



3.7.

Geomatics Systems Management

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Geomatics Systems Management

Background

Geomatics includes the set of tools and methods used to acquire, represent, analyze and integrate geographic data. The term “geomatics” is derived from the contraction of the words “geography” and “informatics.” Geomatics is closely related to the geographic information that represents an object or phenomenon in space.

Within the Ville de Montréal (the City), the Système d’information géographique et spatiale (SIGS) presents all the geographic data found in the associated systems to which it is connected. Databases and a Serveur d’imagerie containing aerial photos of the territory of the Island of Montréal make up these associated systems.

Geomatics has extremely numerous fields of application, such as surveying, topography, urban planning, snow clearing and traffic signal operations.

Purpose of the Audit

The purpose of this audit was to assess the effectiveness of the control mechanisms in place to ensure the integrity, confidentiality and availability of data in both the SIGS environment and the hosted databases and files to which it is connected.

Results

Overall, we concluded that the City has established several control mechanisms that ensure sound geomatics systems management.

Some improvements are required in the areas of the roles and responsibilities framework associated with management of the SIGS and the owner of this system, management of privileged logical access to geomatics systems, the management framework for SIGS incidents and the IT contingency plan for the SIGS within the City.

Main Findings

Governance

- No roles and responsibilities matrix has been developed for management of the SIGS. The concept of owner has not been defined within the City.

Privileged Logical Access Management

- Although the informal processes are adequate, no procedure for managing privileged logical access to geomatics systems has been developed.
- There is no procedure concerning authentication parameters for the Oracle databases.
- With the exception of the Serveur d'imagerie, the authentication parameters set forth in the City's logical access management standard are not all applied in the geomatics systems.

Resources Specialized in Geomatics

- The stakeholders associated with geomatics systems management have a sufficient number of specialized resources. A succession and reorganization plan exists for the stakeholders involved to ensure appropriate succession. A training program or plan has been defined and training programs are pursued based on needs.

Functional Documentation

- The existing documentation helps ensure sound geomatics systems management. It is reviewed and updated by the appropriate resources and is known to and used by those who require it in accordance with their responsibilities.

Security Configuration

- Management of the SIGS security configuration is adequate.

Incident Management

- No procedure for managing SIGS incidents has been documented. The informal management process is in keeping with sound practices.

Backup Copies Management of Configuration Parameters

- A procedure for managing backup copies has been developed and is in keeping with sound practices.

IT contingency plan for the SIGS

- Although a business impact analysis has been conducted, no IT contingency plan for the SIGS exists within the City.

In addition to these results, we have made various recommendations to the business units, which are presented in the following pages. These business units were given the opportunity to agree to the recommendations.

List of Acronyms

ATI	Analyse, traitement et intégration
DB	database
RACI	Responsible, Accountable, Consulted and Informed
RIRE	Répertoire informatisé des rues et emplacements
SCA	Service de concertation des arrondissements
SIA	Système d'information des arrondissements
SIGS	Système d'information géographique et spatiale
SIRR	Service des infrastructures du réseau routier
SIURS	Système d'informations urbaines à référence spatiale
STI	Service des technologies de l'information



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1. Background

In Canada, the term “geomatics” appeared in the early 1980s. This discipline arose from geography and developments in computer science. Like other cities in the world, the Ville de Montréal (the City) wanted to gather all its geographic data and make it available. As a consequence, it turned to technologies that already existed on the market and were well established in other large cities. It therefore acquired the Système d’information géographique et spatiale (SIGS) in order to graphically represent the reality of the land covering the territory of the Island of Montréal.

These days, many of the decisions made all over the world take geography into account. Geographic data is at the very source of the science of geomatics. Geographic data is often processed in specialized software called a geographic information systems or GIS. This type of system is an integrated set of hardware, software and data for gathering, managing, analyzing and displaying all spatially referenced information (e.g., aqueducts, streets and parks), regardless of the format.

A system such as the SIGS quickly reveals features that might go unnoticed or be difficult to understand if they were presented other than on a map (e.g., in a report or spreadsheet).

1.1. Definition of Geomatics

Geomatics includes the set of tools and methods used to acquire, represent, analyze and integrate geographic data. The term “geomatics” was derived from a contraction of the words “geography” and “informatics.” A decision was made to group together in a coherent way all the knowledge and technologies necessary for the production and processing of digital data describing the land, its resources or any other object or phenomenon (e.g., floods) with a geographical position.

Geomatics consists of at least three separate activities: gathering, processing and distributing geographic data.

While geomatics is not well understood by the general public, citizens use its applications on a daily basis without even knowing it (e.g., GPS navigation).

Common examples of fields in which geomatics is used:

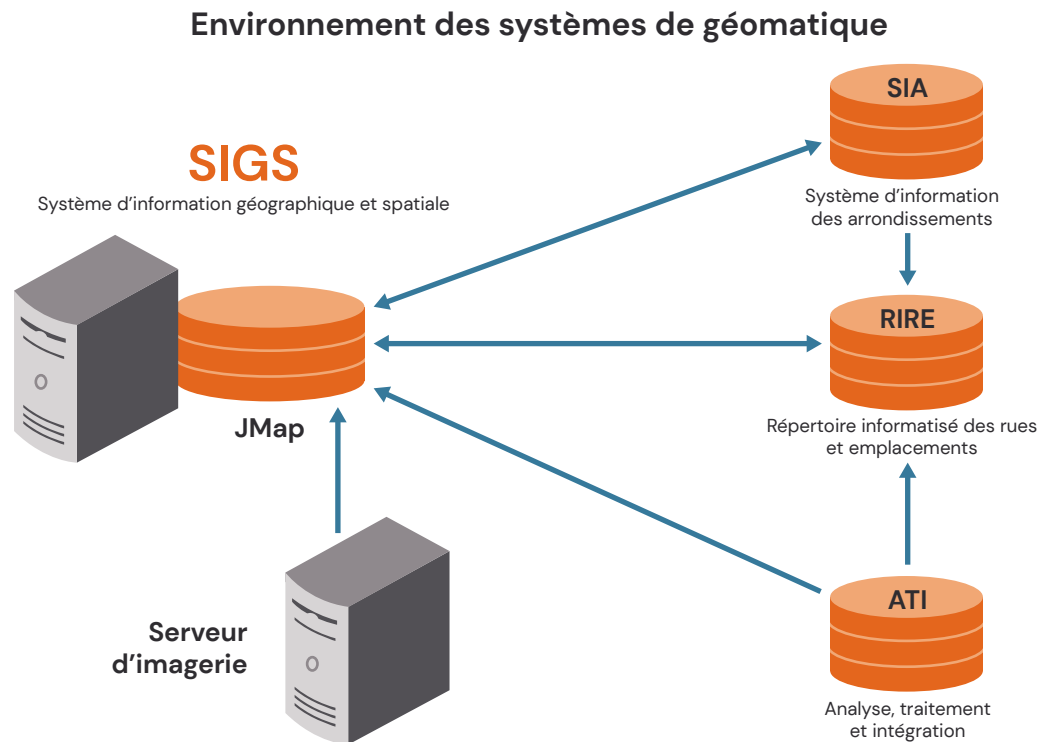
- Engineering;
- Land surveying;
- Geography;
- Topography;
- Land use and urban planning;
- Agriculture;
- Risk management;
- Meteorology;
- 911;
- Public safety;
- Hydrography;
- Transportation.

1.2. Description of Systems in the Field of Geomatics in Ville de Montréal

The main sources of data in the geomatics systems are the following:

- Land data;
- Topography;
- Green spaces;
- Heritage;
- Water and sanitation;
- Security;
- Service de police de la Ville de Montréal;
- Service de sécurité incendie de Montréal;
- Streets and parking;
- Construction permits;
- Urban planning;
- Habitat;
- Urban travel;
- Urban cleanliness;
- Public;
- Outreach mission.

The following diagram shows the environment of the City's geomatics systems.



Here are details of the components of this environment:

- **SIGS**: can be used to query, interpret and understand geographic data. This system is supplied by JMap, a map-based integration platform delivered by a supplier specializing in geomatics.

This platform is connected to a large number of systems and consolidates disparate data to facilitate the creation of a fully integrated IT ecosystem. It enables managers, SIGS analysts and non-technical users to collaborate, analyze, make decisions and take action in real time. It was deployed within the City in client-server mode.

Mapping data is structured in 366 layers in the SIGS. These layers (e.g., land register, buildings and plans) are displayed on the map like transparencies piled on top of each other. They are independent of each other and can be displayed or hidden.

- **Répertoire informatisé des rues et emplacements (RIRE)**: This database (DB) can be consulted to obtain information on roads and locations (property tax and tenant accounts) on the territory of the island of Montréal, including a map section. The data in this DB converges towards the SIGS.
- **Système d'informations urbaines à référence spatiale (SIURS)**: This system contains the geomatics data (e.g., addresses, islands, lakes and railways) found in the SIGS. This is not a system in the usual sense of the term, but rather a file storage centre in a network directory connected to the RIRE database.

- **Système d'information des arrondissements (SIA):** This system is a DB of non-mapping data that is geographically represented in the SIGS. About thirty applications originating from business units supply this DB, such as applications for managing routes and road signs.
- **Analyse, traitement et intégration (ATI):** This is a DB containing the geospatial data (geographic data that uses coordinates to indicate position) of the Division de la géomatique of the Service des infrastructures du réseau routier (SIRR). This DB supplies the RIRE and SIGS systems.
- **Serveur d'imagerie:** This server hosts orthophotographs, which are digitized aerial photos corrected by a computer so that they can be superimposed according to the ground mapping. Orthophotographs display geo-referenced data: the water network, the aqueduct system, the roads, the canopy, the géobase (the road network layer in the SIGS) and the basic model (three-dimensional digital modelling of buildings and topography of the ground, on which are placed aerial photographs).

SIGS users are from the City's different business units and boroughs as well as related cities. An internal survey on the use of the SIGS was conducted from July to September 2019.¹ Based on the number of responses received, 47.3% of the respondents are from central departments and 52.7% are from boroughs. Nineteen of the 36 central departments responded to the survey, including the Service de l'eau, the SIRR, the Service de la gestion et de la planification immobilière and the Service de sécurité incendie de Montréal. All 19 boroughs use the SIGS.

1.3. Main Advantages of a Geographic Information System

The main advantages of a geographic information system—such as the GIS used by the City—are as follows:

- Centralization of data from a variety of applications;
- Management of a great deal of information of all types, e.g., satellite images, aerial photographs, maps, databases; spatial and non-spatial data (GIS, databases, sensors, GPS and radio frequency identification);
- Rapid data updating;
- Production of queries (classical and spatial);
- Creation of new layers of information through data crossing or data queries;
- Viewing of geographic data;
- Optimization of the functioning of an organization;
- Powerful decision-making tool (e.g., for planning road work or snow clearing).

¹ Results of the survey on the use of the SIGS by the Service de concertation des arrondissements.

1.4. Main Issues with a Geographic Information System

The main issue associated with a geographic information system is obtaining data of a high enough quality that it is reliable and representative of reality. For this purpose, a separate audit on the quality of geomatics data is under way.

The other issues normally associated with a system or a DB also apply to the use of a geographic information system. In particular, these issues concern:

- the protection of sensitive or confidential data, if applicable (e.g., land-related data, building permits). For this purpose, the City has decided to remove all personal information;
- keeping accessible data up to date;
- the security configuration of the system;
- patch management;
- IT recovery in the event of a system breakdown;
- logical access management, especially privileged access, for the purpose of preserving data integrity.

2. Purpose and Scope of the Audit

Under the provisions of the *Cities and Towns Act* (CTA), we completed a performance audit mission on the Geomatics Systems Management. We performed this mission in accordance with the *Canadian Standard on Assurance Engagements* (CSAE) 3001, described in the *CPA Canada Handbook – Assurance*.

The purpose of this audit was to assess the effectiveness of the control mechanisms in place to ensure the integrity, confidentiality and availability of data on both the SIGS environment and the hosted databases and files to which it is connected.

The role of the Auditor General of the Ville de Montréal is to provide a conclusion regarding the objectives of the audit. To do so, we collected a sufficient amount of relevant evidence on which to base our conclusion and to obtain a reasonable level of assurance. Our assessment is based on criteria we have deemed valid for the purposes of this audit. They are presented in Appendix 5.1.

The Auditor General of the Ville de Montréal applies *Canadian Standard on Quality Control* (CSQC) 1 from the *CPA Canada Handbook – Certification* and, accordingly, maintains a comprehensive system of quality control, including documented policies and procedures regarding compliance with ethical requirements, professional standards and applicable legal and regulatory requirements. In addition, it complies with the independence and other ethical requirements of the *Code of ethics of chartered professional accountants*, which are founded on fundamental principles of integrity, professional competence and due diligence, confidentiality and professional conduct.

Our audit focused solely on the SIGS, the RIRE, SIA and ATI databases and the Serveur d'imagerie. The SIGS contains geomatics data from these associated databases and this associated server.

To conduct our audit work, we audited the following business units involved in geomatics systems management:

- The Service des technologies de l'information (STI);
- The Service de concertation des arrondissements (SCA);
- The Service des infrastructures du réseau routier (SIRR).

Our audit work focused on the period from June 2020 to January 2021. Our audit work consisted in interviewing personnel, examining various documents and conducting surveys that we considered appropriate to obtain conclusive evidence. We also took into account information that was sent to us up to March 22, 2021.

Upon completing our work, we submitted a draft audit report to the managers of each of the audited business units for discussion purposes. The final report was then forwarded to the management of each of the business units involved as well as to the Direction générale to obtain action plans and timelines for implementing the recommendations concerning them.

3. Audit Results

3.1. Governance of the Système d'information géographique et spatiale (SIGS)

Sound governance of the SIGS consists primarily in defining the roles and responsibilities of the various parties involved in each task associated with managing it. This is formalized in a RACI (Responsible, Accountable, Consulted and Informed) responsibility matrix.

It also consists in identifying and formally assigning an owner to the SIGS, one vested with the appropriate legitimacy and authority to make decisions concerning this system and provide adequate guidance to all the stakeholders involved concerning their actions, such as adding layers of information and applying a new strategic orientation, or simply in their queries or requests, and ultimately to have these actions accepted or refused, depending on their impacts on the SIGS.

We were informed by the business units we met with that the parties involved in governing and managing the SIGS are the STI and the SCA.

We noted that one of the City's intranet pages concerns the geomatics applications (e.g., the SIGS) that are maintained by the Centre d'expertise en géomatique. It also lists resources to be contacted based on the specific need (e.g., requesting access or advice in geomatics, reporting an incident or a data problem, making a request for a change or a project, contacting the SIGS or RIRE pilot). All this information is kept up to date. In addition, details on SIGS support groups are given in the IT services management tool accessible through the STI.

However, in our estimation, the elements listed above do not correspond to a RACI responsibility matrix for the SIGS. Furthermore, a SIGS owner has not been formally identified or assigned.

A lack of formality concerning the roles and responsibilities of the stakeholders involved and their assignment could lead to a duplication of responsibilities or ignorance about them, or even lead to forgetting a responsibility. This situation could impact on the quality of services offered and expected by users in the business units.

3.1.A. Recommendation

We recommend that the Service de concertation des arrondissements, together with the Service des technologies de l'information:

- document a roles and responsibilities matrix for managing the Système d'information géographique et spatiale;
- officialize the system owner in the matrix;
- ensure that these roles and responsibilities are communicated and properly understood.

3.2. Privileged Logical Access Management

3.2.1. Authentication Parameters

Authentication parameters can provide a formal framework for the identifiers—user codes and passwords—that are used to connect to the different computer systems. To achieve this, it is above all necessary to define a management framework for authentication and to apply it appropriately in the relevant computer systems. These authentication parameters concern the use of a user code and the password strategy, meaning the minimum length, complexity, period of validity and history of passwords as well as the number of unsuccessful attempts, the account lockout duration and so on.

We noted that a directive concerning logical access management was issued in July 2020 and a logical access management standard was issued in November 2020. Under the directive, the logical access management standard specifies the security requirements to be complied with, including the authentication parameters. This standard is in keeping with sound practices.

However, no procedure on the authentication parameters has been defined for the Oracle DBs, i.e., the RIRE and ATI DBs.

We also found that the authentication parameters set forth in the standard issued in November 2020 are not all applied in the geomatics systems, with the exception of the Serveur d'imagerie.

The use of passwords that are not strong enough could lead to unauthorized access.

3.2.1.A. Recommendation

We recommend that the Service des technologies de l'information develop a procedure concerning the authentication parameters specific to Oracle databases.

3.2.1.B. Recommendation

We recommend that the Service des technologies de l'information comply with the new Logical Access Management Standard concerning authentication for the Système d'information géographique et spatiale (SIGS), the Système d'information des arrondissements (SIA) database, the Répertoire informatisé des rues et emplacements (RIRE) database and the Analyse, traitement et intégration (ATI) database.

3.2.2. Privileged Logical Access Management Procedure

A logical access management procedure outlines the steps to be followed to create, modify, revoke, review and delete accounts and the monitoring of logical access rights, more specifically, privileged access. Privileged access is granted to system administrators and authorized resources who require more extensive access to data to accomplish their tasks.

This procedure should cover the following:

- Limited and restricted use of privileged access by authorized resources;
- Formal approval of all requests to use an account with privileged access;
- Deletion of unused user accounts that have been suspended for a certain period of time;
- Regular review of access rights associated with the accounts;
- Monitoring of high-privilege accounts.

We noted that the logical access management standard issued in November 2020 contains specific requirements for high-privilege accounts. Details of these requirements should be found in a logical access management procedure outlining the steps to be followed to create, modify, revoke, review, delete and monitor logical access rights for this type of account.

However, we found that no procedure for managing privileged logical access to geomatics systems (SIGS/JMap, RIRE, SIA, ATI and the Serveur d'imagerie) has been developed, approved or distributed to the stakeholders.

Nevertheless, on the whole, informal procedures for managing privileged logical access are in place. In the absence of requests to create, modify or revoke privileged access to geomatics systems, no efficiency test was conducted for the period of November 2019 to October 2020. On the other hand, we found no obsolete accounts in the lists of privileged users of geomatics systems. Moreover, the access review conducted on the geomatics systems is adequate.

The absence of a documented procedure for managing high-privilege logical access could lead to poor management of this type of access; it could even result in granting unauthorized access to geomatics data.

3.2.2.A. Recommendation

We recommend that the Service des technologies de l'information develop, approve and distribute a procedure for managing privileged logical access to the Système d'information géographique et spatiale (SIGS), the Système d'information des arrondissements (SIA) database, Répertoire informatisé des rues et emplacements (RIRE) database, Analyse, traitement et intégration (ATI) database and the Serveur d'imagerie.

3.3. Resources Specialized in Geomatics

The presence of resources specialized in geomatics provides an organization with resources skilled in managing the geomatics data integration platform and other associated systems. These resources meet unique, highly specific needs based on their business sector: land use, transportation, traffic signalling, water management and a host of others. To do this, a sufficient number of resources specialized in geomatics should be present and their leading-edge skills should be kept up to date in accordance with changes in geomatics systems.

By department, we took note of the following:

Service des technologies de l'information (STI)

The STI's Direction Solutions d'affaires – Gestion du territoire, with its Centre d'expertise en géomatique, has a sufficient number of resources dedicated to geomatics with extensive expertise in this field. This number meets the Centre's current needs, because priority is given to the operation of systems according to geomatics projects that are carried out based on available resources. This Centre also has one resource that specializes in the RIRE DB as well as one resource that specializes in the SIURS (file storage centre). This Direction also has resources that support the SIGS. The Direction engagement numérique has one resource that specializes in the SIA DB.

A reorganization plan has been deployed within the Direction Solutions d'affaires – Gestion du territoire to ensure succession for key positions occupied by specialized resources for the RIRE, SIA and SIURS DBs. A human resources training program has been defined for the resources that support the SIGS in this division. In addition, a table listing training programs for the Centre d'expertise en géomatique is kept up to date and approved by the management team.

No recommendation is necessary.

Service de concertation des arrondissements (SCA)

The SCA's Division du développement, exploitation et pilotage de système has a sufficient number of resources dedicated to geomatics-related tasks. They are experts in the field of geomatics and meet this division's current needs.

A human resources succession plan is under development to cover all employees in this division. No formal training plan has been developed within this division. However, training is taken based on needs and production systems. In addition, steps are being taken to develop the service offering and the tools required for applications that enter the SIGS, such as Planif neige and Info remorquage. Additional training will therefore be introduced to support these services.

No recommendation is necessary.

Service des infrastructures du réseau routier (SIRR)

The SIRR's Division de la géomatique and, more specifically, its geomatics engineering section, has a sufficient number of resources dedicated to geomatics activities to meet the current needs and responsibilities associated with the ATI DB and the Serveur d'imagerie.

A training plan has been developed and will be updated in early 2021. All the resources of the geomatics engineering team received online training in accordance with this plan. A reorganization plan is under way within this team to address succession and ensure all tasks are assigned a manager.

No recommendation is necessary.

3.4. Functional Documentation

Functional documentation deals with the technical information of a system. This type of documentation covers system configuration and the creation of the IT environment and is used as a reference for maintenance, development, technical support, training and operations management activities.

We noted that functional documentation on the geomatics systems—SIGS, the RIRE database (including its SIURS file storage system, which is connected to RIRE), the SIA and ATI databases and the Serveur d'imagerie—had either been developed by stakeholders involved in system management or obtained from the suppliers concerned.

In our estimation, all of the existing documentation helps ensure sound geomatics systems management. More specifically, for example, one set of functional documents is used to manage the RIRE DB containing data sets, a second is helpful for understanding the functioning of the SIURS, its components and the update procedures applied, a third covers the configuration of the ATI DB environment and its stored data, and a fourth outlines the procedure for distributing orthophotographs from the Serveur d'imagerie.

We also noted that functional documents are reviewed and updated by the appropriate resources and are known to and used by the stakeholders who require them in accordance with their responsibilities.

No recommendation is necessary.

3.5. Security Configuration

A security configuration consists in defining the values assigned to the security parameters of a computer system so it is not vulnerable to malicious connections and to protect its content, which may include sensitive data. A security configuration guide formally defines the values to be implemented in the configuration of a computer system.

We noted that the SIGS does not contain any confidential, strategic, sensitive or personal data. The SIGS client interface is built on the map-based integration platform JMap. JMap is a product purchased from a supplier that specializes in the field of geomatics and is responsible for maintaining and updating it.

The supplier also provides a configuration guide on its website, which is accessible to everyone. This guide describes security configuration and how to publish a map with JMap. The version in production, with the SIGS client interface, dates from 2010. No other update has taken place. We found no deficiencies in the configuration in production following correlation with the configuration guide.

No recommendation is necessary.

3.6. Incident Management in the Système d'information géographique et spatiale (SIGS)

To ensure effective, efficient incident management, a formally approved incident management procedure will serve as a reference for the stakeholders involved in this type of management. The key steps in the incident management process include opening, categorizing, prioritizing, investigating, resolving and closing an incident record.

We noted that the STI had no procedure for managing SIGS incidents. However, the STI teams apply an informal incident management process.

In a random selection from the list of incidents we obtained from the STI, we selected eight of the 71 moderate and high-priority incidents² and two of the 166 low-priority incidents that occurred in the period from November 1, 2019, to October 30, 2020. This list does not include any critical-priority incident. Our incident sample is as follows:

- five high-priority incidents;
- three moderate-priority incidents;
- two low-priority incidents.

We noted that this informal process for managing SIGS incidents follows sound practices in terms of documenting, categorizing, prioritizing, resolving and closing an incident in the City's IT services management tool.

However, we noted that the SIGS does not send a notification at the time of an incident. This is because notification is not integrated into the map-based integration platform, JMap, which is currently in production. Nevertheless, as soon as an SIGS incident record is opened in the IT services management tool, it sends a notification email to the Centre d'expertise en géomatique team. We further noted that this tool also sends an email to IT managers when an incident is not dealt with within the prescribed recovery times. In this regard, all the incidents in our sample had been resolved within these periods.

The absence of a documented procedure for managing SIGS incidents could lead to poor management of such incidents, which could cause instability in the SIGS and even lead to a significant reduction or a temporary unavailability of the service expected.

3.6.A. Recommendation

We recommend that the Service des technologies de l'information document, approve and distribute a procedure for managing incidents in the Système d'information géographique et spatiale.

² The priority of an incident is a combination of its impact and its urgency. Priority is useful in identifying the relative importance of incidents and assigning resources accordingly.

3.7. Backup Copies Management of the Système d'information géographique et spatiale (SIGS) Configuration Parameters

A computer system contains several types of information, including configuration parameters. These parameters are the very foundations of the computer system. Without these parameters, the system cannot be functional and perform the intended operations. They can be used to define, for example, the parameters for displaying data and the parameters of connection paths to other systems, such as databases or the file server.

Backup copies contain information on the configuration parameters. In a situation of system breakdown, equipment damage or loop back, it is necessary to have access to backup copies of the up-to-date configuration parameters in order to reconstruct a computer system. Without this, reconstruction could be very difficult, even impossible.

During our meetings with the STI, we noted that the SIGS, with its map-based integration platform, JMap, does not host and does not produce any data on business units originating from the RIRE, SIA or ATI DBs or the Serveur d'imagerie, which shows the data in these databases.

The information hosted in JMap consists of the configuration parameters of applications (e.g., the SIGS) and personal layers. More specifically, these parameters are listed as follows:

- The DB connection configurations (addresses, user names, passwords) used by the application layers;
- The layer display parameters;
- The connection paths from the layers to the DBs or data files;
- Schedules for refreshing data sources;
- User identifiers, i.e., the user code and password;
- Interfaces with the other, non-mapping systems.

Personal layers refer to the data layers that users create for their personal use or to share with their colleagues.

We noted that a procedure for managing backup copies of the SIGS configuration parameters has been developed by a technical resource of the STI and approved by both the line manager and the information security team. This procedure, which can be accessed by administrators of backup copies, covers the IT infrastructure, including, in particular, the Windows servers that host the SIGS. It contains the information normally expected, including a description of the backup service (type of backup tool, replication, autonomy), the computer architecture and the backup policy (frequency and retention).

Moreover, backup copies are produced regularly. Every day, a backup tool makes incremental backup copies³ of all the Windows server files in which the SIGS is hosted, including the system configuration parameters. The replication is carried out simultaneously at the second site, seven kilometres away. Every year, a complete backup of the City's IT infrastructure is made. An automated alert system is in place to inform administrators on a daily basis of any execution problem encountered in the production of backup copies.

We also noted that recovery tests are conducted on the IT infrastructure, but none on the SIGS configuration parameters. These parameters could be easily defined by referring to the configuration guide provided by the supplier specializing in the field of geomatics. Consequently, we consider the residual risk to be acceptable.

No recommendation is necessary.

3.8. IT Contingency Plan for the **Système d'information géographique et spatiale (SIGS)**

In the event of an incident, breakdown or contamination by malware or hacking software, an organization's computer systems can suddenly become unusable. Having an adapted IT contingency plan can help an organization quickly resume operations. IT recovery also relies on the existence of a backup environment. The only way of knowing whether the contingency plan and backup environment pass the reality test is to perform regular tests. The test results, if applicable, provide an opportunity to update the contingency plan and backup environment.

The business units we interviewed informed us of the existence of a persistent problem. A preventive restart of the SIGS needs to be carried out every week in order to prevent sudden breakdowns caused by a memory leak in JMap. A memory leak occurs when the SIGS uses more memory than necessary, which leads to saturation of the hosting application server's memory.

During these restarts, the SIGS does not always come back functional. Event logs do not cite any problem in particular. The Centre d'expertise en géomatique suspects long DB reconnection times. In the event of a breakdown, users wait for the SIGS JMap service to restart for lack of another option. In the event of server corruption, the backup copies of the SIGS configuration parameters can be restored.

We noted that the City has not developed an IT contingency plan for the SIGS. An inventory of the IT systems used by the Direction Solutions d'affaires – Gestion du territoire, including the SIGS, was produced by the architects. Over the course of our mandate, a business impact analysis was conducted and completed on these systems. The IT contingency plan of this division will ensue at a later date yet to be determined.

³ An incremental backup contains only what has changed since the previous backup copy.

Furthermore, no backup environment has been deployed for the SIGS to date. A new server could be recreated from backup copies. However, this option has not been tested since January 2017. Since the SIGS was not considered a critical system that needs to be available 24/7, no budget has been set aside to create a contingency.

In the absence of an IT contingency plan or a backup environment for the SIGS, no contingency test has been conducted on this environment.

The absence of an IT contingency plan for the SIGS could cause this system to be unavailable during a breakdown. This situation could also cause users to lose confidence in the system and lead to an interruption of activities in their geographic data projects.

3.8.A. Recommendation

We recommend that the Service des technologies de l'information develop, approve, distribute, test and keep up to date an IT contingency plan of the map-based integration platform Système d'information géographique et spatiale/JMap.

4. Conclusion

Overall, we conclude that the Ville de Montréal (the City) has put in place several control mechanisms ensuring sound geomatics systems management. However, some elements need to be improved.

Our audit revealed that neither the roles and responsibilities associated with management of the Système d'information géographique et spatiale (SIGS) nor the owner of this system are supported by a RACI (Responsible, Accountable, Consulted and Informed) responsibility matrix. Without such a matrix, an overlooked area of responsibility could impact on the services provided by geomatics systems that the business units expect.

A logical access management standard, issued in November 2020, is not applied uniformly on the authentication parameters of geomatics systems, with the exception of the Serveur d'imagerie. In addition, no documented procedure exists concerning either management of privileged logical access to geomatics systems or the authentication parameters specific to Oracle databases (DBs). This situation could lead to unauthorized access.

No documented procedure for managing SIGS incidents has been developed, approved or distributed to the stakeholders involved. This could lead to instability in the SIGS.

No IT contingency plan for the SIGS has been deployed within the City. However, a business impact analysis of systems operated by the STI's Direction Solutions d'affaires – Gestion du territoire, including the SIGS, was conducted in November 2020. This analysis will be used as a premise to develop an IT contingency plan. This absence could cause the SIGS to become unavailable.

More specifically, here are the details based on the following evaluation criteria:

Evaluation criterion – Governance

No RACI matrix of roles and responsibilities associated with SIGS governance and management has been developed, approved and distributed to the stakeholders involved. Furthermore, the concept of owner has not been defined within the City.

Evaluation criterion – Logical access management

The City's logical access management standard of November 2020 specifies the requirements for the authentication parameters and is in keeping with sound practices. However, these parameters are not all applied in the geomatics systems, with the exception of the Serveur d'imagerie. Furthermore, no procedure concerning authentication parameters has been defined for Oracle DBs.

No documented procedure for managing privileged logical access to geomatics systems has been developed, approved and distributed to the stakeholders involved. Nevertheless, as a whole, the informal processes in place for managing privileged logical access are adequate.

Evaluation criterion – Specialized geomatics resources

Stakeholders associated with geomatics systems management all have a sufficient number of resources specialized in geomatics and in the geomatics systems.

A succession or reorganization plan exists for stakeholders in order to ensure appropriate succession at all times. A training program or plan has been defined for the stakeholders involved and training programs are pursued based on needs.

Evaluation criterion – Functional documentation

All the existing documentation helps ensure sound geomatics systems management. The functional documents are reviewed and updated by the appropriate resources and known to and used by the stakeholders who require them in accordance with their responsibilities.

Evaluation criterion – Security configuration

Management of the SIGS security configuration is adequate. It is compliant with what is recommended in the configuration guide provided by the supplier.

Evaluation criterion – Incident management

No procedure for managing SIGS incidents has been documented, approved and distributed to the stakeholders involved. However, the informal process for managing SIGS incidents follows sound practices in terms of documenting, categorizing, prioritizing, resolving and closing an incident.

Evaluation criterion – Backup copies management of the configuration parameters

A procedure for managing backup copies has been developed and it is in keeping with sound practices. Backup copies of the SIGS configuration parameters are made regularly and replicated at two physical sites. Recovery tests are conducted on the IT infrastructure.

Evaluation criterion – IT contingency plan for the SIGS

No IT contingency plan for the SIGS exists within the City. A business impact analysis was conducted within the Direction Solutions d'affaires – Gestion du territoire, and will be used as a premise for developing an IT contingency plan for the SIGS.

5. Appendix

5.1. Objective and Evaluation Criteria

Objective

Assess the effectiveness of the control mechanisms in place to ensure the integrity, confidentiality and availability of SIGS environment data and the hosted databases and files to which it is connected.

Evaluation Criteria

Our audit focused on the following evaluation criteria:

Criterion 1: Governance

The roles and responsibilities associated with the governance and management of the SIGS geomatics system are documented, comprehensive, approved, up to date and are formally distributed to and applied by the stakeholders involved.

A SIGS owner is formally identified and assigned.

Criterion 2: Logical access management

The Service des technologies de l'information (STI) has defined a management framework for the authentication parameters, based on sound practices, that is applied to geomatics systems: SIGS/JMap, the Répertoire informatisé des rues et emplacements (RIRE) DB, the Système d'information des arrondissements (SIA) DB, the Analyse, traitement et intégration (ATI) DB and the Serveur d'imagerie.

A procedure for managing logical access (creating, modifying, cancelling, reviewing, deleting and monitoring privileged access rights) to the geomatics systems—SIGS/JMap, the RIRE DB, SIA DB and ATI DB and the Serveur d'imagerie—has been developed and is followed by the stakeholders involved.

Criterion 3: Resources specialized in geomatics

There are a sufficient number of resources specialized in geomatics to allow adequate management of geomatics systems.

A human resources succession plan and a geomatics training program are in place.

Criterion 4: Functional documentation

Technical documentation covering the configuration, the use and the environment of the geomatics systems—SIGS/JMap, the RIRE DB, SIA DB and ATI DB and the Serveur d'imagerie—was developed by the parties involved in managing these systems—the STI, the Service de concertation des arrondissements (SCA) and the Service des infrastructures du réseau routier (SIRR).

These documents are approved and known to and used by all these stakeholders.

Criterion 5: Security configuration

A security configuration guide for SIGS/JMap, i.e., an enterprise repository, has been developed and approved by the STI, based on good market practices.

The security configuration parameters defined in the configuration guide are applied on the map-based integration platform in production and kept in a configuration management DB.

Criterion 6: Incident management

A procedure for managing SIGS incidents has been developed, approved, and distributed to the stakeholders involved and is reviewed at a predefined frequency.

The application of this procedure includes sending automated alerts at the time of technical incidents, classifying and prioritizing incidents based on their impact and urgency and resolving and closing incident records in the City's Système de gestion des services informatiques.

Criterion 7: Backup copies management of the configuration parameters

Adequate backup copies of the SIGS are produced regularly and stored at an external site.

Recovery tests are performed on backup copies on a regular basis.

Criterion 8: IT contingency plan for SIGS

A backup or contingency plan of the SIGS/JMap map-based integration platform has been developed, approved, distributed and kept up to date.

A backup or redundancy environment has been deployed to ensure that the SIGS and its components resume operations in a timely manner in the event of a major breakdown of the production server.

A contingency plan test of the SIGS/JMap map-based integration platform is performed every year on the SIGS backup environment.

If applicable, action plans are defined and applied on the basis of the results of this test.



