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**GEOMATICS CANADA
OPEN FILE 48**

Federal environmental scan of geospatial building data

E. Wright

2019

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E. Wright¹

¹AECOM Canada Ltd.

2019

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Natural Resources Canada

Federal Environmental Scan of Geospatial Building Data

Final Report

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Jean-Samuel Proulx-Bourque, M.Sc.
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April 12, 2019

Project #
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Dear Mr. Proulx-Bourque

**Subject: Federal Environmental Scan of Geospatial Building Data
Final Report**

We are pleased to submit our final report for Natural Resources Canada's environmental scan of geospatial building scan. The primary purpose of this study is to provide NRCan with the overview of the available data as well as the supporting information required to support decision making related to the creation of the geospatial buildings database. The key objectives of this study are as follows:

- Review and summarize current efforts made by NRCan and the related stakeholders to compile all geospatial building information.
- Building on current progress, complete an Environmental Scan of the federal, provincial/territorial, and commercially available geospatial building information by evaluating availability, scope, geographical coverage, licensing, and the available attributes.
- Use the results of the Environmental Scan to complete a review of jurisdictional roles, responsibilities, and legislative directives for gathering, managing, and distributing geospatial building information.
- Identify key points of comparison in other countries who have already compiled all geospatial building information or are in the process of doing so.

We trust this final report meets your needs, for any questions please don't hesitate to contact Jeff Atherton.

Sincerely,
AECOM Canada Ltd.



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1. Introduction

Natural Resources Canada (herein referred to as “NRCan”) is a Canadian federal department charged with a diverse array of responsibilities including natural resources, energy, earth sciences, and of note to this project, mapping and remote sensing. NRCan (along with many other federal agencies) is continually evolving its operations and service delivery with new technology and the ongoing digital transformation of the public service. Increasingly, data is at the root of service delivery and planning activities, and the federal jurisdiction is no exception.

Recognizing this reality as part of a broader federal data strategy, NRCan wishes to develop a comprehensive geospatial layer of building footprints with accompanying attributes for all of Canada. The objective of this undertaking is to obtain building footprints as well as information about the building footprint that can support federal decision making related to emergency management, climate change preparedness, energy efficiency, and other priorities that matter to Canadians.

Due to the vast range of potential sources for building footprint data (both publicly and commercially), AECOM was engaged to provide an Environmental Scan of the available building footprint data. The results of this study are intended to be adopted by NRCan to assist in the decision making and data gathering process for the creation of a geospatial buildings database, or “layer”, with national coverage.

1.1 Background

The development of a federal layer of geospatial building information is an ongoing effort lead by Natural Resources Canada. Prior to the initiation of the Environmental Scan, there were several key milestones in the initiative. This background serves as useful context before presenting the state of current progress within **Section 2**.

1.1.1 Government of Canada Data Strategy and GeoBase Steering Committee

The development of a federal buildings layer began with a meeting between NRCan, Statistics Canada, Elections Canada, National Defence, and provincial and territorial representatives in June 2018. These stakeholders form the GeoBase Steering Committee of the Canadian Council on Geomatics. During this meeting, building footprints was established as a key datasets desired by all stakeholders.

In November 2018, the Privy Council Office (PCO) and the Treasury Board of Canada Secretariat (TBS) published the Government of Canada Data Strategy. This strategy provides a roadmap for how public service could adapt to the growth of data and digital technologies, including the recommendation for the continued and improved use of geospatial data. As part of the broader objective of building the federal datasets used for emergency management, building footprints was selected as the pilot project for future data collection efforts by the GeoBase Steering Committee. This pilot project is a shared initiative between Natural Resources Canada and Statistics Canada.

1.2 Project Overview

The primary purpose of this study is to provide NRCan with the overview of the available data as well as the supporting information required to support decision making related to the creation of the geospatial buildings database. The key objectives of this study are as follows:

1. Review and summarize current efforts made by federal stakeholders to compile all geospatial building information.
2. Building on current progress, complete an Environmental Scan of the federal, provincial/territorial, and commercially available geospatial building information by evaluating availability, scope, geographical coverage, licensing, and the available attributes.
3. Use the results of the Environmental Scan to complete a review of jurisdictional roles, responsibilities, and legislative directives for gathering, managing, and distributing geospatial building information.
4. Synthesize the results of Items #2 and #3 through a Strengths, Weakness, Opportunities and Threats (SWOT) assessment. The goal of the assessment is to examine the availability of the data and the supports available to NRCan through jurisdictional roles and responsibilities that would enable the development of the federal buildings layer.
5. Identify key points of comparison in other countries who have already compiled all geospatial building information or are in the process of doing so.

2. Summary of Current Progress Collecting Building Footprints

Before undertaking the Environmental Scan, it is first important to establish the areas of current progress. A summary of current progress by extension provides the focus required for an Environmental Scan and excludes successfully completed areas from the scope of further research. Establishing a baseline will also provide insight into how the Scan may be conducted.

2.1 Non-Residential Buildings Inventory: Feasibility Study

In January 2015, Natural Resources Canada and Statistics Canada partnered to complete a feasibility study to assess the cost, benefit, and challenges of developing a Canada-wide inventory of building footprint information for non-residential buildings. The scope of geospatial building information that NRCan and Statistics Canada are exploring has since expanded to include residential buildings. During this feasibility study, a pilot for data collection from open sources was performed for Metro Vancouver, as well as hospitals across Canada. Following thorough research and the pilot, the following conclusions were drawn:

- There are a wide range of uses across the public service for geospatial building information
- Building footprints allow for integration of existing attribute datasets (ex. business registries) for analytical and operational purposes that are not offered by other data formats
- The development of a non-residential buildings inventory is feasible, but requires a significant amount of integration from a variety of sources.

As part of this project, a preliminary data model was developed and 60 classes of non-residential buildings were defined. **Figure 1** provides a useful reference point: the data model considered during the feasibility study was ultimately adjusted to produce the Open Database of Buildings (**Section 2.2**).

While the focus of the Environmental Scan is information related to the availability of building information, the maintenance of geospatial building information once it is created is an important consideration for the Strengths, Weaknesses, Opportunities, and Threats Analysis (**Section 5**). This feasibility study reported that maintaining an inventory of non-residential buildings could cost approximately \$1.5 M/year once created.

Buildings inventory: data model

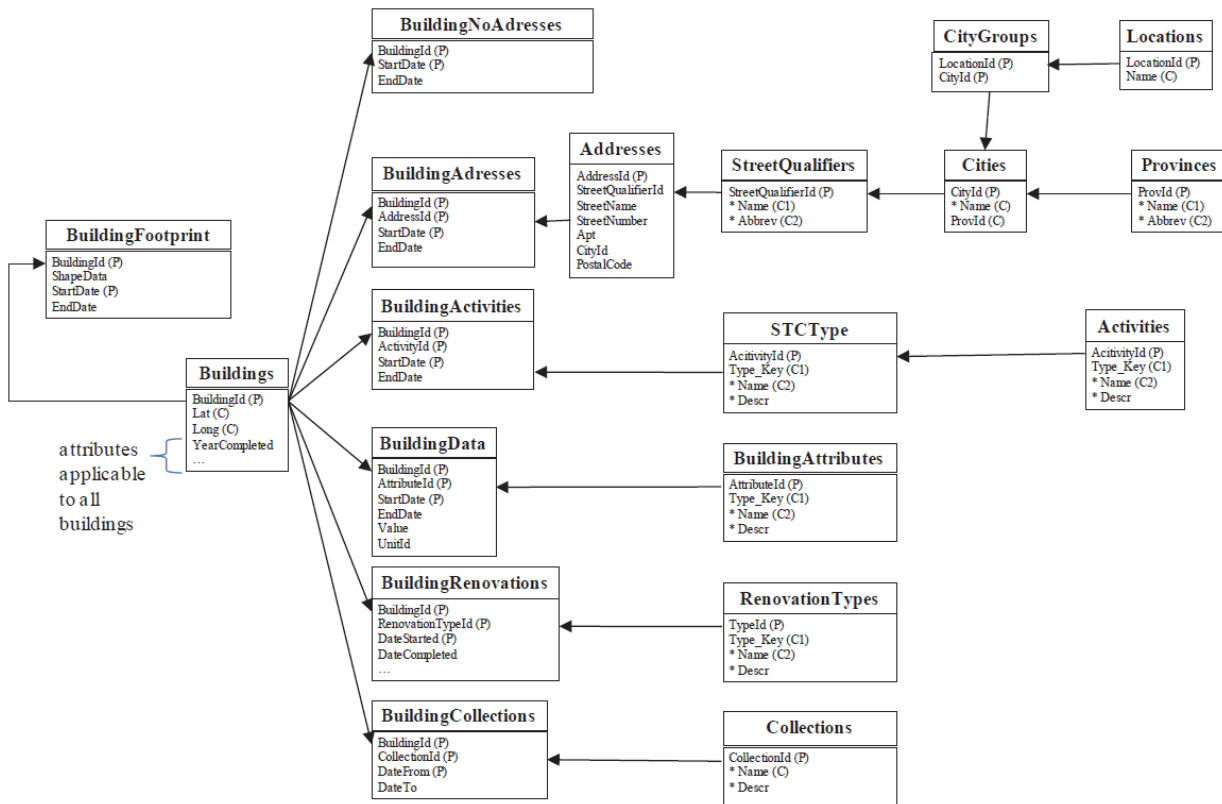


Figure 1 – Data Model Considered During the Non-Residential Buildings Inventory Feasibility Study

2.2 Open Database of Buildings

At present, Statistics Canada has made significant progress in developing a national building layer through an aggregation of available open GIS data, known as the Open Database of Buildings (ODB). This database is comprised of datasets maintained by upper and lower tier municipalities. ODB data comes from authoritative municipal sources, and it is of good quality (although the scope of attribute data is limited). The ODB is a recent milestone, with the first iteration published in November 2018. This layer presents a useful starting point for an Environmental Scan by examining current coverage. A gap analysis can provide indication of where further research is required. To structure the gap analysis, coverage of data was examined at 2 levels: Statistics Canada Metropolitan Areas and Census Agglomerations.

Table 1 presents a gap analysis of coverage offered by the Open Database of Buildings for Census Metropolitan Areas. Evident from the table is that considerable progress has been made, and that only 15 metropolitan areas are outstanding.

Table 1 – Gap Analysis of Metropolitan Census Area and Provincial/Territorial Capital Coverage in the Open Building Database

Name	Census Metropolitan Area (CMA)* or Provincial/Territorial Capital (PC)**	Province/Territory	Included in Open Database of Buildings?
St. John's	CMA, PC	Newfoundland	No
Halifax	CMA, PC	Nova Scotia	Yes
Moncton	CMA	New Brunswick	Yes
Saint John	CMA	New Brunswick	Yes
Fredericton	PC	New Brunswick	Yes
Charlottetown	PC	PEI	No
Saguenay	CMA	Quebec	No
Québec	CMA, PC	Quebec	Yes
Sherbrooke	CMA	Quebec	Yes
Trois-Rivières	CMA	Quebec	No
Montréal	CMA	Quebec	Yes
Ottawa-Gatineau	CMA	Ontario	Yes
Kingston	CMA	Ontario	Yes
Peterborough	CMA	Ontario	No
Oshawa	CMA	Ontario	Yes
Toronto	CMA, PC	Ontario	Yes
Hamilton	CMA	Ontario	Yes
St. Catharines - Niagara	CMA	Ontario	Yes
Kitchener - Cambridge - Waterloo	CMA	Ontario	Yes
Brantford	CMA	Ontario	Yes
Guelph	CMA	Ontario	Yes
London	CMA	Ontario	No
Windsor	CMA	Ontario	No
Barrie	CMA	Ontario	Yes
Greater Sudbury	CMA	Ontario	No
Thunder Bay	CMA	Ontario	No
Winnipeg	CMA, PC	Manitoba	No
Regina	CMA, PC	Saskatchewan	Yes
Saskatoon	CMA	Saskatchewan	No
Calgary	CMA	Alberta	No
Edmonton	CMA, PC	Alberta	Yes

Name	Census Metropolitan Area (CMA)* or Provincial/Territorial Capital (PC)**	Province/Territory	Included in Open Database of Buildings?
Kelowna	CMA	British Columbia	Yes
Abbotsford - Mission	CMA	British Columbia	No
Vancouver	CMA	British Columbia	Yes
Victoria	CMA, PC	British Columbia	Yes
Iqaluit	PC	Nunavut	No
Yellowknife	PC	Northwest Territories	Yes
Whitehorse	PC	Yukon	No
*As defined by Statistics Canada, a Census Metropolitan Area has a population of 100,000 or more.			
**Capitals were also identified when the population did not meet the criteria the definition set by Statistics Canada			

While metropolitan areas present a significant amount of coverage based on population and a useful starting point, it does not address the scope of the federal scan in its entirety. To drill down further, examining Statistics Canada Census Agglomerations (defined as 10,000 to 99,999 people) provides a more complete picture. The Open Database of Buildings contains several census agglomerations. See **Table 2**.

Table 2 - Gap Analysis of Census Agglomeration Coverage in the Open Building Database

Province/Territory	Included in Open Buildings Database*	Not Included	Total Census Agglomerations
Alberta	7	8	15
British Columbia	5	17	22
Manitoba	0	5	5
New Brunswick	0	5	5
Newfoundland and Labrador	0	4	4
Northwest Territories	1	0	1
Nova Scotia	1	3	4
Ontario	5	24	29
Prince Edward Island	0	2	2
Quebec	3	21	24
Saskatchewan	0	8	8
Yukon	0	1	1
Grand Total	13	109	122

Evident from the results of **Table 2** is that there are many census agglomerations without readily available data, and the total number of areas suggests individual data licenses may not be practical. Where possible, scalable solutions that will address larger areas of Canada are desirable.

2.3 Federal Data Catalogue

To further the efforts of data collection completed through the Open Database of Buildings, NRCan has undergone a review of the datasets currently available through provincial and territorial open data portals. These datasets should be leveraged where possible. At a high level, the results of this process can be summarized as follows (Table 3):

Table 3 – Overview of Open Data Queries for Buildings Completed by NRCan

Province/Territory	Total Number of Datasets	Government Buildings, Civic Facilities, Buildings of Interest	Complete Private Buildings and Households	Private Buildings and Households - Select Locations	Notes
Alberta	9	Yes	No	No	
British Columbia	74	Yes	No	No	
Manitoba	51	Yes	Yes	Yes	
New Brunswick	18	Yes	No	No	
Newfoundland and Labrador	24	Yes	No	Yes	Gander, Labrador City
Northwest Territories	34	Yes	Yes	Yes	
Nova Scotia	117	Yes	Yes	Yes	Building footprints are digitized when a size threshold is met. Most residential buildings are captured as points.
Nunavut	24	Yes	Yes	Yes	
Ontario	33	Yes	No	Yes	Contains building footprints across Ontario that met a size threshold. Most residential buildings did not meet the threshold.
Prince Edward Island	28	Yes	No	Yes	
Quebec	36	Yes	No	Yes	Montreal, Rimouski, Shawinigan, Repentigny, Sherbrooke, Longueuil, Repentigny, Blainville.
Saskatchewan	91	Yes	No	Yes	Regina, Saskatoon
Yukon	15	Yes	No	No	

Evident from the results are that government buildings and other points of interest are accounted for in the data for each province/territory (PT). Four PTs have a complete inventory of buildings, while the majority of PTs only have buildings digitized in select locations. These PTs will serve as the focus of the Environmental Scan.

3. Environmental Scan of Available Building Data

The Environmental Scan is a review of the available building footprint data in a GIS format across the Canadian jurisdiction. The goal of the Environmental Scan is to exhaustively research and document the existence of such data held by governments, agencies, companies, vendors, etc. known to be operating in the Canadian jurisdiction. For each potential source of data, the following questions will be answered and documented:

- Does the identified candidate store data about buildings in Canada?
- Is the data in a GIS format?
- Is the data stored as points or polygons?
- What attributes are available within the dataset?
- Is the data publicly available?
- What are the licensing requirements?
- Does licensing the data have a financial cost?
- Is the data enabled by a policy or business requirement?
- Who uses the data?

3.1 Methodology

3.1.1 Process

To perform the Environmental Scan an iterative process was taken, completing record searches for publicly available information on geospatial building datasets. For each potential source, the record search was recorded. To record information, the questions outlined above were converted to a table format, such that each candidate that is reviewed is thoroughly documented. The table format of the successful record searches completed can be viewed within **Appendix A**. Unsuccessful record searches are recorded in table format in each report section of the Scan (**Section 3.2.10** and **Section 3.3.2.14** for commercial and public data respectively).

3.1.2 Scope

The scope of the Environmental Scan were the publicly available, provincial, territorial and commercially available datasets. It is understood that there are also internal datasets maintained by NRCan, Statistics Canada, the Department of National Defence, and others that are readily shared between national stakeholders through day to day business processes. These datasets are internal and not publicly shared but are known to NRCan. When determining the desired approach to materializing the geospatial building information, NRCan will use the current internal federal datasets as key considerations. Therefore, the scope of the Environmental Scan is the datasets available commercially and at the other levels of government (namely, provincial and territorial).

3.2 Summary of Commercial Data

The following sections summarize all research into the available geospatial building information from commercial sources. A review of commercial data is provided for vendors with national coverage (**Section 3.2.1**) provided by an overview of vendors with a local presence within each province (**Section 3.2.2 - 3.2.9**). For a review of publicly available data, please proceed to **Section 3.3**).

3.2.1 Canada

Several commercial sources of building information offer the potential for national coverage. These were examined first before exploring PT sources of information.

3.2.1.1 Canada Post

Canada Post does not maintain a geospatial buildings layer, but licenses several datasets that could supplement other sources of data. Canada Post is known for its registry of civic addresses across Canada (approximately 14 million addresses registered), but also has data recording the number of buildings within each postal code area. This dataset is known by Canada Post as the “Householder Data” dataset. It includes the number of houses, apartments, farms, and businesses within the boundaries of a postal code area. This dataset could be of significant value to NRCan, as it has Canada-wide coverage. The Householder Data dataset can help establish the number of building footprints known to Canada Post by postal code area, which could support analysis of building information as well as the planning for data collection. This information could also help validate the results of other forms of data collection (ex. remote sensing). It could also be matched with other products offered by Canada Post, such as address points. The attributes available present a useful starting point for an “intelligent” building layer, as the data delineates numbers of households, apartments, commercial and agricultural buildings.

Canada Post offers two types of data licenses: commercial, and internal. It is anticipated that NRCan would require a commercial license. Here, Canada Post describes “creating mapping software” as falling within the scope of a commercial license. The scope of the data licensed and the type of license taken will determine the cost. Canada Post provides a “Request of Licensed Data Products” form. It is anticipated that this would initiate a requirement gathering and negotiation process between Canada Post and NRCan.

3.2.1.2 Ecopia and DigitalGlobe

Ecopia is an artificial intelligence company that specializes in processing geospatial data. Ecopia uses a combination of machine learning and human guided edits to produce large quantities of building footprint data. Ecopia partners with DigitalGlobe to source up-to-date aerial imagery, including within Canada. Most notably, Ecopia is known for producing a “map of every building” for the following countries:

- United States
- Australia
- Tanzania

While building footprints are not a readily available product for Canada, it is within the scope of Ecopia’s capabilities. Having reviewed Ecopia’s services, Ecopia stands out when compared to other commercial services available to NRCan. Ecopia also stands out for its ability to produce “intelligent” building footprints. This is accomplished by pairing vector data with point of interest data. Ecopia’s services extend beyond delineating building footprints to pairing building footprints with address points. An example of this process is presented in **Figure 2**. Once addresses are paired, there is significant opportunity for integration with other NRCan datasets. Other vendors within Canada typically only offer vector data without point of interest data.

From a quality standpoint, the use of this commercial vendor would provide the advantage of having quality assurance measures included within the purchase of data. If the service to pair address points was enlisted, it is predicted this would provide further quality screening for NRCan. This would be in contrast to publicly available classifications of buildings, which (when extracted automated) require public resources to ensure data quality). However, one trade-off to highlight is that this source of data does not provide building height information (a requirement identified by NRCan).



Figure 2 – Example Output from Ecopia's Building Delineation Process

3.2.1.3 AW3D

AW3D (a child company of NTT Data) is a Japan-based remote sensing and classification company. AW3D uses LiDAR data to capture land information ranging from 5 meters in resolution (for very large land areas) to 0.5 meters (in the case of urban areas). AW3D's product offer includes a 3D vector map of buildings, providing shape and height. An example of this output is shown in **Figure 3**. Buildings are extracted in 3D using information from remote sensing through machine learning. AW3D does not have a readily available dataset for Canada, but is able to provide the data based on a customer order.

This vendor was highlighted because of the ability to gain building height information, information not offered by some vendors. As with Ecopia, it is understood that by using a commercial source of data, that quality assurance would be provided to NRCan. However, this service is limited by the availability and expense of LiDAR data (a challenge currently observed by NRCan's Automatic Extraction of Buildings (**Section 3.3.1.2**))



Figure 3 – Example AW3D Output for 3D Mapping of Buildings

3.2.1.4 DMTI Spatial

Data Offerings

DMTI offers two key data products for building footprints within Canada – the CanMap suite, and a classification service paired with validation from the CanMap suite.

The CanMap suite of datasets is one of DMTI's core offerings, aggregating 300 mapping layers related to base mapping and points of interest. This data is acquired by consolidating data from a large number of public information sources. Data is subsequently cleaned and brought into a common format. This suite of datasets includes a layer that depicts building footprints. This dataset is currently used by government agencies including two users identified by NRCan (see below – **User Consultation**). This dataset has a significant amount of coverage but is limited to the current public datasets. Despite this, DMTI regularly works to improve and update the data, which is issued quarterly.

DMTI has a commercial partnership to provide a data offering in addition to the CanMap suite. What differentiates this offering from the CanMap suite is the potential for Canada-wide coverage with up-to-date information. To provide geospatial building information, DMTI enlists the services of Ecopia (please see **Section 3.2.1.2**). While Ecopia's services provide building footprint polygons, DMTI builds on this raw data by validating it and populating attribute information based on the datasets within the CanMap suite. DMTI estimates it would take 6 months to deliver buildings for all of Canada. While this product is significant, it should also be highlighted that it may not offer all of the attributes desired by NRCan (ex. building height/number of floors) if it is not already captured within CanMap. Observations made about CanMap (see below – **User Consultation**) will be analyzed in further detail during the SWOT analysis.

DMTI has indicated that the data usage could have some constraints. DMTI requires a 3 year agreement with annual billing, and stipulates that data can only be used internally within the client environment. DMTI specifically states that building footprints are not for display on public portals. The data can be delivered as a file or through API data streaming. DMTI indicates that footprints can be delivered for regions or the entire country. Population centers are refreshed annually while rural areas are updated over a 5 year period.

User Consultation

As the key example of commercial geospatial building information currently being licensed at the federal level, the data offered by DMTI Spatial was discussed with two current data users identified by NRCan. The purpose of these discussions is to learn about the context for the data and how it is used. The results of consulting two stakeholders can be summarized as follows (**Table 4**):

Table 4 – Summary of DMTI Data User Consultation

Data User	Department of National Defence (DND)	Public Safety Canada (PSC)
What data product from DMTI is being used?	DND sometimes uses a package of infrastructure datasets with federal coverage provided by DMTI. These are datasets provided by NRCan and other federal data holders. DMTI packages the data for redistribution, managing updates and consolidation. The data package provided by DMTI to DND includes a layer for buildings.	PSC uses the same package of infrastructure datasets as DND (described at left).
When is the geospatial building information used?	The DMTI building information is used in support of planning and emergency management activities when there is a potential interaction with infrastructure assets. The DMTI building information is used as a supplement to the internally maintained datasets, which are known to be more accurate and have more of the attributes needed by DND. When internal datasets have a gap, DMTI data is then referenced.	PSC deals with critical infrastructure analysis and spatial analysis and uses DMTI data in conjunction of internal datasets to assess the assets PSC is charged with evaluating.
What considerations are there when using the geospatial building information?	When presented with multiple sources of data for a subject of interest, DND staffs are directed to select the dataset “closest to the source”. In such cases, government datasets are prioritized over the data provided by DMTI.	Individual groups within the PSC are small and cannot compile many of the government datasets themselves. The service provided by DMTI addresses this need. As with DND, PSC typically uses other sources of data to validate data provided by DMTI. Authoritative sources (ex. Transport Canada) are typically prioritized over DMTI data when selecting an information source.
What are the advantages?	DMTI uses a data dictionary shared by Canada and USA to define the attribute requirements. This ensures data is matched to the standard requirements of emergency management.	The key advantage of the DMTI data is that it does the work of consolidating many publicly available datasets for PSC, who does not have the resources to do this themselves. Overall, PSC reported that the package of datasets (including buildings) is robust.
What are the opportunities for improvement?	DND has observed that data is occasionally incorrect and can be less reliable than internal datasets. Updates and corrections to DMTI data can be challenging due to funding requests made by DMTI.	It was reported that while DMTI tracks many attributes for buildings and points of interest, not all attributes are 100% populated and others are very sparsely populated. The current information about buildings could be improved using this information. PSC reported occasional errors in geographic and attribute data.
Other User Desires and Observations	DMTI data is of sufficient quality since it is used as a supplement only. The use of internal data is	DMTI’s building footprint information does not compile all the attributes needed by PSC,

Data User	Department of National Defence (DND)	Public Safety Canada (PSC)
	<p>preferred based on quality, ease of sharing, and ability to correct data in real time.</p> <p>During emergency management, only critical information is required. Rather than all buildings, typically the focus is key points of interest where detailed attribute data related to emergency management is required. Contact information is very important.</p> <p>Outside the federal jurisdictions with regular data sharing practices, data sharing in a timely manner is challenge. At present, sharing is currently only a requirement during an emergency. These types of agreements do not support planning activities.</p> <p>DMTI data can be useful for planning despite reduced accuracy. If accuracy is limited (ex. to 90%) during a planning exercise, it is understood that accuracy will be supplement during emergency management when new data from government stakeholders (ex. PTs and municipalities impacted by an emergency) is received.</p>	<p>meaning that a variety of sources typically need to be checked to gather the required information. A layer that consolidates all the information used by PSC is highly desirable.</p> <p>During time sensitive safety management scenarios, there is limited time for PSC to validate the data provided by DMTI. This is in part addressed by ongoing review of the data by DMTI and its clients. DMTI issues quarterly updates as well as supplementary datasets. PSC reported that DMTI is receptive to feedback and incorporating fixes.</p> <p>PSC expressed the desire for an authoritative building footprints dataset used by all federal emergency management stakeholders, reporting that a lack of authoritative sources has been a challenge in the past.</p>

Overall, it can be observed that while DMTI spatial data is robust, is not treated as robust by users due to preference and directives for government data as well as some observed quality issues (both in geography and attribute data). This should remain a consideration for NRCan.

3.2.1.5 *Mapbox*

Mapbox is a large American-based company that provides the tools for developers to construct location-based platforms. Typically, Mapbox provides the APIs required to develop a location-based application. However, after contacting Mapbox it was reported that building footprint information is part of its base mapping service within Canada, and that this dataset is available for licensing within Canada. To explore this option further, Mapbox may need to be engaged to learn more about the needs of NRCan. This source of data should be highlighted, given that other software developers such as Google and Microsoft indicated that basemap data from its applications (ex. Google Maps, Bing Maps) was not available for license. Mapbox also reported that building footprint data within Canada was available in 3D within certain applications.

3.2.1.6 *Teranet*

Teranet is a Canadian property registration company currently providing services for Ontario and Manitoba. Traditionally, Teranet's focus has been parcel related. However, inquiries into geospatial building information discovered that focus may be shifting to buildings in the upcoming months. Teranet reported that there is an upcoming initiative to delineate building outlines that will focus on all urban areas across Canada. This is still an emerging initiative and is planned for deployment in June, 2019. Information was not available related to classification methods or if building outlines could be integrated with other land registry information. It is expected that more information may become available to NRCan in coming months as the initiative is rolled out.

This concludes the review of commercial data sources with federal coverage.

3.2.2 British Columbia

Research into data vendors within British Columbia confirmed that there is not a readily available building footprints dataset. In spite of this, several observations were made about potential sources of data for NRCan.

3.2.2.1 Pacific Geomatics Ltd.

Pacific Geomatics is a professional imagery and GIS services company located in Vancouver. Pacific Geomatics does not have a readily available building footprints dataset, but is a licensed reseller of two key commercial sources – Ecopia (**Section 3.2.1.2**) and AW3D (**Section 3.2.1.3**). This presents one potential avenue for engaging with and licensing data from the producers of building footprint information for British Columbia.

3.2.2.2 McElhanney

McElhanney is an engineering firm with a large presence in Western Canada as well as a dedicated geospatial practice. McElhanney has produced a large number of building datasets for municipalities within British Columbia, including several of those within current municipal open data catalogs. These projects were driven by a need to validate geo-coded civic address locations. It was reported that this service has been provided for some smaller BC municipalities who do not currently have the data published openly. Given McElhanney's ties to emergency services and GIS, this could be explored further for collecting building information within British Columbia.

3.2.3 Alberta

Research into data vendors within Alberta confirmed that there is not a readily available building footprints dataset. In spite of this, several observations were made about potential sources of data for NRCan.

3.2.3.1 AltaLIS and the Alberta Data Partnership

AltaLIS is the operating partner of Alberta Data Partnerships (ADP), the public-private partnership created to provide data management for provincial stakeholders. The objective of the ADP is to promote and distribute provincial mapping to address the needs of stakeholders as well as the commercial market (ex. Fortis Inc, Alberta). Similar to partnerships in other provinces (ex. Teranet, Ontario), the ADP is responsible for managing survey plans for public lands in addition to the management, maintenance, and distribution of spatial data. AltaLIS was highlighted for its presence within Alberta as a key service provider. Consultation with AltaLIS established that building footprints are not part of its available data holdings and that there are no establish plans to create such a dataset. Given the similarities of the Alberta Data Partnership to Teranet (who is currently pursuing the collection of building footprints), this source of data should be monitored.

3.2.3.2 Atlis Geomatics

Atlis is a LiDAR and remote sensing service provider based in Calgary. Though Atlis does not have readily available building information, research observed that its FastMap service includes a 3D reconstruction service for buildings based on LiDAR and aerial imagery (**Figure 4**). Research found that Atlis LiDAR data is readily available for Calgary and the surrounding area, a potentially useful starting point within Alberta for NRCan to gather building information.

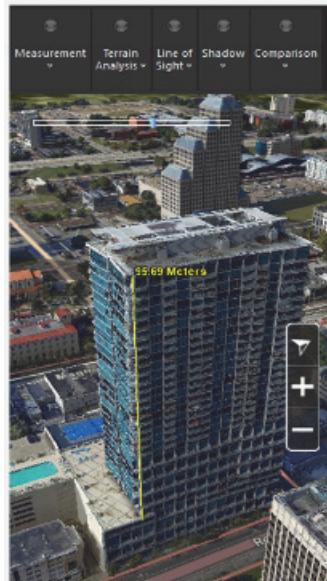


Figure 4 –FastMap Reconstruction Service

3.2.4 Saskatchewan

Within Saskatchewan, Altus Geomatics has the largest presence. There are a limited number of consultants and vendors, and most overlapped with those reviewed in British Columbia/Manitoba, or did not provide the desired services. Altus Geomatics has offices across Canada, but Saskatchewan was selected as the point of reference due to its presence within the province. Consultation with Altus Geomatics established building footprint information for Saskatchewan is not available.

3.2.5 Manitoba

Data vendors with a presence in Manitoba that were reviewed in other provinces including Altus Geomatics and Atlis. Aside from these companies, the main potential service provider was observed to be Duncan and Barnes. Duncan and Barnes reported that base mapping is limited to what is available through the Manitoba Land Initiative, which was found during the review of public data assets not to have building footprints (although another public dataset was discovered for Manitoba that was not within the MLI – see **Section 3.3.2.3**).

3.2.6 Ontario

Research into data vendors within Ontario confirmed that there is not a readily available building footprints dataset. In spite of this, several observations were made about potential sources of data for NRCan.

3.2.6.1 DMTI Spatial

Review of Ontario-based commercial GIS companies found that DMTI had the largest presence within Ontario. For a review of the DMTI data products, please refer back to **Section 3.2.1.4**.

3.2.6.2 MPAC and GeoWarehouse

MPAC and MPAC Geowarehouse were both researched during the Environmental Scan. Inquiries about available information were forwarded to Teranet (see **Section 3.2.1.6** within the overview of commercial data sources), who reported on future initiatives for building footprints in Canada.

3.2.6.3 First Base Solutions

First Base Solutions is an Ontario-based aerial imagery and classification company. It does not maintain a geospatial buildings layer, but collects aerial photography for all of southern Ontario (imagery accounts for areas as far north as Muskoka and Renfrew, but does not reach areas such as Sudbury, North Bay, and beyond). First Base Solutions offers an image classification service for the aerial imagery it has collected, and can provide building classifications upon request for a fee. Imagery for population centers in southern Ontario is typically collected on a yearly basis. Rural areas outside population centers are not maintained as frequently (most were collected between 2006 and 2010).

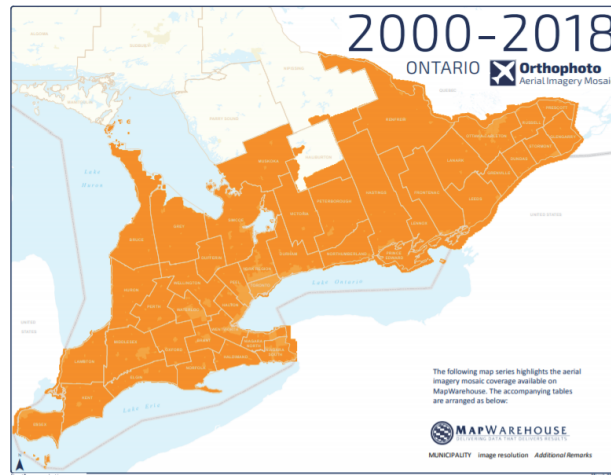


Figure 5 – Coverage offered by First Base Solutions

The Open Database of Buildings shows that there are available datasets for most population centers within the coverage provided by First Base Solutions, as shown in **Figure 5**. However, a classification service presents a useful option to address gaps in building footprints in rural areas of Southern Ontario. The image classification service would provide building footprints, but not the desired attribute data.

3.2.7 Quebec

A number of vendors within Quebec were reviewed including Groupe Info Consult, Trifide Group, and Geo-Plus. Of these, Geo-Plus was the main candidate notable to the Environmental Scan. Geo-Plus provides a tool known as “VisionLidar Premium”. An example of the extraction tool used by Geo-Plus is provided in **Figure 6**. Geo-Plus does not have readily available LiDAR data, but could delineate buildings upon receiving LiDAR data. This source of geospatial building information is important to highlight. The use of LiDAR data for large captures of building footprints (as opposed to detailed 3D constructions of small areas by vendors such as Atlis) is in direct contrast to the typical classification methods used by other vendors (for example, Ecopia uses imagery but not LiDAR). Given that NRCan’s Automatically Extracted Buildings dataset also uses LiDAR, the services of Geo-Plus should be highlighted as an opportunity for additional data collection services within Quebec.

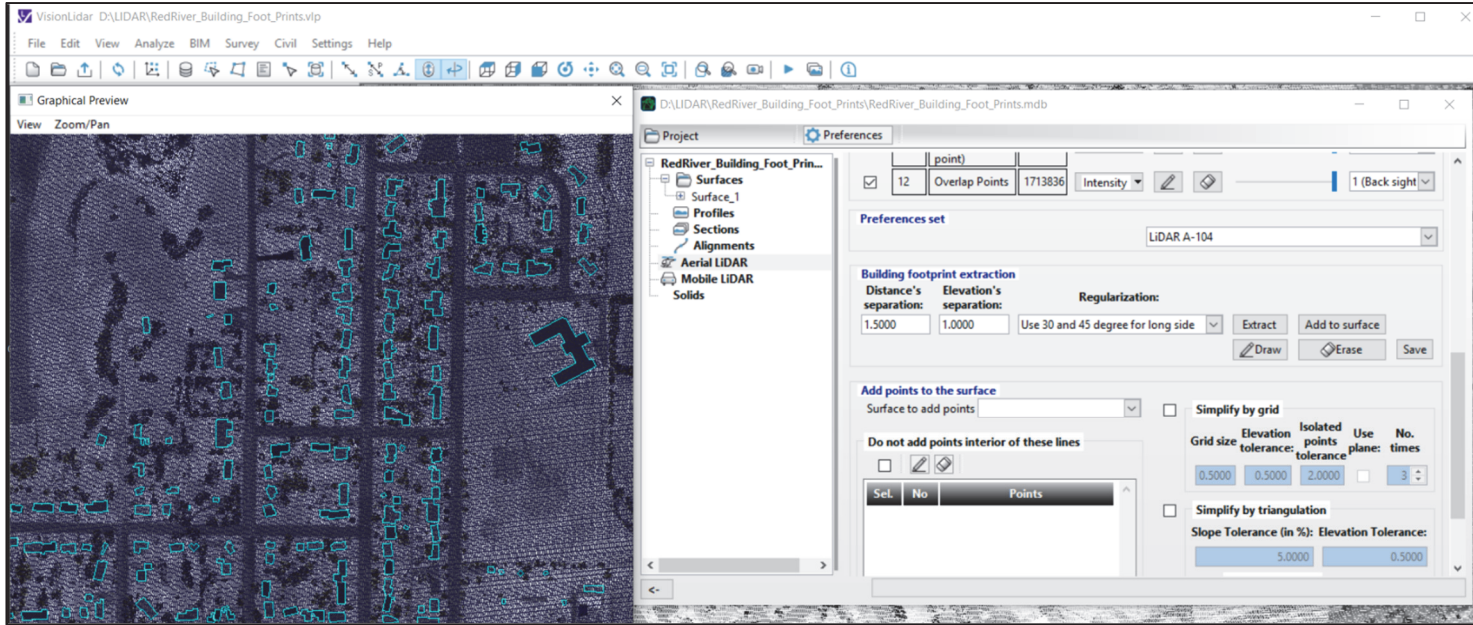


Figure 6 – Geo-Plus VisionLidar Premium Building Extraction Tool

3.2.8 New Brunswick

Research suggested that there are no companies with a local presence who currently provide geospatial building information - please refer to **Table 5** in **Section 3.2.10** for the vendors that were considered.

3.2.9 Nova Scotia

Research suggested that there are no companies with a local presence who currently provide geospatial building information - please refer to **Table 5** in **Section 3.2.10** for the vendors that were considered.

3.2.10 Other Vendors

While the results of the Environmental Scan highlight several potential vendors for data, other vendors were contacted that were found not to have data. These have been listed to document that research was unsuccessful to limit the redundancy of future efforts by NRCAN. Following a summary of potential vendors (**Table 5**) and their service areas, detailed are provided in further detail when warranted (**Section 3.2.10.1 - 3.2.10.5**). This concludes the review of commercial data sources. The Environmental Scan resumes with a review of publicly available sources of geospatial building information in **Section 3.3**.

Table 5 – Summary of Commercial Data Sources without Geospatial Building Information

Province/Territory	Company*	Notes
Canada	Google	See 3.2.10.1
	Microsoft	See 3.2.10.3
	Envionics Analytics	See 3.2.10.2
	Environmental Risk Information Services	See 3.2.10.4
	Pitney Bowes	See 3.2.10.5

Province/Territory	Company*	Notes
Alberta	AltaLIS and the Alberta Data Partnership	Provides GIS services for clients including Alberta utilities. Confirmed that building information is not being developed.
	CanAm Geomatics	
	Atlis Geomatics	
	Integrated Geomatics	Provides classification services but does not provide data.
	Millenium Geomatics	
	Challenger Geomatics	A licensed provider of Digital Globe, and provides classification services. Research did not indicate that Ecopia's services are also offered.
	Valard Geomatics	
British Columbia	3vGeomatics	
	Vector Geomatics	
	Spatial Vision Group	
	Pacific Geomatics	
	MCEIhanney	
Manitoba	Duncan and Barnes	
New Brunswick	Leading Edge Geomatics	Reported that they are currently monitoring for provincial initiatives.
	Digital Earth Geomatics	Reported that they are currently monitoring for provincial initiatives.
Nova Scotia	Highland Geomatics	Reported that any data capture would be driven by municipalities or the province.
	Gateway Geomatics	Reported that any data capture would be driven by municipalities or the province.
	Eastcan Geomatics	Reported that any data capture would be driven by municipalities or the province.
Ontario	MPAC	
	Geowarehouse	
	First Base Solutions	
Quebec	Group Info Consult	
	Trifide Group	
	Geo-Plus	
Saskatchewan	Information Service Corporation	Confirmed that there is no building information and no future plans to develop this data with an ISC representative.
	Altus Geomatics	
<p>*Throughout this listing, companies under the term "Geomatics" are listed. Here, companies were only selected if they provided GIS or remote sensing services. Companies that only provide land surveying services (many of whom identify as offering "geomatics") were not considered.</p>		

3.2.10.1 Google

Research into products offered by Google established that Google does not currently license its data products. Instead, it licenses the APIs used by its platform to assist in the development of custom tools. Google does not currently license its orthoimagery (a potential source of building footprint information if it were classified by NRCan), but reported that it intends to within Canada in the future.

3.2.10.2 Microsoft

Research into products offered by Microsoft and Bing matched the findings of Google, where it was indicated that offerings were limited to APIs. Microsoft vendors did not appear to be aware of the initiative completed through GitHub to classify all buildings within Canada. While Microsoft's commercial offerings do apply to the objectives of the Environmental Scan, the publicly available data provided by Microsoft for building footprints should still be highlighted (please refer to **Section 3.3.1.6**).

3.2.10.3 Environics Analytics

Environics Analytics is a marketing and analytical services company that specializes in segmented datasets. Within Canada, Environics is known for producing multiple datasets that capture socioeconomic information in small geographic aggregates such as postal code areas or dissemination areas. A review of Environics' data offering established that geospatial building information is not available. In spite of this, a dataset held by Environics could support NRCan's objective of developing an "intelligent" building footprint layer

Environics maintains a database of businesses within Canada using location coordinates and company name or NAICS industry code. These locations can also be paired with a second dataset to provide additional info such as number of employees. While building footprints aren't available, geocoded business locations across Canada provide an opportunity to add attributes to any footprint data collected by NRCan.

It should also be noted that Canada Post uses Environics datasets to validate its information.

3.2.10.4 Environmental Risk Information Services (ERIS)

ERIS is a company that provides property-based environmental risk information inquiries when requested for specific properties in support of various development and environmental regulations. To do so, it maintains a large number of historical private and publicly available datasets related to environmental risk. A review of its data catalog confirmed that although this company contains a significant amount of property-based data for Canada, this information does not include building footprints. ERIS could be considered a source of complementary information related to properties and buildings.

3.2.10.5 Pitney Bowes

Pitney Bowes is a global technology company that offers enterprise software for location services as well as data and APIs for location intelligence. Datasets relevant to the Environmental Scan include a global layer of points of interest and a registry of all business within Canada and the US.

Pitney Bowes provides a building footprints dataset that covers all of the United States. This dataset provides polygon boundaries as well as attributes including address, postal code, building type, usage, and height. The dataset is updated quarterly. Pitney Bowes does not state how the dataset is generated or provide a data schematic.

When viewing the Canadian version of the Pitney Bowes website, a limited offering of products is advertised when compared to the US website. Here, offerings are focused on analytics software and shipping/commerce solutions, suggesting that data product offerings for Canada are limited.

3.3 Summary of Publicly Available Data

The following summarizes all research into the available geospatial building information from publicly available sources. The scan of publicly available geospatial building information begins with an overview of data sources with national coverage (**Section 3.3.1**). This is followed by an overview of provincial/territorial datasets within **Section 3.3.2**.

3.3.1 Canada

Several public sources of building information offer the potential for national coverage. These were examined first before exploring PT sources.

3.3.1.1 Federal Geospatial Platform Provincial and Territorial Inventory

The Federal Geospatial Platform (FGP) (explored in further detail during **Section 4.1.1**) is an expansive online environment comprised of federal producers and consumers of geospatial information. Recognizing the expanse of open data sources available federally and within the provincial/territorial jurisdiction, the FGP maintains an inventory of open data sources. Prior to the Environmental scan, NRCan performed a series of automated queries to learn about the availability of building information datasets. So far, this inventory has been synthesized to provide an overview of PTs with completed building inventories (see **Section 2.3**). During the Environmental Scan, the individual datasets were examined for their suitability. This has been summarized for each PT (**Section 3.3.2 - 3.3.2.13**).

3.3.1.2 Automatically Extracted Buildings

NRCan has classified building footprints using LiDAR data and/or optical imagery for a number of settlement areas across Canada. Here, the title “automatically extracted” is used because data is automatically extracted from classified LiDAR point clouds without human interventions, and requires a quality review once extracted. To obtain classified LiDAR point clouds, NRCan collaborates with federal, provincial and territorial partners. Because classified LiDAR point clouds used for extraction are 3 dimensional, NRCan is able to extract building height information in addition to footprint boundaries (an important distinction when compared to other sources). NRCan has reported that approximately 1 million building footprints have been collected so far. The main challenge with data collection reported by NRCan was the availability of LiDAR data or optical imagery, which is reliant on provincial initiatives (LiDAR data collection is reported as being expensive when compared to conventional remote sensing). In spite of these challenges, the fact that this dataset meets the need for building height information (not addressed by other datasets reviewed) is an important distinction (to be explored during the SWOT assessment).

Whereas other building footprint datasets do not include attribute data, the Automatically Extracted Buildings dataset includes an attribute data schematic. Data recorded for each record includes:

- Unique identifiers
- Acquisition Technique
- Data Provider
- Date (Start and End Date)
- Accuracy (Horizontal and Vertical, Minimum and Maximum)
- Building Height (Minimum and Maximum)
- Building Elevation (Minimum and Maximum)
- Building Area
- Source

An example of the data collected is provided in **Figure 7**. The total coverage of the approximately 1,000,000 records is provided in **Figure 8**, which shows that footprints mainly coverage hotspots in Quebec, New Brunswick, and Alberta (as well as the metropolitan area of Vancouver).

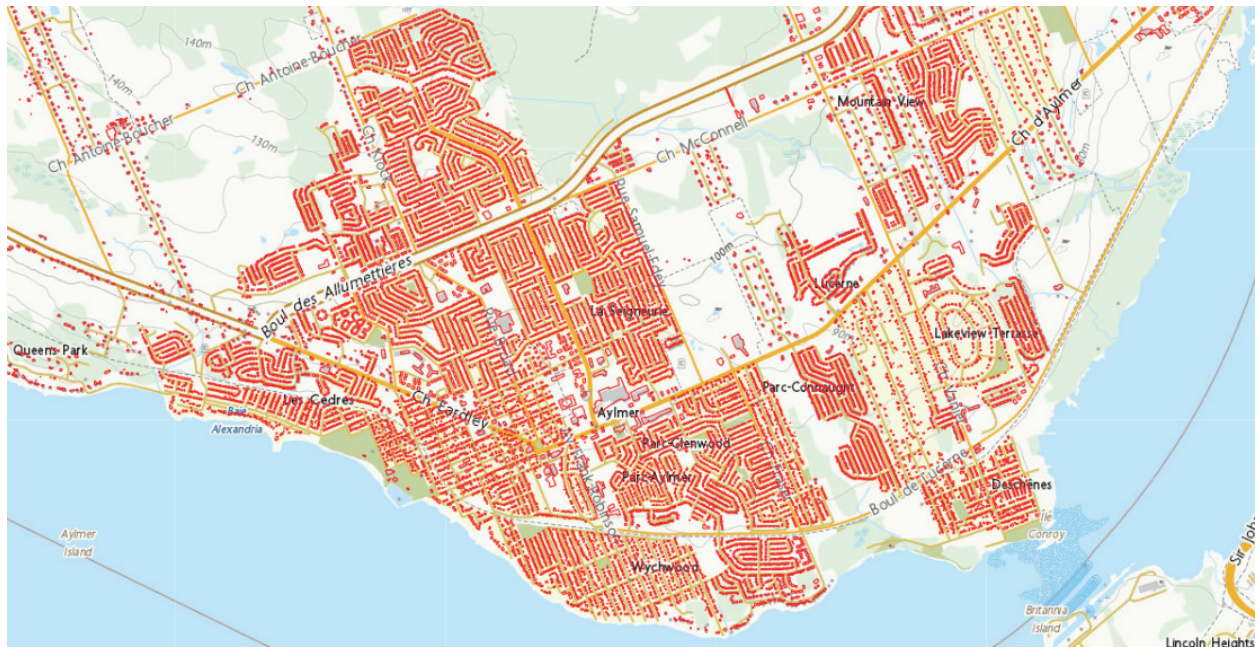


Figure 7 – Example of Automatically Extracted Buildings



Figure 8 – Coverage of Automatically Extracted Buildings

3.3.1.3 ArcGIS Hub

Review of the ArcGIS Hub for open geospatial building datasets identified several new datasets of value to NRCan that are not captured within the current Open Database of Buildings. Overall, each dataset provided footprint delineations, but very limited attribute data. Licensing requirements varied between datasets – most either had an open license or did not specify a license, while two datasets (Cornwall and Peterborough) provided their own licenses. The total number of new records captured through ArcGIS Hub was over 100,000 footprints. This has been summarized for the applicable PTs (**Section 3.3.2 - 3.3.2.13**).

3.3.1.4 Buildings Register

The Buildings Register is an internal Statistics Canada dataset developed through its Data Integration Infrastructure Division. The Buildings Register is a recent Statistics Canada initiative and its development is ongoing (it was also considered during the 2015 Feasibility Study identified during **Section 2.1**). The Buildings Register is a tabulated register of all Canadian Buildings that is integrated without statistical registers for population and other activities. The register is created from Canada Post Remission Points, 911 Emergency information, property assessments, electricity distribution companies, driver's license information, and telephone lists. The register captures approximately 12 million building footprints and has a significant number of attributes applicable to the Environmental Scan including:

- Total floor area
- Number of floors
- Address
- Structure Type
- Accuracy

Additional information when buildings have multiple units is also captured:

- Unit Number
- Use of Building Unit
- Occupancy
- Telephone Number

While the Buildings Register is currently tabular, Statistics Canada has expressed an interest in integrating it with spatial data infrastructure used internally within Statistics Canada, which provides ways to link the information as points to other information (ex. address ranges).

The Buildings Register offers additional benefits in that it is continually updated by Statistics Canada, with the downside that is not shared with other ministries or the public (the directives that limit data sharing by Statistics Canada are exploring during the overview of Policy in **Section 4.3**). Conversely, there are other data collection efforts for buildings that are open to NRCan and the public (below).

3.3.1.5 OpenStreetMap – Building Canada 2020 Initiative

The Statistics Canada Data Integration and Exploration (DEIL) has partnered with OpenStreetMap (OSM) to support the collection of building footprint information using crowd sourcing through a project known as the Building Canada 2020 initiative. This is a crowd-sourced (information is voluntarily collection by a community of users) project aiming to map all buildings in Canada by 2020. This project follows the methodology used by other OSM projects – the approach taken for this project can be summarized as follows:

- Data is collected voluntarily by users

- Data is spatial (polygon building footprints) and attribute based (over 60 fields describing address, height, number of floors, name, age, entrances, etc.)
- Collection is organized using an OSM Task Manager
- Communication is facilitated by an online messaging platform (“Talk-ca”)
- Data collection follows OSM guidelines
- Recommended methodologies include manual digitization using aerial photos, importing data from other open data sources, and attributing features using local knowledge.
- Data is imported using an OSM Import Plan

A full review of the open data listing provided by Building Canada 2020 confirmed that the listing is largely the same as those within the ODB (OSM provides greater detail on each source using an expanded table) with exceptions. Three datasets were identified as not overlapping with the ODB in its documented form:

- Mississauga, ON
- Brandon, MB (identified within NRCan’s scan of data catalogs, but not in ODB)
- Gatineau (identified within NRCan’s scan of data catalogs, but not in ODB)

The listing provided by Building Canada 2020 should be reviewed in further detail to learn information related to licensing. As well, address points and parcels have been collected by OSM from open data portals to facilitate data collection in areas with no building data.

While Building Canada 2020 is an important initiative and a source of geospatial building information, licensing is an important consideration. The OSM produces its data under a Creative Commons license. A Creative Commons license allows the user to share and edit data (which NRCan would likely do if it acquired data from OSM). However, the distribution of data edited by NRCan is required to be maintained in the same license format in which it was received, namely the Creative Commons license. This is in direct contrast to the Open Government License used by NRCan and other stakeholders to release open data. An Open Government License is required for NRCan to distribute the data, as it establishes the Government of Canada as the authoritative provider of information. Without such a license, NRCan would not have the directive to distribute geospatial building information and the information could not be considered authoritative.

3.3.1.6 *Microsoft*

During the creation of the Open Database of Buildings, Microsoft joined the DEIL as a voluntary partner in the collection of building information. Microsoft was identified by the DEIL as a potential partner following Microsoft’s work to map building footprints for the United States. Microsoft mapped approximately 125 million footprints across the United States using machine learning and remote sensing image classification.

To build on the efforts completed through the collection of building footprints through the Open Database of Buildings, Microsoft applied its image classification service to imagery of Canada. To calibrate the algorithms used by Microsoft for the United States, the ODB was supplied to Microsoft. The results of the image classification process were polygon boundaries across Canada, totaling approximately 12 million footprints. An example output is provided in **Figure 10**.

The dataset produced by Microsoft has since been released to the DEIL as well as the OpenStreetMap group working towards Building Canada 2020.

With a dataset complete, the DEIL has stated that the focus of the efforts will now be to validate the data produced by Microsoft in conjunction with work being done by the OpenStreetMap community. As part of this effort, the building footprints require attribute information from Statistics Canada and the OpenStreetMap community. Statistics Canada reported that there is a significant amount of cleaning work required.

The Microsoft building footprints provides a useful comparison with NRCan's Automatically Extracted Buildings dataset, the second main example of building footprint data capture with federal contributions. An example of this comparison is provided in **Figure 9**. Here it can be observed that while Microsoft has captured more buildings across Canada, examining a sample area shows that NRCan data may provide greater accuracy.



Figure 9 – Comparing Microsoft Building Extraction and NRCan Automatically Extracted Buildings

Discussion with the DEIL indicated the current project is a collaborative effort with Microsoft and that there are no binding agreements. DEIL expressed that each group was responsible for maintaining its own data produced through the collaborative effort.

As with the data produced by Open Street Map, Microsoft provides its geospatial building information under a Creative Commons License. This underscores the observations made in the above paragraph that while the data is a collaborative product, Statistics Canada does not assume responsibility or ownership of the data. During the discussion of Open Street Map (**Section 3.3.1.5**), the limitations of the Creative Commons license were introduced. Given that Microsoft data falls under a Creative Commons License, the efficacy of leveraging this dataset for NRCan will be limited. This initiative will be explored in further detail during the SWOT assessment.



Figure 10 – Example Output of Microsoft and Statistics Canada Image Classification

3.3.1.7 Other Statistics Canada Initiatives

While the focus of the Environmental Scan is building footprints, other initiatives being completed by the DEIL should be highlighted:

1. The DEIL is exploring the use of automation to delineate businesses by building footprint within Canada. This is another example of Statistics Canada taking an open approach to project and data development. Here, a Python script is being used to compile, process and integrate sources of government data about businesses to build on current inventories. This project is ongoing and is known as the Open Database of Businesses (ODBZ). This process is built on 26 government databases including a select few of those identified (**Section 2.3**) by NRCan within its query of provincial/territorial data catalogs (ex. BC Indigenous Business Listings). Current progress suggests over 1 million businesses have been identified (**Figure 11**). Given the interest NRCan has in attribute data related to building footprints, this progress is important to highlight and offers data similar to what is offered by Canada Post (**Section 3.2.1.1**).

The Open Database of Businesses: *preliminary results*

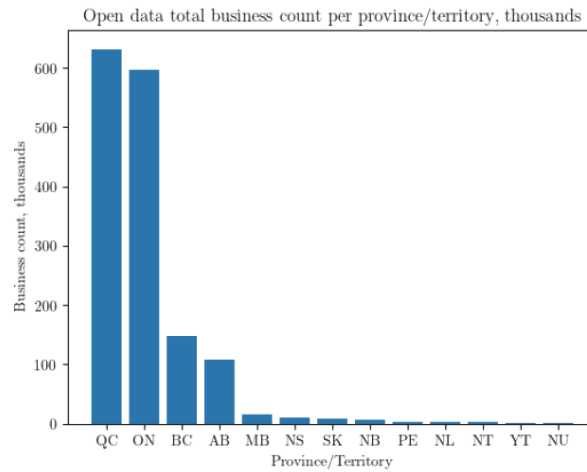


Figure 11 – Preliminary Results of the Open Database of Businesses¹

- Statistics Canada has endeavoured to create a Linkable Open Data Environment comprised of government datasets from federal, provincial/territorial, and municipal sources. This undertaking is underway and is published through GitHub. Of note, GitHub provides a master list of known official data portals with accompanying license information. The list of portals highlights each portal’s contributions to a number of databases under construction by Statistics Canada. This Open Data Environment is important to highlight for NRCan as it is envisioned by Statistics Canada as containing a significant amount of attribute data related to buildings that Statistics Canada will gather through open data. See the current components of the Open Data Environment and progress made by Statistics Canada within **Figure 12**.

	Assessment	Compilation	Cleaning	Dissemination	Expected coverage (%)	Completion of development phase
Buildings (with Microsoft)	Green	Green	Green	Green	100%	Completed
Education facilities	Green	Green	Green	Yellow	95%	3 months
Addresses (with OpenAddresses)	Green	Green	Yellow	Yellow	70-80%	3 months
Businesses	Green	Green	Yellow	Yellow	50-60%	6 months
Health facilities	Green	Green	Green	Green	95%	6 months
Public transit (GTFS)	Green	Yellow	Yellow	Yellow	95%	6 months
Parks & recreational	Green	Yellow	Yellow	Green	80%	6-12 months
Museum and culture	Green	Yellow	Yellow	Green	90%	6-12 months
Arenas & sports	Green	Green	Green	Green	90%	6-12 months
Infrastructure assets	Green	Green	Green	Green	TBD	TBD
Property values	Green	Yellow	Yellow	Green	20%	6-12 months

Note: coverage and completion timelines are preliminary estimates or aspirational.

Figure 12 – Current Components and Progress of the Linkable Open Data Environment²

¹ Alessandro Alasia, March 13 2019. Open Projects at DEIL: Open buildings, open businesses and a linkable open data environment. Presented to the Institute for Data Science Carleton University.

Retrieved from https://carleton.ca/cuids/wp-content/uploads/Open_Data_Carleton_20190312-FINAL.pdf

² Alessandro Alasia, March 13 2019. Open Projects at DEIL: Open buildings, open businesses and a linkable open data environment. Presented to the Institute for Data Science Carleton University.

Retrieved from https://carleton.ca/cuids/wp-content/uploads/Open_Data_Carleton_20190312-FINAL.pdf

3.3.1.8 Canada's Historic Places

Canada's Historic Places is a source of conservation information administered by Parks Canada. One service offered by Canada's Historic Places is the Canada Register. This database can be queried for information related to Canada's historic places. Initial queries of the database indicate at least 1000 building related records. Registry within this database is voluntary, meaning it is likely not comprehensive.

3.3.1.9 Esri GeoFoundation Exchange

The Esri GeoFoundation Exchange (GFX) is a platform being developed by Esri with contributions from the federal, provincial/territorial, and municipal levels of government within Canada. The GFX is intended to serve as a platform for collaboration and open data initiatives within Canada by linking the various jurisdictions, providing an exchange for topographic information between providers and users. The GFX was developed in partnership with NRCan. The GFX emphasizes the participation of authoritative data providers, and is currently the source of the Community Map of Canada as well as the data for Public Safety New Brunswick.

The GeoFoundation Exchange is a significant source of building information. Buildings are one of four core datasets that are most requested by users and is regularly reported on by the GFX. At present, there are just over 7 million building footprint records present in the database, with data predominantly coming from municipal sources (making it comparable to the data integration exercise completed by the Open Database of Buildings (ODB)). In spite of the similarities to the ODB, there are several important distinctions to highlight with respect to the ODB:

- Updates provided by contributing members are made live within 24-48 hours
- Provincial and federal aggregators can leverage the updates at lower jurisdictions to make their own updates through automated processes
- Quality control checks are automated for any updates to the data
- Data schema was developed in collaboration with federal stakeholders, and leverages existing federal data schemas where applicable (ex. National Roads Network)
- Change detection during updates allows target updates, as opposed to enterprise wide updates
- Features are cached for base mapping as well as vector formats used for analysis
- Dedicated users (ex. Public Safety New Brunswick) are set up with subscription services that push data automatically to local systems.

Overall, it can be observed that the GFX provides similarly high quality data to the ODB (due to the use of authoritative municipal sources) with the added advantage of provided automated, system-wide quality checks.

The GFX provides a data model for building footprint information, including 14 building classes, and many building types under overall 21 categories (ex. agricultural, commercial). The data model provides approximately 60 data fields for building properties, classification, location, jurisdictional, dimensional and point of interest information. While many fields are not populated, this model provides a framework for participations to structure their data. Of these fields, the GFX highlights the following field as being requested during data contributions:

- Feature ID
- Building Class (Class of building)
- Building Type (Detailed breakdown of building classification)
- Name
- Building Height
- Floors
- Floors below Grade

The GFX data model shares some resemblance to the INSPIRE data model provided by the European Commission, albeit in a more simplified form (documented in the review of international comparators in **Section 5**). This is most pronounced in the breakdown of building classes and types provided by the GFX data model.

Evident from the above observations is that the GFX offers a data integration process similar to what is achieved through the ODB with additional features related to data update and sharing mechanisms. These benefits of these distinctions will be explored further during the SWOT assessment.

3.3.1.10 ESRI Canadian Municipal Data Model

Research during the Environmental Scan also identified the Canadian Municipal Data Model as a potential driver for geospatial building data in Canada. The Canadian Municipal Data Model harmonizes datasets, web services, and maps produced by Canadian municipalities publishing their data using ArcGIS for Canadian Municipalities. One of the feature classes defined by the Model is buildings. The Model includes a data dictionary. The attributes defined by the data model for the Buildings feature class have the potential to align with the needs of NRCan, with attributes including number of floors, occupancy, building class, operational hours, access type, accessibility, and owner. Review of the available data during the Environmental Scan suggests that most municipalities are not populating many of the available attributes within the data model.

3.3.1.11 First Nations

Within many Canadian settlement areas, First Nations are the leading source of land information. Recognizing this, several resources were researched for potential building footprint information. Here, the scope of the resources that researched was dependent on the scope of the Environmental Scan. Because First Nations cover areas similar to municipalities (ex. there are 45 First Nations that could be researched for Alberta only), only First Nations with large jurisdictions were researched. It was found that jurisdictions within British Columbia, Yukon, Northwest Territories, and Nunavut met these criteria. First Nations within Northwest Territories and Nunavut were not evaluated due existing PT buildings dataset coverage. Overall, it was found that geospatial building information was not readily available through public First Nations Resources - contact to learn about internal GIS resources may be required. **Table 6** summarizes the sources that were researched.

Table 6 – Summary of Public First Nation Resources Reviewed

First Nation	Province/ Territory	Website
Dene Tha	BC	https://denetha.ca/
Saulteau	BC	http://www.saulteau.com/
Aseniwuche Winewak	BC	https://www.aseniwuche.ca/
West Moberly	BC	http://www.westmo.org/
Carrier Sekani Tribal Council*	BC	http://www.carriersekani.ca/about-cstc/cstc-services/
Gitxsan	BC	http://www.gitxsan.com/
Nisga'a Lisims	BC	https://www.nisgaanation.ca/maps
Tahltan Central Government	BC	http://tahtlan.org/
Kaska	BC/YK	https://kaskadenacouncil.com/
Tagish	BC/YK	https://www.ctfn.ca/
Teslin Tlingit	YK	http://www.ttc-teslin.com/maps.html
Ta'an Kwach'an **	YK	http://taan.ca/departments/lands-resources-and-heritage/
Little Salmon Carmacks	YK	http://www.lscfn.ca/
White River	YK	https://whiteriverfirstnation.com/
Tr'ondek Hwech'in**	YK	http://www.trondek.ca/
Vunut Gwitchin	YK	https://www.vgfn.ca/index.php
Tetlit Gwichin	YK	https://www.cyfn.ca/nations/tetlit-gwichin-council/
<i>*Provides technical support services to 8 First Nations including GIS and mapping. Information was not publicly but this could be investigated further.</i>		
<i>**Provides contact information for a GIS technician</i>		

3.3.1.12 Utilities

Though public mapping is not a service typically offered by utilities, large service areas mean that spatial data is expected to be in use (similar to the logic applied to Canada Post as a potential supplementary data source). The usage of geospatial building information from utilities within the tabular Buildings Register (described in **Section 3.3.1.4**) was also noted. To investigate the possibility of available building information, a sampling of the largest utilities in Canada was selected in the event that large data captures have been completed. The following utilities were consulted:

- Hydro Quebec
- Hydro One (Ontario)
- Fortis Alberta
- BC Hydro

These utilities did not have available data and had limited support available for commercial data inquiries. There are other utilities within Canada that can be contacted but initial results indicate this may not be fruitful.

3.3.1.13 Census Metropolitan Areas

Census metropolitan areas contain the majority of Canada's populations and therefore offer the greatest opportunities to collect building information. NRCan has reported that while municipalities offer an opportunity to collecting building information, this type of data collection may not be desired given the level of effort involved and the lack of scope (when compared to a PT jurisdiction). While municipalities were not the key focus of the Environmental Scan, those listed in **Section 2.2** were explored further. The areas without readily available data were investigated. The result of this process was finding a building footprints dataset for Whitehorse (Yukon), while all others were confirmed as not having data. See **Table 7** as modified from **Section 2.2**.

Table 7 – Review of Outstanding Census Metropolitan Areas

Name	Census Metropolitan Area (CMA)* or Provincial/Territorial Capital (PC)**	Province/Territory	Included in ODB	Data Located through Open Data Catalogs
St. John's	CMA, PC	Newfoundland	No	No
Charlottetown	PC	PEI	No	No
Saguenay	CMA	Quebec	No	No
Trois-Rivières	CMA	Quebec	No	No
Peterborough	CMA	Ontario	No	No
London	CMA	Ontario	No	No
Windsor	CMA	Ontario	No	No
Greater Sudbury	CMA	Ontario	No	No*
Thunder Bay	CMA	Ontario	No	No
Winnipeg	CMA, PC	Manitoba	No	No
Saskatoon	CMA	Saskatchewan	No	No
Calgary	CMA	Alberta	No	No
Abbotsford - Mission	CMA	British Columbia	No	No
Iqaluit	PC	Nunavut	No	No
Whitehorse	PC	Yukon	No	Yes**

**Thought open data is not available, past AECOM work with Greater Sudbury indicates that non-open data for building footprints is held by the City.*

*** A dataset for Whitehorse was located within City's open data catalog, and includes 10,756 records. The schema for this dataset includes attributes for "Number of Floors" and "Has Basement", but these fields are not populated.*

3.3.2 Provinces and Territories

Following the review of national datasets, the focus of research was narrowed to consider datasets within each PT individually. Each province and territory is analyzed in the following **Sections (3.3.2.1 - 3.3.2.13)**. This is followed by a summary of the findings in **Section 3.3.2.14**.

3.3.2.1 Alberta

Review of publicly available provincial data (namely through Open Alberta) did not identify building footprint information at the provincial level outside of information collected by the ODB and the FGP P/T Inventory. Internal consultation may be required to locate additional data assets.

During a review of the Esri ArcGIS Hub, the following new dataset was identified (**Table 8**):

Table 8 – ArcGIS Hub Data, Alberta

Municipality	Source	Number of Footprints
Airdrie	Esri ArcGIS Hub	26,253

Finally, a review of the FGP P/T Inventory queries was conducted. Four datasets were identified as being of interest to NRCan (**Table 9**), while other datasets identified by the queries were found not to be applicable to the needs of NRCan.

Table 9 – Inventory Query Observations, Alberta

Dataset	Observation
Base - Small Scale Topographic Base - 20K Base Features	As provided in the dataset description, these datasets are distributed by Altalis. Research of Altalis (Section 3.2.10) confirmed that the building footprints do not exist in their data products, just select facilities.
CN Building CS Building	These datasets are not available by download and are listed as being accessible through an ArcGIS Server service. After navigating the directories of the service, these datasets could not be located, suggesting the directories have changed since they were first identified by NRCan. More research is required to identify the nature of these potential sources of building information.

3.3.2.2 British Columbia

Review of publicly available provincial data (namely through BC Data Catalog and GeoBC Gateway) did not identify building footprint information at the provincial level outside of information collected by the ODB and the FGP P/T Inventory queries. Internal consultation may be required to locate additional data assets.

During a review of the Esri ArcGIS Hub, the following new datasets were identified (**Table 10**):

Table 10 - ArcGIS Hub Data, British Columbia

Municipality	Source	Number of Footprints
District of Lake Country	Esri ArcGIS Hub	8,513
Regional District of Okanagan	Esri ArcGIS Hub	6,795
Resort Municipality of Whistler	Esri ArcGIS Hub	5,449
Peachland	Esri ArcGIS Hub	2,953

Finally, a review of the FGP P/T Inventory queries was conducted. Of the 74 records returned from NRCan queries, 8 were found not to be applicable to building information. The remaining records do not provide large coverages of geospatial building information (scope was typically very narrow and specific to a particular point of interest), but

offer opportunities for data integration once footprints are delineated (the identified records were predominantly point datasets). The BC catalogue also included a UTM, which could be useful in classifying building footprints.

3.3.2.3 Manitoba

Review of publicly available provincial data (namely through Manitoba Land Initiative) did not identify building footprint information at the provincial level outside of information collected by the ODB and the FGP P/T Inventory queries.

Of the datasets collected through FGP's queries, 10 provide information about points of interest while one dataset is of particular significance. A dataset titled "Topographic Maps – Buildings" provided building footprints across Manitoba and is published by the Manitoba Department of Conservation. Research suggests this dataset is not widely used, although its coverage is significant. It is unknown how data was collected or maintained, making quality difficult to infer. The dataset contains 450,936 records, although features are not attributed. This is an important dataset to highlight for Manitoba (a province with otherwise limited data assets). See **Figure 13– Figure 14**.



Figure 13 – Sampling of Manitoba Department of Conservation Building Footprints

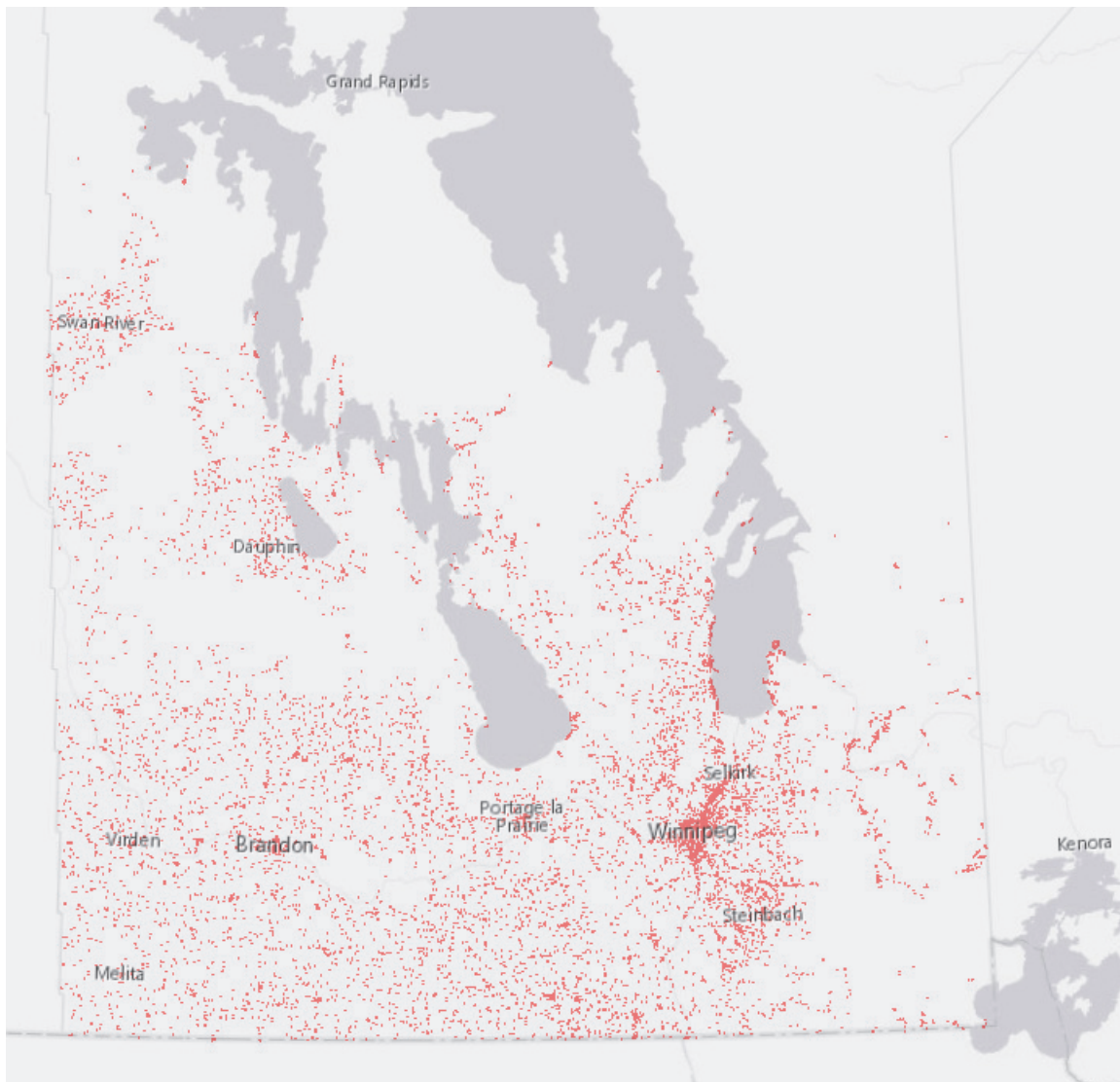


Figure 14 – Total Coverage of Manitoba Department of Conservation Building Footprints

3.3.2.4 *New Brunswick*

Review of publicly available provincial data (namely through GeoNB New Brunswick) did not identify building footprint information at the provincial level outside of information collected by the ODB and the FGP P/T Inventory queries.

GeoNB was also contacted to inquire about future potential data offerings. GeoNB indicated that there is not currently work on a building layer with no future plans to proceed. GeoNB reported they are currently monitoring for initiatives at the national level for building footprint data collection, quoting Microsoft as a potential source for data.

Finally, a review of the FGP P/T Inventory queries was conducted. Here, it was found that there is limited building and point of interest data available. One dataset is listed as depicting buildings. When the feature service was explored it was found that this was not the case – it instead showed select property boundaries.

3.3.2.5 Newfoundland and Labrador

Review of publicly available provincial data (namely through Newfoundland Open Data) did not identify building footprint information at the provincial level outside of information collected by the ODB and the FGP P/T Inventory.

Within FGP P/T Inventory queries performed by NRCan, a building footprints layer was identified as part of a base mapping package. When the feature service was investigated, it was found that building footprints are depicted across the provinces but that residential buildings are not included. Documentation was not available to establish the threshold for depicting buildings that was used, when data was collected, and if it is maintained. Because footprints are part of a limited basemap service, they could not be queried to determine the number of features or attributes. See **Figure 15** for an example of the base map. Overall, the buildings in the basemap provide a useful starting point within Newfoundland but may not meet the needs of NRCan (due to quality, relevance, and scope).

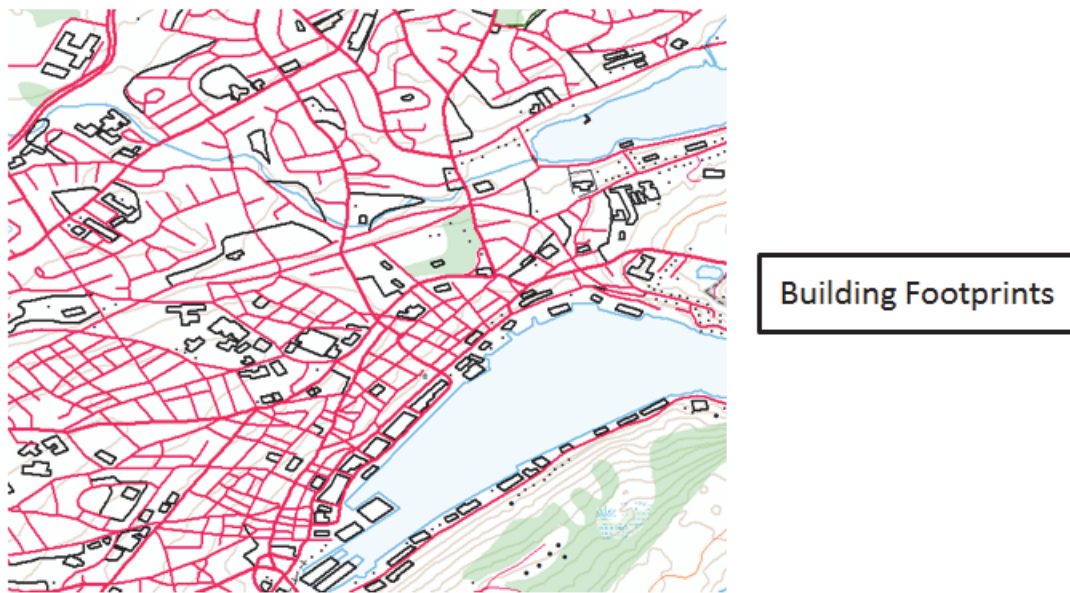


Figure 15 – Building Footprints within Base Mapping, Newfoundland

Further to the review of the building footprints identified by FGP P/T Inventory queries, it was observed that there are 14 datasets depicting points of interest. While these datasets do not provide building footprints, they could be used by NRCan to add attribute information once footprints are collected.

3.3.2.6 Northwest Territories

To build on efforts completed by NRCan, the Northwest Territories Bureau of Statistics as well as the Center for Geomatics were both reviewed. Here, it was found that building information was not available that had not already been identified by NRCan queries of the FGP P/T Inventory .

As identified within the FGP P/T Inventory, building footprint information is maintained by the Government of the Northwest Territories. There are multiple ways to access this information, including through web services and an online application (GeoCortex). Due to the nature of the service, buildings could not be queried to learn about attribute data, data quality, or the total number of records. Scale dependency within the service also limited the ability to infer coverage. See **Figure 16** which provides a sampling of the data published by the Government of the Northwest Territories.



Figure 16 - Sampling of Government of Northwest Territories Building Footprints

Aside from the building footprint information published by the Government of Northwest Territories, there was limited point of interest data identified within FGP P/T Inventory that could support the other needs of NRCan (ex. building attributes).

3.3.2.7 Nova Scotia

Review of publicly available provincial data (namely through GeoNova) did not identify building footprint information at the provincial level outside of information collected by the ODB and the FGP P/T Inventory.

Reviewing the GeoNova Catalog and the FGP P/T Inventory queries, it was established that all buildings within Nova Scotia are currently captured by GeoNOVA in a dataset titled “Nova Scotia Topographic Database – Buildings”, but that buildings less than 30 meters long are only digitized as points. This dataset is separated between two feature classes – one for building points (titled “BL_POINT_10k”), and one for building polygons (titled “BL_POLY_10k”).

Reviewing the Buildings dataset, it was observed that building points has 538,562 features while building polygons has 18,548 records.

The building points contain one attribute of interest to NRCan – a building type code. GeoNOVA provides an accompany spreadsheet that maps building codes – there are 141 building type codes for points of interest. The building codes do not classify types of residential buildings. Building codes are mixed with codes signifying the type of digitization for the feature building (ex. “approximate point”). Of the 538,562 features in the point dataset, 98.7% are simply classified as “Building Point”. For the remaining 1.3% of buildings (which are classified as various buildings of interest such as churches and hospitals), it is not stated how they were assigned a classification. Similarly, most building polygons are not classified. Of the 18,548 records, 83.8% are classified as “Building Polygon”.

See examples of GeoNOVA data in **Figure 17 – Figure 18**. Evident from **Figure 18** is that cleaning and quality improvements may be required – there are visible discrepancies in footprints as well as instances where buildings were not classified. As well, the total number of records should be a source of consideration. While 538,562 records are available, Statistics Canada reported in 2016 that there are approximately 401,990 dwellings within Nova Scotia.

GeoNOVA was contacted to inquiry if there are plans to update this data layer. It was reported that there are no current plans to change the specifications of the Nova Scotia Topographic Database. GeoNOVA reported that there is an ongoing effort to capture the entire province using LiDAR as part of a 5 year campaign. GeoNOVA reported that completion of this project could lead to an effort to delineate building footprints.

Further to the review of the FGP P/T Inventory queries, the following observations could be made:

- A total of 118 results were returned by queries
- Of, these 48 were found not to be applicable to the needs of NRCan due to duplication or scope
- There were 70 datasets that did not provide polygon building footprints but could provide building information once polygons are delineated. These datasets were a collection of point of interest datasets, each with their own scope.

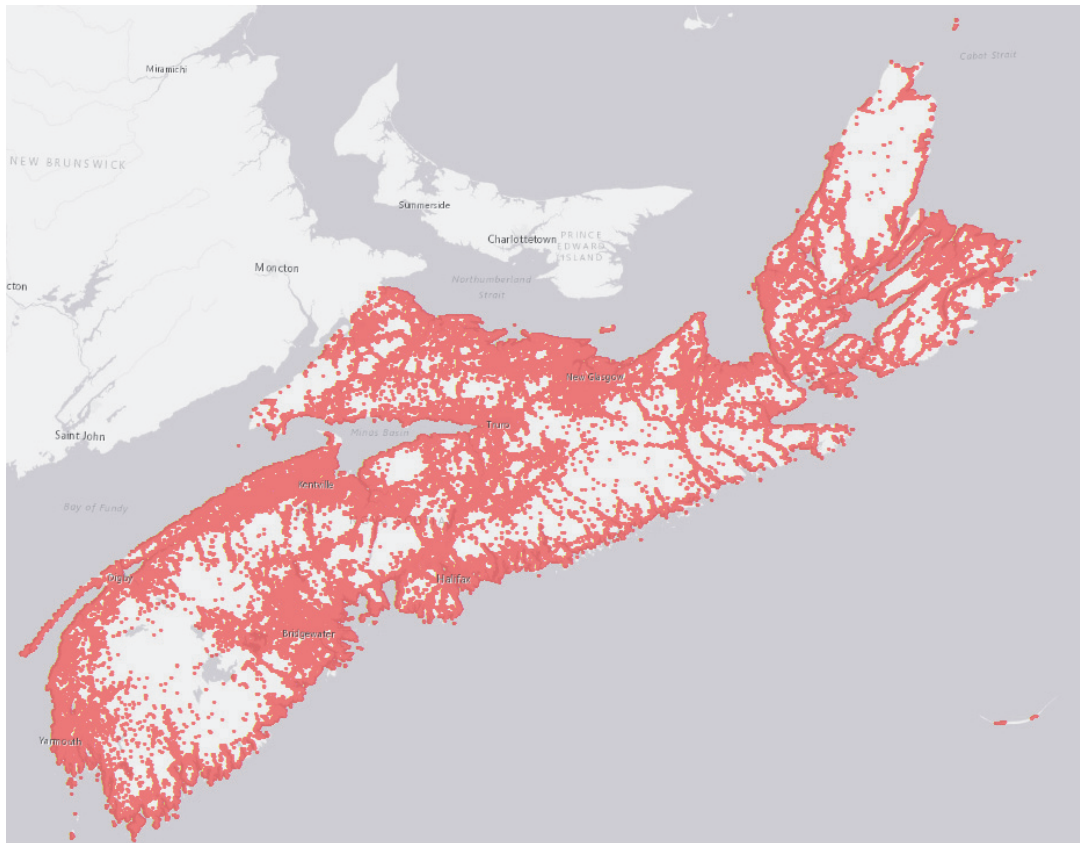


Figure 17 – Total Coverage of GeoNOVA Building Footprints



Figure 18 – Sampling of GeoNOVA Building Footprints

3.3.2.8 Nunavut

As identified by FGP P/T Inventory queries, there are 24 building footprint datasets (each covering a major settlement area in Nunavut). These datasets are published by Government of Nunavut Community & Government Services Planning & Lands Division (explored in further detail during the overview of Roles and Responsibilities). Review of publicly available territorial data (namely through Canada Nunavut Geoscience Office) did not identify additional building footprint information at the territorial level.

Examining the 24 building footprint datasets it was found that there are 8,456 records, with each dataset covering a single settlement area. Each dataset has the same attribute schematic. There is only one field (outside of geometric and indexing fields) in each schematic – building height. Each dataset provides building heights, measured in meters to one decimal place. Information is not provided on how heights were calculated, but the values imply a measurement from the ground surface. Building height was noted as being of interest to most NRCAN stakeholders, meaning that this is an important highlight to make. See **Figure 19** depicting building height in a community.

Reviewing a list of communities within Nunavut issued by the Government of Nunavut, there are 25 communities. The building footprint information (24 communities covered) is therefore close to being comprehensive. After exploring the data, the standardized nature and the presence of building height information suggests a higher level of quality than what was observed for other PT datasets.

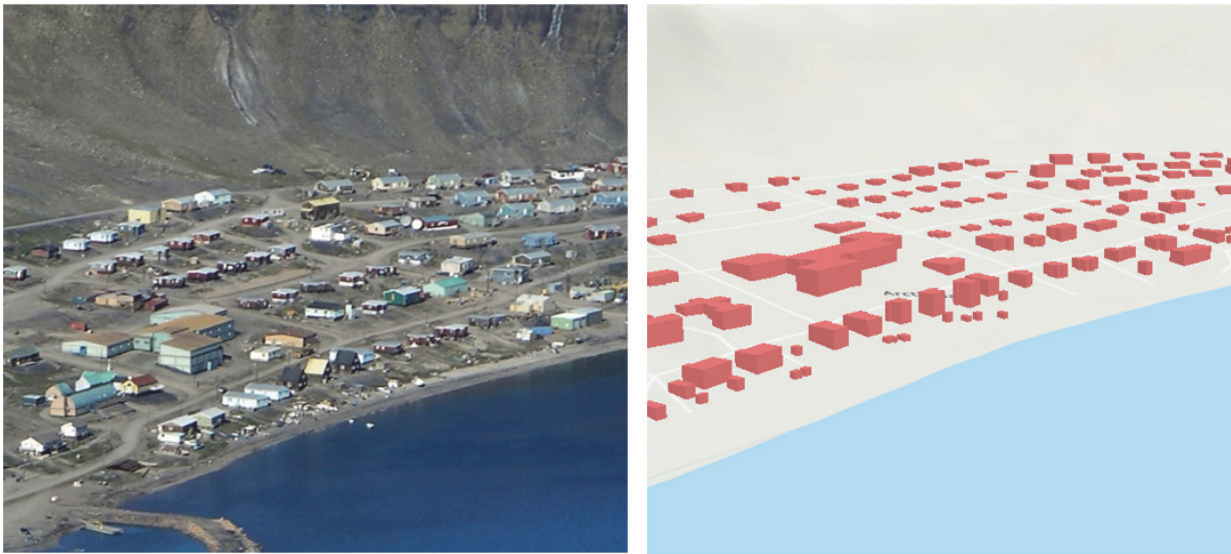


Figure 19 – Mapping Building Height in Arctic Bay, Nunavut³

3.3.2.9 Ontario

As identified by FGP P/T Inventory queries, a provincial dataset of select buildings titled “Buildings to Scale” is published by Land Information Ontario. This dataset has 201,238 records – coverage is across Ontario, but is limited to buildings of certain size thresholds matched to the imagery it was delineated from (building must be at least 30m long for a 1:10,000 image and 50m long for a 1:20,000 image).

To supplement FGP P/T Inventory queries, Land Information and Ontario.ca data catalogs were both reviewed for additional information. There was no building information that was not captured by the queries.

³ * Photo Excerpt provided under the [Creative Commons Attribution-Share Alike 3.0 Unported](https://creativecommons.org/licenses/by-sa/3.0/) license from WikiMedia Commons

Within the datasets schematic, there are attributes for accuracy and collection date. Accuracy is stated as being within 10 meters. The metadata indicates that the dataset was created in 2010, and that it is not actively maintained. The dataset is accompanied by a spreadsheet of building code classifications which imply buildings can be classified by type. The spreadsheet was found to have many errors and was not properly organized. There were no building codes provided in the GIS data to join this spreadsheet to. These observations all suggest that the data is of limited quality.

Evident from **Figure 20**, the coverage does not capture residential buildings, and the data does not capture recently constructed buildings.

Finally, a review of the Esri ArcGIS Hub was completed. Here, two datasets not captured by the ODB were identified. See **Table 11**.



Figure 20 – Sampling of Land Information Ontario Building Footprints

Table 11 - ArcGIS Hub Data, Ontario

Municipality	Source	Number of Footprints	Notes
Cornwall	Esri ArcGIS Hub	31,652	Both datasets have a custom license that could limit usage.
Peterborough	Esri ArcGIS Hub	31,660	

3.3.2.10 Prince Edward Island

Prince Edward Island has an inventory of building footprints that is listed in multiple locations (as identified by FGP P/T Inventory queries). It can be located through a webpage titled “Free GIS Products” on the Government of PEI’s website as well as within its Open Data Portal. Both locations advertise the file as being available as an Esri Shapefile, however the data can only be downloaded as a design exchange AutoCAD file.

Within the download, two files are provided: “Building Outlines Oct 2003” and “Building Outlines Nov 2003”. Both are in AutoCAD format and are not spatially referenced. The Oct 2003 file shows building outlines, but does not appear to be comprehensive – it only contains 4304 records. The Nov 2003 shows a series of points across PEI, and has 50,769 records. See **Figure 21** for an example of the coverage provided by the layers – a sampling indicates that the data may not be comprehensive, and that a cleaning effort is likely required.



Figure 21 - Building Footprint Information from AutoCAD, PEI

Queries completed by NRCan identified a number of duplicates datasets. There are estimated to be 8 point of interest datasets that could complement building footprints by providing attribute information.

Findings from the FGP P/T Inventory queries aligned with research completed by AECOM. Review of the Prince Edward Island Open Data Portal as well as the Data Catalog did not identify additional building information.

3.3.2.11 Quebec

Evident from the Open Database of Buildings, as well as FGP P/T Inventory queries, is that a number of municipalities within Quebec having building footprints but that a provincial coverage is not openly available. This was confirmed during a review by AECOM of Donnees Quebec as well as the Affaires Municipales et Habitation Quebec Carthotheque. Internal consultation with the province may be required to locate further data assets with broader coverage.

3.3.2.12 Saskatchewan

Evident from the FGP P/T Inventory queries is that building footprints are limited to the municipalities of Regina and Saskatoon. This aligns with AECOM findings, where datasets within the Sask Interactive Mapping were reviewed. Internal consultation with the province may be required to locate further data assets with broader coverage.

3.3.2.13 Yukon

Review of the publicly available GIS data within Yukon confirmed that there is not any geospatial building information. However, it was found that a digital elevation model is available for the territory. This could be considered a potential source of land classification as well as the extraction of building heights. Review of FGP P/T

Inventory queries found that there are 4 point of interest datasets that could provide additional information for select building footprints once delineated.

3.3.2.14 Summary

The section for each PT summarizes if data assets were located and what the source was. To summarize the sources of information that were consulted outside of the Geoportal, see **Table 12**. The listing includes those found not to have geospatial building information.

Table 12 – Summary of Public Data Sources Reviewed by the Environmental Scan

Source	Province/Territory
Open Alberta	Alberta
GeoDiscover Alberta	
BC Data Catalog	BC
GeoBC Gateway	
BC Oil and Gas Commission Open Data Portal	
BC Integrated Cadastral Information Sharing Society	
ArcGIS Hub	Canada
Manitoba Land Initiative	Manitoba
GeoNB New Brunswick	New Brunswick
Newfoundland Open Data	Newfoundland
GeoNOVA Nova Scotia	Nova Scotia
Canada Nunavut Geoscience Office	Nunavut
Government of Nunavut Community & Government Services Planning & Lands Division	
Northwest Territories Bureau of Statistics	NWT
Northwest Territories Center for Geomatics	
Land Information Ontario	Ontario
Ontario.ca	
Prince Edward Island Data Catalog	PEI
Prince Edward Island Open Data Portal	
Affaires municipales et Habitation Quebec Carthotheque	Quebec
Sask Interactive Mapping	Saskatchewan
GeoYukon	Yukon
Environment Yukon	

3.4 New Data Availability

Overall, the Environmental Scan of public data closely aligned with the findings of the Open Database of Buildings and FGP P/T Inventory queries. In general, geospatial building information is predominantly located within municipalities, although there are hotspots for higher jurisdictions within the Maritimes, the Territories of Canada, and Manitoba. There were a select number of datasets not captured by current efforts that are publicly available –

these datasets could add up to 125,000 records to NRCan's current data assets. See a summary of these datasets within **Appendix A**.

3.5 Next Steps

The results of the Environmental Scan provide a detailed and descriptive overview of the availability of dataset based on information that can be access by the public. However, as was noted during the results of the Scan, information could not be collected in several jurisdictions. Because directly engaging these jurisdictions was not part of the Environmental Scan, this may serve as a potential next step for NRCan. It is anticipated that the reliance on public information during the Scan may reduce the range of options presented to NRCan, a reality that could be addressed by reaching out to the jurisdictions without public data to confirm coverage gaps after incorporating any internal data.

4. Jurisdictional Roles, Responsibilities, Policies, and Legislative Directives

In order to develop an effective business strategy and an approach to the federal buildings layer that will underpin the delivery of the layer, it is vital that NRCan objectives effectively incorporate:

- The context, sometimes known as the business environment or landscape, within which it is operating, and
- Its stakeholders, those groups or individuals that have an interest in the organisation because they can affect or be affected by how the organisation is run and what it delivers.

The results of the Environmental Scan suggest that there are a number of data sources available to NRCan, but that a strategy and plan for developing a federal buildings layer is required. Ultimately, the approach taken by NRCan should be matched to the available resources and existing directives to ensure that the creation of a federal buildings layer is enabled by organizational context. Here, the full lifecycle of the data must be considered, including the creation, distribution, usage, maintenance, and management of a federal buildings layer.

To establish this context, a review of the jurisdictions, responsibilities, policies, and other directives was taken. The results of research and analysis were used to draw conclusions about how different stakeholders will contribute to geospatial building information initiatives for consideration during the SWOT analysis.

4.1 Federal Roles and Responsibilities

At the outset of the Environmental Scan, NRCan identified a series of stakeholders to be considered based on initial internal consultations and formalized meetings (ex. GeoBase Steering Committee). Overall, it was found that there are a diverse array of stakeholders within the federal jurisdiction that are directly related to the need for geospatial building information. There are 12 distinct groups, with each providing one or more services related to building information. These stakeholders can be characterized as:

- | | |
|--------------------------|--|
| Sponsors | <ul style="list-style-type: none"> ▪ Sponsors describe the federal stakeholders with the greatest investment in a federal buildings layer. Sponsors both use and contribute data, and are envisioned as steering the creation and subsequent management of the buildings layer. |
| Data Users | <ul style="list-style-type: none"> ▪ Data users are those who currently use or have an identified need for geospatial building information. Data is used to support directives and ongoing operations. |
| Data Contributors | <ul style="list-style-type: none"> ▪ Data contributors are stakeholders who contribute to internal building information and datasets. These stakeholders have information that could support the development of geospatial building data. |

With this understanding, the roles and responsibilities of stakeholders will be examined. An overview of the stakeholders is provided in **Table 13**:

Table 13 – Summary of Federal Geospatial Building Information Stakeholders

Stakeholders	Sponsor	Data User	Contributor
Canada Mortgage and Housing Corporation			✓
Canadian Border Service Agency			✓
Canadian Heritage			✓
Election Canada	✓		
Environment and Climate Change Canada		✓	
Public Health Agency of Canada		✓	
Department of National Defense		✓	✓
NRCan	✓	✓	
Public Safety		✓	
Royal Canadian Mounted Police			✓
Statistics Canada	✓		
Treasury Board Secretariat			✓

A review of these stakeholders begins with Natural Resources Canada in **Section 4.1.1**. **Sections 4.1.1 - 4.1.10** provide an overview of each stakeholder introduced in **Table 13**. The results of this process are synthesized as observations and conclusions in **Section 4.1.11**. Recognizing the contributions of provinces and territories, the analysis of roles and responsibilities transitions to an overview of PTs in **Section 4.2**.

4.1.1 Natural Resources Canada

4.1.1.1 Overview

NRCan is the Canadian department responsible for resource management, earth science, and (of particular importance to the Environmental Scan) mapping and remote sensing (a shared responsibility with other departments). Its main legislative authorities are the Department of Natural Resources Act, the Forestry Act, Resources and Technical Surveys Act, and the Energy Efficiency Act. There are three major strategic outcomes mandated to Natural Resources Canada (based on the 2016 Performance Report⁴), the third of which is most applicable to the Environmental Scan. The strategic outcome states that “Canadians have information to manage their land and natural resources, and are protected from related risks”. Here, it was stated that hazards and emergency management processes are of critical importance and that there are opportunities for modernization. To address this, it was stated that providing “information, knowledge products and services to governments, the private sector, media and non-governmental organizations” were a key issue. More recently, the 2018 Performance Report⁵ highlighted progress on these directives that included critical infrastructure and flood mapping, the collection of LiDAR data for 19 Canadian cities, and the development of a tool to track geospatial assets. In both the strategic priorities and the operational risks identified by NRCan, it is clear that the development of geospatial building information is well supported by the directives.

⁴ Department of Natural Resources Canada. Department Results Report, 2015-2016. Accessed at <https://www.nrcan.gc.ca/plans-performance-reports/dpr/2015-2016/18983>.

⁵ Department of Natural Resources Canada. Departmental Results Report, 2017-2018. Accessed at <https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/performance-reports/files/drr-2017-18/2017-18DRR-en.pdf>

4.1.1.2 Geomatics Expertise

Within the department and across the public service, NRCan provides leadership in the collection and distribution of topographic information through a centre of excellence known as the Canada Centre for Mapping and Earth Observation (CCMEO). Using CCMEO and other members of NRCan, NRCan provides remote sensing and geographic information to a number of different departments and decision makers, as well as the public. NRCan has led a number of initiatives that show leadership in geomatics including the Canadian Geospatial Data Infrastructure (through the GeoConnections program), the Federal Geospatial Platform, and the Geospatial Standards and Policies. **Table 14** summarizes NRCan's role in these initiatives and how they establish NRCan's role within the federal jurisdiction.

Table 14 – Summary of NRCan-Led Geomatics Initiatives

NRCan-Led Initiative	Description	Observations
GeoConnections	<p>GeoConnections mandates the development of the Canadian GeoSpatial Data Infrastructure (CGDI, below). The objective of GeoConnections is to facilitate the accessibility and usage of geospatial information.</p> <p>GeoConnections is federally funded, with mandates to focus on public health and safety, security, environment, and matters of importance to Aboriginal people.</p>	<p>GeoConnections serves as the top directive that enables a wide range of initiatives used to expand the usage and availability of spatial data, both internally and externally. The need for a federal building footprints dataset was identified through processes falling under GeoConnections.</p> <p>GeoConnections as a federally funding program serves as the top-down directive for many of the initiatives taken by NRCan. Building footprints falls within directives given with funding appropriations, notably for public safety, security, and sustainable development.</p>
Canadian Geospatial Data Infrastructure (CGDI)	<p>The CGDI is the product of GeoConnections. The CGDI is a combination of data sharing services, and policies that enable and standardize the use of spatial information.</p>	<p>Since 1999, NRCan has worked to deliver a large number of services and initiatives that comprise the CGDI, including the Federal Geospatial Platform. The requirements for a building footprints layer present a clear next step for the CGDI.</p> <p>In 2016, a Value Study was conducted of the overall impact of geomatics within the Canadian economy. This Study further supported the business case for the enabling work NRCan provides the federal public service as well as the role of open data within the Canadian economy.</p>
Geospatial Standards and Policies	<p>As part of the CGDI, there are standards and policies that control and enable the usage of spatial information. Examples include standards for visualization, the encoding and transfer of data, and the accessibility of data using web services.</p>	<p>Given the need to bridge many different standards when creating federal building information, the use of standards created by the CGDI will be a key enabler in delivering a valuable and usable final product.</p>
Federal Geospatial Platform	<p>The Federal Geospatial Platform (FGP) was created in support of Canada's Action Plan on Open Government, and unites users and creators of GIS data across the federal public service through an online environment to promote coordination and collaboration. The platform is used to share skills and expertise, internal datasets, as well as to identify common needs for data.</p>	<p>Evident from Section 4.1 is that there are a wide array of federal stakeholders connected to the need for geospatial building information. Recognizing these stakeholders is one of the goals of the Federal Geospatial Platform, and ensures that efforts by NRCan are open to other departments. Given the expanding use of GIS within the public service, NRCan is wise for recognizing broader needs. The FGP provides useful tool for maintaining NRCan's open approach to geospatial building information during next phases of the project.</p>

4.1.1.3 Operational Data Requirements

The NRCan-led GIS initiatives summary (**Table 14**) establishes context for NRCan's role as a key sponsor of the geospatial building information. The above summary focuses on NRCan's role as providing the leadership and frameworks that have shaped the sharing of geomatics, but NRCan also regularly use geomatics within its own operations. There are several business units within NRCan that are identified as data users. While it is understood that NRCan is a key sponsor of the geospatial building information when planning the eventual development of the buildings layer, the usage of building information should also be explored (**below**).

Energy Sector

Energy usage and efficiency was identified by NRCan as a building information requirement. Within NRCan, the Energy Sector is divided between the Office of Energy Efficiency, the Office of Energy Research and Development, and CanmetEnergy. NRCan reported that the Office of Energy Efficiency and CanmetEnergy are the closest stakeholders for geospatial building information. Across the Energy Sector, geospatial building information is required for building and infrastructure inventories, planning for climate adaptation measures, mapping and modelling energy consumption, estimating consumption at community scales, conducting spatial analysis between waste and demand, and modelling the built environment.

Office of Energy Efficiency

The Office of Energy Efficiency administers energy efficiency programs for NRCan as part of the NRCan Energy Sector. The focus of energy efficiency programs includes housing, buildings, vehicles, equipment, and industry. The Office of Energy Efficiency is enabled by federal directives such as the Clean Air Agenda. Evident from the focus of energy efficiency is that two main areas (housing and buildings) will require building information. An authoritative source of building information would enable work in both of these service areas.

Buildings Division

The Buildings Division of NRCan provides services and leadership guiding the energy efficiency of commercial and institutional buildings within Canada. The Buildings Division falls under the Office of Energy Efficiency (see above – **Office of Energy**). While the Buildings Division currently uses internal registries of commercial and institutional of buildings to support its operations, an authoritative building footprints layer would allow for improved analysis.

CanmetEnergy

CanmetEnergy enables the research and development of clean energy within Canada. This is completed for a variety of service areas, including buildings and communities (of particular interest for the Environmental Scan). CanmetEnergy produces a Building Strategy with the goal of reducing energy usage in buildings. Geospatial building information will support performance monitoring, analysis, and planning in these areas. CanmetEnergy provides software tools for analysis, modeling, and simulation of energy usage that would benefit from building footprint data.

Geological Survey of Canada

The Geological Survey of Canada (GSC) is the federal agency that surveys Canada's natural resources, and supports resource development and environmental protection. Within this purview are other duties including natural hazards risk analysis, vulnerability and risk assessment, and simulation exercises. These duties are supported by the GSC's Strategic Plan. Here, a strategic objective of reducing economic, social and environmental impacts from

natural hazard events is stated as one of the GSC's overarching goals⁶. Given the potential impact to buildings from natural hazards, geospatial building information is expected to be of significant importance to modeling exercises.

4.1.2 **Statistics Canada**

As explored within the Project Overview, Statistics Canada is a key stakeholder within the GeoBase Steering Committee. Statistics Canada is the federal agency responsible for collecting and synthesizing socio-economic statistical information within Canada, including through the Census Program. Statistics Canada's mandate is based on the Statistics Act, which mandates the collection, analysis, and publication of statistical information about Canada that can be used to develop policies and improve decision making.

Given the scope of the Statistics Canada mandate, the use of information about buildings is commonly used. Statistics Canada maintains a number of datasets applicable to a federal buildings inventory including the Address Register, the Business Register, and the Land Accounts Program that could be a significant source of geospatial building information. Most importantly, Statistics Canada has recently developed a Building Register through its Data Integration Infrastructure Division. Context to the availability of Statistics Canada data observed during the Environmental Scan (**Section 3.3.1.4**) is provided during a review of the Statistics Act (**Section 4.3.4**).

4.1.2.1 *Data Integration and Exploration Lab*

Increasingly, Statistics Canada's data is spatial in nature, leading to a number of initiatives to gather geospatial building information through the Data Integration and Exploration Lab. Statistics Canada is working to integrate government and open sources of data to increase the availability of spatial and attribute data, and selected building footprints as a key starting point. The leading example of this progress is the Open Database of Buildings (**Section 2.2**). Other initiatives currently be completed by Statistics Canada than should be highlighted are open-source data collection as well as a collaboration with Microsoft.

All Statistics Canada datasets and initiatives were highlighted during the Environmental Scan.

4.1.3 **Elections Canada**

Elections Canada is the federal agency responsible for organizing and executing elections within Canada. Elections Canada is divided into service areas for regulatory affairs, internal services, and electoral events and innovation. Elections Canada is a large contributor of building footprint information, as large amounts of data are generated by registering and delineating voters spatially. Elections Canada has a number of directives to support the collection of this information, including electoral innovation, electoral data management and readiness, and operations and field governance.

4.1.4 **National Defence**

The Department of National Defence (DND) provides public service driven by a number of laws and statutes related to national security and emergency preparedness. As reported during consultations with regards to stakeholders using DMTI Spatial (**Section 3.2.1.4**), DND maintains data for emergency management and response. ND maintains a Canadian Infrastructure Database, which captures the infrastructure assets and points of interest relevant to ND's emergency management activities. It was reported (**Section 3.2.1.4**) that although there are a number of internal datasets available that can be supplemented by commercial datasets, the need for an authoritative dataset is desired. When using data, DND has received directives to always use the datasets closest

⁶ Natural Resources Canada. Geological Survey of Canada Strategic Plan 2013-2018 Accessed at http://ftp.maps.canada.ca/pub/nrcan_rncan/publications/ess_sst/293/293638/gid_293638.pdf

to the source of information. Based on this understanding, DND can be considered a user of geospatial building information (provided that it is authoritative).

In addition to the usage of geospatial building information, it is understood that DND also creates information related to building footprints. With military bases stationed across Canada, each has internal information related to the buildings within its respective service area.

4.1.5 Public Safety Canada

Public Safety Canada has similar interested in geospatial building information to National Defence. Public Safety Canada is the federal department responsible for maintaining safety in Canada, and includes agencies such as Border Services and the RCMP. Key component of Public Safety Canada's objectives are emergency preparedness and emergency response. Public Safety Canada supports emergency response from the Government Operations Center, which harmonizes information and stakeholders to plan, analyze, and provide logistics to emergency response efforts. Both during planning and during responses, building information is a key consideration. During discussion with a member of Public Safety Canada (**Section 3.2.1.4**), it was reported that building information is important for planning and analysis. It was reported that the size of Public Safety Canada as well as its objectives mean that while they are important data users, they would not produce geospatial building information themselves.

Royal Canadian Mounted Police

As previously stated the Royal Canadian Mounted Police (RCMP) is one of the agencies under Public Safety Canada, and was identified as a stakeholder by NRCan with respect to geospatial building information. The RCMP regularly uses geographic information to respond to, monitor, and analyze emergencies within its jurisdiction. Geospatial building information will enhance the RCMP's ability to manage emergencies and analyze criminal activity.

Canadian Border Service Agency

As with military bases within the service areas of DND's military bases, the Canadian Border Service has border stations along the Canadian border. Each border station produces building information based on its location. Border stations should be highlighted as well as military bases as potential sources of building footprint information for NRCan.

4.1.6 Public Health Agency of Canada

The Public Health Agency of Canada (PHAC) is the department of the federal government responsible for national public health. PHAC examines a wide range of public health considerations, with environmental health being of relevance to the Environmental Scan. NRCan reports that PHAC is a user of building information during the analysis of urban heat islands. As well, the management and prevention of infectious and chronic diseases is an emerging area of geospatial building information usage for PHAC. The needs of PHAC for geospatial building information should be considered when collecting information.

4.1.7 Environment and Climate Change Canada

As with PHAC, Environment and Climate Change Canada (ECCC) analyzes urban heat islands using building information, instead with the focus of assessing the impacts of urban areas on weather conditions. This is accomplished through the Meteorological Survey of ECCC. It is expected that PHAC and ECCC may have similar needs for geospatial building information, focusing on urban centers.

4.1.8 Treasury Board of Canada Secretariat

The Treasury Board of Canada Secretariat (TBS) advises the federal government on the efficient usage of government funds and assets. Two areas of interest to the Environmental Scan under the purview of the TBS are the federal government's Public Services and Procurement Canada as well as the Directory of Federal Real Property. Given the number of service delivery locations across Canada, these two sources of information will account for an important subset of buildings within Canada and could be a source of geospatial building information.

4.1.9 Canadian Heritage

The Department of Canadian Heritage is responsible for culture, official languages, and media within Canada. Canadian Heritage generates data about buildings that fall under the definition of heritage buildings and accomplished through initiatives such as the Federal Heritage Buildings Review Office. Canadian Heritage should be understood as a potential source of data for an important subset of buildings within the scope of the Environmental Scan.

4.1.10 Canada Mortgage and Housing Corporation

The Canada Mortgage and Housing Corporation (CMHC) is a Crown corporation that receives oversight from the Department of Employment and Social Development, with a mandate to improve the access and delivery of housing services for Canadians. CMHC generates information related to building footprints that should serve as a potential source of data for NRCan. Information is generated during research and analysis of housing related data including household characteristics, ownership types, etc. The information CMHC may be able to provide will be focused on residential housing.

4.1.11 Federal Stakeholders – Observations and Conclusions

Section 4.1 and **Table 13** establish the different stakeholders as reported by Natural Resources Canada. This introduction summarizes the interactions each stakeholder has with geospatial building information. **Section 4.1.1 - 4.1.10** provides a brief overview of each stakeholder for NRCan, which should serve as a reference for where geospatial building information could be collected as well as what data each user could require (either operationally or analytically). While an overview of each stakeholder is useful, it is also important to synthesize these observations to provide NRCan with trends in responsibilities and directives that could drive the materialization of geospatial building information.

The 12 major stakeholders identified by NRCan support a wide range of public services but have similar directives that should be recognized. The overall "outcomes" of the stakeholder directives include:

- Emergency Management
- Public Health and Safety
- Security
- Resiliency and Climate Change Adaption
- Technical Surveys
- Information gathering (ex. socioeconomic)
- Mobilizations (ex. census, elections)
- Service Delivery

Review of the stakeholders established that the use of geospatial building information in actualizing these “outcomes” is either operational or analytical. The distribution of activities and outcomes by stakeholder based on the review of each stakeholder is summarized in **Table 15**.

Table 15 – Outcomes of Geospatial Building Information by Stakeholder

Stakeholders	Emergency Management		Health and Safety		Security		Resiliency and Climate Change		Technical Surveys		Information Gathering		Mobilizations		Service Delivery	
	O	A	O	A	O	A	O	A	O	A	O	A	O	A	O	A
Canada Mortgage and Housing Corporation											✓					✓
Canadian Border Service Agency					✓	✓										
Canadian Heritage																✓
Election Canada											✓		✓		✓	
Environment and Climate Change Canada				✓			✓	✓				✓				
Public Health Agency of Canada				✓				✓								
Department of National Defense	✓	✓			✓	✓										
NRCan		✓						✓	✓	✓	✓		✓			
Public Safety Canada	✓	✓	✓	✓	✓	✓	✓	✓								
Royal Canadian Mounted Police	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓
Statistics Canada								✓	✓	✓	✓	✓				✓
Treasury Board Secretariat												✓				✓
Total	7		6		8		7		4		7		3		7	

The review of stakeholder outcomes established that the largest drivers of geospatial building information include security, emergency management, and resiliency. Drivers common to many stakeholders at a broader level included information gathering, and service delivery (this is to be expected given the similarities for information requirements in many federal services). Recognizing this, security, emergency management, and resiliency should be highlighted as the key drivers of geospatial building information above the basic requirements identified by most of the stakeholders. This is logical to expect given the operational and analytical activities that geospatial building information would enable for stakeholders including Public Safety Canada and the Department of National Defence. These drivers are also important to highlight as they generally (although it is not stated within the materials researched) take precedence over public services that do not impact public health and safety (ex. non-essential services). In recognition of the needs of its stakeholders, observations about the stakeholder suggest that NRCan should emphasize outcomes related to security, emergency management, and resiliency when working to materialize the geospatial building information.

While the stakeholder analysis helps to establish sources of geospatial building information as well as highlight where the greatest needs are, these results do not directly translate to the stakeholder best positioned to materialize geospatial building information. For example, as reported during the consultation with DMTI CanMap users (**Section 3.2.1.4**), stakeholders such as Department of National Defence and Public Safety Canada are heavy data users but are not positioned to produce the required geospatial building information themselves. Recognizing these realities, a cross-departmental view of directives is required to determine how different stakeholders can support one another. Here, it was observed that:

- Public Safety Canada, the Department of National Defence, and other stakeholders have a strong interest in using geospatial build information for outcomes related to security, emergency management, and resiliency but may not have the resources required to produce the data of interest.
- NRCan and Statistics Canada both have directives to collect/distribute data to other members of the public service while advancing the use of survey technologies
- NRCan and Statistics Canada both have a need and directives to utilize geospatial building information in addition to the directives to collect/distribute data.

Based on this understanding, it can be concluded that directives of security, emergency management, and resiliency could be the most important drivers for materializing geospatial building information. The business case for materializing the information is enhanced by the observations that many stakeholders with a need for information do not have the resources to produce it themselves. NRCan and Statistics Canada are both positioned to produce the information to meet the needs of others as well as their own internal requirements. While geospatial building information has strong ties to directives related to public health and safety, the business case is further developed by recognizing that many other stakeholders could take advantage of the same information for different purposes. Similar observations were made by New Zealand (see **Section 5.5**) when materializing its geospatial building information – while a pilot project was driven by needs for resiliency and emergency management, the usage of the data was inevitably much broader.

4.2 Provincial and Territorial Roles and Responsibilities

While the primary focus of the analysis of roles and responsibilities related to data was the federal jurisdiction (as this will be the jurisdiction responsible for aggregating and scaling geospatial building information to create a national coverage), PTs are an important consideration. Given the oversight of distinct areas of Canada performed by PTs, PTs should be understood as a potential opportunity to scale data being provided to a federal collection of geospatial building information.

PTs hold jurisdiction over a number of areas of governance applicable to geospatial building information including municipal affairs, land use, land registration, infrastructure projects, employment, public health, agriculture, and environmental regulation. These areas will logically use or produce a significant amount of geospatial building information, either for analytical or operational purposes. This understanding served as the basis for the investigation of the available building information performed during the Environmental Scan.

Overall, it was found that while it can generally be assumed the PTs leverage a significant amount of geospatial building information, in most cases this information was not publicly available at the scope and level of detail of interest to NRCan and the Environmental Scan. In spite of these overall findings, there are select PTs that have a collection of geospatial building information. Based on the scope of the Environmental Scan, these PT were investigated further to determine potential drivers and lessons learned for provincial roles and responsibilities.

4.2.1 Provinces and Territories with Building Information

4.2.1.1 Nova Scotia

The collection of geospatial building information is driven by the Nova Scotia Geospatial Infrastructure (NSGI), which aims to provide the base mapping foundation for government and the public. Building footprints were identified as part of the base mapping initiative. NSGI aimed to provide a foundation for all mapping activities, and has since engaged all stakeholders and stewards of data within the provincial government to collect additional datasets. NSGI aims to update and advance its base mapping through cost sharing with municipalities as well as commercial partnerships.

As reported during the Environmental Scan, the province is completing a 5 year campaign to collect LiDAR data for the province (a campaign notable to the requirements of the Automatically Extracted Buildings data). This was enabled through the development of a Strategic Directions report for the province which made the business case for data collection as well as proposed approaches to financing and cost sharing.

4.2.1.2 Prince Edward Island

The government of PEI states that its approach to open data is driven by the Government of Canada's Open Data Principles, which has also adopted for its own use. These principles were adopted at the government level, providing a very clear directive for subsequent publications of open data.

4.2.1.3 Northwest Territories

The publication of open data by the Northwest Territories is enabled and directed by the Open Government Policy. This policy provides the directives and guidelines for sharing data to all departments within the Territory including standards, principles, and processes. Currently, there are a number of different open data source maintained by the territory that are in the process of being consolidated.

4.2.1.4 Nunavut

Rather than produce a single dataset capturing all building within the territory, Nunavut has instead collected a series of datasets for each major settlement area in Nunavut. These datasets are provided by the Community and Government Services (CGS) Planning and Lands Division. These datasets are supported by CGS's directives to provide planning and lands services of the territory. Here, it is understood that this directive in place to meet the context of Nunavut's collection of remote communities with limited individual resources. CGS provides topographical mapping for settlement areas as well as all non-tax based communities (as defined by CGS). CGS's responsibilities also include property assessment. Given the role of CGS as a regional planner as well as a technical resource for individual communities it is logical to expect that it would produce building information for

each community. In conclusion, the availability of building information for Nunavut can largely be attributed to the organizational context and heightened need for regional planning and technical support for communities.

4.2.1.5 *Manitoba*

Although Manitoba has a building footprint dataset published, there was no documentation to suggest the drivers of the data collection. The Government of Canada listing of open data initiatives indicates that Manitoba is not part of open government initiatives. Searches of public records indicate that there are not currently any directives that would drive open data initiatives.

One exception to the observations made about Manitoba is the initiative is the Manitoba Land Initiative (MLI). This Initiative supplies open datasets for administrative boundaries, base maps, remote sensing, environment, transportation, and municipal datasets. The Initiative is driven by directives that have not been updated since 1999. While the website and datasets are maintained, the last reported meeting related to the Initiative was in 2002. The Department of Conservation's building footprint information was not published through the MLI, suggesting that the usage of building information was specific to the needs of the Department of Conservation.

4.2.1.6 *Observations and Conclusions*

From examining each PT's data infrastructure, the following observations could be made:

- Case can be made for collecting building footprints provincially/territorially as a base mapping requirement to stimulate the growth of other datasets
- Municipal contributions are readily available and should be recognized with mechanisms for cost and data sharing
- Large data captures are successful when supported by planning and strategies
- PT's with readily available data typically also have strong directive or embrace open data as part of government operations
- Internal context related to the usage of data within provincial/territorial public service is not readily available public information. With the exception of Nunavut (which provided a useful organizational context on its website), the internal data usage (either analytically or operationally) can be inferred but not defined based on the available public records. It can be assumed that the production of each dataset was due to drivers specific to each PT.

4.2.2 *Provinces and Territories without Building Information*

Evident from the results of the Environmental Scan is that geospatial building information is not available at the provincial/territorial level for many PTs. This was further contextualized by an overview of the roles and responsibilities of each PT. Overall, it was found that while it can generally be assumed the PTs leverage a significant amount of geospatial building information, in most cases this information was not publically available at the scope and level of detail desired by NRCan. There were several PTs with active open data initiatives that did not have building footprint information. The key exception to these PTs was Saskatchewan – see **Table 16**.

Table 16 – Provinces without Open Data Initiatives

Province	Observations
Saskatchewan	Historically, the Government of Saskatchewan and Information Services Corporation (the province’s authority for land registry services) jointly operated an open data portal for GIS data known as GeoSask. This portal was terminated in May 2016. At present, Saskatchewan provides maps and web applications related to administrative boundaries, agriculture, base maps, imagery, environment, natural resources, and transportation. A landing page consolidates the available data, but there is not a centralized open data collection effort. Many of the datasets published in GeoSask are still maintained by ISC but have licensing fees and limitations. Public record searches indicate that there are no new directives for open data. Therefore, discovering geospatial building information is expected to be limited to internal consultations.

The lack of available geospatial building information could be attributed to some of the observations made during the 2015 Feasibility Study, which noted that the integration efforts that are required can be significant when scaling geospatial building information to broader coverages. Given that many of the largest provinces do not have a provincial dataset, this is one potential explanation for why open data provinces do not provide geospatial building information. See **Figure 22**. This will be explored further during the SWOT analysis.

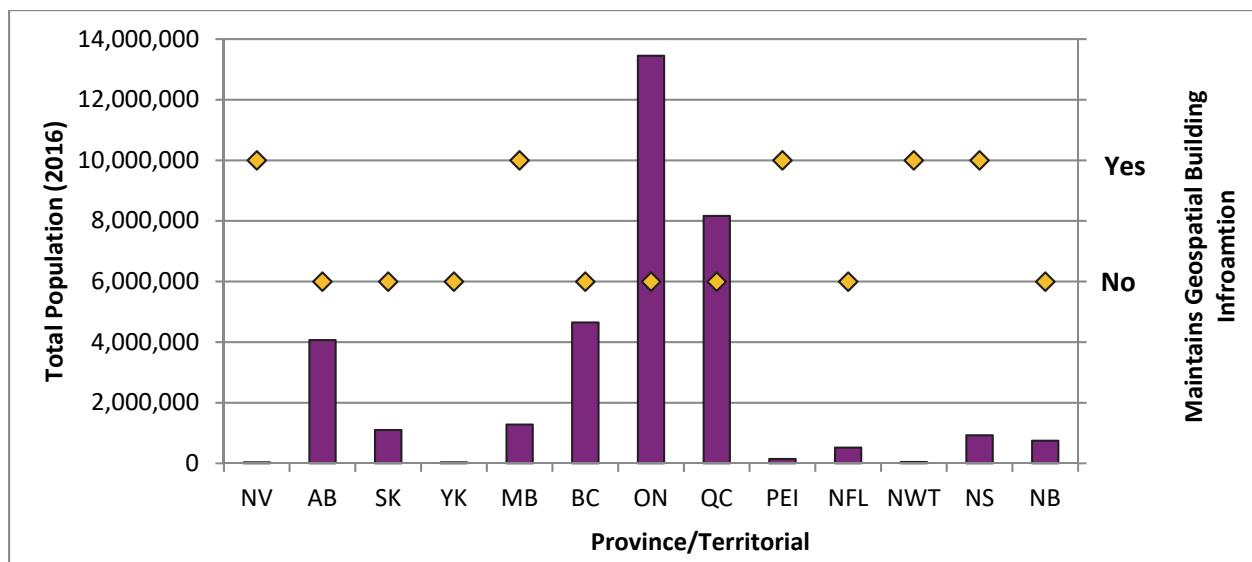


Figure 22 – Summary of Provinces/Territories with Geospatial Building Information

4.3 Federal Policy Review

The overview of federal stakeholders (**Section 4.1**) produced several instances where policy had important implications for the Environmental Scan and NRCan’s goals of materializing geospatial building information. To support planning for the development of a federal layer, a policy review was conducted to build on some of the concepts introduced in **Section 4.1**. A policy is a document that provides a set of mandatory rules for an organization. Within the context of the Environmental Scan, this takes the form of Acts and amendments issued by the federal government. All of the stakeholders within **Section 4.1** are impacted in different ways by policy. Policies of particular interest to the Environmental Scan were identified by NRCan. It is expected that the development of federal geospatial building information will require an allocation of federal resources – in recognition of this; policies were examined for where directives that could support these requirements exist.

4.3.1 Department of Natural Resources Act

The Department of Natural Resources Act (DNRA) builds on directives for mapping, surveying and remote sensing to establish the Department of Natural Resources. The DNRA assigns the jurisdiction of natural resources, explosives, and technical surveys (the main mandate of interest to the Environment Scan) to NRCan. Examining the components of the DNRA applicable to the Environmental Scan, there are several important highlights to make that support the development of federal geospatial building information (**Table 17**).

Table 17 – Highlights from the Department of Natural Resources Act

Overview of Select Department of Natural Resources Act Directives
<p><i>Develop Canada’s technical capabilities</i></p> <p>Foremost, the mandate to develop Canada’s technical capabilities directly empowers NRCan to address the needs for greater technical capabilities identified by a wide range of stakeholders and data users at the federal level. Even before considering the operational needs of NRCan, this directive empowers NRCan to pursue technical capabilities that will improve service delivery of other departments and agencies.</p>
<p><i>Promote the use of remote sensing technology</i></p> <p>The evolving commercial exploration of geospatial building information is indicative of the expanding capabilities of remote sensing technologies within Canada, and the desire of the public service to implement new technologies to improve analysis and operations of Canada. The DNRA provides direction to NRCan to respond to the needs and goals of federal stakeholders by promoting new uses of remote sensing technology, including remote sensing technologies such as advanced methods of image classification. Evident from the Environmental Scan is that while technologies exist commercially, they have not yet been widely embraced. Pursuing geospatial building information will directly promote the use of these technologies within Canada as well as internationally.</p>
<p>Promote cooperation with PTs, municipalities, non-government organizations, and international organizations.</p> <p>Evident from the Environmental Scan is that a significant amount of data integration with PT stakeholders could be required to actualize a federal layer of building information. To do so, a collaborative effort will be required with leadership from the federal jurisdiction that empowers the contributions of each province.</p> <p>Once the federal layer is actualized, the case for making the dataset open (building on the current Open Database of Buildings) would be a significant example of cooperation with other organizations by embracing the principles of open data.</p>

4.3.2 Resources and Technical Surveys Act

The Resources and Technical Surveys Act (RTSA) establishes the responsibilities of NRCan for mapping Canada’s resources by performing technical surveys. Here, technical surveys capture a wide range of survey methods including geographical and topographical. Highlights applicable to the Environmental Scan are provided in **Table 18**.

Table 18 - Highlights from the Resources and Technical Surveys Act

Overview of Select Resources and Technical Surveys Act Directives
<p>Perform technical surveys for obtaining a representation of geographical features</p> <p>This directive provides NRCan a clear directive to obtain geospatial building information as a type of geographical feature. While the Environmental Scan focuses on leveraging existing sources of information, this directive could empower NRCan to collect data in areas where gaps in data exist.</p>
<p>Distribute products of technical surveys on behalf of the Department</p> <p>This directive clearly indicates that any mapping services performed by NRCan should be shared with others within the public service as well as the public. It speaks directly to the wide range of stakeholders who have identified a need for geospatial building information that look to NRCan to collect the information and share it with them. It also provides support for open data initiatives similar to the directives provided by the Department of Natural Resources Act.</p>
<p>Coordinate, promote, and recommend national technical survey programs, and coordinate with institutes and other facilities conducting applied research and economic studies</p> <p>As with the directive listed above, this directive further establishes NRCan as the source for geographical information that enables a wide range of different operations and analyses. It requires NRCan to coordinate with those who have expressed the need for information related to research and studies within Canada. This coordination supports the need for data integration between a variety of sources that was observed during the overview of Roles and Responsibilities.</p>
<p>Consult with producers, industry, universities, and PT and municipal authorities during technical surveys</p> <p>Evident from the results of the Environmental Scan is that there are a number of different sources of geospatial building information, notably commercially and municipally. The RTSA provides NRCan the means to consult and coordinate with these stakeholders. It could also be used to plan data collection exercises in partnering with lower jurisdictions such as PT and municipalities.</p>

4.3.3 Emergency Management Act

The Emergency Management Act (EMA) requires emergency management planning and applies to a number of federal ministries. The directives either apply directly to NRCan or make requirements for NRCan to provide a supporting role. Observations from the EMA are provided in **Table 19**.

Table 19 - Highlights from the Emergency Management Act

Overview of Select Emergency Management Act Directives
<p>Identify risks related to areas of responsibility and critical infrastructure</p> <p>This directive serves as the basis for Canada's National Strategy for Critical Infrastructure, which is divided into 10 categories (each with a respective lead department or agency). Critical infrastructure categories applicable to building footprint information include energy, government, health, and safety.</p>
<p>Prepare emergency management plans</p> <p>Agencies including National Defence and Public Safety Canada regularly conduct planning exercises related to emergency management. These planning exercises often involve building information and other points of interest. The EMA provides NRCan with the directive to support the needs of these exercises by providing building footprint information.</p>
<p>Develop programs, arrangements and other measures to assist PT and local authorities</p> <p>Given that many PTs and local authorities do not currently have geospatial building information, federal ministries may act as a support to build capacity and resiliency. By leading directives at the federal level, the data collection effort will also provide assistance to provincial/territorial and local authorities.</p>
<p>Support overall defence effort</p> <p>While many parts of the emergency management act apply to planning for emergencies, the operational requirements for emergency response are also recognized. Here, it is understood that geospatial building information will contribute to emergency response efforts as well as planning.</p>

4.3.3.1 National Strategy for Critical Infrastructure

One outcome of the Emergency Management Act is the National Strategy for Critical Infrastructure. This Strategy provides the framework for planning between federal, provincial and territorial initiatives within each critical infrastructure sector. Here, critical infrastructure refers to systems, facilities, networks, assets, and other services.

Geospatial building information is a key component of emergency management planning. Additionally, the Strategy mandates the "timely sharing and protection of information among partners and key stakeholders", which is stated as being a key requirement for emergency management and resiliency. Pathways for information are identified as federal, provincial and territorial.

4.3.4 Statistics Act

The Statistics Act provides a number of directives to Statistics Canada that are directly applicable to the Environmental Scan. As demonstrated during the overview of roles and responsibilities, Statistics Canada and NRCan have entered partnerships on a number of initiatives related to GIS data collection. The Statistics Act is important to the Environmental Scan because some of the datasets collected by Statistics Canada (ex. the Buildings Registry) are desired as contributions to geospatial building information. Observations about directives applicable to the Environmental Scan are provided in **Table 20**.

Table 20 - Highlights from the Statistics Act

Overview of Select Statistics Act Directives
<p>Collect, compile, analyse, abstract and publish statistical information relating to the commercial, industrial, financial, social, economic and general activities and condition of the people</p> <p>Statistics Canada compiles information through the census and other data gathering activities including information about commercial and residential dwellings, building units, and other information applicable to the analysis and operational needs of NRCan stakeholders assessing public safety, energy usage, and resiliency.</p>
<p>Collaborate with departments of government in the collection, compilation and publication of statistical information, including statistics derived from the activities of those departments</p> <p>Statistics Canada regularly collaborates with NRCan and other stakeholders through the sharing of certain types of information, typically in the form of derived statistics. Statistics Canada maintains the Buildings Registry, which is an internal dataset not shared with other departments.</p>
<p>Promote the avoidance of duplication in the information collected by departments of government</p> <p>The Statistics Act recognizes the inefficiencies of duplicating information as well as the challenge to establish authoritative sources. Given that there are identified needs for Statistics Canada data within other ministries, it is logical to expect that data sharing could be used to avoid duplication.</p>
<p>Prohibition of divulging information except for the purpose of communicating information in accordance with any conditions of an agreement</p> <p>This directive establishes a potential challenge for NRCan, as some of the information desired for geospatial building information could have limitations on usage (ex. the Buildings Registry). However, if use limitations prevented Statistics Canada contributions and data was instead collected by NRCan, this could result in duplication (which is directed as being avoided). More research is required to identify how these directives can be reconciled.</p>

4.4 Stakeholder Input

There are a variety of stakeholders with a need for building footprint data, are contributing to the development of the federal dataset, or currently hold building footprint data. To learn more about these activities beyond what is available through public records, a stakeholder survey was distributed. The survey is summarized in **Table 21**.

Table 21 - Survey Questions Distributed to Geospatial Building Information Stakeholders

Survey Questions
<p>1. Does your business unit rely on information about building footprints for its operations?</p> <p>a) If yes, please specify if attribute data about each building is required in addition to a geographical building footprint.</p> <p>b) Please specify the most important building attributes.</p>
<p>2. Does your business unit currently produce building data?</p> <p>a) If yes, please distinguish whether the data produced by your business unit includes private and residential buildings, civic facilities and other points of interest, or both.</p> <p>b) If yes, please describe the process for producing building data.</p>
<p>3. Has your business unit received legislative or policy directives to utilize, generate, or maintain geospatial building footprint data during operations?</p> <p>a) Please state the act, policy, or directive. Examples could include Department of Natural Resources Act, Resources and Technical Surveys Act, Emergency Management Act, etc.</p>
<p>4. Does your business unit maintain agreements with other provincial/territorial or federal groups to provide or contribute to a business process that utilizes, generates, or maintains geospatial building footprint data? If your business unit participates in data sharing but it has not been formalized, please state this.</p> <p>a) If yes, please state the nature and origin of the service agreement.</p>
<p>5. Does your business unit maintain agreements with municipalities to provide or contribute to a business process that utilizes, generates, or maintains geospatial building footprint data? If your business unit participates in data sharing but it has not been formalized, please state this.</p> <p>a) If yes, please state the nature and origin of the service agreement.</p>
<p>6. Does your business unit license commercially available data to provide or contribute to a business process that utilizes, generates, or maintains geospatial building footprint data?</p> <p>a) If yes, please state the vendor, type of license, data received, and how the data is used.</p>

The survey resulted in valuable input from several stakeholders. This is summarized in **Table 22**. Stakeholder input specific to the usage of the DMTI buildings dataset is also provided in **Section 3.2.1.4**.

Table 22 – Results of Stakeholder Input

Stakeholder Respondent	Key Information
National Defence (ND)	<p>Identified requirements for geospatial building information include building dimensions, number of occupants, and usage information (ex. commercial)</p> <p>Data is produced for select buildings identified as critical infrastructure relevant to ND</p> <p>Geospatial information is a requirement for operational planning Does not maintain data sharing agreements with provinces, territories or municipalities.</p>
Public Services and Procurement and Accessibility Canada	<p>Identified requirements for property information (usage and occupancy), building dimensions, building condition values, tenancy, ownership for buildings related to Federal custodian.</p> <p>Produces geospatial building information for the Treasury Board Director of Federal Real Property based on directives from the Real Property Management Policy and the Policy of Information Management</p> <p>Information is shared with other groups using service agreements and memorandums of understanding.</p> <p>Data sharing with municipal partners takes place to meet operational requirements.</p> <p>Data is licensed from a number of commercial (ex. Google, Esri) and public (federal, provincial, municipal) sources for base mapping and operational needs</p>
Environment and Climate Change Canada Economic Analysis Directorate	<p>Requires province totals of buildings, broken down by energy use by energy source.</p> <p>Additional information is produced through projections with metrics including energy usage and floor space.</p>
NRCan Buildings and Industry Division	<p>Is committed to supporting provinces and territories in benchmarking energy usage, building characteristics.</p> <p>Desired attributes are building coordinates, floor space, energy use intensities, ENERGY STAR score, fuel type, postal code, address</p> <p>Building and energy information is compiled through a benchmarking tool</p> <p>Highlighted the Building Registry (Statistics Canada) as a potential source of future information</p>
Public Safety Canada	<p>Building information is used to analyze infrastructure for exercising, planning, and managing emergencies.</p> <p>Desired attributes are critical infrastructure sector, business registry, owner, population, revenue, demographics, service providers (utilities), and points of contact.</p> <p>Focus is points of interest but residential information is desirable.</p> <p>Internal directives and SOPs identify the need for infrastructure data</p>
Statistics Canada	<p>Building information is desired as an advancement of the Canada spatial data infrastructure. Statistics Canada has indicated multiple desired uses for building footprint information including:</p>

Stakeholder Respondent	Key Information
	<ul style="list-style-type: none"> • Validate administrative files including the Buildings Registry • Expand and validate the National Roads Network • Alignment of administrative and statistics boundary • Field data collection activities <p>Statistics Canada currently collects information through the Building Register, which includes GPS coordinates for each building. Statistics Canada reported that an internal geocoding process as well as its Spatial Data Infrastructure are used to assign building geocodes. These efforts are in preparation for Census 2021. While the use of this information is internal, there is an ongoing review to determine if information can be shared with partners. Statistics Canada cited Statistics Canada Open Data License, the Statistics Act, and the Data Strategy Roadmap for the Public Service as policy drivers.</p> <p>Current administrative files shared with Elections Canada through the National Geographic Database. The current data is reported as being able to meet operational needs but that building footprints could improve performance. The current data includes information from Canada Post, Telus, Hydro, and Bell.</p>

4.5 Conclusions

Evident from the overview of federal stakeholders is that there are a robust range of federal departments and agencies that can support the creation, use, and management of geospatial building information.

As was reported during the Feasibility Study (2015), the needs for geospatial building information across the various stakeholders can generally be classified as operational or analytical. Review of stakeholders also found that some are already generating building information. While some information requirements are common to all stakeholders, each potential user or contributor of building information has unique requirements as well. In most cases, research suggests that while geospatial building information is a key need, the associated attribute data is generally already being collected by each agency. Therefore, the review of roles and responsibilities suggests that the creation of a federal layer will focus on an integration of various attribute datasets with the common needs for geospatial building footprints. This will be explored in further detail during the SWOT analysis.

While there are a range of users and contributors, most stakeholders are limited in the scope of potential involvement in the initiative with the exceptions of NRCan and Statistics Canada. During the review, NRCan and Statistics Canada stand out as being positioned to lead the development of building information that meets the needs of the group.

Of all stakeholders, NRCan has the most directives for geomatics leadership as well as an established history in leading geospatial initiatives within the federal public service. The Feasibility Study (2015) is a useful example of the long standing relationship between NRCan and Statistics Canada as well as the shared interest in geospatial building information. Here, it was expressed that while a large number of stakeholders would be engaged in developing geospatial building information, NRCan was best positioned to provide the necessary leadership role. This matches the findings of the overview of roles and responsibilities. The Feasibility Study suggests that Statistics Canada’s leading role would be based on the significant amount of resources at its disposal for being an implementation, maintenance, and dissemination service provider. In spite of these synergies, the Policy Review identified a potential roadblock to collaboration due to directives provided by the Statistics Act to Statistics Canada. Some of the information necessary for geospatial building information is held by Statistics Canada, but this information has usage limitations. These directives require further investigate to determine how Statistics Canada

can be used (in order to avoid duplicate collection by NRCan). Overall, Statistics Canada has significant amounts of building information that should not be overlooked if usage is permitted.

4.6 Continual Monitoring

Neither NRCan's context or its stakeholders are static. The roles and responsibilities, policies, and stakeholder needs are likely to change over time – sometimes predictably, other times less so. To complete a federal buildings layer, a significant amount of coordination and communication will be required. Recognizing this, it is important that the consideration of context and stakeholders is carried out thoroughly and comprehensively and re-visited on a regular basis. It is recommended that once an approach to creating a federal buildings layer is established and confirmed by all relevant stakeholders that NRCan develop a communications strategy. This will ensure that changes in organizational context are accounted for within the project.

5. Benchmark with International Comparators

Not unlike Canada, many federal governments are driving the digital transformation of government services and operations. Increasingly, data is at the root of service delivery and planning activities, and the federal jurisdiction is no exception. As recognized by recommendations from the Federal Geospatial Platform, the science of “where” captured by geospatial data is at the root of understanding socioeconomics and resilience in Canada. To understand and compare how these realities translate to other federal jurisdictions, a review of international comparators was completed to contextualize the Environmental Scan.

5.1 United States

Within the United States, the federal geospatial practice is still emerging. Currently, the United States is in the progress of modernizing and updating its geospatial practices through the development of the National Spatial Data Infrastructure. The NSDI is still evolving – current objectives include developing interoperability through reference architecture, establishment of the geospatial platform, and promoting the use of multiagency acquisition vehicles. The NSDI is currently being driven by an advancement strategy that recognizes the changes to technology since the NSDI was first formed in the 1990s after federal directives to use geospatial information. Since it was created, federal agencies have made significant contributions to the usage of geospatial information. Recently, the NSDI has focused on transitioning from discovering data assets and building management strategies to developing shared services.

The NSDI includes a data catalog known as the Data.Gov GeoPlatform. This platform is very similar to the FGP P/T Inventory queries provided by NRCan in that it aggregates many datasets provided by federal agencies.

With respect to building footprints, there are a number of building footprint datasets available through the GeoPlatform. All datasets are provided by local governments, with the exception of some regional groupings of municipalities (ex. counties). If there are state or federal data assets, they do not appear to be published within the GeoPlatform (based on preliminary research within the scope of the Environmental Scan). Research indicated three examples of geospatial building information produced commercially. Datasets with federal coverage have been created by Microsoft, Ecopia, and Pitney Bowes. See **Table 23**.

Table 23 – Summary of Observed Building Footprint Products with American Coverage

Commercial Data Source	Observations
Microsoft	<p>Microsoft released data (geographic boundaries only) for all building footprints to OpenStreetMap. The OpenStreetMap community is currently in the process of exploring and improving upon the data provided by Microsoft.</p> <p>The United States served as the area used to develop Microsoft’s algorithms. These algorithms were subsequently applied to Canada using the ODB and a partnership with Statistics Canada.</p> <p>It is not apparent whether this data has been adopted beyond Open Street Map (ex. at the local, state, or national levels).</p>
Ecopia	<p>Ecopia states that building footprints have been delineated for the United States using Digital Globe imagery, and that the product is currently available for order. The data is refreshed every six months.</p> <p>Ecopia does not indicate if the data is currently being used at the federal level, simply that it can be ordered. It does not state if building footprints have been paired with other services such as geocoded addressing.</p>
Pitney Bowes	<p>As previously explored, Pitney Bowes offers building information for the United States with attribution. It does not state how the data is created or if it has been adopted federally.</p>

Overall, the situations in Canada and the United States are very comparable. There are clear leaders in geomatics within the federal ministries, GIS is widely used, and there are clear directives to use and improve geospatial information. There are ongoing efforts to improve collaboration and to drive national scale initiatives. The current building information assets comprise a collection of datasets produce by local governments and larger agencies. Efforts are made to make data open and accessible, but datasets have not been integrated or made interoperable at the federal level. There are opportunities for developing national layers of information (including for building footprints), but the various stakeholders do not appear to be positioned to initiate data collection or adopt commercial solutions. Based on public information, the United States serves as the best example of Canada’s situation.

5.1.1 Hotspot Analysis – State of Virginia

Given the similarities between US and Canada in terms of progress towards a federal layer of geospatial building information, the US was investigated further through a review of open data sources. Overall, it was found that most states are comparable to Canadian provinces in that building footprints have not been delineated for the entire jurisdiction, but that municipal sources of data have been added to the respective state data catalogues. This represents an initial observation (research at the level of detail provided by the Environmental Scan was not performed).

Recognizing these observations, research was done to identify potential “hotspots” of building information to learn about potential drivers and lessons learned for provinces in Canada. During research, the State of Virginia emerged as the leading example of state-wide building information. The State of Virginia has gathered 4,221,205 building footprints. Features are not attributed beyond identifiers and geometry features as well as a field delineating municipality. A normalized schema was designed for fields like building height and stories, but this part of the schema has yet to be populated. See coverage as well as a sampling in **Figure 23 - Figure 24**.



Figure 23 – Coverage of Building Footprints in the State of Virginia

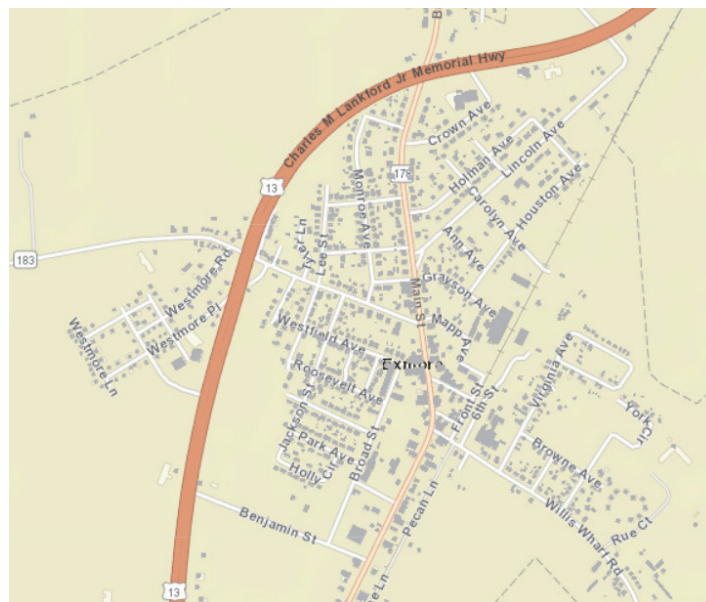


Figure 24 – Sampling of Building Footprints in the State of Virginia

The building information is created and maintained through a business process model similar to what is envisioned for Canada through the GeoFoundation Exchange (Esri Canada). The layer is assembled by the Virginia Geographic Information Network (VGIN), who coordinates the development and maintenance of building information by local governments who all contribute data. Data is developed by local governments and sent to VGIN, who run checks for quality and pare the various data schemes. The development of the building footprint data was cited as being in response to investments made in base mapping through digital orthophotography.

The VGIN is enabled by a decision by the Virginia Information Technologies Agency (VITA, an agency of the Commonwealth of Virginia established in 2003) to integrate its GIS services. VITA provides cybersecurity, IT infrastructure, and IT governance services on behalf of other state agencies. Several services were consolidated in 2006 to form the VGIN. The VGIN is designed to support both local and state agencies through GIS technical assistance, data assistance, and staff support. This service places a strong emphasis on emergency management, and includes a Public Safety Communications department that supports local 9-1-1 programs.

Examining lessons learned from Virginia, it is clear that the directives for GIS, emergency management, etc. of the VGIN are similar to the goals of NRCan and its stakeholders (albeit with a different scope). It can be observed that the organizational structure and business processes are very different from provinces in Canada, who do not generally provide GIS resources outside the scope of the provincial jurisdictions and program areas (with key exceptions such as the Territories and the Maritimes) to member municipalities. If NRCan wishes to further develop the GeoFoundation Exchange and a business process that includes provincial data aggregation, the VGIN and its building footprint information is a useful point of reference for how provinces drive the production of data and geospatial building information at the municipal level.

5.1.2 *Spatial Data Standards for Facilities, Infrastructure, and Environment*

The Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) are a series of standards for vector data, metadata, raster data, and data quality adopted by all agencies across the United States Department of Defense and its stakeholders (ex. US Army Corps of Engineers). Of note to the Environmental Scan, this family of standards provides logical data models for facilities. Adoption of these standards is mandated for members of the Department of Defense, and includes requirements for storage and change management. Access to the data model requires that users be registered as a Components Manager within the SDSFIE, meaning that the quantity and types of attributes in the data model could not be reported for the Environmental Scan. However, this serves as a useful example of a data model applicable to some NRCan stakeholders (ex. DND), and should be highlighted.

5.2 Australia

In Australia, the dissemination of authoritative geospatial information is performed by a Crown corporation known as the Public Sector Mapping Agency (PSMA). PSMA has similar directives to NRCan (including to advance the use of remote sensing, improve technology, and distribute information to various stakeholders), with distinction that it does not participate in open data initiatives (instead, datasets are licensed for a fee). PSMA is a commercial, for-profit company owned by the government of Australia.

PSMA has building footprint information for approximately 8.8 million buildings within Australia. Total coverage of Australia was achieved in 2018 (the total time to complete data collection was not stated). There are two products offered by PSMA:

1. 2-D Building Footprints. According to the Ecopia website, Ecopia provided its classification services to PSMA (the PSMA website simply states that the dataset was “commissioned by PSMA under commercial arrangements”). A training dataset or data schema could not be located.
2. GeoScape is a 3-D rendering of the built environment that was commissioned by PSMA. GeoScape uses three layers of information (buildings, vector based; surface cover, raster-based; and tree coverage, raster-based) to depict the environment in 3D. The product combines high-resolution satellite imagery (Digital Globe) with crowd sourcing and machine learning. Urban areas are captured using a 2 meter resolution while rural areas are captured using a 30 metre resolution. The 3D visualization is achieved using stereo-satellite imagery. The visualization of the data was rendered by Pitney Bowes, a global technology company. A summary of the information provided through GeoScape is provided in **Figure 25**. An example is provided within **Figure 26**.

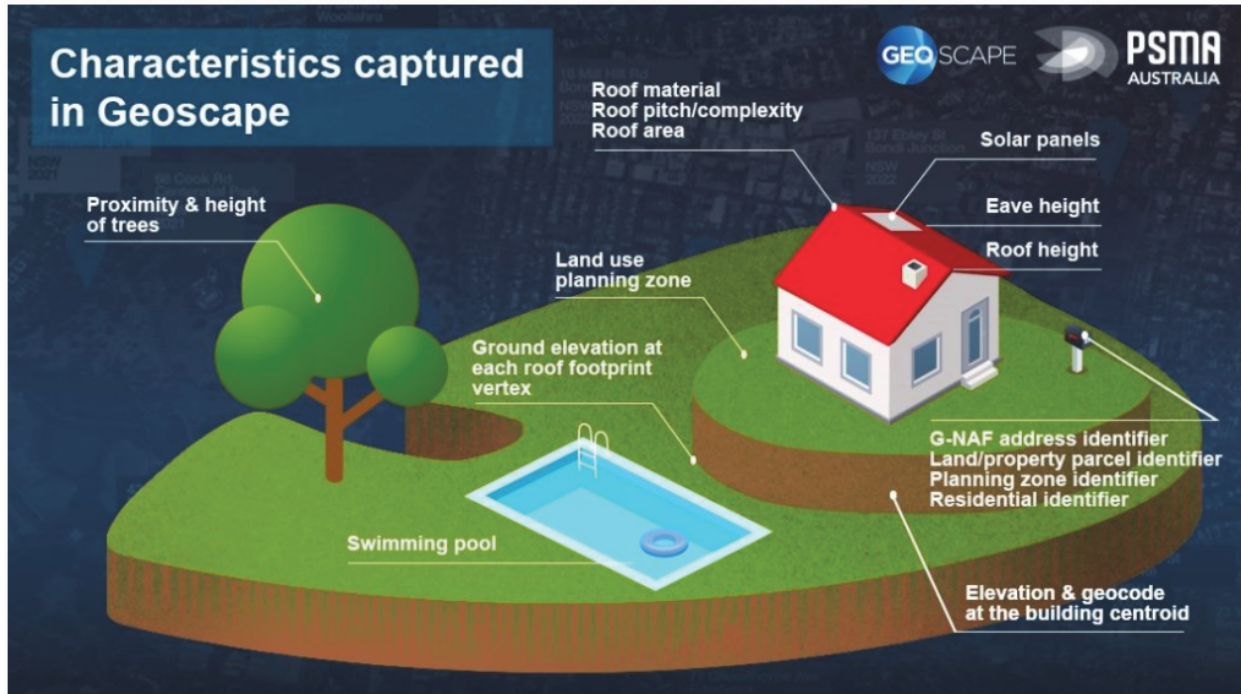


Figure 25 – Information Depicted by PSMA’s GeoScape Dataset



Figure 26 – Example of GeoScape Data

Evident from the review of Australia’s data products is that Australia is significantly ahead of Canada in progress for collecting building footprint information. This could in part be attributed to the organizational context of Australia, where the geomatics service provider for all jurisdictions is a for-profit company. This organizational could create efficiency by empowering unilateral decision making (as opposed to the approach taken within Canada, which is collaborative between various branches of government. PSMA’s for-profit directive is a strong indication that not only is the delineating of building footprints a valuable exercise for decision support and planning, but that it is also

economically defensible and a highly utilized product (however, PSMA did not disclose the government and commercial users of the data).

As well, Australia provides a useful point of comparison to Canada given its geography – whereas other countries with a federal layer (ex. New Zealand) have smaller coverage, Australia is more comparable to Canada. The rollout of Geoscape for Australia was approximately two years (not including enabling work conducted prior to the rollout of the first pilot areas).

5.3 Britain

Similar to the model taken by Australia, Britain's mapping services are performed by a government-owned organization known as Ordnance Survey (OS). This organization maintains a public sector mapping agreement that enables data sharing to all members of the public service in exchange for a single payment from the federal government. Conversely, businesses can obtain OS data through licensing. OS has stated that key drivers of the arrangement include emergency management, logistics, and public safety. Rather than contracting services, OS maintains its own resources for data collection including 300 surveyors and two aircrafts – staff are estimated to produce 10,000 updates to a Master Map database every day.

OS has mapped every building in Britain as part of its MasterMap Topography dataset (**Figure 27**). The dataset provides coverage for all of Great Britain, and is updated every 6 weeks. The dataset includes building heights, which are calculated using digital surface and terrain models. With a baseline of attributes collected for all features, OS is now starting to develop enriched content within urban areas to support emergency management and planning. This includes main points of access, routing options, and other information related to points of interest such as facilities and hospitals.

Though a data schema was not available, OS has indicated they follow schemas use the Open Geospatial Consortium and the World Wide Web Consortium (W3C). The MasterMap Topography dataset is sorted into themes of feature classes paired with key words that are designed to be queried.

Evident from the MasterMap Topography dataset is that once building footprints are delineated there are significant opportunities for data integration. Clear lessons learned that may be applied to Canada are the business processes and financing structures (ex. cost sharing) used to drive the creation and maintenance of data. The structure and financing provided to OS enables the continual improvement and collection of data through dedicated resources.



Figure 27 – Sampling of MasterMap Topography Data

5.4 Europe

Evident from results of scanning Britain is that collecting building information is an ongoing process. The European Commission aims to facilitate this process by providing data specifications for 34 spatial data themes through the INSPIRE Directive. INSPIRE (interoperability of spatial data sets and services) establish common data models for use by all members of the European Commissions with the objective of ensuring different data and services can be combined across the EU.

INSPIRE provides a data model for building footprints that serve as a useful example of how building data is defined internationally. Research of building footprint information in Britain could not establish whether the INSPIRE model is being used.

The INSPIRE model is a complex but comprehensive approach to defining spatial data. It organizes its specifications within 34 themes. In cases where a dataset falls within multiple themes (ex. an agricultural facilities falls within an agricultural theme and a structural theme), congruent options are provided for how to profile the data.

In the case of buildings, data models are provided for both 2D and 3D datasets. Each dataset has the same core profile of attributes. Here, stringent definitions for feature types, elevations, height, classification, external references, dimensions and geometry, and identifiers are provided. Core attributes are defined as 16 types – each type may have several attributes (for example, building height information is stored across 4 fields). The extended profiles can also add to these core attributes but providing additional fields. The extended model provides additional opportunities to capture building properties such as feature type, construction, installation, units, and other detailed physical descriptions.

INSPIRE has stated that the provided data models are intended as an illustrative profile, and recognize that it may only be used for certain parts or sections.

To assist in the adoption and usage of the INSPIRE data model, INSPIRE has developed a series of usage cases that highlight who the data model for buildings will be used in the future. Use cases include scenarios, business process maps, and narratives that integrate the usage of its data model. Use cases also include population assessment, urban area mapping, land management, safety, risk assessment, and natural disasters. The scenarios are hypothetical and don't provide indication of the level of buy-in received to adopt the model.

5.5 New Zealand

Land Information New Zealand (LINZ) is responsible for managing land titles, surveys, topographic information, and other geomatics services that support government decision making in New Zealand. LINZ is currently a key example of an international comparator with a complete and utilized federal layer of geospatial building information.

The classification of building footprints has been ongoing in New Zealand since a successful pilot project completed in 2016. At present most major settlement areas have been classified, and additional collection and validation will be ongoing. The target for 2019 is to have collected 95% of all buildings within New Zealand. See an example of a classified area in **Figure 28**.

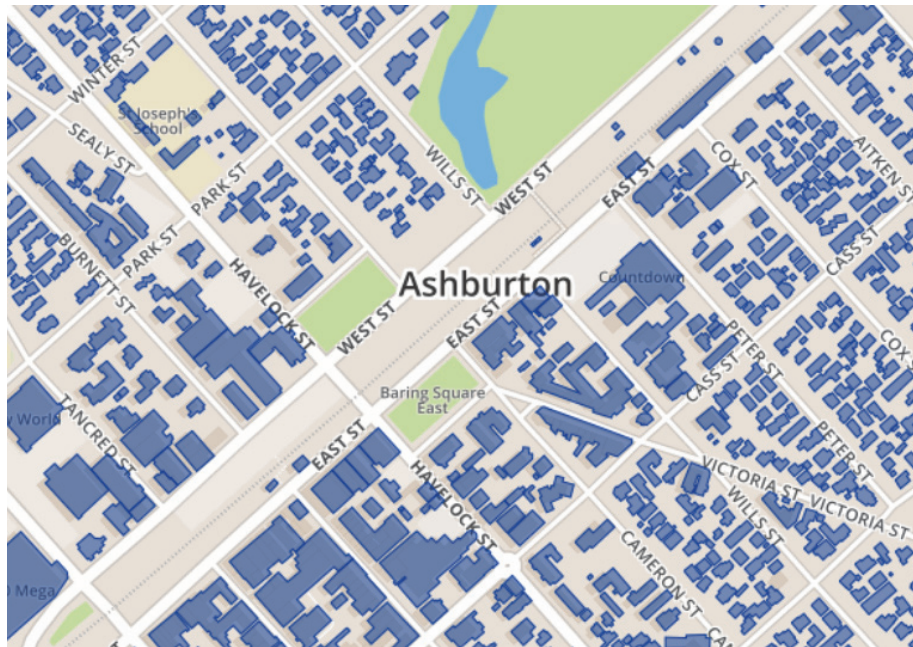


Figure 28 – Example of NZ Building Outlines

To capture building information, LINZ classifies satellite imagery. The imagery sources varies between settlement area, and current imagery has been identified as a constraint controlling the rollout of building information in 2019 (buildings are being added to the current dataset as new imagery becomes available). According to the pilot dataset, the imagery is 50cm pixel resolution in most urban settlement areas. Rural air photos from recent flyovers are also being used in certain areas. Resolutions range from 0.5 to 0.1m.

Once buildings are classified, LINZ will also attribute the building footprint. Highlights of this process include:

- Buildings are tracked with unique identifiers
- Building names and uses for points of interest were integrated from a previous topographic dataset (remaining gaps will be populated over time).
- Location is classified using various geographic boundaries
- Source capture method is documented by year, platform, and resolution
- Over time, buildings will be captured using multiple imagery sources. This will be used to establish the date the building was first visible as well as if it is no longer visible. This is enabled by a layer of information delineating remote sensing surveys by year of collection
- Proximity to features including watercourses is classified
- Building footprints are quality checked using the Open Geospatial Consortium standards for feature representation

The LINZ dataset does not include attributes identified as being of interest to NRCan's stakeholders including building height, energy usage, etc. See the data model summarized in **Figure 29**. Evident from the figure is that rather than adopt an international standard, New Zealand has developed a simplified model.

The LINZ dataset is endorsed by the government and supported by a successful pilot project and other initiatives within LINZ. LINZ has cited a successful pilot project as one of the drivers for a national layer. In 2016, three regions of New Zealand were classified. Once the pilot had been distributed, users were surveyed to determine overall satisfaction. Here, it was found that the vast majority of users agreed it would be useful data for their particular organization, that it was better than existing data, fit the needs of the organization, and offered significant data integration opportunities. Furthermore, the data from the pilot was used during an emergency response to an earthquake, the planning of large installations of broadband infrastructure, as well as the assessment of property

markets and valuations. These successes lead to a firm commitment by LINZ to continue providing and improving the information.

The building outlines dataset is being completed in conjunction with other LINZ initiatives. LINZ has indicated that the development of a national elevation dataset is ongoing, which could support further attribution such as building height. The elevation dataset is being collected through local governments in collaboration with LINZ. LINZ has cited flood risk mapping, climate change preparedness and resource management as the drivers of the elevation dataset.

LINZ is supported by a number of directives and strategies that enabled the creation of building outlines. This includes a Location Strategy, a Cadastral strategy, a Positioning Strategy, a Topographic Strategy, and a 10-Year Vision. The key challenges LINZ is aiming to address include hydrology, resilience and climate change, and management of urban areas. These challenges closely align with the needs identified by NRCan stakeholders.

Overall, New Zealand offers a useful point of comparison as a country that has materialized a building footprint layer that is actively used by the public service. While there are several important lessons that can be learned, they should be underscored by New Zealand's size – it is much smaller than Canadian and therefore requires a smaller level of effort. As well, its immediate proximity to areas of natural disasters could explain why New Zealand is ahead of Canada's progress.

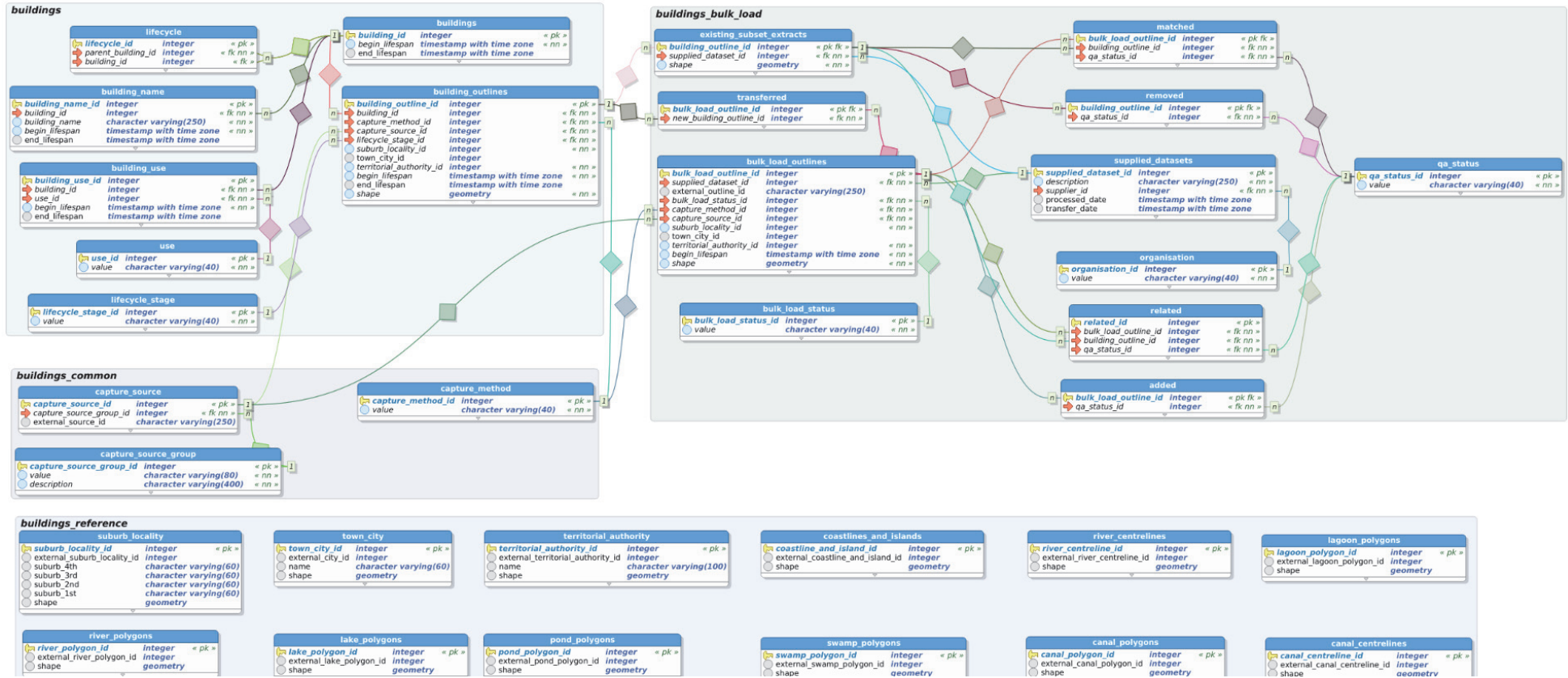


Figure 29 – LINZ Building Footprint Data Dictionary

6. Strengths, Weaknesses, Opportunities, and Threats Analysis

A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis provides a critical and holistic assessment of the findings of the Environmental Scan. SWOT will provide NRCan with a range of perspectives and observations that can be weighed by NRCan to support decision making and the development of a strategy to materialize a federal layer of geospatial building information.

6.1 Strengths

6.1.1 *Commercial Data*

The Environmental Scan identified several sources of commercially available geospatial building information. The main sources of information at present are:

- Ecopia
- DMTI Spatial Inc.

Teranet is also an emerging source of geospatial building information with federal coverage.

While a greater number of vendors would be desirable to support any commercial tendering, the availability of commercial solutions within Canada should be considered a strength that can be leveraged to address gaps in the public record. Given the state of current technology, only one vendor is required to establish national coverage.

6.1.2 *Public Data*

While the current public data does not provide 100% coverage with the detail and attribution desired by NRCan, there is a significant amount of public data available. This should be considered a strength of the current environment and provides an excellent starting point for NRCan. Current sources of information within the public service include:

- Open Database of Buildings
- Automatically Extracted Buildings
- GeoFoundation Exchange
- Building Canada 2020
- Statistics Canada Buildings Registry
- Microsoft Canadian Building Footprints
- Municipalities

Each of these information sources offers varying coverages and trade-offs that are explored elsewhere in the report. Overall, the presence of these information sources should be considered a strength and signify milestones that NRCan can build upon to materialize a national layer of information. Overall, it is clear that there is a greater number of data sources publicly than commercially (albeit with varying levels of coverage). While the above datasets were highlighted, there are also important data assets within certain processes that could lead to opportunities for savings when seeking commercial solutions.

6.1.3 Availability of Aerial Imagery

In places where geospatial building information is not currently available, aerial imagery is available through NRCan's Long Term Satellite Data Record (as well as through commercial options such as Digital Globe). If geospatial building information cannot be located, NRCan has the data required to begin classifying and generating building footprints. The availability of aerial imagery as a supplement to geospatial building information should be considered strength and improves the starting point for NRCan to materialize a federal layer. However, regular imagery is not suitable for the extraction of buildings performed by NRCan, which requires LiDAR data or optical imagery (two types of information with less availability).

6.1.4 Data Integration

Once geospatial building footprints are created, there are significant opportunities for data integration using address points and other methods. This can be achieved by leveraging data offered by Canada Post, Statistics Canada, Elections Canada, Environics, DMTI Spatial, and other sources. The availability of attribute information (with some exceptions) is a key strength of the current environment will support NRCan's desire to develop an "intelligent" layer of information.

6.2 Weaknesses

6.2.1 Attribute Data

While there are a few building footprint datasets and data collection methods available to NRCan, there is currently very limited attribute information aside from the datasets (ex. Buildings Register) maintained internally in the various federal departments. Desired attributes such as building height and number of floors are not readily available in the current data. This presents a weakness within the availability of geospatial building information.

To obtain the desired attribute information, a significant integration process between different sources would be required. The integration process would have to be organized in a manner that could be reproduced to ensure the master dataset is well maintained. While NRCan has expressed geospatial building footprints are desired at a minimum, further research is required to determine the best approach to address gaps in attribute information (such as the feasibility of LiDAR or stereo orthophotography). If the information gaps cannot be addressed at present, a re-evaluation of who would benefit from geospatial building information with fewer attributes could be conducted (ex. which stakeholders are impacted if building height is not feasible).

6.2.2 Creative Commons License

The Creative Commons License has been previously exploring during the review of data produced by Microsoft and Open Street Map (**Section 3.3.1.5 - 3.3.1.6**). As previously stated, the Creative Commons License is not congruent with the needs of NRCan, who aim to materialize geospatial building information and distribute authoritative data internally to stakeholders (as well as potentially to the general public through an Open Government Initiative). The requirement of the Creative Commons License to keep modified data under this license (for example, after a cleaning or integration process by NRCan) means that an Open Government license for the data is not possible. While the initiatives that fall under this license (Microsoft Building Footprints and Building Canada 2020) are important initiatives with large data captures of geospatial building information, they do not meet the requirements of NRCan or the objectives of the Environmental Scan.

6.2.3 *DMTI CanMap Suite*

Within the Canadian jurisdiction, there were a few key commercial vendors who could support a large data capture of geospatial building information using remote sensing classifications. The Environmental Scan identified that while there are several classification services available, DMTI is the stand-out source of building attribute information.

Currently, DMTI classifies and attributes the data produced by Ecopia using the datasets within the CanMap suite. Federal users of the DMTI CanMap suite have reported its advantageous as well as its limitations. Given that the Environmental Scan would seek to improve on the existing data offerings, the current limitations of building information should be recognized. Overall, it can be observed that while DMTI spatial data is robust, it is not treated as robust by users due to directives for sourcing data closest to the source as well as some observed quality issues (both in geography and attribute data). This should remain a consideration for NRCan.

Alternatives to attribution of building footprints with DMTI could include collaborations with Statistics Canada, Canada Post, and Environics Analytics.

6.2.4 *Municipal Data*

The Open Database of Buildings demonstrates that the majority of building information is currently produced by municipalities. While this is to be expected, this should be considered a weakness of the available data. While municipal data can offer advantages (ex. accuracy, authoritative, quality, and use of local knowledge), scaling municipal data across the country could prove challenging (given the number of datasets and attributes used). Municipal data does not provide as many advantageous as datasets with large coverage that would be easier for NRCan to scale. As well, reliance on municipal data could make updates challenging – many of the municipal datasets are “one-time” productions based on a particular initiative or “fly-over” over the settlement. Most municipal datasets will not meet the attribute requirements of NRCan’s stakeholders. The Open Database of Buildings demonstrates that the available information can be consolidated, but does not provide a mechanism for maintenance without contributions from community users (Open Street Map). This is in direct contrast to the mechanisms provided by the GeoFoundation Exchange (**Section 6.3.2**).

This weakness could be balanced by opportunities presented by data models that would support aggregation of municipal data. This is explored within **Section 6.3.1**. While data models still rely on municipalities populate the information, they can provide a common framework.

6.2.5 *Delegation of Authority*

As explored elsewhere in the SWOT analysis, the availability of building information provincially and municipally presents opportunities as well as challenges. Where possible, existing datasets and initiatives should be leveraged to the benefit of NRCan. Unfortunately, the gaps in data within these jurisdictions limit the viability of such an approach.

NRCan has policy directives that mandate the distribution of mapping by NRCan as well as collaboration with provinces, territories and municipalities. Unfortunately, these directives do not provide NRCan with the authority to delegate mapping requirements to provinces and municipalities. Without a mechanism to download responsibilities to provinces or municipalities, NRCan is reliant on the willingness of other jurisdictions to participate and share data. While municipalities regularly collect information, most provinces are not aggregating the information for broader purposes (based on public information).

6.2.6 Building Registry

The Statistics Canada Building Registry is a rich source of building information that meets many of the attribute requirements for NRCan's stakeholders. The Building Registry could be integrated with building footprint information to produce a fully attributed dataset. Unfortunately, directives to Statistics Canada through the Statistics Act limit the dissemination of the information. Here, the Building Registry is limited to the use of statistics unless specifically indicated. If the Buildings Registry could not be used, the collection of data could be duplicated between NRCan and Statistics Canada.

6.2.7 Open Government Data Attributes

While a significant amount of geospatial building information is readily available, there is limited population of the attribute information. While data models offered by the Open Database of Buildings or Esri's Canadian Municipal Data Model are available and recognized, most open datasets are seldom populated.

Typically, it is true the open data sources are condensed or simplified versions of datasets maintained internally by municipalities. While open data is readily available to NRCan, review of the datasets observed that the available attributes are quite minimal and don't necessarily support NRCan's objective of developing an "intelligent" layer with attribute information. It is possible that open data is also held with more robust information internally (to be highlighted by the SWOT assessment).

The weakness of reviewing open data is that it does not capture the information held internally by municipalities. More robust attribute information may be internal only. The GeoFoundation Exchange (**Section 6.3.2**) provides a robust attribute data schema that could be an opportunity to address this weakness, although it is not widely used to its full extent yet.

6.3 Opportunities

6.3.1 Data Models

Based on the Environmental Scan, there are a few available data models that have national presence within Canada already for geospatial building information. These include Esri's Canadian Municipal Data Model and the Open Street Map data model used to collect building information. The Esri model is well established, while the OSM model is still an emerging template for data collection. While research indicates that many of the attributes are typically not being populated, each provides a potential framework that NRCan may use to facilitate data collection. Depending on the data integration processes that is established to maintain a federal dataset of geospatial building information (ex. aggregating data compiled at the municipal and provincial levels), adopting a common format may be required to unify various data sources. Leveraging an existing/accepted model (ex. Esri's) may present the best opportunity for maintaining geospatial building information. The best example of success in this approach is the GeoFoundation Exchange (**Section 6.3.2**).

6.3.1.1 Using a Data Model to Manage Stakeholder Requirements

Overall, it can be observed that a reliance on open data is not practical for those executing the directives of the Emergency Management Act. There is a need for comprehensive and authoritative data, as well as data with a high level of detail. These needs may not align objectives and data models of open formats such as the open database of buildings. The usage of building information for emergency management will differ drastically from other potential uses identified by stakeholders.

Based on this, it may be logical to establish secure related tables that could be linked to public building footprint information. These tables would not be made public, but would provide the information needed to support emergency management. This approach could address the needs of various stakeholders as well as provide opportunities to use government information with usage limitations (ex. Statistics Canada, **Section 4.3.4**).

In the reality of global warming, and the increase frequency and severity of storms related events, the need for better planning for emergencies is becoming more apparent and becoming a data requirement at municipal, provincial and federal levels.

6.3.2 GeoFoundation Exchange

The GeoFoundation Exchange (GFX) is an excellent “proof-of-concept” of the data integration opportunities available to NRCan through provincial and municipal sources. While the current geospatial building information is comparable to the Open Database of Buildings, the GFX goes further by provide frequent and automated update, aggregation, and quality assurance mechanisms for maintaining geospatial building information. To maintain a layer with the coverage desired by NRCan, the aggregation of many data sources requires rigid frameworks for upholding data quality and coverage. The GFX is the best example of this requirement, and is a key opportunity for NRCan if an aggregated approach to materializing a federal layer is taken.

In addition to the business and aggregation processes the GFX enables, it also provide a comprehensive data model that meets the most requirements for attribute data identified by NRCan stakeholders (with some exceptions such as contact information and occupancy numbers). Given the number of contributors to the GFX at present and the wide usage of the Esri Canada Municipal Data Model, the attributes provided by the GFX and the current usage of these fields by GFX contributors should be examined for further opportunities for a national data model.

6.3.3 Cost Sharing Initiatives

Evident from the Environmental Scan is that geospatial building information raises considerations at both the provincial and municipal levels. Recognizing this, data collection could be coordinated as a collaborative effort by NRCan. One successful example of this Nova Scotia, where GeoNOVA has entered cost sharing initiatives with the municipalities it collects data for.

Cost sharing is a common practice in some municipal jurisdictions for other data collection activities. As an example, many upper and lower tier municipalities as well as County and Conservation Bodies have been employing cost sharing initiatives and sharing agreements for rural and low population regions to build data and collect imagery. Another example applicable to the Environmental Scan is provincial parcel fabrics – for instance, municipalities will typically provide updates to the provincial jurisdiction (ex. MPAC Ontario).

6.3.4 Leadership Directives

The overview of roles and responsibilities establishes NRCan as a clear leader in geomatics within the federal public service. NRCan has directives to provide mapping, data collection, and technology improvements to support its services as well as those of its stakeholders. Should NRCan proceed with the development of a federal layer, it will be well supported by policy directives. Directives for collaboration, development of technical capabilities, and expanding the use of technology create opportunities for NRCan to pursue the federal layer of buildings.

6.3.5 Data Collection Directives

The analysis of stakeholder requirements establish that the greater number of requirements for geospatial building information are attributable to security, public health and safety, and resiliency. The stakeholder analysis observed

that many of the stakeholders with an identified operational or analytical requirement for geospatial building information (ex. Public Safety Canada) may not have the resources required to produce the geospatial building information themselves. This disparity establishes further direction for service providers like NRCan and Statistics Canada, both who have received directives to provide broader support to the federal government within their areas of expertise and jurisdiction (ex. technical surveys, statistics).

The directives for security, public health and safety, and resiliency are similar to those in jurisdictions with completed geospatial building information. Notable examples from the review of international comparators include New Zealand and Britain. In each case, geospatial building information was driven by needs related to emergency management. New Zealand reported the use of its pilot data during response to a natural disaster. Highlighting the existing directives and similarities to other jurisdictions could drive the development of business cases by NRCan.

6.3.6 Statistics Canada

The expertise and resources of Statistics Canada should be considered a key opportunity for collaboration to actualize a federal layer of geospatial building information. This is well affirmed by the 2015 Feasibility Study, which identifies Statistics Canada as a key contributor under the leadership of NRCan. Here, it was stated that while NRCan is best positioned to provide leadership within the initiative, Statistics Canada's significant resources are well matched to the needs for data validation and maintenance.

Once a complete layer of building information is materialized, Statistics Canada datasets offer significant opportunities for integration.

6.3.7 Open Government

While the current state of open government data has been highlighted for its contributions to the ODB as well as the current gaps in coverages, open government initiatives should continue to be monitored for further opportunities. The overview of each province/territory establishes that there is significant room for improvement within the current open government initiatives. This should be understood as a future opportunity for geospatial building information.

6.4 Threats

6.4.1 Provinces and Territories

The Environmental Scan found that outside of hotspots in the Maritimes and Territories (as well as Manitoba), there are no examples of geospatial building information with total provincial coverage that are publicly available. It is recommended that NRCan verify these findings through internal consultations to verify the presence of any datasets not made public.

The ODB and the GeFoundation Exchange demonstrate that the vast majority of geospatial building information is currently produced at the municipal level. Provinces/territories therefore serve as the logical jurisdiction for scaling the current information to a wider coverage. In spite of this, most do not appear to have done so at present. The desired approach to scaling data is currently only being performed by the GeoFoundation Exchange (Esri with NRCan sponsorship, **Figure 30**).

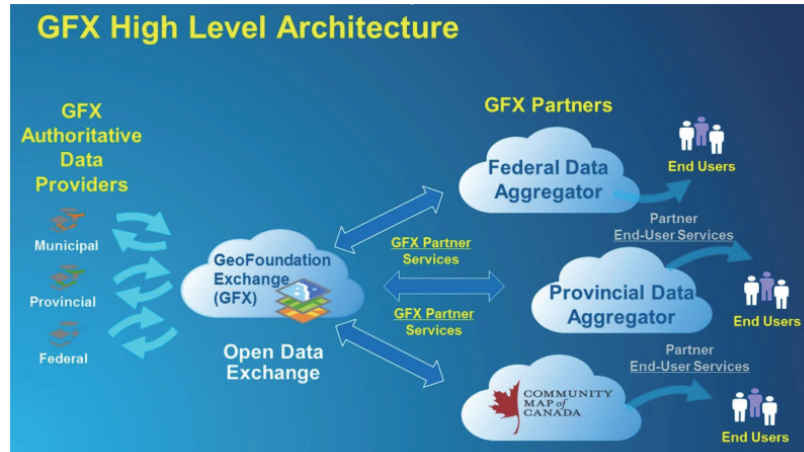


Figure 30 – Provinces/Territories Contribute to the GeoFoundation Exchange by Aggregating Data⁷

Evident from **Figure 30** is that many approaches to data sharing and aggregation are reliant on provincial input. Based on the Environmental Scan, most provinces are not aggregating building footprint information from the municipalities. A lack of provincial contributions could pose a threat to NRCan depending on the approach to data collection taken.

6.4.2 Concurrent Internal Initiatives

The Environmental Scan found that there are a number of different initiatives to collect geospatial building information that are currently ongoing. This is logical to expect given the size of the federal government as well as the variety of different demands for this information. However, a duplication of effort and “silos” of different departments with different objectives could present a threat to the successful materialization of the federal dataset. To achieve this, the status of the current initiatives and their potential contribution to a federal dataset should be clearly understood. See **Table 24**.

⁷ Esri Canada, 2016. *The GeoFoundation Exchange – Modernizing Canada’s Digital Infrastructure*. Accessed via https://esri.ca/sites/default/files/pdf/GFXExecutiveBriefing_Final_May2016.pdf

Table 24 – Summary of Concurrent Geospatial Building Information Initiatives

Initiative	Status	Observations
NRCan Environmental Scan	NRCan's is currently investigating the availability of geospatial building information both internally and externally before determining the approach to materializing the layer.	Recognizing the complexity and range of options for collecting geospatial building information, NRCan is beginning its efforts to materialize a layer by studying data availability and documenting the needs and contributions of a variety of stakeholders. This is an excellent first step that could work to find alignment within the various initiatives.
Automatically Extracted Buildings	NRCan collaborates with provincial sources of LiDAR and optical imagery to extract building footprints and heights using classification algorithms.	This initiative distinguishes itself from other concurrent initiatives in that it is the only initiative to extract building heights from three dimensional data. Overall, this initiative is limited in scope when compared to Microsoft due to the reliance on available LiDAR data. This initiative meets more data requirements for emergency planning such as building height, and has been observed to be more accurate than the Microsoft classification in some instances.
Open Database of Buildings	Statistics Canada and NRCan have successfully compiled an open database of buildings using municipal datasets from across Canada. The initiative has collected all the available open information and there are gaps in coverage remaining.	<p>This is widely regarded as the first successful milestone and a significant measure of progress towards creating a federal layer.</p> <p>While a significant milestone, NRCan must now determine how to build on the ODB. Given the large number of inputs, licensing and maintaining the datasets of many municipalities could prove challenge. As well, addressing gaps in federal coverage would require approach to data collection that may not match those used by the contributing municipalities. While the use of the ODB is logical given that it maximizes the use of existing information, a commitment to the ODB approach presents challenges to complete a federal layer.</p>
Microsoft	Microsoft and Statistics Canada used remote sensing and machine learning algorithms to delineate building footprints across Canada.	<p>While the classification exercise completed by Microsoft demonstrate the "proof-of-concept" of delineating buildings across Canada, it also presents a challenge. This dataset overlaps with other data collection efforts (ex. ODB), meaning that Statistics Canada must determine how to integrate these two datasets.</p> <p>The current partnership with Microsoft is based on principles of open data and open collaboration. While a valuable undertaking, it could present challenges for maintaining the layer in the future. Because Microsoft is not bound to provide its classification services and Statistics Canada does not own the current dataset. The Creative Commons license for this data means that NRCan and Statistics Canada cannot distribute the data authoritatively, a strong limitation.</p>
Open Street Map	The Data Integration and Exploration Lab has initiated the Building Canada 2020 initiative with Open Street Map to collect information outside the coverage	While Open Street Map provides an excellent opportunity to address data gaps, its congruency with other data sources (ex. Microsoft) is limited. The Creative Commons license for this data means that NRCan and Statistics Canada cannot distribute the data authoritatively, a strong limitation.

Initiative	Status	Observations
	of the ODB as well as to collect attributes for buildings within the ODB.	
Buildings Register	Statistics Canada maintains a Buildings Register to support census operations and socioeconomic analysis.	The Buildings Register is an internal dataset only used by Statistics Canada, and contains many attributes desired by NRCan and its stakeholders. To avoid duplicating information and effort, the usage of this dataset should be coordinated between NRCan and Statistics Canada unless there are clear limitations.

For a layer to materialize that addresses the wide range of stakeholder requirements, a coordinated effort is required. It is strongly recommended that NRCan work to align objectives and develop an interdepartmental plan for developing the layer. Here, a common goal, a plan for action, a communication strategy, and a road map of milestones with methodologies for each is recommended. At present, there are a number of concurrent initiatives with varying scopes and limitations. These initiatives should be better coordinated with clear linkages between each.

6.4.3 Open Source Data

Methods of data collection such as Open Street Map use open sourced data collection to build geospatial building information. While open source data offers a number of advantages including lower cost, transparency, and the leverage of existing knowledge systems, it also poses some threats to the success of the project. Primarily, the use of open source methodologies relies on contributors being incentivized to participate. While hotspots of active geomatics communities are expected to provide significant contributions in key areas, it is possible that gaps will remain. These gaps pose a threat to the completion of the project unless they are properly addressed.

The use of open source data appears advantageous for data collection but could present additional challenges in maintain the layer once it is created. Here, it could be assumed that an open source community will strive for continual improvement and would contribute to the maintenance of the data. However, without proper incentives this could lapse, therefore posing a threat to the project.

Finally, the use of open source data presents a commitment to open methodologies on the parts of NRCan and Statistics Canada. The Environmental Scan observed that there are significant opportunities for integration between internal datasets to build the required attribution. The use of open source methodologies could limit these applications if release of internal datasets is not desired.

6.4.4 Privacy

At present, research has not identified any major challenges to geospatial building information due to privacy concerns. However, this should be monitored as a potential threat to the project as NRCan begins to collect building attributes. While building footprints themselves may not pose privacy challenges, some of the attributes desired by NRCan and its stakeholders (ex. contact information) could raise such issues.

The extent of privacy issues could depend on whether or not NRCan makes geospatial building information publicly available. This could be addressed by managing building footprints and the attributed information separately, joining the two datasets through an index. In doing so, the public could receive a dataset with less information than the dataset with full attribution used internally.

6.4.5 Maintaining Data

As mentioned previously, there are several threats to the project related to the maintenance of data. While the Environmental Scan's focus is the availability of data, each data source should also be understood for its feasibility for maintenance. When selecting data sources, NRCan should consider the full lifecycle of the dataset and map the business process that will be required for data maintenance when the federal layer is materialized.

6.5 Summary and Conclusions

Evident from the SWOT analysis is that there are a wide range of considerations. The SWOT analysis is intended to introduce ideas that can be used by NRCan during its decision making processes. Ultimately, NRCan aims to establish a strategy and roadmap for the collection of building information. Based on the Environmental Scan, the jurisdictional overview and the SWOT assessment, there are a few main options that can be broadly characterized:

Option 1 – Aggregation of Public Information

Overview: The Open Database of Buildings or the GeoFoundation Exchange, when paired with the comprehensive provincial datasets provides a significant coverage of building footprint information. Once building footprints are collected, other public information can be integrated to provide intelligent building footprints (excluding desired attributes like building height).

Available Data Assets:

Open Database of Buildings
 Automatically Extracted Buildings
 GeoFoundation Exchange
 Manitoba Building Footprints (Department of Conservation)
 Northwest Territories Building Footprints (Government of Northwest Territories)
 Nova Scotia Building Footprints (GeoNOVA)
 Open Street Map (a source of information only – it cannot be redistributed or made authoritative due to the Creative Commons license).
 Microsoft (a source of information only – it cannot be redistributed or made authoritative due to the Creative Commons license).

Pros:

Maximizes the use of information as well as proximity to the source
 Potentially generates efficiency by building on previous efforts
 Fosters collaboration between governments
 Supported by directives to NRCan

Cons:

Coverage is limited in rural areas
 Gaps in coverage still need to be addressed through data capture methods
 No established business process to ensure contributors maintain data (GeoFoundation Exchange does not edit data, only flagging quality issues for the data owner)
 Data assets are of varying accuracy, age, update frequency
 Key datasets are strongly limited by the Creative Commons License.

External Factors:

Success could be dependent on provincial buy-in and aggregation
 Statistics Canada is also pursuing the usage of public datasets, in addition to its own internal Buildings Registry
 Open data initiatives offered by Microsoft and Open Street Map cannot be managed by NRCan, and have unknown drivers of decision making (ex. incentives to provide open information could change)
 Concurrent public initiatives do not have clearly defined roles and responsibilities
 Business processes for data maintenance and improvements reliant on external stakeholders

Option 2 – Commercial Data Capture

Overview:

NRCan commissions a large data capture through a commercial vendor. Once building footprints are delineated, the data can be integrated with other public (ex. civic addresses) and private (ex. Environics Analytics) sources of attribute data.

Available Data Assets:

- DMTI Spatial Inc.
- Ecopia

Pros:

- Commercial solutions available within Canada
- Commercial solutions (ex. DMTI spatial) are already used in some federal ministries
- All data will be congruent and up-to-date
- Same data integration opportunities with open data exist once footprints are collected
- Use of vendors establishes a clear mechanism for updating and maintaining the information
- Supported by directives to NRCan
- Could provide support to jurisdiction who don't have NRCan's technical resources

Cons:

- Creates duplication with other efforts (ex. provincial datasets, Statistics Canada initiatives)
- Could overlap with existing datasets
- Only one major option for classification services (Ecopia)
- Potentially more costly than Option 1
- Vendors place limitations on how data is publicized
- Current commercial solutions have limited options for building height information: LiDAR data is limited and expensive.

External Factors:

- Commercial solutions within Canada are still emerging (ex. Teranet)
- Requires coordination due to concurrent initiatives with Statistics Canada

6.5.1 Conclusions

During the Environmental Scan, the following objectives were accomplished:

- Current progress towards materializing a federal layer of geospatial building information was summarized
- Availability of public and commercial dataset within the scope of the Environmental Scan was established
- Roles, responsibilities, and policy directives applicable to geospatial building information were summarized
- International comparators to Canada were observed and lessons learned for Canada were drawn
- A SWOT assessment of the availability of data assets within the framework of Canada's stakeholders was completed
- Observations were categorized within two possible approaches to a data collection strategy

The Environmental Scan is an excellent step forward for NRCan towards its goal of materializing a federal layer of geospatial building information. The background established by this report will be a significant support to NRCan's decision making and data collection process by establishing context. Using the information within this report, NRCan's next steps are to strategize an approach to the materialization of a federal layer of geospatial building information.

This concludes the Federal Environmental Scan of Geospatial Building Data.

Appendix **A**

Table of Additional Datasets

Index	Source	Layer Title	Coverage	Number of Records	Type (Point/Polygon?)	Description	Relevant Attributes	Licensing	Access	Cost	Users	Available Formats	Spatial Reference	Date	URL	Metadata URL
1	ArcGIS Hub	Building	Peterborough, Ontario	31660	Polygon	The building layer is area features representing building structures captured from the most recent Air Photo.	Location, Status	Custom License	Open	None	Government	SHP, KML, CSV, FGDB	Not specified	24-Jan-18	Link	Link
2	ArcGIS Hub	Buildings	Cornwall, Ontario	31652	Polygon	City of Cornwall building footprints	Area, Elevation	Custom License	Open	None	Government	SHP, KML, CSV	Not specified	10-Feb-18	Link	Link
3	ArcGIS Hub	Building	Airdrie, Alberta	26253	Polygon	Building footprints polygon derived from Atlis Geomatics Inc. LiDAR data collection, flown August 1, 2015.	n/a	No license specified	Open	None	Government	SHP, KML, CSV	Not specified	25-Jul-17	Link	n/a
4	White Horse	Building Footprints	White Horse, Yukon	10756	Polygon	From 2011 aerial photo.	Name, Type, Number of Floors, Has Basement* *Fields are not populated but included within schema.	Unknown	Open	None	Government	SHP, DWG, KML	NAD 1983 UTM Zone 8N	2011	Link	n/a
5	ArcGIS Hub	DLC Buildings	District of Lake Country, British Columbia	8513	Polygon	Buildings gathered from 2014 imagery.	n/a	No license specified	Open	None	Government	SHP, KML, CSV	Not specified	08-Mar-19	Link	n/a
6	ArcGIS Hub	RDCO Buildings	Regional District of Okanagan, British Columbia	6795	Polygon	Buildings gathered from 2014 imagery.	n/a	No license specified	Open	None	Government	SHP, KML, CSV	Not specified	08-Mar-19	Link	Link
7	ArcGIS Hub	Buildings	Resort Municipality of Whistler, British Columbia	5449	Polygon	Building footprints originally digitized using the extent of visible rooftops from the 2014 orthoimagery, with edits made as recent as 2018.	Data Source, Perimeter	Open Government License	Open	None	Government	SHP, KML, CSV	Not specified	13-Nov-18	Link	Link
8	ArcGIS Hub	PCH Buildings	Peachland, British Columbia	2953	Polygon	Peachland Buildings gathered from 2014 Imagery	Area Elevation	No license specified	Open	None	Government	SHP, KML, CSV	Not specified	08-Mar-19	Link	Link

