Digital Twin Ontario

Geospatial Enterprise Ontario

Business Case and Data Standards

Revision 2025

©2025 Digital Twin Ontario

The information herein is confidential, draft and under development, and for authorized discussion purposes only. No part of it may be circulated, quoted, or reproduced for distribution without prior written approval.

This document is solely for working group use.

Digital Twin Ontario

DigitalTwinOntario.ca

info@digitaltwinontario.ca

Table of Contents

Infrastructure Ontario's GIS Data Inventory

Understanding what data exists, and who owns it

Overview:

Infrastructure Ontario has built a database of GIS* datasets (and sources) that describe the key pieces of data required for Ontario's digital twin initiative. The GIS Data Inventory (and its accompanying GIS For Ontario poster) outline what data sources the government should utilize when building and operating digital twins. The database details the datasets themselves and the data owners, along with key contacts (where available). While not every dataset is required for every potential digital twin, acquiring a comprehensive base layer of data in a common platform will allow for synergies between twins (and their users).

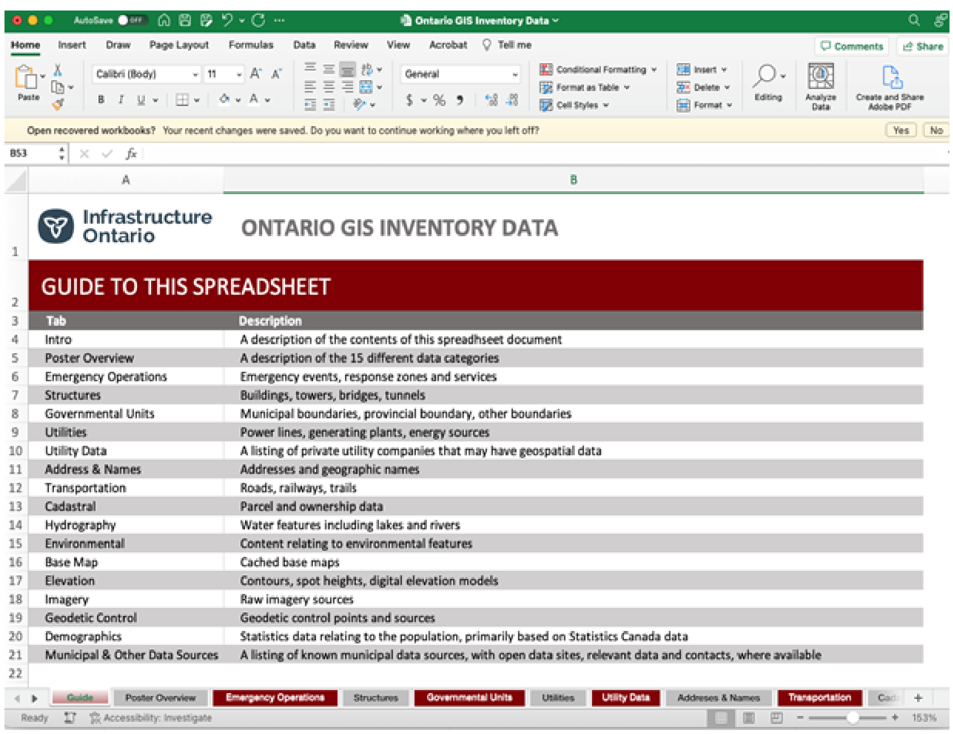
Analysis:

Data is the fuel that drives the value in digital twins. Without the required datasets, twins are unable to deliver their full value in optimizing design, mitigating utility conflicts, and reducing the cost of major infrastructure projects. While many of the datasets required to enable digital twins for Ontario are publicly available, most are vendor-locked at the asset-owner level. Namely, data related to existing utility infrastructure (water, gas, electric, telecom, etc.) remains locked, which poses a significant challenge. In order to harness the power of digital twins, this data must become unlocked, either via voluntary data sharing agreements, or legislative compulsions.

Intended Audience and Purpose:

The GIS data inventory and poster can be used as a tool to determine what data is needed for various digital twin endeavours, and who owns it. The tool can be used by government decision-makers in understanding the current state gap for the use of digital twins in Ontario. In addition, the inventory can be used for the following:

- Recognizing what datasets are currently publicly available (or not)
- Understanding who owns what, and some of the key contacts (for both available and non-available datasets)
- Assessing the need for legislative/regulatory compulsions to close the data gap
- Recognizing the number and diversity of data owners involved
- Engaging data-owning stakeholders for consultations around potential data sharing (incl. legislative options)



Tab	Description
Intro	A description of the contents of this spreadhseet document
Poster Overview	A description of the 15 different data categories
Emergency Operations	Emergency events, response zones and services
Structures	Buildings, towers, bridges, tunnels
Governmental Units	Municipal boundaries, provincial boundary, other boundaries
Utilities	Power lines, generating plants, energy sources
Utility Data	A listing of private utility companies that may have geospatial data
Address & Names	Addresses and geographic names
Transportation	Roads, railways, trails
Cadastral	Parcel and ownership data
Hydrography	Water features including lakes and rivers
Environmental	Content relating to environmental features
Base Map	Cached base maps
Elevation	Contours, spot heights, digital elevation models
Imagery	Raw imagery sources
Geodetic Control	Geodetic control points and sources
Demographics	Statistics data relating to the population, primarily based on Statistics Canada data
Municipal & Other Data Sources	A listing of known municipal data sources, with open data sites, relevant data and contacts, where available

* GIS, or geographic information system, is software that creates, manages, and analyzes geospatial information for enhanced decision-making. GIS connects data to a map, integrating spatial data (location) with descriptive information. This provides a foundation for mapping and analysis that that is used globally for countless use cases and outcomes.

1. Executive Summary

Objectives

Geospatial Enterprise Ontario ("the Enterprise") aims to provide a convening platform for public, private, and non-profit leaders in Ontario to address geospatial-related challenges and explore new ways to use geospatial assets to promote economic growth and social wellbeing.

This proposed Enterprise is supported by a business case that includes the following objectives:

- **Outline current challenges in Ontario** that can be addressed by, or significantly alleviated through standardizing geospatial data practices, enhancing data sharing and coordination, and leveraging geospatial data.

- **Illustrate proposed Geographic Information System (GIS) standards** for relevant Ontario stakeholders and the value of standardization.

- **Demonstrate the potential qualitative and quantitative benefits** for public, private, and non-profit organizations, including an illustrative cost-benefit analysis for investing in this Enterprise and implementing GIS standards.

- **Propose a governance and operational structure** to support effective creation, maintenance, sharing, and access to geographic information.

Context

The current state of geospatial data in Ontario is fragmented, with a wide range of geospatial datasets and resources available for use across different stakeholders. The province, municipalities, and other organizations have made significant efforts to collect, maintain, and share geospatial data to support various applications and decision-making processes. While these efforts represent a diverse geospatial ecosystem, they exist in silo of one another which limits cross-sector collaboration.

The province established the Ontario GeoHub, which operates a central repository of geospatial data. The GeoHub provides access to a variety of datasets, including land use, transportation, infrastructure, environmental, and demographic data. These datasets are available to the public and can be accessed through web mapping services or downloaded for further analysis.

Additionally, municipalities in Ontario maintain their own geospatial datasets, covering areas such as zoning, property boundaries, utilities, and transportation networks. Moreover, academic institutions, research organizations, and private companies like Esri also contribute to the geospatial data ecosystem in Ontario. They often collect and maintain specialized datasets for research, analysis, and commercial purposes.

However, while geospatial data available for use, challenges related to data quality, consistency, and interoperability still exist. An Enterprise that establishes an operational structure that coordinates and requires adherence to standards for geospatial data in the province will assist in alleviating these existing challenges.

Opportunity

The Enterprise can unlock economic value for the province by accelerating knowledge exchange and collaboration that advances the benefits of geospatial data.

The Enterprise aims to provide a convening platform for government, academic, and industry leaders in Ontario to:

1. Facilitate the **standardization** of geospatial data and enable data sharing.
2. Expand **partnerships between public, private, and non-profit sectors** to collect and improve a range of foundational geospatial data (e.g., roads, water).
3. Exchange **knowledge and insights** on effective and innovative uses of geospatial data (e.g., identify new use cases for adoption of real-time geospatial data).
4. Explore **new ways** geospatial data and technologies can **promote economic growth** (e.g., new sector-specific programs to address targeted challenges).

Benefits and Outcomes

The anticipated economic impact of geospatial technologies on the global economy is set to rise by ~196% between 2025 and 2030 with enabling public policy reforms, increased public investments, and more strategic roles of national geospatial agencies and governments.[1]

In Ontario, the benefits of geospatial investments may include:

1. **Increased efficiencies and cost savings:** Costs are driven, in large part, by incomplete data that requires an organization to spend additional time and resources filling its

1 Geospatial World, Global Geospatial Industry Outlook, 2022 (linked here)

informational gaps. Geospatial data creates cost savings by providing organizations with a complete geographic picture which helps to inform efficient deployment planning.

2. **Improved decision-making:** The majority of data and information that governments and public entities collect have distinct location markers which makes it geographic in nature. Advancements in technology, particularly the accessibility of earth observation data from low-earth orbit, will enhance the quality, quantity, and accuracy of this available data. As a result, it enables organizations to make informed decisions at scale and over longer time horizons.

3. **Enhances economic productivity:** The anticipated economic impact of geospatial technologies on the global economy is set to rise by ~196% between 2025 and 2030.[2] Geospatial technologies can offer a precise view into how existing assets are used, maintained, and optimized, leading to improved services. For example, the UK's digital twin platform (i.e., National Underground Asset Register) powered by geospatial data, is estimated to expand the economy by £490 million per year through increased efficiencies in construction and development.[3]

The intended outcomes of the Enterprise are as follows:

- Enhanced coordination, access, and cost effectiveness with adoption of common data standards.
- **Innovative partnerships** between public, private and non-profit sector collaborators which can help address challenges across industries.
- **Enhanced productivity** by leveraging geospatial assets and capabilities across sectors.
- Better and more targeted policies, investments, and innovations informed by geospatial ecosystem insights.
- **Unlocked economic value** through identifying new uses cases of geospatial assets.

Next Steps

The establishment of the Enterprise aims to address key gaps in the province's geospatial ecosystem. This Enterprise has the potential to drive economic and social well-being in Ontario. The path forward involves conducting an in-depth return-on-investment (ROI) analysis specific to

2 Geospatial World, Global Geospatial Industry Outlook, 2022 (linked here)

3 UK Government, New digital map of underground pipes and cables on track to grow economy by £5 billion, 2023 (linked here)

Ontario to showcase the quantitative and qualitative benefits, engaging relevant stakeholders in the geospatial ecosystem, and aligning with the province on priority geospatial initiatives.

Ontario has an opportunity to become a national leader in geospatial utilization, promoting economic growth and enhancing the well-being of its residents through improved coordination and standardized.

2. Importance of Geospatial Data, Standards, and Technology

2.1 Geospatial Data, Standards, and Technology Overview

Geospatial data plays a crucial role in the every-day decision-making across several organizations, including governments, private sector companies, and non-profit organizations, as well as the general public. Whether it be urban planning, consumer preference mapping, or emergency management, geospatial data and technologies are used in all aspects of daily life. For example:

Navigation Apps	Weather Reports	Delivery Trackers	Real Estate Listings
Viewing live location and road conditions (e.g., traffic)	*Monitoring weather across a specific region*	*Tracking package and shipping whereabouts*	*Viewing properties in a specific geography*

These every-day use cases are powered by data, standards, and technologies, which are defined below:

Geospatial data is data that includes information related to locations on the Earth's surface. This type of data is commonly created through a Geographic Information System (GIS) used to map events and objects to specific locations using latitude and longitude coordinates.

Geospatial data is a digital representation of these real-world locations.

Geospatial standards, or GIS standards, are a set of guidelines and specifications that define how geospatial data should be structured, organized, and shared within GIS platforms. These standards help enable interoperability, consistency, and quality of geospatial data across different systems, platforms, applications, and organizations, enhancing collaboration and decision-making.

Geospatial technologies, also known as geospatial tools or geospatial systems, are a collection of technologies that enable the capture, analysis, visualization, and management of geospatial data. These technologies utilize various hardware and software tools to process and interpret geographic data.

In Ontario, several GIS platforms have been established across sectors and organizations. These systems include:

- ArcGIS
- QGIS
- GeoMedia
- Google Earth Pro

While geospatial technologies play a critical role in the collection and analysis of data, the role of Geospatial Enterprise Ontario will focus on convening the sector and advancing geospatial data that meets a high standard in accuracy, quality, security, transparency, and interoperability across GIS platforms, systems, and users. Therefore, this business case will focus on building an Enterprise that enhances the value of geospatial data and standards in building economic opportunities and improving public services across Ontario.

2.2 Benefits of Geospatial Data, Standards, and Technology

While different sectors can experience various benefits from the use of geospatial assets, there are three overarching benefits that apply to all stakeholders of the geospatial ecosystem:

- **Increased efficiencies and cost savings:** Costs are driven, in large part, by incomplete data that requires an organization to spend additional time and resources filling its informational gaps. For example, the deployment of aerial broadband infrastructure is more costly when an Internet Service Provider lacks the topographical knowledge of a region. Geospatial data creates cost savings by providing organizations with a complete geographic picture which helps to inform efficient deployment planning.

- **Improved decision-making:** The majority of data and information that governments and public entities collect have distinct location markers which makes it geographic in nature. Advancements in technology, particularly the accessibility of earth observation data from low-earth orbit, will enhance the quality, quantity, and accuracy of this available data. As a result, it enables organizations to make informed decisions at scale and over longer time horizons. For example, geospatial data allows municipalities to track historical topographical data and predict changes to surrounding land, enabling them to plan zoning by-laws more accurately for municipal development. An example of this benefit in action is in the City of Ottawa where they are creating a Digital Twin to support their New Zoning Bylaw Consolidation project.[4]

- **Enhances economic productivity:** The anticipated economic impact of geospatial technologies on the global economy is set to rise by ~196% between 2025 and 2030.[5] Geospatial technologies can offer a precise view into how existing assets are used, maintained, and optimized, leading to improved services. For example, the UK's digital twin platform (i.e., National Underground Asset Register) powered by geospatial data, is estimated to expand the economy by £490 million per year through increased efficiencies in construction and development.[6]

Beyond these overarching benefits, geospatial data provides specific value to public, private, and non-profit sector organizations (see **Figure 1**) with the potential to enhance decision- making, streamline processes, and drive sustainable growth.

4 The City of Ottawa is building a Digital Twin of the city using enterprise GIS, 2023 (linked here)

5 Geospatial World, Global Geospatial Industry Outlook, 2022 (linked here)

6 UK Government, New digital map of underground pipes and cables on track to grow economy by £5 billion, 2023 (linked here)

Figure 1: Examples of Public, Private and Non-profit Sector Benefits from Geospatial Data

Sector	Use of Geographical Information
Public Sector	**Infrastructure and Transportation:** Supports the creation and effectiveness of digital twin platforms by identifying suitable locations for projects and assesses their impact on the environment and communities, enabling policy makers to make informed decisions about the placement and alignment of roads, bridges, railways, airports, and other assets. **Disaster Risk Management:** Identifies vulnerable areas, evacuation routes, and critical infrastructure, which supports real-time monitoring of conditions, aiding in emergency responses. **Public Safety:** Provides situational awareness by visualizing incidents and events on maps, enabling agencies to allocate resources and respond effectively and efficiently. **Urban Planning:** Analyzes land use patterns, transportation networks, and demographics to prioritize resources in community development.
Private Sector	**Insurance Companies:** Enhances the assessment and mitigation of financial risk, managing claims, and detecting fraud by comparing insurance claims to geographic zones with high- or low-risk of naturally occurring damage. **Manufacturing:** Optimizes supply chain development and transportation, and improves production efficiency, facility locations, and distribution networks. **Utility Companies:** Enhances asset management, and improves customer service by accurately mapping assets, identifying risks, and integrating customer information.
Non-Profit Sector Organizations	**Academia:** Advances research teaching, and innovation, particularly in the fields of urban growth, climate change, or transportation networks, and enhances collaboration with industry and government agencies. **Non-Governmental Organization:** Enhances the planning, resource allocation, and impact assessment of their operations. These organizations use geospatial data to enhance operations, including identifying areas with vulnerable populations or underserved communities, improving program efficiency, and supporting infrastructure development.

2.3 Risk of Not Leveraging the Geospatial Opportunity

Enhancing coordination across the geospatial ecosystem and enabling standardization presents a significant opportunity for Ontario as it streamlines workflows, reduces duplication of efforts, and improves overall efficiency. Neglecting this opportunity and failing to coordinate efforts could lead to substantial risks, including:

- **Inefficient resource allocation and missed cost-saving opportunities:** In standing up its GIS Utility and community coordination initiative, the state of Oregon projected cost savings of over $80 USD for state agencies and over $100 USD for city and county governments. Ontario's larger scale presents an even greater opportunity for cost savings.

- **Disjointed sector coordination:** An uncoordinated and siloed approach to geospatial data hinders the optimization of public policy objectives that benefit the general public, as well as public and private sector organizations. For example, greater collaboration between private-stakeholders in the insurance industry and disaster risk-management agencies can better identify at-risk regions. In sharing data and information, these organizations can identify disaster risk mitigation strategies, which could both lower the premium costs for the general public and financial burden on insurance companies.

- **Untapped expertise in geospatial data:** Governments and organizations are increasingly reliant on data-driven decision-making. Cross-sector geospatial efforts can contribute to the sharing of resources and expertise and effective decision-making. As an example, Location Data Scotland has amplified the country's experience and capabilities in location data through convening a community of 120+ start-ups, subject matter experts, corporations, and government organizations.[7]

Organizations that fail to harness the power of geospatial data and coordination risk making ill- informed decisions. With the increasing availability and advancements in GIS technology, organizations that do not leverage this valuable resource may find themselves falling behind in the global ecosystem. It is imperative for Ontario to recognize the value of geospatial data and invest in the necessary tools and expertise to unlock its full potential.

7 See Section 4.2 for more information.

3. Current Status of Geospatial Efforts in Ontario

3.1 Existing Geospatial Ecosystem in Ontario

The current ecosystem of geospatial data usage in Ontario is fragmented, with a wide range of geospatial datasets, resources, and stakeholders across public, private, and non-profit sectors. However, these activities lack standardization or coordination, leading to siloed approaches and operations that fail to maximize the potential of geospatial data.

Efforts and initiatives in the public sector are led by Ontario's Ministry of Natural Resources and Forestry (MNRF) and Land Information Ontario (LIO). LIO acts as a facilitator of geographical information for public and private organizations to access and share geographic data, including key infrastructure corridors, topographical information, and the overall management of official geographic names, boundaries, and classification details. LIO's mandate includes three key initiatives:

- **Ontario Geospatial Data Exchange (OGDE):** The OGDE is a platform for public organizations to share geographic data through a single agreement administered by LIO. Membership to the OGDE is free, but eligibility is restricted to municipal, provincial, and federal governments, Indigenous communities, conservation authorities, public health units, non-profit organizations, colleges, universities, and public utilities.

- **Ontario GeoHub:** Ontario GeoHub serves as a centralized repository for geospatial data. Using ArcGIS, GeoHub provides geospatial data sets, maps, and applications to support decision-making, planning, and analysis using aerial imagery, topographic data, land use maps, transportation networks, and environmental data.

- **Ontario Geodesy:** Ontario Geodesy maintains Ontario's geodetic control database, providing more than 125,000 horizontal control monuments and vertical benchmarks provided by public sector stakeholders. Geodetic control surveying is a precise method of establishing and measuring reference points on the Earth's surface to create a framework for accurate positioning and mapping.

Augmenting these public sector efforts, leading private sector stakeholders in the geospatial ecosystem include:

- **Esri:** A global leader in GIS solutions, Esri offers its flagship software, ArcGIS, to provide a comprehensive suite of tools for capturing, managing, analyzing, and visualizing geospatial data. Esri's GIS solutions are used extensively by governments, businesses, non-profit organizations, and academic institutions, such as Ontario's GeoHub and Service Ontario, to address complex spatial challenges. The Esri Partner Network is a global ecosystem that sets a private-sector standard for delivering the benefits of GIS software and location intelligence.

- **Teranet:** Responsible for operating the Electronic Registration System (ERS) for Ontario, Teranet's GIS work within the ERS involves capturing and organizing geospatial data related to land parcels, boundaries, and ownership information.

Finally, efforts in the non-profit sector are driven by non-profits such as Ontario One Call, which serves as a central contact point for individuals and organizations planning to undertake any excavation or digging activities in the province. Its primary purpose is to promote safety and prevent damage to underground infrastructure.

Overall, there are several existing geospatial efforts across sectors in Ontario. However, the lack of standardization and coordination across the wide range of geospatial datasets, resources, and stakeholders has led to siloed approaches to advancing geospatial development. This dynamic ultimately makes it challenging for the province to fully unlock the potential of geospatial data.

3.2 Current Gaps and Challenges in the Geospatial Ecosystem

As noted in Section 3.1, the current geospatial ecosystem in Ontario includes several geospatial initiatives and organizations with their critical yet distinct mandates. Limited coordination within this space, coupled with a lack of standardization for the collection, storage, and sharing of geospatial data and information can lead to several challenges including:

- Increased costs to stakeholders in accessing and leveraging geospatial data critical to public interests.
- Lack of collaboration between geospatial stakeholders that prevent economic gains and opportunities.
- Lack of clear guidance and shared expectations among geospatial stakeholders due to fragmented standards.

These challenges, as illustrated in the below examples, have led to gaps in Ontario's geospatial ecosystem that prevent the optimized use of geospatial data.

1. **Increased costs to users in accessing and leveraging geospatial data critical to public interests.** The lack of coordination and consolidation of geospatial data for flood mapping in Ontario has resulted in increased costs for disaster risk management. According to a 2019 independent survey on managing flood risk in Ontario, the current state of flood mapping

data management is fragmented and inaccessible.[8] The data created through the Federal Damage Reduction Program (FDRP) and National Disaster Mitigation Program (NDMP) projects are not centrally managed or easily accessible to stakeholders in Ontario (including those in Ontario's geospatial ecosystem and emergency response agencies), with some mapping data being restricted to the client who acquired it from vendors.

The absence of consolidated data management has several negative consequences. Firstly, it hampers the ability of provincial programs to incorporate the data into their operations and respond efficiently to flood events. Secondly, is raises the risk of data loss as there is no centralized system for data storage and management. Thirdly, the inconsistency in data standards (e.g., data formats) makes it difficult to compare and analyze the flood mapping data effectively across data sets. Lastly, the lack of data consolidation hinders the utilization of data in light detection and ranging acquisition planning, limiting the effectiveness of floodplain mapping.[9]

The estimated costs of mapping Ontario's flood plains are another key reason to address the data consolidation challenge. A study commissioned by Public Safety Canada in 2014 estimated that the costs of mapping currently unmapped floodplains in Ontario could reach as high as $119.6 million. A more recent estimate in 2017 by Conservation Ontario put the same cost at approximately $136 million. These significant costs highlight the need for a more efficient and coordinated approach to data management for not only flood mapping, but for other critical services in Ontario that experience similar challenges in data consolidation and coordination.

2. **Lack of collaboration between geospatial stakeholders that prevent economic gains and opportunities.** The lack of integrated collaboration across Ontario's geospatial ecosystem hinders the full realization of economic opportunities that have been seen globally. A 2012 assessment on the Value of Ordnance Survey (OS) OpenData to the economy of Great Britain provides valuable insights into the economic benefits of data sharing. The study concluded that a public sector investment in making OS OpenData free for public download resulted in improved productivity and higher overall levels of output in the economy. The analysis suggested that OS OpenData would generate a net growth in Gross Domestic Product (GDP) of between £13.0 million and £28.5 million per annum by 2016. Additionally, there was an increase in real national income (real GNP) in

8 Ministry of Natural Resources and Forestry, Challenges and opportunities to managing flood risk, 2019 (linked here)

9 Light Detection and Ranging (LiDAR) technologies refer to the use of laser-based remote sensing techniques to capture highly accurate and detailed geospatial information. LiDAR technology enables the collection of precise elevation, terrain, and surface data, allowing for the creation of accurate 3D models of the Earth's surface.

the range of £10.2 million to £24.1 million by 2016, indicating an increase in economic welfare for British society as a whole.[10]

By promoting collaboration and data sharing between geospatial platers, Ontario can unlock similar economic gains and opportunities. The exchange and coordination of geospatial data can lead to increased productivity, innovation, and overall economic growth.

3. **Lack of clear guidance and shared expectations among geospatial stakeholders due to fragmented standards.** GIS standards are differ across different levels of government and industry stakeholders within Ontario in the usage of geospatial data. As a key stakeholder for geospatial data in Ontario's public sector, the MNRF is committed to geospatial data services that reduce costs and promote geospatial data that is accurate and accessible.[11] Their efforts are guided by Ontario's Digital Service Standard, which offers thirteen guiding principles for data-driven government services; however, they lack clear guidelines and expectations surrounding the use and interoperability of geospatial data in the province.[12] In contrast, Esri encourages the use of industry standards that are published by external organizations like Open Geospatial Consortium (OGC) and the International Organization for Standardization (ISO).[13] Esri also points to the Government of Canada's Standard on Geospatial Data as sound data standards that organizations should follow. While these standards exist within Canada at the federal level, they do not apply to Ontario's Ministries and Agencies.[14] As a result, there is no clear guidance on the expectations surrounding Ontario's geospatial data standards and how they interact across the province's geospatial stakeholders.

The challenges illustrated above can be attributed primarily to processes and coordination, rather than technical constraints. Establishing an Enterprise that facilitates robust coordination and adherence to standards for geospatial data can address these issues and unlock the full potential of geospatial data across sectors and industries.

---

10 Ordnance Survey, Assessing the Value of Ordnance Survey OpenData to the Economy of Great Britain, 2012 (linked here)

11 Ministry of Natural Resources and Forestry, Published plans and annual reports 2023-2024, 2024 (linked here)

12 Government of Ontario, Digital Service Standard, 2021 (linked here)

13 Esri, Understanding geospatial governance: policies, standards and guidelines, 2023 (linked here)

14 Government of Canada, Standard on Geospatial Data, 2012 (linked here)

4. Geospatial Enterprise Ontario Overview

4.1 Geospatial Enterprise Ontario Objective and Structure

The proposed Enterprise would serve as a public sector response to the province's current geospatial coordination challenges and aims to unlock the benefits of geospatial data through existing and new initiatives.

The Enterprise will be a convening platform for public, private, and non-profit sector leaders in the Ontario geospatial sectors to:

- Facilitate the standardization of geospatial data practices, including the organization, representation, and sharing of data within the geospatial ecosystem. For more details on proposed GIS standards, see **Section 5** of this document.
- Expand partnerships with government agencies to collect and improve a range of foundational geospatial data such as land parcels, aerial photography, elevation, roads, and water to avoid duplication, reduce costs and enhance data quality.
- Exchange knowledge and insights on effective and innovative uses of geospatial data (e.g., identify new use cases for adoption of real-time geospatial data).
- Explore new ways in which geospatial data and technologies can promote economic growth (e.g., setting up new sector-specific programs to address targeted challenges that can benefit from geospatial data).

The intended outcomes of this Enterprise are as follows:

1. **Enhanced coordination, access, and cost effectiveness** with the adoption of common data standards and implementation of a shared language for geospatial concepts.
2. **Innovative partnerships** between public, private and non-profit sector collaborators which can help address challenges across industries.
3. **Enhanced productivity** by leveraging geospatial assets and capabilities across sectors (e.g., adopting real-time data to inform timely decision-making).
4. **Better and more targeted policies, investments, and innovations** informed by insights from the geospatial ecosystem.

5. **Unlocked economic value** through identifying new uses cases for geospatial assets, generating both new financial gains and cost savings.

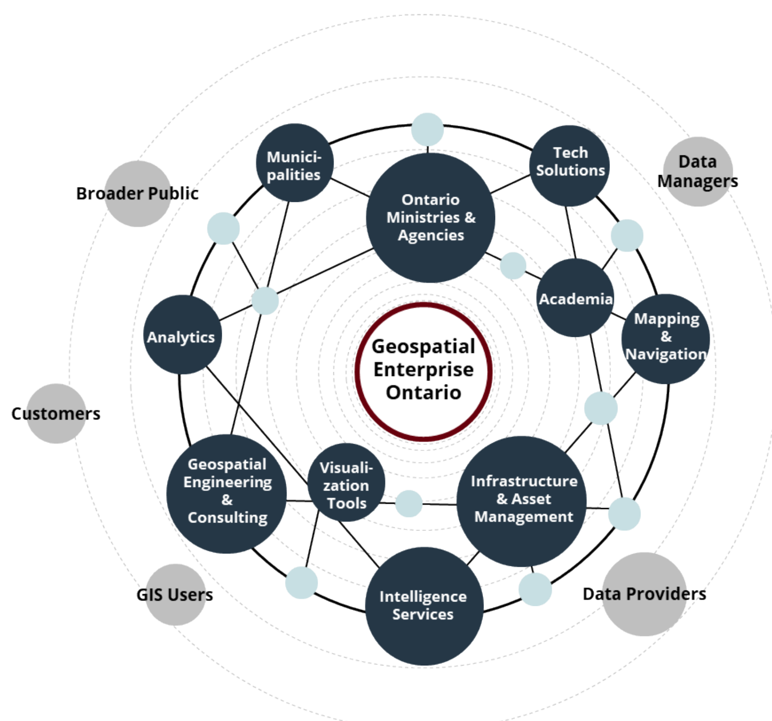
The organizational and governance structure for the Enterprise must clearly define the initiative's leadership, management, and methods of coordination. The main components of the Enterprise would include:

- **The Governing Board** which includes a select body of leaders in government, the private sector, and other organizations in the geospatial ecosystem. This governing board would have decision-making authority on the Enterprise's strategy, policies, geospatial standards, and operations. The Governing Board would be led by a President, a leader at an organization who is well-connected within the Ontario geospatial ecosystem, possesses geospatial subject matter expertise, and can guide decision-making within the Board.

- **A Management Unit** which is responsible for day-to-day administrative and operational support to Enterprise members, including supporting the adoption of GIS standards, guiding parties through the data sharing and standardization process, and facilitating dispute resolution processes between parties.

- **Member Community** which encompasses a range of current and potential users and enablers of geospatial data within public, private, and non-profit sectors. Examples of the types of members in the Enterprise can be seen in **Figure 2**.

Figure 2: Example of Members in the Geospatial Enterprise Ontario



Overall, a successful Enterprise can unlock immense value for the province by accelerating knowledge exchange, collaboration, and data sharing within the geospatial ecosystem.

Comparable jurisdictions that have already established similar initiatives have reaped many benefits which are highlighted in the following section.

4.2 Precedent in Other Jurisdictions

Several jurisdictions outside of Ontario have already seen success in establishing and implementing similar initiatives. **Figure 3** highlights these initiatives and their key impacts.

Figure 3: Geospatial Initiatives and Impacts

Jurisdiction	Description	Key Impacts
United Kingdom	The **Geospatial Commission** is a committee responsible for setting the UK's geospatial strategy and coordinating public sector geospatial activity	The Geospatial Commission has a mandate and budget to deliver geospatial policy and strategy. Since 2020, the Commission has: • Launched the National Underground Asset Register (NUAR) minimum viable product in Northeast England, Wales and London, which is a Digital Twin asset that manages buried infrastructure. • Invested over £1 billion, through the Public Sector Geospatial Agreement (PSGA) with Ordnance Survey, to enable better access to location data for 5,500+ public sector organizations across the country. • Invested £5 million in private sector innovation to solve major transport sector challenges through product development and testing. • These efforts have helped curate a geospatial ecosystem in the UK that employs 30,000 people.

Oregon, US	**Oregon's Geospatial Enterprise Office (GEO)** coordinates with all levels of government to develop geospatial data standards and tools to support Oregon's geospatial community.	Since 1989, Oregon's GEO has been successful across three critical areas: • The administration of the Oregon Framework Program[15] and data distribution, which creates and maintains geospatial data and makes it accessible to support the equitable provision of services. • Supporting the Oregon Geographic Information Council, which is responsible for overseeing the strategic development and governance of geospatial data.[16] • Managing the Esri enterprise agreement for the State of Oregon where eligible agencies in Oregon can leverage Esri GIS software, applications, and services. Oregon's GEO has also established the state's centralized geospatial data repository (GEOHub) while facilitating community-wide coordination across government and the general public.

15 The Oregon Framework Program is a geospatial data governance program that advises the Oregon Geographic Information Council.

16 State of Oregon, Oregon Geospatial Enterprise Operations, 2024 (linked here)

Scotland	**Location Data Scotland** is an inclusive geospatial community active in producing and using geospatial data to deliver value and benefits for their constituents. This initiative is supported by both Governments of Scotland and the UK.	Since its creation, the community has helped accelerate capabilities in data analytics, location intelligence, data provision and mapping by: • Raising the profile of geospatial technologies across sectors through facilitating 45 introductions between industry, academia, and the public sector. • Amplifying Scotland's experience and capabilities in location data through convening a community of 120+ start-ups, subject matter experts, corporations, and governments. • Helping shape and influence policy around geospatial strategies in the Scottish Government and contributing to national Government thinking.

During the design and implementation of the Geospatial Enterprise Ontario, the jurisdictions mentioned above will be engaged to better understand leading practices and lessons learned that can be applied in Ontario's context.

4.3 Development Approach and High-Level Timeline

The Enterprise would be developed in four phases which is anticipated to start in April 2024. The phases are outlined in **Figure 3** below.

Figure 4: Development Approach and Timeline

Development Phase	Key Objective(s)
Phase 1: Ideation and Business Case	• Conduct market sounding to better understand the industry's challenges and opportunities, and perspectives on the establishment of the Enterprise and standards for geospatial data. • Develop high-level business case demonstrating context for change and need for action.
Phase 2: Strategy Design and Standards Development	• Develop strategic plan for the Enterprise, outlining strategic priorities based on geospatial opportunities in the province, approach to standardize geospatial data, geospatial-related stakeholder engagement activities, and financial planning and delivery timelines to support execution of strategic plan. • Finalize geospatial requirements used to standardize geospatial data sharing. • Collaborate with partners in the UK and US (e.g., Location Data Scotland) to obtain insights on their efforts in community building and geospatial data standardization; identify lessons learned and apply to the Ontario context.
Phase 3: Organizational Development	• Stand up the Governing Board and Management Unit for the Enterprise, including finalizing the detailed governance structure for the Enterprise, convening Board members, and • recruiting and training Management staff.
Phase 4: Enterprise Launch and Ongoing Operations	• Stand up Member Enterprise by engaging key stakeholders within the geospatial ecosystem

The detailed implementation plan for the Enterprise with specific activities and timing will be developed at a later stage.

5. Proposed Geospatial (GIS) Standards

5.1 GIS Standards and its Applicability to Ontario Stakeholders

Geospatial Enterprise Ontario intends to promote a set of GIS standards that all stakeholders must adhere to in the use of geospatial data to promote greater data accuracy, quality, and interoperability and community coordination and collaboration.

This section focuses on the existing GIS standards and requirements for sharing geospatial data that the Enterprise will promote and require adherence to by stakeholders. The content aims to outline the GIS standards and data sharing requirements, with emphasis on the protocols and requirements necessary for efficient data exchange. It references existing international standards, such as those set by the Open Geospatial Consortium (OGC) and the International Organization for Standardization (ISO), that govern the use, sharing, and management of geospatial data, ensuring interoperability and consistency across different platforms, systems, and software.

By promoting and adhering to the standards and protocols outlined in this section, Geospatial Enterprise Ontario can help to ensure effective, accurate, and secure exchange of geospatial data, leading to more efficient infrastructure development. For more detailed information on the required GIS standards, see **Appendix A**.

Figure 5: Summary of Proposed GIS Standards

GIS Category Standards	Description	Relevant Standard(s)
Conceptual Modelling and Application Schemas	Stakeholders are expected to standardize the way they visualize the design of geospatial schemas by using a common a set of symbols and diagrams to represent different aspects of various schemas, including a schema's structure, behavior, and interactions.	• ISO 19101:2014 • ISO 19109:2015

Transfer Formats	Stakeholders are expected to adhere to standards for the transfer of geographic data to support integration and interoperability. The transfer formats should accurately represent and maintain the integrity of the geometry, attribute data, and their links, as well as the metadata. Standardizing transfer formats involves leveraging a common set of encoding rules and data formats that adhere to ISO 19118:2011.	• ISO 19118:2011
Encoding	Stakeholders are expected to adhere to standards in encoding requirements. Data should be encoded in an open standard format, while spatial data should be in encoded as GML or GeoJSON. The data should also be stored in a manner that maintains integrity and longevity, with strict adherence to organizational requirements. Lastly, all encoded data should be validated against the appropriate schema to ensure compliance with ISO 19118:2011.	• ISO 19118:2011
Spatial Representation	Stakeholders are expected to standardize their framework for the representation of spatial objects. Raster data should be represented as a grid of cells with each cell containing a value representing the attribute of interest, while vector data should be represented using points, lines, and polygons. These data should be collected using accurate methods like GPS or remote sensing, and the collection method should be documented in the metadata.	• ISO 19107:2019

Spatial Referencing	Stakeholders are expected to adhere to standardized guidelines on spatial references, in which all geospatial data should adhere to a standard coordinate reference system, with the North American Datum 1983 (NAD83) recommended for use in Canada. Spatial referencing should adhere to ISO 19112:2019, including the use of geographic identifiers to reference locations based on locational attributes, gazetteer, and location-based services. Metadata must be provided for spatial referencing.	• ISO 19111:2019 • ISO 19112:2019
Temporal Characteristics	Stakeholders are expected to adhere to standardized temporal referencing requirements within GIS platforms. A standard temporal reference system should be used, with the Gregorian calendar and the ISO 8601 format recommended. Metadata for temporal referencing should be provided to ensure interoperability and accurate interpretation of data.	• ISO 8601 • ISO 19108:2019
Data Quality Description and Evaluation	Stakeholders are expected to uphold strict data quality in a standardized format, including positional and temporal accuracy. Completeness is also essential, requiring 100% inclusion of all required objects, attributes, and relationships in the dataset, with any deviations documented.	• ISO 19157:2013

Portrayal	Stakeholders are expected to adhere to standardized guidelines for the portrayal of geographic information, leveraging methods like direct and indirect portrayal, supported by computer graphic standards such as OpenGL, PHIGS, and GKS. Cartographic symbols used in portrayal should be distinguishable, recognizable, and appropriate, with a legend or key provided.	• ISO 19117:2012
Geographic Information Services and Interfaces	Stakeholders are expected to adhere to the following requirements on services and interfaces. Geographic data should be accessible via HTTP/HTTPS protocols and compatible with open standards. Data transfers must be secured using industry- standard security protocols and in compliance with data privacy regulations. Lastly, geographic data should be interoperable, meaning it can be combined with other datasets without losing meaning.	• ISO 19119:2016 • ISO 19128:2005
Data Quality Description and Evaluation	Stakeholders are expected to uphold strict data quality in a standardized format, including positional and temporal accuracy. Completeness is also essential, requiring 100% inclusion of all required objects, attributes, and relationships in the dataset, with any deviations documented.	• ISO 19157:2013

Portrayal	Stakeholders are expected to adhere to standardized guidelines for the portrayal of geographic information, leveraging methods like direct and indirect portrayal, supported by computer graphic standards such as OpenGL, PHIGS, and GKS. Cartographic symbols used in portrayal should be distinguishable, recognizable, and appropriate, with a legend or key provided.	• ISO 19117:2012
Geographic Information Services and Interfaces	Stakeholders are expected to adhere to the following requirements on services and interfaces. Geographic data should be accessible via HTTP/HTTPS protocols and compatible with open standards. Data transfers must be secured using industry- standard security protocols and in compliance with data privacy regulations. Lastly, geographic data should be interoperable, meaning it can be combined with other datasets without losing meaning.	• ISO 19119:2016 • ISO 19128:2005
Object Catalogues	Stakeholders are expected to adhere to the requirements for standardization object cataloguing, including categorization under standardized themes. Stakeholders must also utilize the ISO feature cataloguing methodology to develop a comprehensive data dictionary. The data must be consistent within its theme and compatible with other data in the same theme to ensure data consistency and compatibility. Lastly, stakeholders must commit to regularly updating their data to maintain relevance and accuracy.	• ISO 19110:2016

Metadata	Stakeholders are expected to adhere to standardized requirements for the usage of metadata, including identification information such as title, abstract, temporal, and geographic range, principal investigator, and point of record for data. Keywords should be attributed to a recognized thesaurus for improved interoperability and searchability. Metadata details should specify update schedules, metadata authority, and point of contact.	• ISO 19115-1:2014 • ISO 19115-2:2009

5.2 Benefits of ISO Standardization

Adopting the ISO 19100 series of standards for geospatial data and services would provide several benefits to Ontario's geospatial stakeholders. These include:

1. **Interoperability:** The ISO 19100 series provides a common framework and standardized data models for the exchange and integration of geospatial data, enhancing interoperability between different systems, platforms, and organizations.

2. **Data Sharing and Collaboration:** The ISO 19100 standards provide a common language and structure for describing and sharing geospatial data, advancing collaboration, knowledge exchange, and decision-making.

3. **Data Quality and Consistency:** The ISO 19100 standards promote data quality by defining standardized metadata elements, data models, and specifications, creating consistent data structures, accurate descriptions, and reliable data quality assessments that can improve decision-making.

4. **Data Integration and Analysis:** The standardized data models and schemas provided by the ISO 19100 series facilitate data integration and analysis that combines geospatial data from different sources to perform spatial analysis.

5. **Global Compatibility:** The ISO 19100 series is an internationally recognized set of standards, allowing Ontario to create compatibility with global geospatial data initiatives and facilitates the exchange of geographic information across national and international boundaries.

6. **Futureproofing:** The ISO 19100 standards are regularly updated and maintained to keep pace with technological advancements and evolving requirements. By adopting these standards, organizations can help future-proof their geospatial data infrastructure and

ensure compatibility with emerging technologies and trends, reducing the risk of data and technology becoming obsolete.

These benefits can contribute to more effective and efficient use of geospatial data, leading to improved data-driven decision-making, cross-sector planning, and collaboration, and interoperable data management.

5.3 The Broader Societal Benefits of GIS Standardization

Beyond direct benefits to geospatial stakeholders, adoption of ISO 19100 can bring broader benefits to Ontario society, including aligning with ongoing data standardization initiatives occurring in sectors across Ontario, and supporting Ontarians through time savings when travelling and injury prevention.

As other sectors are expressing the need for increased data standardization, ensuring the geospatial ecosystem does the same will be crucial for advancing broader benefits to Ontarians. One example is in healthcare where the 2022 Ontario Health Data Council Report[17] highlights the impacts of the lack of standardization on Ontarians. This includes:

Population Health Management: Although population health survey data has helped identify inequities, the absence of standardized and routinely collected socio-demographic data hinders organizations from monitoring their performance and identifying improvements to reduce these inequities.

Sociodemographic Health Data: To gain a comprehensive understanding of the factors impacting health, there is a need to collect standardized sociodemographic health data beyond just injury and illness. However, Ontario's fragmented health data ecosystem, which includes the absence of standardized lab testing data, fails to provide the comprehensive and real-time data required to inform public health decisions. The absence of a system-wide, standardized collection of sociodemographic data across healthcare settings hinders the ability of policymakers to understand, identify, and address health disparities.

As other sectors look to improve data standardization, ensuring the geospatial ecosystem does the same will be crucial for realizing the benefits in Ontario. Enhanced data standardization across sectors creates value for society by improving effectiveness and efficiency, resulting in benefits such as time savings and injury prevention.[18]

---

17 Government of Ontario, Ontario Health Data Council Report: A Vision for Ontario's Health Data Ecosystem, 2022 (linked here)

18 Ordnance Survey, Assessing the Value of Ordnance Survey OpenData to the Economy of Great Britain, 2012 (linked here)

- **Time Savings:** Standardized geospatial data has the potential to save people significant amounts of time, as evidenced by Transport for London's (TfL) bike hire initiative. By using geospatial data to provide real-time information on the availability of docking stations, individuals can save time when renting bikes. TfL estimates that on average, there are 50,000 bike rentals per day, with 1-2 minutes saved per rental by users knowing the location of available docking stations. By considering that 50% of hires occur during working time and 50% during non-working time, the time saved translates into an economic value of £22,500 per day or £5.85 million per year (working days only), based on calculations by the Department for Transport (DfT). This significant time-saving benefit is made possible in part due to the integration of standardized geospatial data, provided through initiatives such as OS OpenData embedded in Google Maps. A similar potential for time savings exists in Ontario where its Bike Share Toronto program has leveraged geospatial data to inform its fourth-year growth plan. The geospatial analysis used quantitative data to identify areas for Bike Share expansion with the goal of improving the city's traffic flow and accessibility.[19]

- **Injury Prevention:** Standardized geospatial data can significantly contribute to injury prevention by enabling risk reduction strategies. For instance, a study conducted by the UK's DfT in 2005 valued the average prevention cost per fatal casualty in road transport at £1,428,180, providing an estimate for the economic value society places on injury prevention. In the context of route optimization, standardized geospatial data plays a crucial role in mitigating the risk of injury by increasing the quality and availability of data, thereby creating more accurate and safer routes for vehicles.

These broader benefits to society further demonstrate the importance and need for geospatial coordination and data standardization in Ontario.

19 Toronto Parking Authority, Bike Share Toronto: Four-Year Growth Plan, 2022 (linked here)

6. Illustrative Cost-Benefit Analysis

6.1 Cost-Benefit Analysis Overview

A cost-benefit analysis aims to articulate the financial and qualitative benefits of the proposed Enterprise and its associated standards for geospatial data. For purposes of this business case, this section is illustrative in nature and provides an example of the approach, process, and information required to conduct a full cost-benefit analysis in the Ontario context.[20] A full and detailed cost-benefit exercise will be completed in the future following alignment with Ontario government and industry stakeholders.

The cost-benefit analysis exercise consists of two main parts, including:

- **Financial Return-on-Investment Analysis** which includes an identification of staff productivity, cost savings, and revenue enhancement expressed in monetary terms over a ten-year period.
- **Collateral Value Measures** which identify a range of tangible benefits which are either:

a. financial in nature but which cannot be reliably predicted or measured at this time or

b. best measured in non-financial term.

Note that the financial return and collateral value articulated is defined as the value generated for the stakeholder investing in the Enterprise and implementing the GIS standards. This key stakeholder is most likely to be an Ontario government entity.

6.2 Financial Return on Investment (ROI)

The ROI identifies quantifiable financial benefits of the Enterprise and its associated GIS standards. In concept, the approach for this exercise is straightforward:

1. Identify baseline costs (e.g., current geospatial-related operational costs incurred by government)

---

20 Note that the approach, process, and type of information outlined in this section was informed by the *2005 Business Case for the Development of Statewide GIS Utility* prepared by the State of Oregon with the assistance of PlanGraphics, Inc.

2. Project financial investment costs into this initiative (e.g., costs for the Enterprise and GIS standards development and maintenance)

3. Identify benefit opportunity by tabulating expected financial benefits over a set period of years.

4. Compare the baseline costs, investment, and anticipated benefits; identify a payback on the investment (i.e., return on investment)

Components of costs and financial benefits are illustrated in further detail in **Figure 6** below.

Figure 6: Cost and Benefits Examples for ROI Analysis

ROI Component	Definition	Examples
Baseline Costs	Baseline costs reflect the portion of government budgets that are related to geospatial-related business processes and programs.	• Percentage of Ontario's Ministry of Natural Resources and Forestry (MNRF) budget dedicated to Land information Ontario (LIO) and other geospatial-related efforts • Percentage of Ontario Government's budget dedicated to geospatial-related efforts
Investment Costs	Investment costs include all development and operational costs, one-time and ongoing.	• Personnel for employees of the • Enterprise's Management Unit • Consulting / Support Services for Member Community and enforcement of GIS standards • Equipment and Facilities

Benefit Opportunity	Measurable financial benefits for government organized in three main categories: • Operational and efficiency benefits • Cost savings and cost avoidance • Revenue enhancement	• Expected gains in current personnel efficiency and productivity will allow them to carry out their work in less time and with lower costs • Actual cost savings (contract costs, direct expenses) or the avoidance of future costs that might be necessary to support or comply with new program requirements (resulting from new regulations, legislation, legal decisions, public demand, or growth) • Opportunities for additional revenue by using geographic data and technology to support more effective real property tax and fee collection, increases in federal appropriations, and the location of other revenue sources

Using this type of information, costs and benefits can be projected over a set period of years (e.g., 5-years) to articulate the total financial gain. This gain is then compared to the upfront investment in developing the Enterprise and GIS standards to derive the ROI.

Using this ROI method, the State of Oregon projected the costs and benefits of their geospatial community from 2005 to 2015. The range of their costs were as follows (note that the ranges are net present valued and reflect dollar value in 2005):

- Baseline costs: ~$4 million USD.
- Investment costs: ~$3-34 million USD; over the years, investment costs trend downwards as most costs are required in the upfront years to establish the community.

Overall, the estimated financial benefit from Oregon's geospatial initiative between 2005-2015 ranged from $4-148 million USD annually. Note that over the years, financial gains trended upwards as benefits are reaped from investments in the community and its initiatives. Adjusted for inflation, this financial benefit would be ~$6-236 million USD annually in 2024.[21]

---

21 The US dollar had an average inflation rate of 2.50% per year between 2005 and 2024, producing a cumulative price increase of 59.92%. This means that today's prices are 1.60 times as high as average prices since 2005, according to the US Bureau of Labor Statistics Consumer Price Index.

6.3 Collateral Value Benefits

Not all benefits of this initiative can be quantified in financial terms for the ROI analysis. However, these more-difficult-to-quantify benefits will have a profound positive impact on the geospatial ecosystem in Ontario.

As noted in Section 6.1, the analysis of collateral value benefits includes an examination of a range of tangible benefits that are either: (a) financial in nature but which cannot be reliably measured at this time, or (b) best measured in non-financial terms. This analysis uses a formal methodology known as Value Measuring Methodology (VMM). The approach will require input from geospatial ecosystem stakeholders to identify "value categories" important for the province for which Geospatial Enterprise Ontario and GIS standards will deliver benefits.

An illustrative example of value categories and measures for collateral benefits are included in **Figure 7**.

Figure 7: Example Value Categories and Measures

Value Category	Measure	Performance
Operational / Foundational: Benefits realized in current government operations and processes, and in laying the groundwork for future initiatives.	**Productivity and Efficiency:** Processes, standards, and practices that reduce duplication in geographic data management and in all public programs that use geographic information.	**Current:** Many different versions of similar geographic data sets are redundantly created and maintained by different organizations. The result is discrepancies in data and varying results in spatial data analysis. **Target:** Provide a structure and mechanism to reduce the number of versions and designate a "master' version that can be maintained by the authoritative source with updates shared by a multitude of users. Expand access and use for quicker turnaround time for responding to requests for spatial information and providing public access for self-service for routine requests.
	Reduced Administrative Burden: Geographic information efforts result in minimal administrative burdens and program overhead associated.	**Current:** Some coordination and cooperation with data develop, very limited sharing of data management, application development, or user support. **Target:** Lower overhead because of need for managing data development, system implementation, coordination of procurements, and user respond.

Social (Non-User/ Public): Benefits related to non-direct geospatial users or society with particular emphasis on the residents of Ontario.	**Economic Development:** Provides information to encourage a positive economic outlook, to better position provincial and municipal governments to attract and compete for new business development, and to support effective employment programs.	**Current**: The percentage of agencies using geospatial data to support economic development and business retention is low and fragmented. **Target:** Support and promote a more comprehensive and consistent use of geospatial data to support economic development. Serve as a catalyst for technology advancement and employment by stimulating the growth of private industries in Ontario.
	Natural Resource Management: Provides information to support planning and management of natural resources in a sustainable manner.	**Current:** Geospatial data has and is being used extensively to support natural resource management in Ontario. However, many existing geospatial data users and additional organization could benefit from access to better more current and consistent data. **Target:** Improve the quality of data need to support natural resource management. Expand uses of spatial information by the public, governments, non- profit, and businesses to improve planning and management. In addition to these programs, some Ontario organizations could also benefit from improvements in the ability to better track activities such as mineral extraction.

Overall, the combination of a financial ROI analysis and Collateral Value Benefits evaluation can be effective in capturing both qualitative and quantitative benefits of Geospatial Enterprise Ontario and the implementation of GIS standards.

7. Conclusion

Geospatial Enterprise Ontario would address key gaps in the province's existing geospatial ecosystem by facilitating greater collaboration and ensuring data interoperability among geospatial stakeholders. These efforts will incite knowledge sharing, exploration, and new forms of geospatial partnerships that can unlock economic and social value for the province, setting a national standard for effective geospatial data usage.

The proposed path forward to develop the Enterprise includes:

- Conducting an in-depth cost-benefit analysis tailored to the Ontario context to accurately demonstrate the financial and qualitative benefits of this geospatial initiative, as seen in other jurisdictions.
- Socializing the Enterprise with relevant stakeholder in Ontario's geospatial ecosystem to obtain their feedback on relevancy and feasibility.
- Collaborating with Ontario government partners on how the Enterprise aligns with and seeks to advance geospatial priorities for the province.

The benefits of geospatial advancements are clearly illustrated in this document. Moving forward, Ontario has the unique opportunity to accelerate geospatial ecosystem collaboration and data standardization, propelling further economic growth that will facilitate the well-being of Ontarians.

8. Appendix A

Geographic Information System Standards

This section of the document focuses on Geographic Information System (GIS) standards and the requirements for sharing geospatial data amongst stakeholders. In the realm of infrastructure development and management, GIS has emerged as a pivotal tool, enabling the capture, management, analysis, and display of geographically referenced information.

This section is designed to outline the GIS standards and data sharing requirements, particularly emphasizing the protocols and requirements necessary for efficient data exchange between diverse stakeholders. It details the international standards, such as those set by the Open Geospatial Consortium (OGC) and the International Organization for Standardization (ISO), that govern the use, sharing, and management of geospatial data, ensuring interoperability and consistency across different platforms and software.

By adhering to these standards and protocols, the Enterprise can ensure effective, accurate, and secure exchange of geospatial data, leading to more efficient and superior infrastructure development.

8.1 Conceptual Modelling and Application Schemas

Stakeholders are expected to standardize the way they visualize the design of geospatial schemas by using a common a set of symbols and diagrams to represent different aspects of various schemas, including a schema's structure, behavior, and interactions.

A. Schema Type

- The application schema should be used to define the structure and type of data that will be shared. This includes defining the classes, class properties, data types, relationships, constraints, and operations that can be performed on the data.

- The schema should be based on the General Feature Model (GFM) defined in ISO 19109:2015, which provides a standard model for representing geographic features.

B. Schema Definition

- The schema should be defined in such a way that it can be easily understood and implemented by application developers. This includes providing clear definitions and descriptions for all classes, properties, and relationships.

- The schema should be designed to support interoperability between different systems and applications. This means that the schema should be based on standard data types and structures and should avoid proprietary or system-specific features.

C. Conceptual Schema Language

- The schema should be defined using a standard conceptual schema language such as the Unified Modeling Language (UML). UML is recommended because it is a widely accepted standard for defining conceptual schemas, and it is supported by a wide range of tools and technologies.

- The use of UML also supports the requirements of ISO 19101:2014, which recommends the use of UML for defining geographic information models.

Requirements are based on the ISO 19101:2014 and ISO 19109:2015 standards and are designed to ensure the integrity and usability of the geospatial data. It is important that all stakeholders adhere to these requirements when sharing data with the province.

Relevant Standard(s):

- ISO 19101:2014

- ISO 19109:2015

8.2 Transfer Formats

Stakeholders are expected to adhere to standards for the transfer of geographic data to support integration and interoperability. The transfer formats should accurately represent and maintain the integrity of the geometry, attribute data, and their links, as well as the metadata.

Standardizing transfer formats involves leveraging a common set of encoding rules and data formats that adhere to ISO 19118:2011.

A. Transfer of Geometry

- All geometric data should be encoded in a format such Geography Markup Language (GML) that maintains the integrity of the geometric structures as per ISO 19118:2011.

- The encoding format must accommodate the representation of both 2D and 3D geometric data in accordance with the provisions of ISO 19118:2011.

- The geometric data must be explicitly defined within the context of the utilized Coordinate Reference System (North American Datum 1983) as stipulated by ISO 19118:2011.

B. Transfer of Links Between Geometry and Attribute Data

- There should be a clear linkage between geometric data and its corresponding attribute data. This linkage should be maintained during the encoding process.
- The linkage information should be encoded using the rules defined in ISO 19118:2011 to ensure that the relationship between the geometric and attribute data is not lost or misrepresented in the transfer process.
- Encoding formats that facilitate a transparent linkage between geometry and attributes, such as Geography Markup Language (GML) or Keyhole Markup Language (KML), should be utilized in accordance with the specifications of ISO 19118:2011.

C. Transfer of Attribute Data

- All Attribute data must be encoded in a format that preserves the integrity of the data, conforming to ISO 19118:2011 standards.
- The encoding process should accommodate various types of attribute data including, but not limited to, numerical, textual, date/time, and Boolean data types.
- The attribute data must be correctly associated with the corresponding geometric data during the encoding process.
- Formats such as CSV, GML, or KML that are capable of effectively storing attribute data should be utilized.

D. Transfer of Metadata

- All metadata should be transferred along with the geographic data. The metadata should be encoded using the rules defined in ISO 19118:2011.
- The metadata should include information about the data source, data quality, data creation date, data update frequency, attribute definitions, and any other relevant information.
- The metadata should be associated with the correct geographic data during the encoding process.
- Metadata should be provided in a standard format such as XML or JSON following the schema provided by ISO 19115 for metadata information.

E. Transfer of LiDAR Data

- LiDAR data should be captured using equipment and methodologies that meet the standard of accuracy as defined in ISO 19118:2011. The equipment and methodologies should be approved by Infrastructure Ontario to ensure the reliability of the data.

- The LiDAR data should be encoded in a format that preserves the integrity of the point cloud data. The encoding process must adhere to the encoding rules defined in ISO 19118:2011 to ensure compliance with the standard.

- The LiDAR data must be georeferenced correctly in accordance with the spatial referencing by coordinates as stipulated in ISO 19118:2011. The data should be associated with the corresponding attribute data during the encoding process to ensure the correct linkage between geometry and attributes.

- Metadata associated with the LiDAR data, including but not limited to, the date and time of data collection, the equipment used, and the data processing steps, should be documented, and transferred along with the data. This metadata should be structured and presented according to the guidelines provided in ISO 19115:2014 for geographic information metadata.

Requirements are based on the ISO 19118:2011 standard and are designed to ensure the integrity and usability of the geospatial data. It is important that all stakeholders adhere to these requirements when sharing data with the province.

Relevant Standard(s):

- ISO 19118:2011

8.3 Encoding

A. Encoding Format

- The data should be encoded in an open standard format as per ISO 19118:2011. We recommend the use of XML (eXtensible Markup Language) or JSON (JavaScript Object Notation) as they are widely used, platform-independent, and support a wide range of data types.

- For the encoding of spatial data, GML (Geography Markup Language) or GeoJSON should be used, as these formats are specifically designed to represent geographical features and are in line with the ISO 19118:2011 standard.

B. Data Storage

- The data should be stored in a manner that maintains its integrity and ensures its longevity as per ISO 19118:2011.

- IO recommends the use of a relational database management system (RDBMS) that supports spatial data, such as PostGIS.

C. Data Format Components

i. Header: The header should contain information about the file, including the file name, creation date, and the software version used to create the file, as per ISO 19118:2011. This provides the necessary metadata for data management and traceability.

ii. Index: An index should be created for each data set to improve ability to retrieve data. The index should be based on the spatial attributes of the data, adhering to the ISO 19118:2011 standard which specifies that indexing should be based on the spatial and temporal attributes of the data.

iii. Data Dictionary: This should contain definitions of all data elements, attributes, and other constructs. It should also include information about the relationships between different data elements. This aligns with ISO 19118:2011's requirement for a detailed description of the data structure and its semantics.

iv. Data Elements: Each data element should have a unique identifier and a clear, descriptive name. Data elements should be structured and encoded in a consistent way to ensure interoperability, in line with ISO 19118:2011.

E. Validation

- All encoded data should be validated against the appropriate schema to ensure it meets the encoding requirements of ISO 19118:2011.

- Any errors or inconsistencies should be corrected before the data is submitted.

These requirements, in line with ISO 19118:2011, are designed to ensure that the geospatial data we receive is accurate, consistent, and usable. All stakeholders sharing data with the province must adhere to these requirements.

Relevant Standard(s):

- ISO 19118:2011

8.4 Spatial Representation

A. Raster and Vector Formats

- Raster data: which represents continuous phenomena such as temperature or elevation, should be represented as a grid of cells or pixels, with each cell representing a specific geographic area and containing a value representing the attribute of interest. This format is in line with ISO 19107:2019's requirements for the representation of spatial-temporal grids.

- Vector data: used for representing discrete objects or phenomena that can be clearly delineated, such as roads or buildings, should be represented using points, lines, and polygons. This format is consistent with the ISO 19107:2019 standard's geometric object types.

B. Data Collection and Representation

- Data should be collected using accurate and reliable methods, such as GPS or remote sensing, to ensure the quality of the spatial representation. The method of data collection should be documented as part of the metadata, as required by ISO 19107:2019.

- The data should be transformed from the field observations to the spatial representation using appropriate methods. For example, GPS coordinates should be transformed to map coordinates using a suitable map projection as per ISO 19107:2019's guidelines for coordinate transformation.

C. Geometric and Topographic Primitives

- Geometric primitives, such as points, lines, and polygons, should be used to represent the shape and location of spatial objects in vector data. These geometric primitives should be defined using coordinates in a suitable spatial reference system, as outlined in ISO 19107:2019.

- Topographic primitives, such as terrain elements, should be used to represent the surface characteristics of the earth in raster data. The topographic primitives should be defined using values in a suitable attribute data type, in line with the specifications of ISO 19107:2019.

All aspects of spatial representation should be in compliance with ISO 19107:2019, which provides a general framework for the representation of spatial objects in a GIS.

Relevant Standard(s):

- ISO 19107:2019

8.5 Spatial Referencing

A. Coordinate Reference System and Units of Measurement

- All geospatial data should adhere to a standard coordinate reference system. The North American Datum 1983 (NAD83) is recommended as it is widely used in Canada for geodetic and topographic mapping.

- All coordinates should be expressed in metres, the standard unit of measure in the NAD83 system, in accordance with the International System of Units (SI).

- Any potential errors or inconsistencies in spatial referencing data should be reported and addressed promptly. As per ISO 19111:2019 and ISO 19112:2019, an error reporting and rectification process should be in place to maintain the accuracy and reliability of geospatial data.

B. Datum and Sequences of Access

- The datum for all geospatial data should be consistent with the North American Datum 1983 (NAD83).

- The datum defines the position of the origin, scale, and orientation of the axes of a coordinate system.

- Sequences of access, the order in which coordinates are read, should follow the Latitude, Longitude, and Elevation (if applicable) sequence in the NAD83 system.

C. Spatial Referencing by Geographic Identifiers

- All spatial referencing should also adhere to ISO 19112:2019. This includes the use of geographic identifiers to reference geographic locations according to locational attributes, gazetteer, and location-based services.

D. Metadata

- Metadata for spatial referencing must be provided, including the coordinate reference system, datum, units of measurement, and sequences of access used, to ensure interoperability and accurate interpretation of data.

The following requirements are aligned with the ISO 19111:2019 - Geographic information - Referencing by coordinates, and ISO 19112:2019 - Geographic information - Spatial referencing by geographic identifiers.

Relevant Standard(s):

- ISO 19111:2019

- ISO 19112:2019

8.6 Temporal characteristics

A. Temporal Reference System

- All geospatial data should adhere to a standard temporal reference system. The Gregorian calendar is recommended as it is widely used internationally. All temporal data should be expressed in the ISO 8601 standard format (YYYY-MM-DD for date and YYYY- MM-DDThh:mm:ss for date and time).

B. Temporal Schema

- The temporal schema for all geospatial data should be consistent with ISO 19108:2019. This includes the use of temporal primitives (instants, periods, durations), temporal topology (before, after, meets, overlaps, during, contains, starts, finishes), and temporal reference systems.

C. Temporal Attributes

- All temporal attributes should be clearly defined and associated with the relevant spatial data. This includes the date and time of data collection, the period of data validity, and any significant temporal events related to the data.

D. Temporal Consistency and Accuracy

- Consistency and accuracy in temporal referencing are paramount. All data must be thoroughly checked for temporal referencing accuracy before submission. This includes ensuring that all dates and times are correctly formatted according to ISO 8601 and that temporal schemas are correctly applied according to ISO 19108:2019.

E. Temporal Metadata

- Metadata for temporal referencing must be provided, including the temporal reference system, temporal schema, and temporal attributes used, to ensure interoperability and accurate interpretation of data.

The following requirements are aligned to ISO 8601 - Data elements and interchange formats - Information interchange - Representation of dates and times, and ISO 19108:2019 - Geographic information - Temporal schema.

Relevant Standard(s):

- ISO 8601

- ISO 19108:2019

8.7 Data Quality Description and Evaluation

A. Positional Accuracy

- Positional accuracy refers to the degree of closeness between the position of a spatial object in the dataset and its true position in the real world. As per ISO 19157:2013

- All spatial data must meet a minimum positional accuracy of 1 meter. This means that the location of any point in the dataset should be within 1 meter of its true location in the real world.

- Any deviation from this requirement must be documented in the metadata, including the reason for the deviation and the expected impact on data quality.

B. Attribute Accuracy

- Attribute accuracy refers to the degree of closeness between the attributes of a spatial object in the dataset and the true attributes of the corresponding real-world object.

- All attribute data must be 95% accurate. This means that the attributes of any spatial object in the dataset should match the true attributes of the corresponding real-world object 95% of the time.

- Any deviation from this requirement must be documented in the metadata, including the reason for the deviation and the expected impact on data quality.

C. Temporal Accuracy

- Temporal accuracy refers to the degree of closeness between the time of a temporal object in the dataset and its true time in the real world.

- All temporal data must be accurate to within 1 minute. This means that the time of any temporal object in the dataset should be within 1 minute of its true time in the real world.

- Any deviation from this requirement must be documented in the metadata, including the reason for the deviation and the expected impact on data quality.

D. Logical Consistency

- Logical consistency refers to the degree of adherence to logical rules of data structure, attribution, and relationships.

- All data must be logically consistent. This means that the data structure, attribution, and relationships of all objects in the dataset should adhere to the logical rules defined for the dataset.

- Any deviation from this requirement must be documented in the metadata, including the reason for the deviation and the expected impact on data quality.

E. Completeness

- Completeness refers to the degree to which all required objects, attributes, and relationships are included in the dataset. As per ISO 19157:2013, the following requirements apply:

- The dataset should be 100% complete. This means that all required objects, attributes, and relationships should be included in the dataset.

- Any deviation from this requirement must be documented in the metadata, including the reason for the deviation and the expected impact on data quality.

Data quality is a critical aspect of Geographic Information System (GIS) data. As per ISO 19157:2013 - Geographic information - Data quality, the following requirements must be adhered to for stakeholders sharing data:

Relevant Standard(s):

- ISO 19157:2013

8.8 Portrayal

ISO 19117:2012 provides a schema for portrayal of geographic information, defining portrayal rules, symbols and their properties.

A. Portrayal Principles

- The portrayal of geospatial data must adhere to the principles set out in ISO 19117:2012, Geographic information - Portrayal. This standard provides a schema for describing the portrayal of geographic information for visualisation, analysis, and data exploration.

- Portrayal should be designed to facilitate understanding of the geographic information being presented, taking into account the intended audience and the purpose of the data sharing.

B. Data Portrayal Methods

- Stakeholders must use methods that are consistent with ISO 19117:2012 to portray the data. These include direct portrayal (where the data is displayed directly) and indirect portrayal (where the data is transformed before display).

C. Computer Graphic Standards

- Stakeholders are required to use computer graphic standards such as OpenGL, PHIGS, and GKS for data portrayal. These standards are consistent with the requirements of ISO 19117:2012 and provide a framework for creating and manipulating visual representations of data.

D. Visualisation of Geometry Using Attributes

- When visualising geometry, stakeholders must use attributes in a manner consistent with ISO 19117:2012. This includes using attributes to determine the size, shape, colour, and texture of the geometric elements.

- The use of attributes should be designed to enhance the understandability of the data, with consideration given to the perceptual characteristics of the intended audience.

E. Cartographic Symbols

- Cartographic symbols used in the portrayal of data must be consistent with the requirements of ISO 19117:2012. This includes using symbols that are clearly distinguishable, easily recognisable, and appropriate for the data being portrayed.

- Stakeholders must provide a legend or key explaining the meaning of all cartographic symbols used.

F. Portrayal Rules

- The portrayal of data should be guided by a set of portrayal rules, as specified in ISO 19117:2012. These rules define how the data is to be displayed, including the use of symbols, colours, and textures.

- Portrayal rules should be designed to ensure consistency in the portrayal of similar data across different datasets and to facilitate comparison and analysis of the data.

Relevant Standard(s):

- ISO 19117:2012

8.9 Geographic Information Services and Interfaces

A. Web Server Interface Requirements

- Geographic data must be accessible via HTTP/HTTPS protocols as per ISO 19119:2016.

- All data must be compatible with RESTful APIs, enabling users to access and manipulate geographic data over the network, as specified in ISO 19119:2016.

- Web services must support JSON and XML data formats for data interchange, as per ISO 19119:2016.

B. Open Information Technology Environment Requirements

- Geographic data must be compatible with open standards such as OGC (Open Geospatial Consortium) and W3C (World Wide Web Consortium) as referenced in ISO 19119:2016.

- Data must be accessible and manipulable via standard SQL queries, as per ISO 19119:2016.

C. Remote Database Querying and Control Requirements

- Stakeholders must provide necessary APIs and/or SQL access points to allow users to query remote databases, as per ISO 19119:2016.

- Stakeholders must provide a mechanism for users to control data processing, such as filtering, sorting, and aggregation, in line with ISO 19119:2016.

D. Security and Privacy Requirements

- All data transfers must be secured using industry-standard security protocols, such as SSL/TLS, as outlined in ISO 19119:2016.

- Stakeholders must comply with all relevant data privacy regulations, as per ISO 19119:2016.

E. Interoperability Requirements

- All geographic data must be interoperable, meaning it should be possible to combine it with other datasets without losing meaning, as per ISO 19119:2016.

ISO 19119:2016 provides a framework for geographic services, including their classification and components, while ISO 19128:2005 provides a standard for Web Map Service Interface.

Relevant Standard(s):

- ISO 19119:2016

- ISO 19128:2005

8.10 Object Catalogues

ISO 19110:2016 provides a methodology for cataloguing feature types.

A. Theme Standardization Requirements

- All data shared must be categorized under standardized themes including, but not limited to, transportation, utilities, broadband network infrastructure, water, administrative units, and land use as per ISO 19110:2016.

- Stakeholders must ensure that the theme categorization is done at the application level to facilitate easy access and retrieval of data, as per ISO 19110:2016.

B. ISO Feature Cataloguing Methodology Requirements

- Stakeholders must utilize the ISO feature cataloguing methodology to develop a comprehensive data dictionary for all data features as per ISO 19110:2016.

- The data dictionary must include clear definitions of each data feature, the authority for each feature, and the relationships between features as per ISO 19110:2016.

C. Data Consistency and Compatibility Requirements

- Stakeholders must ensure that all data is consistent within its theme and compatible with other data within the same theme, in line with ISO 19110:2016.

- Stakeholders are required to ensure that their data is interoperable with other datasets, allowing for seamless integration and use, as per ISO 19110:2016.

D. Data Update and Maintenance Requirements

- Stakeholders must commit to regularly updating their data to ensure its relevance and accuracy, as per ISO 19110:2016.

- A record of all updates and changes made to the data must be maintained and made accessible to users, as per ISO 19110:2016.

Relevant Standard(s):

- ISO 19110:2016

8.11 Metadata

A. Identification Requirements (MD_Identification)

- Metadata must include identification information such as the title (citation.title), abstract (abstract), temporal and geographic range (extent), the principal investigator or creator (pointOfContact), and point of record for information or data, as per ISO 19115:2014 and ISO 19115-2:2009.

- Metadata must include keywords (descriptiveKeywords) related to the dataset. These keywords should be attributed to a recognized thesaurus (thesaurusName) to improve interoperability and searchability, as per ISO 19115:2014 and ISO 19115-2:2009.

B. Distribution Requirements (MD_Distribution)

- Metadata must provide clear distribution information (distributionFormat and distributor) to help users find the data files. This includes the title of the dataset, the point of contact for the data (distributorContact), and the URL where the data and any related information can be accessed (onlineResource), as per ISO 19115:2014 and ISO 19115-2:2009.

C. Quality Requirements (DQ_DataQuality)

- Metadata must include information on the quality of the data. This should detail the precision and accuracy of the data (DQ_AccuracyOfaNumericalQuantity), any known issues or limitations with the data, and reference information such as the source of the data and the methods used for data collection, as per ISO 19115:2014 and ISO 19115- 2:2009.

D. Lineage Requirements (LI_Lineage)

- Metadata must provide clear lineage information. This includes details on the origin of the data (source), how it was collected and processed (processStep), and any actions taken on the data since its original collection, as per ISO 19115:2014 and ISO 19115- 2:2009.

E. Metadata Details Requirements (MD_Metadata)

- Metadata must specify the schedule in which the records are updated (MD_ MaintenanceInformation), and the metadata authority and point of contact (contact). This ensures users have the most current and accurate data and know who to contact for further information, as per ISO 19115:2014 and ISO 19115-2:2009.

ISO 19115-1:2014 provides a schema for describing metadata of geographic information, and ISO 19115-2:2009 extends this to include metadata for imagery and gridded data.

Relevant Standard(s):

- ISO 19115-1:2014
- ISO 19115-2:2009

GIS For Ontario

Proposed Data Sharing Information Model for Municipal, Provincial, Indigenous, and National Data Themes

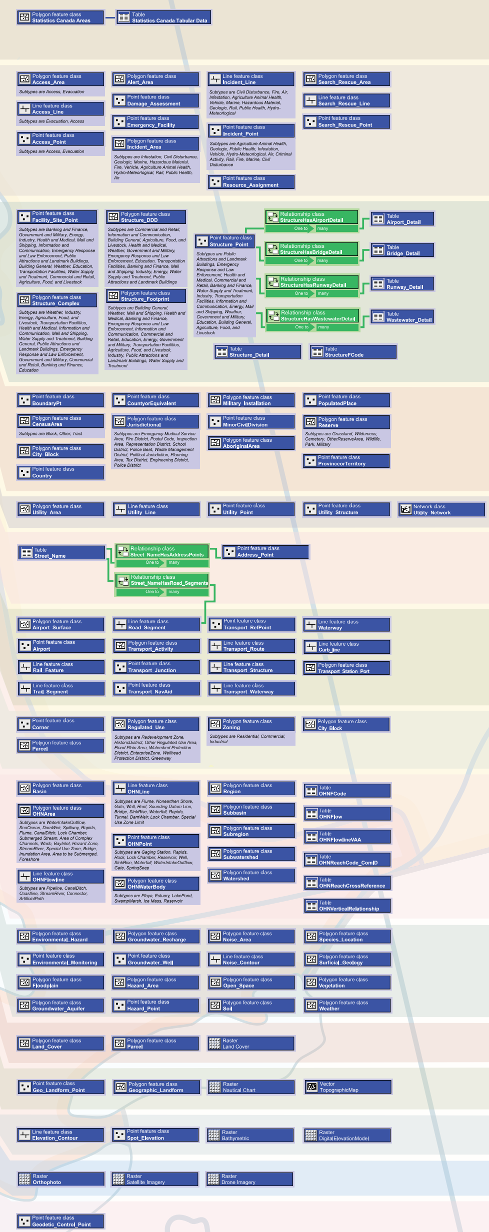
data themes

scales of use

national/provincial — regional/county — city — neighbourhood

guidelines

geographic datasets



Demographic

Feature types: Area polygons representing demographic / census data at multiple scales
Map use: Analysis and reference
Data source: Statistics Canada, Environics Analytics
Representation: Polygon
Spatial relationships: Areas should align with administrative boundaries and physical features
Information needs: Statistical census data, demographics, segmentation, moblie analytics, financial, health, psychographic and behaviuoral data

Guidelines: Census data is collected nationally every 5 years at a local level and aggregated to dissemination blocks, areas, census tracts, and subdivisions.

Emergency Operations

Feature types: Incidents, damage, operations, and safety locations – damage locations, road closures, evacuation routes, shelters, contamination zones, fire boundaries
Map use: Emergency response and preparedness
Data source: Local, indigenous, provincial and federal agencies
Representation: Points, lines, polygons
Spatial relationships: Operations must often be vertically integrated with structures, roads, administrative boundaries, and other geographic features
Information needs: Incident name, organization, address, points of contact, and start and end dates

Guidelines: Operations features should be collected at the appropriate scale for each specific activity or incident. GPS field collection or interpretation from imagery is preferred for data capture. Grid map location descriptions are also useful.

Structures/Critical Infrastructure

Feature types: Structure locations, and building footprints. Point locations for building centroids, entrances, and driveway entrances. Building complexes and wells. Often includes 3D representations of structures
Map use: Tax assessment, planning, emergency response, and critical infrastructure protection
Data source: Federal, provincial, and local government
Representation: Points, lines, polygons, BIMs, 3D objects
Spatial relationships: Often, structure location points must be located along or within the buildings they represent
Information needs: Address, name, points of contact, associated address, and structure names. For critical infrastructure, emergency contact information, level of risk, and facility details

Guidelines: Building footprints, entrances, complexes, driveways, etc. High accuracy required for neighbourhood and city level maps. Should be captured and represented to fit on the orthoimagery base. 3D buildings, BIM files and generation of full digital twins is a growing trend.

Governmental Units

Feature types: Administrative areas, census units, and management jurisdictions for local governments, provincial and federal agencies, and indigenous organizations
Map use: Administrative and legal boundaries
Data source: Federal, provincial, indigenous and local government, Statistics Canada
Representation: Polygons
Spatial relationships: Unit boundaries often must be vertically integrated and follow along the boundaries of features such as roads, parcels, and rivers. Areas must not self-overlap
Information needs: Managing agency, name, uses, and demographic characteristics

Guidelines: High accuracy required. Units can span across a range of map scales from 1:2,000 to 1:10,000 in cities and up to 1:250,000 in regions and provinces. Must be vertically integrated with the base features they are derived from, along with other governmental units.

Utilities

Feature types: The key components of water, wastewater, electrical, telecommunications, and pipeline networks
Map use: Transmission and distribution maps, emergency response, and critical infrastructure protection
Data source: Local indigenous, regional and national utilities
Representation: Points, lines, polygons, utility network
Spatial relationships: Integrates within the parcel and land base (building footprints, curb lines, and other structures)
Information needs: Equipment type, size, data installed, ownership, and connectivity

Guidelines: Accurate relative to cadastral and transportation data. Typical data capture scales are from 1:2,500 to 1:6,000. Accurate, shared local/provincial land base required for integration with other GIS datasets.

Addresses and Names

Feature types: Address ranges along street centerlines as well as address point locations for building entrances. Also, place names for key landmarks, geographic zones, geographic features (such as waterbodies), neighbourhoods and locations
Map use: Geocoding and route planning
Data source: Local, provincial, federal, indigenous and commercial sources
Representation: Points, lines, polygons
Spatial relationships: Address points must fall within buildings and parcels
Information needs: Address, address styles, alternative addresses, address relationship to each feature representation (to parcels, building centroids, building entrances, points-of-interest, and streets)

Guidelines: Address and name information will be associated with features collected at neighbourhood extents for building entrances, structures, parcels, and landmarks. Addresses and names will also be collected for addressable features such as street centerlines and place name locations.

Transportation

Feature types: At neighbourhood level: curb lines, street center lines, rail, commuter lines, bus lines, and other transportation lines; transportation stations as polygons. At city and above, street centerlines and transportation lines, stations as point, underground transportation networks
Map use: Basemaps, transportation planning and analysis, and emergency route planning
Data source: City and county governments, indigenous organizations, provincial and commercial sources
Representation: Lines, junctions, polygons, network
Spatial relationships: Road segments must connect
Information needs: Street names, address ranges, road class, roadway characteristics, optional navigation and linear referencing characteristics, jurisdiction for law enforcement and emergency response

Guidelines: Centerlines for addressing and navigation purposes, larger scale representations provide more detailed infrastructure and network characteristics. Roads should follow a simple centerline with address range approach at regional and provincial levels.

Cadastral

Feature types: Tax parcels, ownership parcels, and parcel corners. Also includes key features that integrate into the land fabric such as zoning, rights, interests, and easements
Map use: Tax mapping, and surface ownership maps
Data source: Local, provincial, indigenous, and federal government
Representation: Points, lines, polygons
Spatial relationships: Parcels and corners integrate with survey and legal description fabrics, many other data themes are referenced to the cadastre
Information needs: PIN, owner, assessed value, improvements, rights, interests, encumbrances, and survey characteristics

Guidelines: Primarily collected at neighbourhood scales using survey techniques. At the neighbourhood level, the parcel is the primary mapping unit. City and county level representations are important to identify and distinguish city blocks and to highlight government and private lands.

Hydrography

Feature types: Hydro points, lines, and polygons. Watersheds, coastlines, and drainage areas. Connectivity and channel profiles for hydrological analysis. Integrates with high resolution DEM
Map use: Surface water and features for moving, storing, and managing water. Flood risk mapping. Includes support for hydrologic analysis.
Data source: Local, indigenous and provincial water management agencies. Local, indigenous and provincial governments and Federal agencies
Representation: LIDAR point collection, points, lines, polygons
Spatial relationships: Spatially integrated into landscape and terrain. Stream and water system connectivity is critical. Stream gauge stations should snap onto the hydro network
Information needs: Identification, names, hydrologic properties, and relationship to landscape features

Guidelines: Regional and provincial analysis at 1:100,000 resolution to 1:25,000 resolution. Local needs dictate better than 1:25,000 resolution, especially in flood prone or coastal areas. Hydrologic network and channel representations are important to support analytical use. LIDAR is the preferred source for detailed flood risk mapping.

Environmental

Feature types: Includes physical features and landform characteristics such as geology, hazards, and events (such as earthquakes, environmental monitoring sensors and measurements)
Map use: Soil maps, geology maps, environmental monitoring, permitting, spatial modeling, and analysis
Data source: Federal agencies, provincial departments and indigenous and local governments
Representation: Points, polygons, lines
Spatial relationships: Landform layers should be vertically integrated and attribute combinations should be consistent
Information needs: Environmental landscape classification, and hazard areas. Need time series information for weather, stream gauges, and other sensors

Guidelines: Three primary information sets: 1) physiographic and landform features, 2) environmental events and hazards, and 3) weather. Mainly collected at city and regional levels. Vertical integration of landform polygons is important to ensure consistency in environmental classification and modeling.

Land Use/Land Cover

Feature types: Area units that define the primary ways in which land is used (e.g., urban, rural, agricultural, range, forest, and so on)
Map use: Land cover maps, planning, and zoning
Data source: Derived from remotely sensed data or captured at the parcel level
Representation: Polygons, raster dataset
Spatial relationships: Land use and land cover are integrated with other key layers depending upon the geographic level
Information needs: Land use classification of parcels for local and regional planning. Also, classification of raster imagery for smaller scale analysis such as natural resource management in a province

Guidelines: Collected at city and regional levels as attributes on parcels and administrative land units. Collected as raster data at scales of 1:50,000 or smaller.

Base Map

Feature types: New cartographic specifications for multiscale web based maps; consistent representation of all map scales. Consistent presentation of national maps, as well as for each province and city. All other data themes should be collected in order to meet these cartographic needs along with other application needs
Map use: Accurate and up-to-date reference maps used to provide a geographic framework for positioning of all data, general purpose mapping
Data source: Federal, provincial, indigenous and local governments
Representation: Points, lines, polygons, rasters, and cartographic representations
Spatial relationships: Overlaps and other cartographic conflicts should be minimized in map representations
Information needs: Text labels, place names, feature representations, cartographic elements, feature classifications, consistent symbology, mapguidelines, web maps and feature services

Guidelines: Modern vector basemaps integrate numerous authorative and up-to-date data sources in to one single, seamless, multiscale, cartographically consistent map.

Elevation

Feature types: Includes surface elevation and bathymetric observations (such as LIDAR point collections, hydrographic surveys, and other 3-D surveys) as well as derived DEMs
Viewshed analysis, surface distance calculation, and resource flows. Environmental and water resources planning and analyses
Map use: General purpose mapping
Data source: LIDAR, surveys, and other remotely sensed data
Representation: Elevation points, contour lines, TINs, DEMs, and hillshades
Spatial relationships: Elevation is related to hydro and orthophotography datasets
Information needs: Elevation at a given location, navigational bathymetry, slope, aspect, historical changes in elevation/bathymetry

Guidelines: Ontario Elevation Data is integrated with the Ontario Hydrography Network. Base digital files at 1:10,000 and 1:20,000. City and regional datasets may also have more detailed elevation data.

Imagery

Feature types: Focus is on high resolution digital orthophotography coverage collected at periodic time intervals. Also includes satellite imagery and drone imagery
Map use: Aerial photography and satellite imagery as reference data
Data source: Various remote sensors
Representation: Raster
Spatial relationships: Many other datasets should align with or be derived from imagery
Information needs: Colour, elevation, georeferencing models including stereo, cloud cover/time, and other metadata

Guidelines: Orthoimagery should be collected for populated areas every two years using the same control as the cadastral data. Provincewide coverage should be collected every three to five years.

Geodetic Control

Feature types: Survey control network for local, regional, and national geo-referencing. For neighbourhood and city level geographies, control can be represented by the cadastral framework
Map use: Common coordinate reference for all other geographic features
Data source: Canadian Geodetic Survey, provincial and regional partners
Representation: Points
Spatial relationships: Cadastral, orthoimagery, and LIDAR data should be tied to geodetic control. GPS ground station and transportation networks may also be referenced to geodetic control
Information needs: Identification, monuments, survey locations, survey order, metadata for coordinate systems including vertical and horizontal datums

Guidelines: Geodetic control provides a common reference system for establishing the coordinate positions of all geographic data. It provides the means for tying all geographic features to common, nationally used horizontal and vertical coordinate systems. The main features of geodetic control information are geodetic control stations.

DTO Digital Twin Ontario — esri Canada

Digital Twin Ontario

DigitalTwinOntario.ca

info@digitaltwinontario.ca