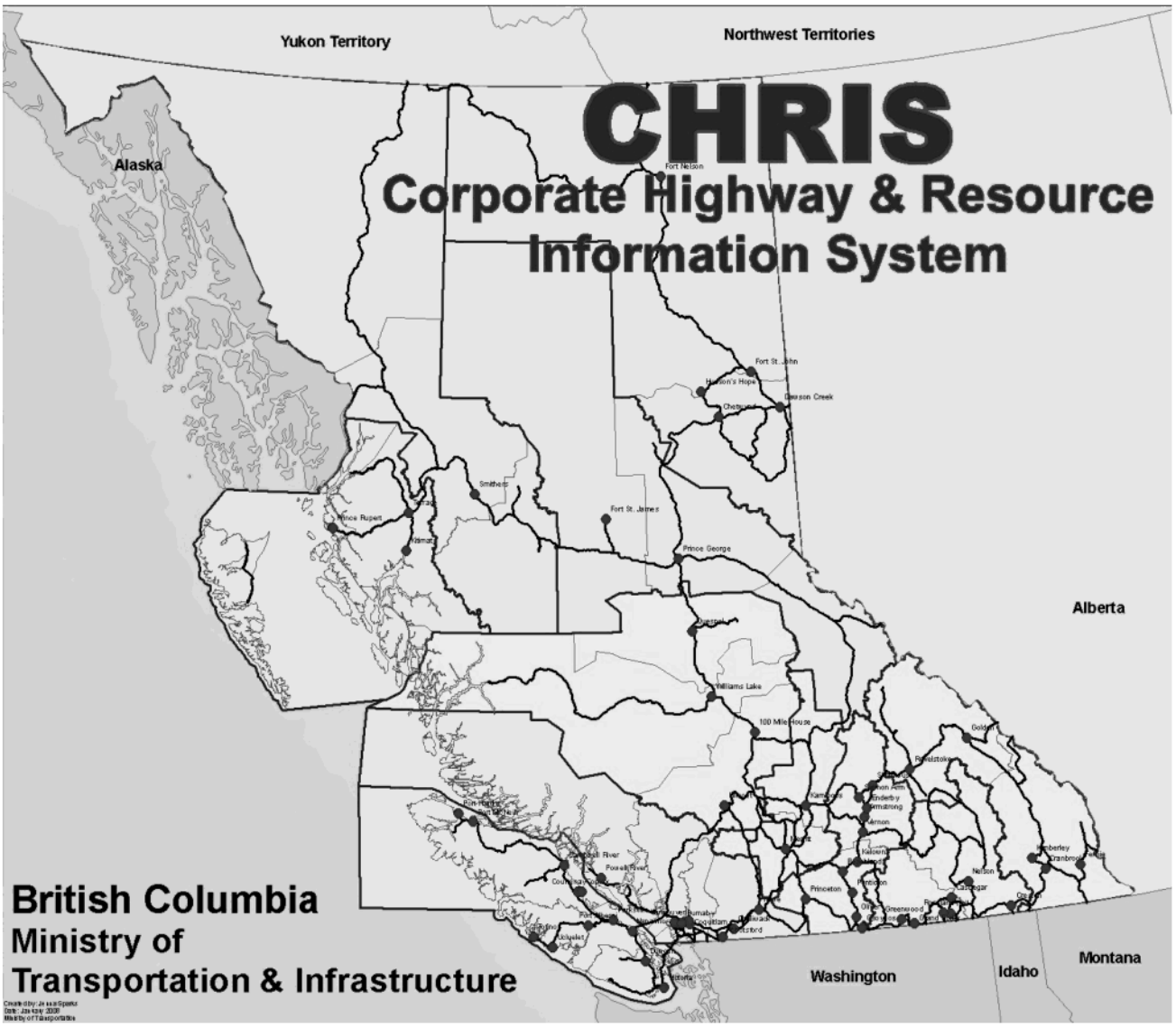
APPENDIX A

INVENTORY TYPE DETAILS - PRERENEWAL DATA COLLECTION 2-FEBRUARY-2017 (APPENDIX A OF THE RFP)

Appendix A

INVENTORY TYPE DETAILS

PreRenewal Data Collection



(Detailed Inventory Type Attributes and Business Rules)
Last Revision Date: 2-February-2017

Table of Contents

1. Introduction

CHRIS – Inventory Type Details:

This document identifies selected Inventory Types that are picked up with the field collection of Highway data for use in CHRIS (Corporate Highway and Resource Information System). It also includes the Attributes and Rules/Considerations for each individual Inventory Type.

This is a living document - subject to change.

2. RFI Network

The RFI Network identifies all of the roads in the province of BC that belong to MoT with the exception of those roads that are **Notionals** or **Pedestrian Notionals** (these roads do not belong to MoT, but with our current way of business we need a road to be able to display Structures that belong to us; therefore we own the structure but NOT the road).

- All RFI Highways start or end at the centreline of the intersecting highway (not at the shoulder).

RFI Unique Identifier (SASHH-H):

- S – Service Area (01 through to 28 plus the 5 Concession Areas 40 through to 44)
- A – Area Manager Area
- S – Sub Area (@ symbol if there is not a Sub Area)
- H – Highway Type (0 (zero) for Road; E for Easement; N for Notional; P for Pedestrian Notional)
- H – Highway Number – consists of 4 digits always (pre-ceded by 0 zeroes)
- H – Highway Alpha – if applicable – not always used – 2 characters (combination of letters and single digit numbers)

3. Service Area Admin Units

Valid Admin Unit Codes:

Admin Unit	Service Area Number	Service Area Name
401	1	South Island
402	2	Central Island
403	3	North Island
404	4	Howe Sound
405	5	Sunshine Coast
406	6	Lower Mainland
407	7	Fraser Valley
408	8	South Okanagan
409	9	Kootenay Boundary
410	10	Central Kootenay
411	11	East Kootenay
412	12	Selkirk
413	13	Okanagan-Shuswap
414	14	Nicola
415	15	Thompson
416	16	South Cariboo
417	17	Central Cariboo
418	18	North Cariboo
419	19	Fort George
420	20	Robson
421	21	South Peace
422	22	North Peace
423	23	Nechako
424	24	Lakes
425	25	Bulkley Nass
426	26	Skeena
427	27	North Coast
428	28	Stikine

4. General Inventory Type Collection Rules

Overall Statement:

The Cardinal Direction for a Highway/Traversal should be Eastbound (EB) or Northbound (NB), where feasible. The Inventory should be picked up in the same direction that the road was entered into CHRIS. The direction of travel must remain the same from start to finish.

- It should be noted that some district roads do not follow this rule. Direction will need to be confirmed prior to starting collection of inventory for each road.

Road Inventory:

There are basically two types of road Inventory that will be collected:

- Points
- Lines (linear)

Points:

Location information should be collected at the centre of the Inventory Item, first access to the Item or beginning of the Item. The location should be collected by being positioned perpendicular to the Inventory Item whether it is on the right hand or left hand side of the road. The location information should be collected in the direction of highway travel.

Lines (Linear):

Linear items on both sides of the highway should be collected in the direction of highway travel.

Inventory Type Attributes:

All Values for the Inventory Type Attributes must be entered in Uppercase so that the CSV Loaders will work properly.

- Other Attributes required for filling in the CSV Loader file; (**M**).
  - These Attributes are not part of the Inventory Type per se, but are required (mandatory) for the CSV loaders to work properly. They include Inventory Type Code, RFI Route Unique Identifier, Start Chainage, End Chainage, Admin Unit, Start Date and XSP (where applicable).
  - The XSP attribute is only applicable if the Inventory Type actually requires a Cross Sectional Position; if it does not, this attribute can be left blank.
- Mandatory Attributes are defined in each Inventory Type; (**M**).
  - These Mandatory attributes must be completed with appropriate values as defined in the Inventory Type details.
- Optional Attributes are defined in each Inventory Type; (**O**)*.
  - These Optional attributes may be completed or populated, if known.
  - * The Optional **Comments** attribute may be needed for general info about a particular Inventory Item (e.g. SIGN: entering the actual Posted Speed of a R-004 sign – see Rules/Considerations).

All Attribute Fields:

All values entered into all attribute fields must be in Uppercase.

Open Attribute Fields:

Do not use any punctuation in Attribute fields that are open to the user for input. The use of punctuation causes problems with the CSV reports. This would include fields such as:

- **RF** – Roadside Facility Name
- Comments fields in all cases

5. Identification of Cross Sectional Position (XSP)

XSP Codes:

Inventory Items are laterally located on the highway based on the following guidelines and relative to the direction of increasing LRM chainage.

- XSPs are Left and Right relative the direction of increasing LRM chainage offset in which the LRM element is defined.
- In the case of a divided highway XSP the assumed road **Centreline** is the **Left Shoulder** marking.
- Where required, a List of Values (LOV) table is provided for each individual Inventory Type.

Valid CHRIS XSP Codes:

XSP Code	Meaning	Description
X	All Lanes	Includes all through and special lanes
RRW	Right of Way – Right	The Right of Way to the right in the direction of chainage
RD	Ditch – Right	The Ditch to the right in the direction of chainage
RS	Shoulder – Right	The Shoulder to the right in the direction of chainage
RL1	1st Lane - Right	The First **Through** Lane to the right of Centreline in the direction of chainage
M	Division of Travel Direction/End of Road	Division of Direction of Travel, Centreline, End of Road or Median
LL2	1st Lane - Left	The First **Through** Lane to the left of Centreline in the direction of chainage
LS	Shoulder – Left	The Shoulder to the left in the direction of chainage
LD	Ditch – Left	The Ditch to the left in the direction of chainage
LRW	Right of Way – Left	The Right of Way to the left in the direction of chainage
O	Over	Over (the Structure is Over the Road)

6. Inventory Types

6.1. CG (Cattle Guard)

Inventory Type Description: A Cattle Guard is a barrier placed in the road surface to prevent the movement of livestock or wildlife from one side of the barrier to the other, but allowing traffic to proceed without interruption. It is represented by a **Point** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	CG
RFI Route Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Chainage in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Chainage in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position (leave blank, if not applicable)
Cattle Guard Type	LOV	**M**	As per LOV
Cattle Guard Width	Num	**M**	Min=1.5m; Max=15.0m (width aross the lanes)
Running Strips	LOV	O	Yes/No
Cattle Guard Base	LOV	O	As per LOV
Installation Date	Date	Leave Blank	
Comments	Text	O	Enter Cattle Guard and/or CG Base Type if **Other** is chosen
X_Coord	Num	**M**	Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Y_Coord	Num	**M**	Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Cattle Guard Type:**

Value	Meaning	Description
C	Concrete	Concrete Grid
M	Metal	Round Metal Bar Grid
MR	Metal Rail	Metal Rail Grid
N	Other	Cattle Guard Type information to be entered in the **Comments** field
U	Ungulate	Special Grid Design for Wildlife
W	Wood	Wood Grid

LOV/Code Table Values – **Running Strips:**

Value	Meaning	Description
Y	Yes	
N	No	

LOV/Code Table Values – **Cattle Guard Base:**

Value	Meaning	Description
C	Concrete	
TW	Treated Wood	
UTW	Untreated Wood	
NB	No Base	
N	Other	Cattle Guard Base information to be entered in the **Comments** field

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LL2	1st Lane - Left
LRW	Right of Way – Left
RL1	1st Lane - Right
RRW	Right of Way – Right
X	All Lanes

Rules / Considerations:

- Location information should be recorded at the centre of the Cattle Guard in the direction of highway travel.
- Width of the Cattle Guard is the distance across the lane/all the lanes.

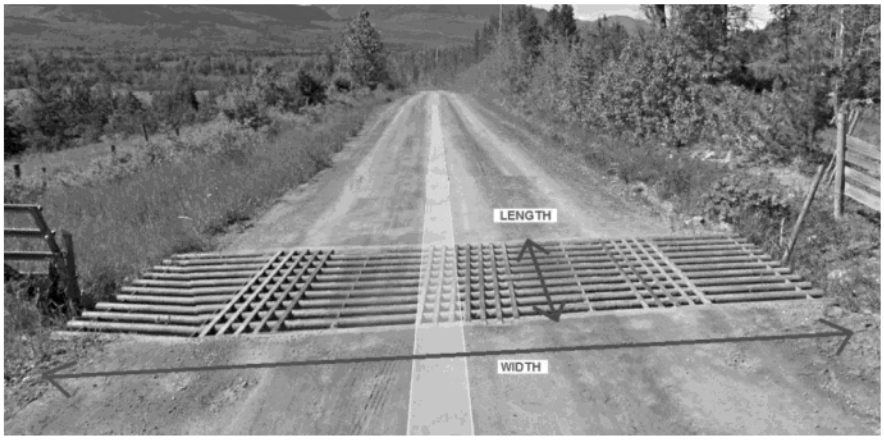


Figure 1 - Width & Length of Cattle Guard

- Only those cattle guards for which the Ministry has a maintenance responsibility should be added to CHRIS.
- Do not include cattle guards at private entrances onto the highways.
- Where two cattle guards are situated side by side, inventory both.

6.2. CGUT (Curb and Gutter)

Inventory Type Description: Curb and Gutter includes all extruded asphalt or concrete curbing used to direct drainage and/or support sidewalk structures. It is represented by a **Linear** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	CGUT
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Curb/Gutter Type	LOV	**M**	As per LOV
Start_X	Num	**M**	Start Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Start_Y	Num	**M**	Start Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum
End_X	Num	**M**	End Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
End_Y	Num	**M**	End Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Curb** / **Gutter Type:**

Value	Meaning	Description
A	Asphalt	Asphalt curbing used to control drainage at roadside
C	Concrete	Concrete curbing used to control drainage at roadside
N	Other	
SA	Asphalt Sidewalk	Asphalt sidewalk that the Ministry is responsible to maintain
SC	Concrete Sidewalk	Concrete sidewalk that the Ministry is responsible to maintain
SG	Gravel Sidewalk	Gravel sidewalk that the Ministry is responsible to maintain - must be a separate entity from the highway shoulder
SW	Timber Sidewalk	Timber sidewalk that the Ministry is responsible to maintain

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LRW	Right of Way – Left
LS	Shoulder – Left
RRW	Right of Way – Right
RS	Shoulder – Right

Rules / Considerations:

- This Inventory Type does not include curbs for traffic islands or lane separation islands.
- If the principal purpose of the curb is to direct water then it should be inventoried.
- Do not inventory curb and gutter along an Arterial Highway where a storm drainage system exists, as the curb and gutter are considered to be part of the storm drainage system, which is a Municipal responsibility.
- If a hard surfaced sidewalk exists beyond the curb and is maintained by the Ministry, inventory the Curb Type as Sidewalk with appropriate surface type.
- Do not measure curb through intersections (stop and then start again).

6.3. GR (Guardrail)

Inventory Type Description: A Guardrail is a barrier fastened to the end of a bridge abutment, along the shoulder of a road or between travel lanes of opposing traffic. It is represented by a **Linear** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	GR
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Guardrail Type	LOV	**M**	As per LOV
Installation Date	Date	Leave Blank	
Comments	Text	O	Enter Guardrail Type if **Other** is chosen; See Rules
Start_X	Num	**M**	Start Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Start_Y	Num	**M**	Start Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum
End_X	Num	**M**	End Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
End_Y	Num	**M**	End Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Guardrail Type:**

Value	Meaning	Description
A	690mm NP Old Style	27” Old Style concrete barrier – no lifting holes
B	460mm NP Old Style	18” Old Style concrete barrier – no lifting holes
C	760mm NP Old Style	30” Old Style concrete barrier – no lifting holes
D	Sub-Standard W-Beam	Metal rail on wood posts
E	Standard W-Beam	Standard W-Beam post mounted barrier - Metal rail on wood or metal posts
F	690mm NP New Style	27” New Style concrete barrier - with lifting holes
G	810mm NP New Style	32” New Style concrete barrier - with lifting holes
H	Cable Barrier	Steel Rope Tension Cable
N	Other	Guardrail Type information to be entered in the **Comments** field

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LRW	Right of Way – Left
LS	Shoulder – Left
M	Division of Travel Direction/End of Road
RRW	Right of Way – Right
RS	Shoulder – Right

Rules / Considerations:

- Inventory a transition piece with the larger of the two barriers.
- Include bull noses with the barrier.

Guardrail Types:

Figure 2 - XSP – A – 690mm (27”) Old Style Concrete Barrier – no Lifting Holes

Note: *Does not need transitions, bullnoses meet with standard pieces.*

Figure 3 - XSP – B – 460mm (18”) Old Style Concrete Barrier – no Lifting Holes

Note: *Does not need transitions, bullnoses meet with standard pieces.*

Figure 4 - XSP – C – 760mm (30") Old Style Concrete Barrier – no Lifting Holes

Note: *Typically used on bridge approaches, needs custom transition from 760mm to 690mm. (Similar to 810mm New Style).*

Figure 5 - XSP – D – Sub Standard W-Beam

Note: *Metal railing on wood posts; typically used on Side Roads.*

Figure 6 - XSP – E – Standard W-Beam

Note: *Metal railing on wood or metal posts; typically used on Bridges.*

Figure 7 - XSP – F – 690mm (27") New Style Concrete Barrier – with Lifting Holes

Note: *Has transition between bullnose and standard pieces.*

Figure 8 - XSP – G – 810mm (32") New Style Concrete Barrier – with Lifting Holes

Note: *Typically used on bridge approaches, sometimes as median barrier. Has transition from 810mm to 690mm.*

Figure 9 - XSP – H – Cable Barrier

Note: *Roadside/shoulder installation – often used in median for divided highways.*

Figure 10 - XSP – N – Other

Note: *An example would be “Thrie-Beam” as depicted in above picture.*

6.4. LPM (Longitudinal Pavement Marking) – Corporate Mandatory

Inventory Type Description: Longitudinal Pavement Markings are pavement markings that are parallel to the center line of the road. It is represented by a **Linear** feature.

Note: *This inventory item type should be collected by another Ministry program.*

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	LPM
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Paint Line Type	LOV	**M**	As per LOV
Paint Type	LOV	**M**	As per LOV
Service Type	LOV	O	As per LOV
Date Painted	Date	O	Format yyyy-mm-dd
Geographic Description	Text	O	Name of area or closed community
Crew Identifier	LOV	O	As per LOV
Comments	Text	O	Enter Paint Type if **Other** is chosen
Start_X	Num	O	Start Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Start_Y	Num	O	Start Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum
End_X	Num	O	End Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
End_Y	Num	O	End Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Paint Line Type:**

Value	Meaning	Description
BA	Barrier Line	Solid yellow and broken yellow lines to permit passing in one direction
BR	Broken Line Yellow Line	Single dash yellow Centreline to permit passing in both directions
C	Centrelines – All Types	All Centreline Types
CW	Continuity – White Paint	Broken white line through access points/merges
CY	Continuity – Yellow Paint	Broken yellow directional dividing line through access points/merges
D	Double Solid Line - Yellow	Double solid yellow prohibiting lane changes
DB	Double Broken (Dashed)	Broken Double white lines – counterflow lanes

Value	Meaning	Description
F	Fog/Edge Line	White shoulder line
GI	Guiding - Intersections	Yellow or white lines used to assist with multi-lane turning movement
GP	Guiding - Pullout	Bus bays and pullouts
L	Lane Line	Dashed white line dividing lanes
M	Median Line	Solid yellow median line
N	Not Listed	
S	Single Solid Line	Single solid yellow line
WCW	Wide White Continuity (Dashed)	Continuity lines for critical areas (e.g. ramps) on Expressway & Freeways
WCY	Wide Yellow Continuity (Dashed)	Continuity lines for critical areas (e.g. ramps) on Expressway & Freeways
WF	Wide Fog Line	White Edge line used for critical and special lane designation on Expressway & Freeways
WL	Wide Lane Line	White Lane line used for critical and special lane designation on Expressway & Freeways

LOV/Code Table Values – **Paint Type:**

Value	Meaning	Description
N	Other	Paint Type information to be entered in the **Comments** field
P	Paint	White or Yellow paint overlaid with glass reflective beads
R	Rain Line	A special Thermoplastic application, white or yellow, which incorporates high reflective glass beads into a raised profile, providing a brighter reflective surface versatile in the most heavy rain conditions
T	Thermal Plastic	White or Yellow plastic marking, generally used for crosswalks, stopbars, lane-use arrows and other lines where high volumes of traffic cause excessive wear
Y	Not Painted	Paint line not required or not in place

LOV Domain Paint Type also used by:
Transverse Pavement Markings

LOV/Code Table Values – **Service Type:**

Value	Meaning	Description
AO	Additional Other Lines	Quantified unit price pavement markings – not included in the annual quantities – provided through additional funding
MC	RB Maintenance Contractor Repaint	MC painted lines as a result of a Maintenance Activity
N	New Lines	First time / establishment of paint lines
O	Other Lines	Quantified unit price pavement markings
P	Primary Lines	Centre and passing lines on designated numbered routes (maintained annually)
Z	Unknown	Unknown at Data Conversion – must be redefined as another type

LOV/Code Table Values – **Crew Identifier Type:**

Value	Meaning	Description
D-1	District - 01 Data Collection	More Values can be added at request; D-1 was collected by BC MoT District #1 personnel
N-52	Northern – 52	Contractor code
SI-53	Southern Interior - 53	Contractor code

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LL2	1st Lane – Left
LL4	2nd Lane – Left
LL6	3rd Lane – Left
LL8	4th Lane – Left
LL10	5th Lane – Left
LS	Shoulder – Left
M	Division of Travel Direction/End of Road
RL1	1st Lane – Right
RL3	2nd Lane – Right
RL5	3rd Lane – Right
RL7	4th Lane – Right
RL9	5th Lane – Right
RS	Shoulder – Right
SLL2	1st Inside Lane – Left
SLL4	2nd Inside Lane – Left
SRL1	1st Inside Lane – Right
SRL3	2nd Inside Lane – Right
Z	Unknown at Data Conversion – must be redefined as another type

Rules / Considerations:

- This data should be collected by contract centreline crews.
- The Geographic Description should include a Regional or nearby community name. (e.g. South of Prince George or between Prince George and Quesnel)
- The Crew Identifier is a value assigned by HQ.
- More information about Longitudinal Pavement Markings can be obtained by referencing the Ministry Pavement Marking Manual.

6.5. LSF (Linear Safety Feature)

Inventory Type Description: A Linear Safety Feature is one of a number of various appliances/appurtenances that have been installed or constructed either alongside or as an integral part of the road infrastructure to reduce the severity or potential of accidents. These items are represented by a Linear feature, versus the Inventory Item, Safety Feature which is represented by a Point feature. It is represented by a **Linear** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	LSF
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
LSF Type	LOV	**M**	As per LOV
Material Type	LOV	**M**	As per LOV
Installation Date	Date	Leave Blank	
Comments	Text	O	Enter LSF and/or Material Type if **Undefined** is chosen
Start_X	Num	**M**	Start Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Start_Y	Num	**M**	Start Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum
End_X	Num	**M**	End Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
End_Y	Num	**M**	End Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **LSF Type:**

Value	Meaning	Description
AB	Arrestor Bed	The portion of a truck escape ramp (runaway lane) designed to assist safe vehicle stopping
GS	Glare Screen	A screen placed above median barriers to reduce headlight glare between opposing traffic
RS	Rumble Strip	Milled or pressed rumble strips on shoulders, centrelines and traffic lanes
RL	Runaway Lane	A lane that is designed to assist safe vehicle exiting from the highway and stopping
UD	Undefined	LSF Type information to be entered in the **Comments** field

LOV/Code Table Values – **Material Type:**

Value	Meaning	Description
CA	Clean Aggregate	Clean Aggregate
CN	Concrete	Concrete
FG	Fiber Glass	Fiber Glass
MS	Masonry	Rock, Brick or Ceramic Tiles held together by Mortar
PL	Plastic	Plastic or Polymer based
ST	Steel	Steel or Metal
TR	Timber/Wood	Timber or Wood
UD	Undefined	Mixture of mediums, a non-existent medium (e.g. for rumble strips) or a material not otherwise defined; Material Type information to be entered in the **Comments** field

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LRW	Right of Way – Left
LS	Shoulder – Left
M	Division of Travel Direction/End of Road
RRW	Right of Way – Right
RS	Shoulder – Right

Rules / Considerations:

- This Inventory Type is **Exclusive** by the XSP value and by the LSF Type.
  In simple terms this means that items of the Inventory Type may only exist once for a given Network Location.
  - More than one LSF can be located in the same offsets on a road; however the XSP and/or the LSF Type must be different.
- Rumble strips can be continuous through intersections, but should show breaks at curb and gutter, guardrail (where not in existence) and bridges with flares.

6.6. RF (Roadside Facility)

Inventory Type Description: A Roadside Facility includes all Lay-bys, pullouts, parking areas and litter barrels that are not associated with Rest Areas or Landscape Areas. It is represented by a **Point** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	RF
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Roadside Facility Type	LOV	**M**	As per LOV
Roadside Facility Name	Text	O	Roadside Facility Name
Number of Tables	Num	Leave Blank	
Number of Standard Barrels	Num	Leave Blank	
Number of Bear Proof Barrels	Num	Leave Blank	
Number of Parking Spaces	Num	Leave Blank	
Comments	Text	O	Enter Roadside Facility Type if **Other** is chosen
X_Coord	Num	**M**	Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Y_Coord	Num	**M**	Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Roadside Facility Type:**

Value	Meaning	Description
A	Litter Barrels	A site where litter barrels are located, but not associated with a maintained lay-by or pullout
B	Brake Check	A lay-by or pullout, which has a designated use as a brake check, stop
CU	Chain-Up	A lay-by or pullout which has a designated use as a chain-Up area
CO	Chain-Off	A lay-by or pullout which has a designated use as a chain-Off area
L	Lay-by	A constructed area beside the highway where vehicles can pull off the main roadway
N	Other	Roadside Facility Type information to be entered in the **Comments** field
PP	Park and Pool	A car-pool meeting location where extra vehicles may be parked
PR	Park and Ride	A location where public transportation may be utilized and vehicles may be parked
S	Stop of Interest	A lay-by or pullout which has a designated use as a Stop of Interest
V	Viewpoint	A lay-by or pullout which has a designated use as a Viewpoint

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LRW	Right of Way – Left
RRW	Right of Way – Right

Rules / Considerations:

- If there is a “toilet” at a Roadside facility, then this site is a “Rest Area” and will be collected by others.
- Location information should be recorded at the centre of the first access to the site or at the beginning of the Roadside Facility in the direction of highway travel.

6.7. SF (Safety Feature)

Inventory Type Description: A Safety Feature is one of a number of various appliances/appurtenances that have been installed or constructed either alongside or as an integral part of the road infrastructure to reduce the severity or potential of accidents. It is represented by a **Point** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	SF
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Safety Feature Type	LOV	**M**	As per LOV
Safety Feature Count	Num	**M**	Count
Installation Date	Date	Leave Blank	
Comments	Text	O	Enter Safety Feature Type if **Other** is chosen
X_Coord	Num	**M**	Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Y_Coord	Num	**M**	Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Safety Feature Type:**

Value	Meaning	Description
B	Barrels	Foam or soft filled Crash Barrels
N	Other	Safety Feature Type information to be entered in the **Comments** field
SB	Sand Barrel Crash	Sand filled Crash Barrels
SL	Sliding	Rail mounted Crash Attenuator
ST	Styrofoam Block	Styrofoam block Crash Attenuator

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LS	Shoulder – Left
M	Division of Travel Direction/End of Road
RS	Shoulder – Right

Rules / Considerations:

- Inventory each site, not the number of components. If on both sides of a center pier of an overhead structure, you would count this as two sites, one on each side, one for each direction of travel.
- The Safety Feature Count represents the number of components within each site.

6.8. SIGN (Sign)

Inventory Type Description: A Sign is a lettered board, message or other display which includes all regulatory, warning, guide, informational, advisory, construction and maintenance and route markers, but excluding electronically controlled messages/displays. It is represented by a **Point** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	SIGN
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Catalog Number	LOV	**M**	As per LOV which contains the Ministry standard signs
Direction Facing	LOV	**M**	The cardinal direction, relative to the predominant direction of the highway, that the outward face of the sign points toward
Sign Post Type	LOV	**M**	As per LOV
Number of Posts	Num	**M**	
Large Sign Flag	Flag	**M**	Yes/No; Yes-greater than 3.2m^2
District Sign Number	Text	O	The unique number that identifies this sign in the District – can be found on back of sign
Installation Date	Date	Leave Blank	
Comments	Text	O	Non generic sign information; Enter Sign Post Type if **Other** is chosen; See Rules
X_Coord	Num	**M**	Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Y_Coord	Num	**M**	Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Catalog Number**

- See the Sign Catalog

LOV/Code Table Values – **Direction Facing Type:**

Value	Meaning	Description
E	East	Facing East, relative to the predominant direction the road, for west bound traffic
N	North	Facing North, relative to the predominant direction of the road, for south bound traffic
S	South	Facing South, relative to the predominant direction of the road, for north bound traffic
W	West	Facing West, relative to the predominant direction of the road, for east bound traffic

LOV/Code Table Values – **Sign Post Type:**

Value	Meaning	Description
B	Bridge	Bridge Structure including Overpasses and Sign Bridges and end posts
G	Gate	Installed on a gate
I	Illuminaire/Davit	Light Standard or Davit
M	Metal	Metal U-channel type post
N	No Post	Used for multiple sign faces on one structure/support or for signs attached to poles, rockwalls, etc.
P	Plastic	Plastic or Polypost
RS	Round Steel	Round Steel post
RW	Retaining Wall	Installed on a retaining wall
SB	Steel Beam	Break away steel beam
T	Telspar	Metal telescopic style post
W	Wood	Wood Post
X	Other	Sign Post Type information to be entered in the **Comments** field

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LD	Ditch – Left
LRW	Right of Way – Left
LS	Shoulder – Left
M	Division of Travel Direction/End of Road
O	Overhead
RD	Ditch - Right
RRW	Right of Way – Right
RS	Shoulder – Right

Rules / Considerations:

- All permanent or semi-permanent and seasonal Highway signs maintained by the Ministry must be inventoried.
- On Arterial Highways, the Ministry must maintain any Regulatory, Warning, Route, and Directional signs. The city maintains the parking and street name signs.
- Do not inventory Construction signs, Construction Project signs or signs being maintained by Construction crews.
- The direction facing should be relative to the highway direction. (e.g. If the sign is facing east bound traffic on highway one, then the sign is facing West, even if the compass direction is "North" for that portion of highway).
- If there are many signs on one post, then only one sign record is assigned a post count. All other sign records except the one, must be given a value of zero posts. All sign records for that one post may be given the same post type (e.g. telspar).
- Locate road name signs at an intersection against only one road.
  Example: A Stop sign with 'Smith' road name sign and 'Main' road name sign (one post) is located on Smith Road at its intersection with Main Road.
  a) Where do you locate the R-001 Stop sign & post?
  b) Where do you locate the G-007 for Smith Road?
  c) Where do you locate the G-007 for Main Road?

  Procedure: All signs and post are located against Smith Road.
- Only give standards/davits a count if they do not have any electrical attachments.
  - If the Sign Post Type (I-Illuminaire/Davit) has electricity, then under the Number of Posts, the count would be 0 (zero). If the Sign Post Type (I-Illuminaire/Davit) does not have electricity, then under the Number of Posts, the count would be 1.
- Do not give bridge end posts a count, they are a part of the bridge.
- Catalog Numbers should be generic, (e.g. G-007-1 is sufficient for a street name and doesn't need to be further defined by size).
- When choosing the Catalog number for Parking, Speed or Distance related signs, enter the appropriate non-generic information in the **Comments** field. For example:
  - P series – where applicable enter the **arrow direction** in the **Comments** field
  - R-003 & R-004 – enter the **speed** in the **Comments** field
  - W-022 to W-025 – enter the **speed/distance** in the **Comments** field
- Where there is a unique District Sign Number assigned to a sign, the following should be put in the Catalog Number field:
  - PB for Parks Branch
  - SA for Service and Attraction
  - G-001 to G-006 for Guide Signs
  - LR for Local Radio Signs
- Catalog numbers with "DO NOT USE" in the description/number are signs that are being phased out through attrition. Ensure that the sign in the field is the old version before accepting this catalog number.
- Large Signs are those signs that are over 3.2m^2.

- Non generic sign information should be added to the **Comments** field.
  Example: Overhead clearance sign W-018 would require a height "9.9m" to be added to the **Inventory Type Code** field. This allows other business units who require specific information to query CHRIS directly without involving the Districts for data requests.
- If **W-055 series** are being used to delineate/show alignment of curve or merging lanes or barriers and there are several/many of them, add them as "REFL" and in the attributes, indicate the product being used in the **Comments** field:
  Example: REFL Type = Roadway Square, RS
  Installation = PostColour = White, White & Yellow, Yellow
  Spacing = # m apart
  Comments = "W-055-1 or -2" (or if you not using the W-055 series, then the "Product code", or description "Button" - put the type of product you used in this field)
- If **W-055 series** are being used to delineate (mark/indicate) an Electrical Junction, Traffic Counter, Street Lamp, Drainage Appliance, Start of Curbing, etc. (usually only 1 or 2 being used and they are not lineal in nature) then they should be added as a "SIGN".

6.9. TPM (Transverse Pavement Marking) – Corporate Mandatory

Inventory Type Description: Transverse Pavement Markings are pavement markings that are not parallel to the center line of the road. It is represented by a **Point** feature.

Attribute	Data Type	Mandatory/ Optional	Description/Comment
Inventory Type Code	Text	**M**	LPM
RFI Unique Identifier	Text	**M**	RFI Route (e.g. 24-B-@-00063)
Start Chainage	Num	**M**	Start Offset in kilometres to the 3rd decimal place
End Chainage	Num	**M**	End Offset in kilometres to the 3rd decimal place
Admin Unit	Num	**M**	Service Area Admin Unit (i.e. 401 to 428)
Start Date	Date	**M**	Collection Date – format dd-MON-yyyy
XSP	LOV	**M**	Cross Sectional Position; As per LOV - leave blank, if not applicable
Marking Type	LOV	**M**	As per LOV
Paint Type	LOV	**M**	As per LOV
Length	Num	O	Length in metres to the first decimal place ((format mask = 999.9)
Painted Area	Num	O	Area in metres squared to the first decimal place ((format mask = 99.9)
Count	Num	O	Enter Marking and/or Paint Type if **Other** is chosen
Date Last Painted	Date	O	Format yyyy-mm-dd
Comments	Text	O	
X_Coord	Num	O	Longitude is the geographic coordinate, in decimal degrees (-ddd.dddddd) – WGS84 as a reference datum
Y_Coord	Num	O	Latitude is the geographic coordinate, in decimal degrees (dd.dddddd) – WGS84 as a reference datum

LOV/Code Table Values – **Marking Type:**

Value	Meaning	Description
AR	Arrows	Direction Arrows - White Paint
CH	Chevron	Chevron marking in Gore area - White Paint
CU	Curb	Curb - Yellow or Red Paint
L	Letters	Letters - White Paint
N	Other	Marking Type information to be entered in the **Comments** field
P	Parking Stall	Lines separating parking stalls - White Paint
RS	Rumble Strips	Milled or pressed rumble strips on Transverse Pavement Marking
SP	Aerial Speed Bars	Bars painted on road for aerial viewing. Usually requested by police to monitor speeding traffic. White or Yellow Paint
ST	Stop Bar	Stop bar at stop sign or signalized intersections. White Paint
SY	Symbols	White, Yellow or Blue Paint. Restricted lane symbol, wheelchair, etc.
X	Advance X	Advance marking for School Crosswalk - White Paint
XH	Cross Hatch	Cross Hatch used to provide 'visual' island for traffic flow - Yellow Paint
XW	Cross Walk	Two parallel bars, perpendicular to traffic - White Paint
ZW	Z-Bar Cross Walk	Zebra Crosswalk consisting of Multiple parallel bars - White Paint

LOV/Code Table Values – **Paint Type:**

Value	Meaning	Description
N	Other	Paint Type information to be entered in the Comments field
P	Paint	White or Yellow paint overlaid with glass reflective beads
R	Rain Line	A special Thermoplastic application, white or yellow, which incorporates high reflective glass beads into a raised profile, providing a brighter reflective surface versatile in the most heavy rain conditions
T	Thermal Plastic	White or Yellow plastic marking, generally used for crosswalks, stopbars, lane-use arrows and other lines where high volumes of traffic cause excessive wear
Y	Not Painted	Paint line not required or not in place

LOV Domain Paint Type also used by:
Longitudinal Pavement Markings

LOV/Code Table Values – **Valid XSPs:**

XSP Code	Cross Sectional Position
LL2	1st Lane – Left
LL4	2nd Lane – Left
LL6	3rd Lane – Left
LL8	4th Lane – Left
LL10	5th Lane – Left
LRW	Right of Way – Left
LS	Shoulder – Left
M	Centreline
RL1	1st Lane – Right
RL3	2nd Lane – Right
RL5	3rd Lane – Right
RL7	4th Lane – Right
RL9	5th Lane – Right
RRW	Right of Way – Right
RS	Shoulder – Right
SLL2	1st Inside Lane – Left
SLL4	2nd Inside Lane – Left
SRL1	1st Inside Lane – Right
SRL3	2nd Inside Lane – Right
X	All Lanes
XL	All Left Lanes
XR	All Right Lanes
Z	Unknown at Data Conversion – must be redefined as another type

Rules / Considerations:

- Location Information should be recorded at the start of each item in the direction of highway travel.
- A group of lines can be recorded as one record:
  Example: All chevrons within one gore area, all stripes within one zebra cross walk
- More information about Transverse Pavement Markings can be obtained by referencing the Ministry Pavement Marking Manual.

APPENDIX B

PROJECT TEAM RESUMES

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APPENDIX C

TECHNOLOGY SPECIFICATIONS

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Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

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TETRA TECH

Sample Panoramic Image Dataset

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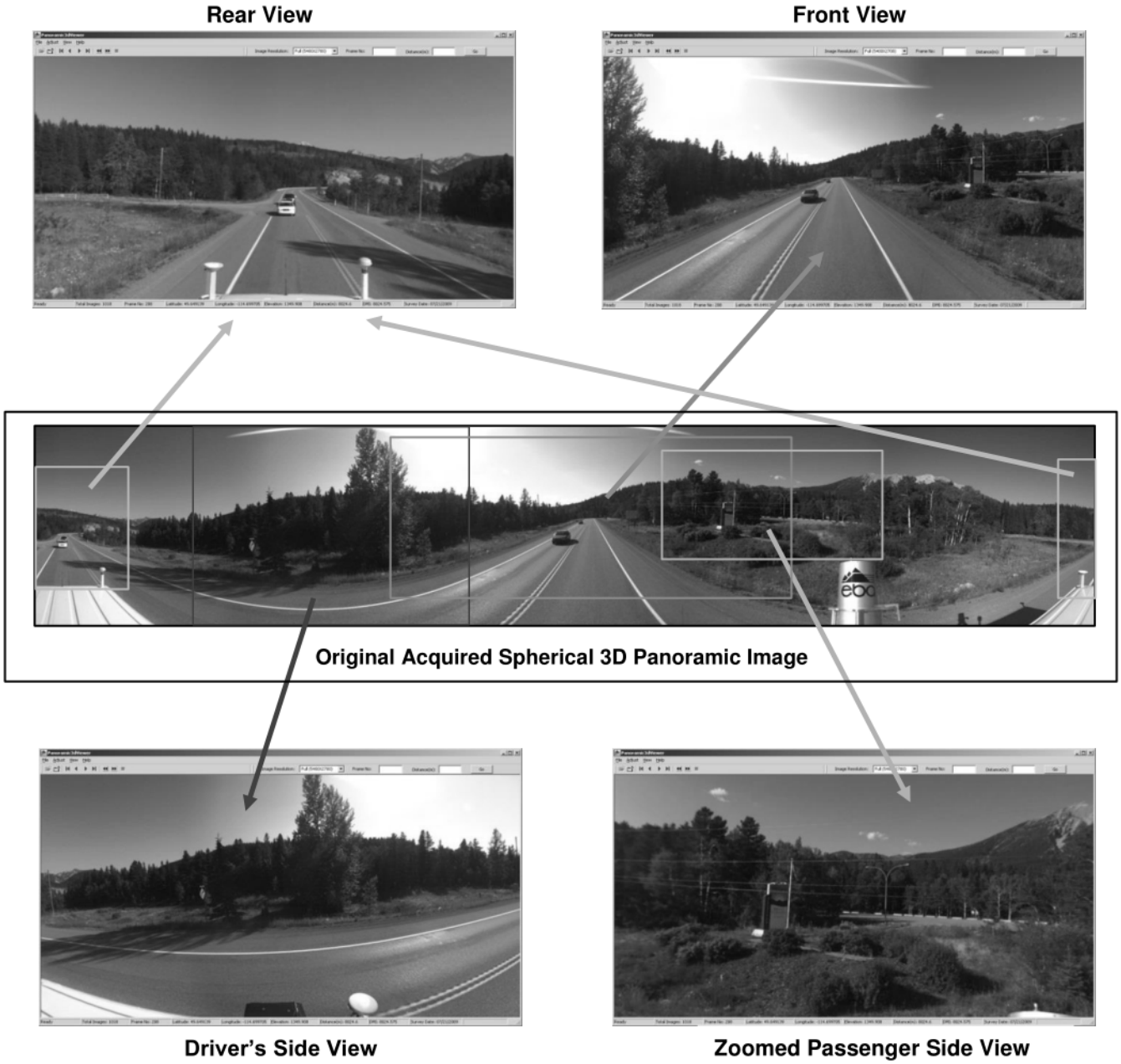

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TETRA TECH

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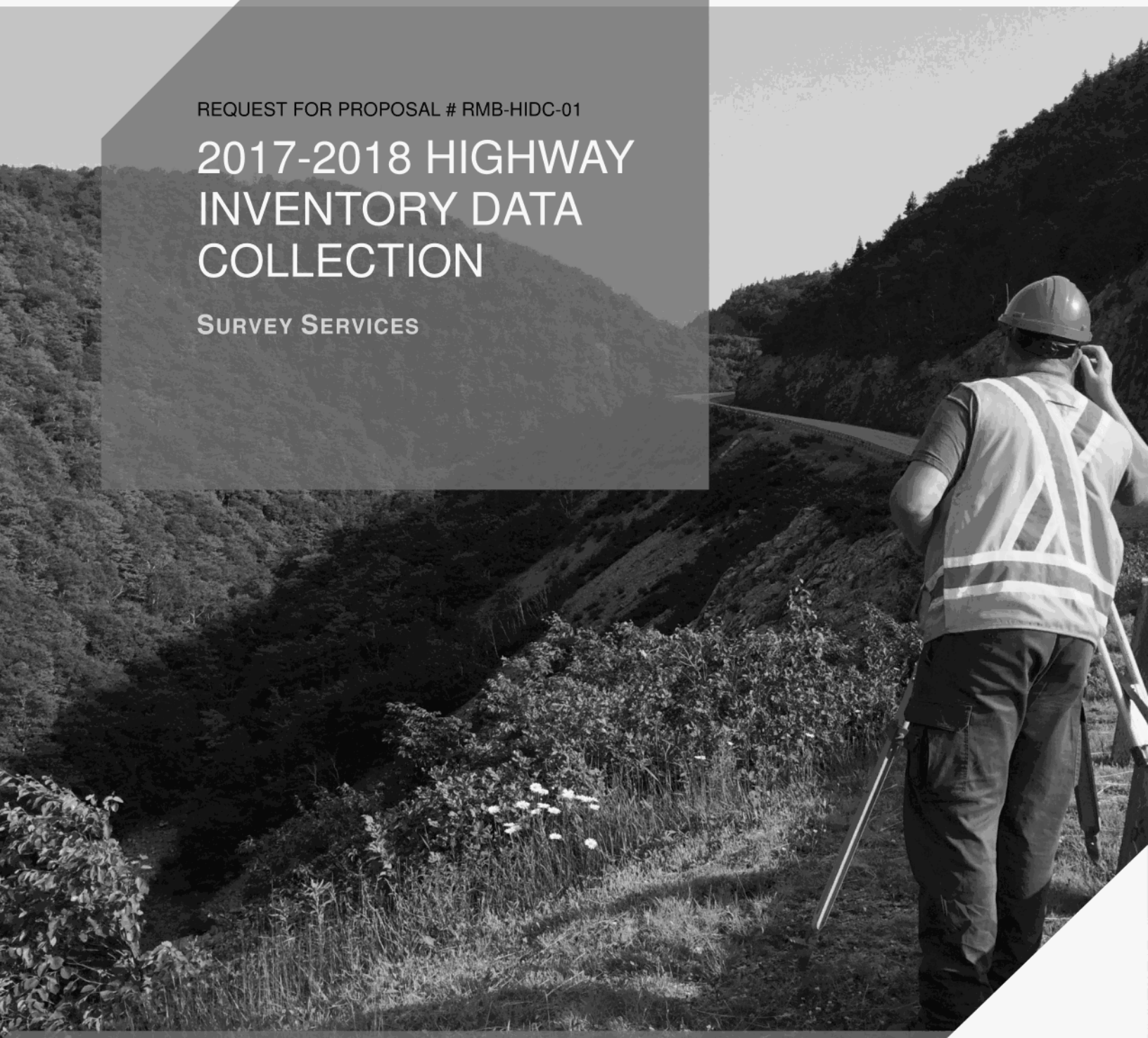
REQUEST FOR PROPOSAL # RMB-HIDC-01

2017-2018 HIGHWAY INVENTORY DATA COLLECTION

SURVEY SERVICES



SERVICE PROPOSAL

FEBRUARY 22, 2017

WSP Canada Inc.
301-3600 Uptown Boulevard
Victoria, BC V8Z 0B9

T +1 250-384-5510

REQUEST FOR PROPOSAL # RMB-HIDC-01

2017-2018 HIGHWAY INVENTORY DATA COLLECTION

SURVEY SERVICES

February 22, 2017

Ministry of Transportation and Infrastructure
Rehab and Maintenance Branch
4th Floor – 950 Blanshard Street
Victoria, BC V8W 3E6

Subject : REQUEST FOR PROPOSAL – 2017-2018 HIGHWAY INVENTORY DATA COLLECTION

Dear Rachel Fox,

WSP Canada Inc. is pleased to provide you with our response to your Request for Proposal (RFP) for the survey services for the Ministry of Transportation and Infrastructure; 2017-2018 Highway Inventory Data Collection Project

CONFIRMATION OF PROPONENT'S INTENT TO BE BOUND:

The enclosed proposal is submitted in response to the referenced Request for Proposals, including any Addenda. By submitting a proposal the Proponent agrees to all of the terms and conditions of the RFP including the following:

a) The Proponent has carefully read and examined the entire Request for Proposals;

b) The Proponent has conducted such other investigations as were prudent and reasonable in preparing the proposal; and

c) The Proponent agrees to be bound by the statements and representations made in its proposal.

PROPONENT NAME (please print): **WSP Canada Inc.**

NAME OF AUTHORIZED REPRESENTATIVE (please print): **Steaphan MacAulay, VP of Geomatics**

SIGNATURE OF AUTHORIZED REPRESENTATIVE:

NAME OF AUTHORIZED REPRESENTATIVE (please print): **Cary Williams, Project Manager Geomatics**

SIGNATURE OF AUTHORIZED REPRESENTATIVE:

WSP Canada Inc.
301-3600 Uptown Boulevard
Victoria, BC V8Z 0B9

T +1 250-384-5510

TABLE OF CONTENTS

1

COMPANY INFORMATION

1.1 WSP PROFILE

WSP Canada Inc. (WSP) appreciates the opportunity to provide the Ministry of Transportation and Infrastructure with this response to your Request for Proposal (RFP) for the 2017-2018 Highway Inventory Data Collection project.

Our firm has been providing professional surveying services to public and private sector clients for more than 70 years. That equates to 7 decades providing innovative approaches to projects, prompt and efficient service, and quality results for our clients.

As the largest geomatics and surveying firm in Canada, with more than **600** dedicated professionals, **150** survey field crews and **21** offices, our teams are committed to helping our clients succeed no matter how they grow, what they choose to do, or where they move.

The experience gained during this time has allowed us to become experts in:

- → Municipal Land Surveying
- → Legal Surveys
- → Deformation Monitoring Surveys
- → GIS & Remote Sensing
- → Laser Scanning As-Built Surveys
- → Bathymetric Surveys
- → Vertical Construction Projects
- → Volumetric Surveys

GEOMATICS
OFFICE LOCATIONS

70+
Years of Experience

600
Professionals

150
Survey Crews

21
Offices

2

EXPERIENCE

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3

METHODOLOGY / DATA QUALITY

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4

TIMELINE

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Please see **Appendix C** for our overview map showing the service areas completion dates.

5

PRICE

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5.1 INSURANCE

Please see **Appendix D** for our Insurance Certificate.

6

TECHNOLOGY & VALUE ADDED

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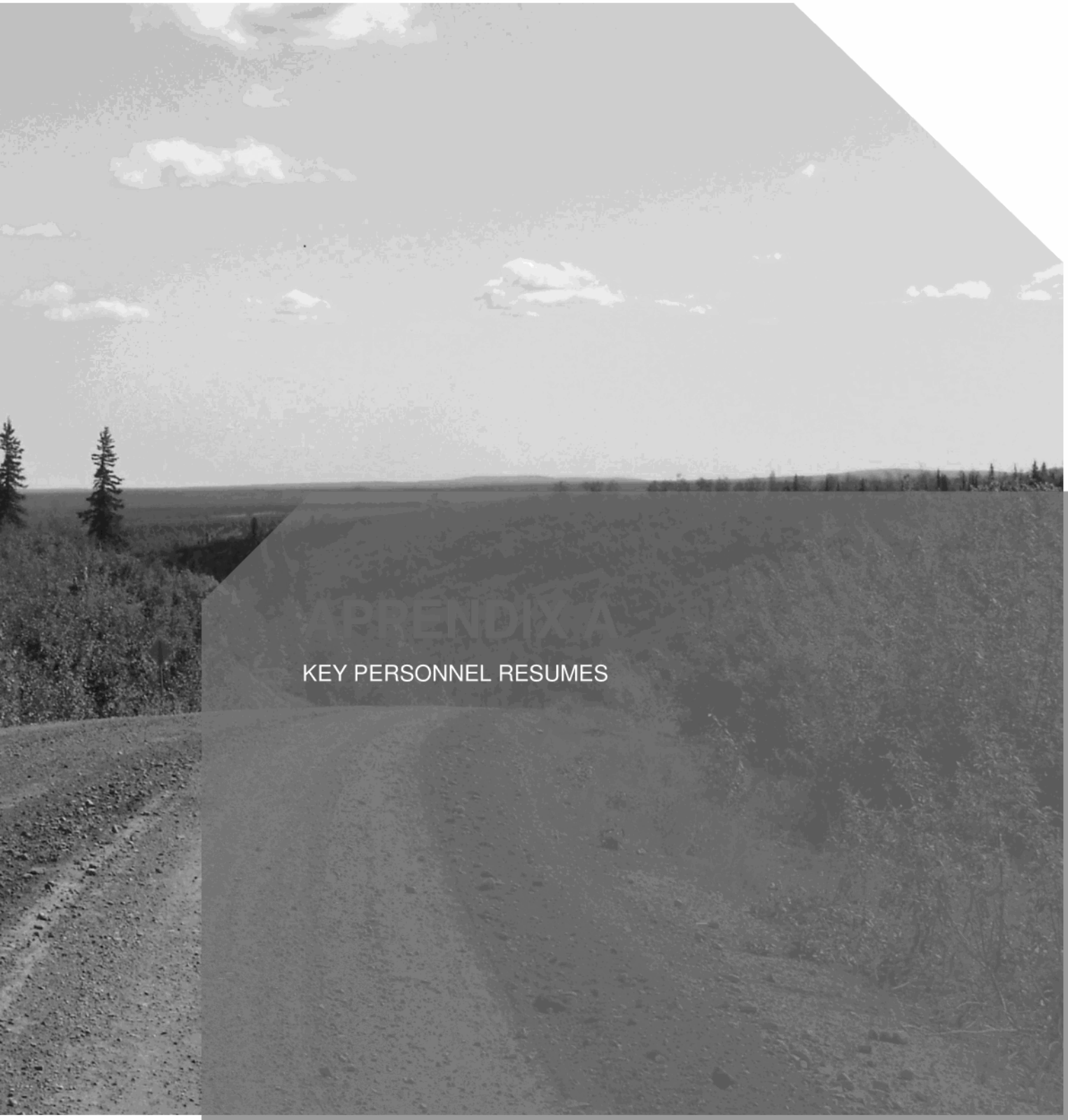

APPENDIX A

KEY PERSONNEL RESUMES

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APPENDIX E

TRIMBLE MX7 DATASHEET

Trimble MX7

MOBILE IMAGING SYSTEM

ENTER THE WORLD OF MOBILE IMAGING

The Trimble® MX7 Mobile Imaging System with VISION™ technology, is a vehicle-mounted photogrammetric system that makes it easy to quickly and completely capture road and site infrastructure information. Capture 360-degree, 30 megapixel geo-referenced images at highway speeds to rapidly reduce project fi time. Then, use Trimble Trident offi e software to extract and analyze your collected data. The Trimble MX7 is the ideal solution for organizations looking to enter the world of mobile imaging with a smaller investment.

Rapid Collection of Geo-Referenced Images

Capture a 30 megapixel panoramic image of the surrounding environment in static or mobile—up to highway speed—modes with the Trimble MX7. Equipped with six, 5 megapixel cameras and Trimble Applanix GNSS and inertial geo-referencing modules, the Trimble MX7 enables you to manage assets—such as bridges, buildings, roads, highways, and power stations—and document site conditions with geo-referenced images. This compact, lightweight, and rugged sensor can be mounted on vehicles of all sizes.

System control and data recording functions are controlled wirelessly through any WiFi enabled PC or tablet device. Trimble Mobile Imaging Software is available with the system and offers a clear, intuitive user interface—making it easy to use—allowing the operator to rapidly set system parameters and manage data recording.

Capture Now, Measure Later

Avoid site rework and benefi from increased quality control and data validation by capturing the data now and measuring later. The Trimble MX7 allows you to visually observe and capture the job site, then produce deliverables in the offi e later using Trimble Trident and Applanix POSPac™ MMS software. For post-processing requirements, use Trimble's powerful Applanix POSPac MMS software.

Trident Imaging Hub software is available with the system and offers robust object positioning, measurement, data layer creation, and analysis of geo-referenced imagery. This powerful software gives you the ability to extract additional data and features without having to re-visit the site.

Key Features

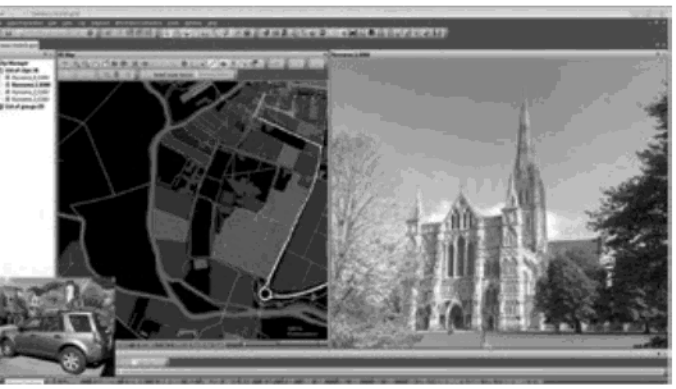
- Versatile system offers signifi ant operational fl xibility
- Six 5 megapixel cameras provide rapid 360-degree image documentation
- Precision positioning using tightly coupled GNSS and inertial referencing system
- Deploys on all sizes of on- and off-road vehicles
- Use with Trimble Mobile Imaging Capture software and Trimble Trident offi e software for data capture, extraction and analysis

Trimble MX7 MOBILE IMAGING SYSTEM

SOFTWARE

Trimble Trident

- Trajectory import
- 360° imagery and vector data visualization
- Database connectivity
- GIS Layer Form creation
- Photogrammetric feature addition
- 3D measurements
- Attribute addition as of user selected snippets or object coding
- Image converter
- SHP/DXF import and export
- Export / Data conversion of MX7 data to Orbit GT and Horus



PERFORMANCE AND SPECIFICATION

System Specification	
Resolution	30 MP (5 MP x 6 sensors)
Field of view	90% of full sphere
Spherical distance	Calibrated from 2 m to infi y
Operating temperature	0 °C to +35 °C
Power	12 V to 24 V DC (typical 100 W)
Weight	11.3 kg

Positioning Sub-system (RMS Error)[1]	
Type	Trimble AP15 GNSS-Inertial System
Technology	Advanced Applanix IN-Fusion™ GNSS-Inertial integration technology
# of GNSS channels	220
Inertial measurement unit	Applanix IMU-69 (non ITAR) with 200 Hz data rate
Position (m): No GNSS outages[2,4] 1 km or 1 minute GNSS outage[2,4]	 0.02–0.05 (post-processed)[2] 0.2–0.8 (post-processed)[2]
True Heading (deg): No GNSS outages[2,4] 1 km or 1 minute GNSS outage[2,4]	 0.08 (post-processed)[3] 0.2 (post-processed)[3]

Options	
Analysis	Applanix POSPac MMS
Positioning	Distance measurement indicator (DMI)

1 Typical performance in a standard road vehicle with appropriate initialization and dynamics. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects.
2 Typical mission profile, max RMS error.
3 POSPac MMS.
4 With DMI option.

Contact your local Trimble Authorized Distribution Partner for more information

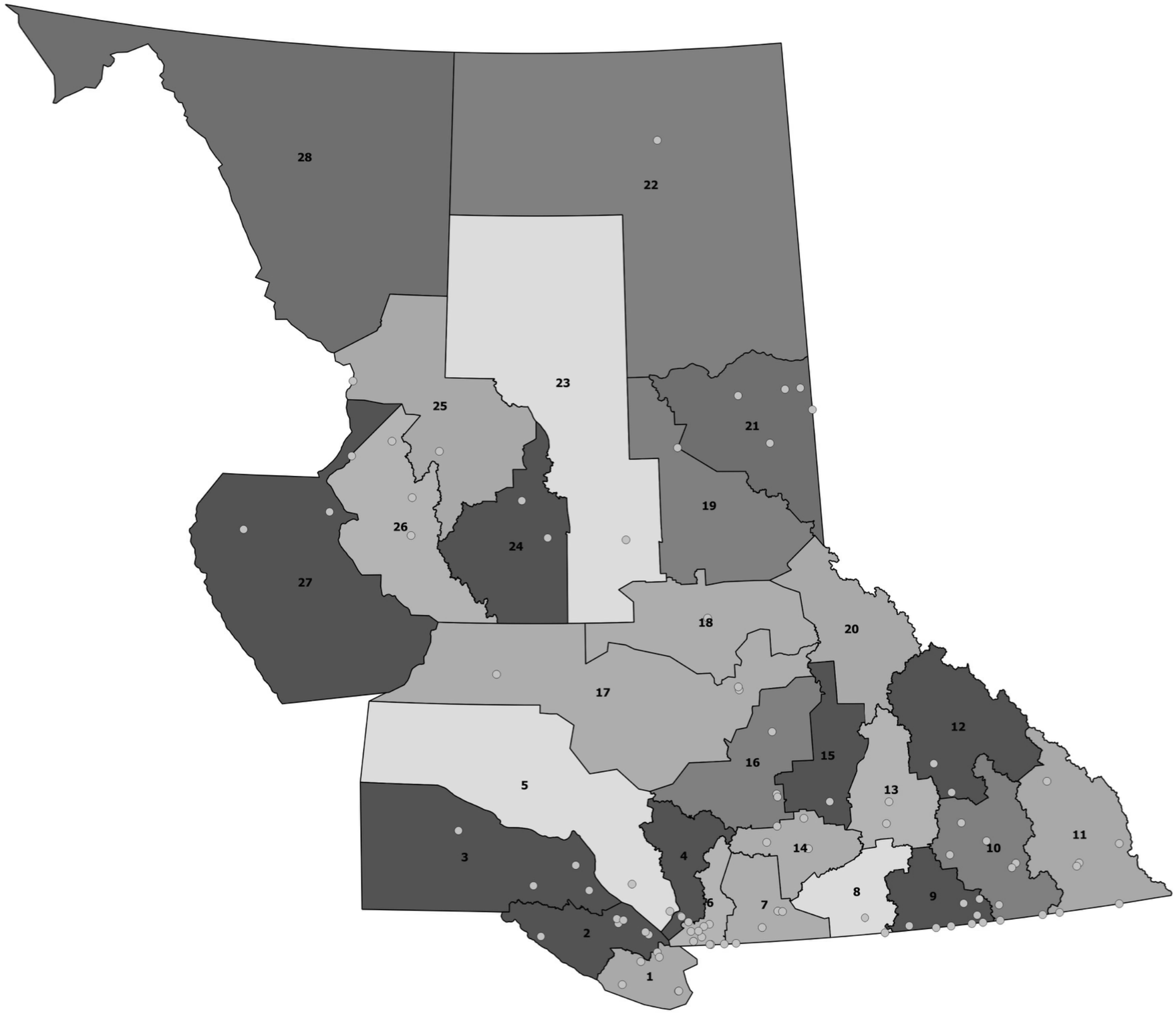
NORTH AMERICA
Trimble Navigation Limited
10368 Westmoor Dr
Westminster CO 80021
USA

EUROPE
Trimble Germany GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY

ASIA-PACIFIC
Trimble Navigation Singapore Pty Limited
80 Marine Parade Road
#22-06, Parkway Parade
Singapore 449269
SINGAPORE

APPENDIX C

OVERVIEW MAP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Legend
From Location
MoT Service Area
May 31, 2017
Jan, 2018
Feb, 2018
Mar, 2018
Apr, 2018
May, 2018
June, 2018

APPENDIX D

INSURANCE

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