

**Report of the Auditor General
of the Ville de Montréal**
to the City Council and to the
Urban Agglomeration Council

For the Year Ended December 31, 2013

5.10

**Laboratory Activities
– Quality Control of
Materials and Expert
Assessments**

(Service des infrastructures, du
transport et de l'environnement –
Direction des infrastructures)

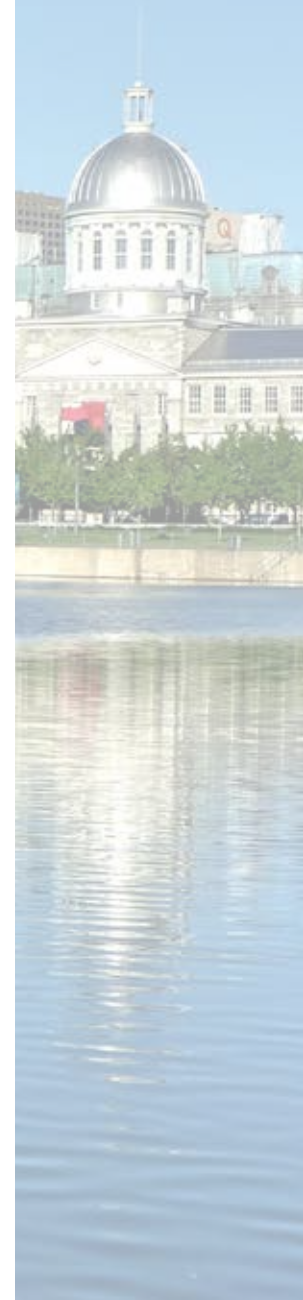


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List of Acronyms

BNQ	Bureau de normalisation du Québec	DTP	Direction des travaux publics
CSA	Canadian Standards Association	MTQ	Ministère des Transports du Québec
DEST	Division de l'expertise et du soutien technique	RCC	roller-compacted concrete
DGSRE	Direction de la gestion stratégique des réseaux d'eau	SITE	Service des infrastructures, du transport et de l'environnement
DI	Direction des infrastructures	TCEP	three-year capital expenditures program

5.10. Laboratory Activities – Quality Control of Materials and Expert Assessments (Service des infrastructures, du transport et de l’environnement – Direction des infrastructures)

1. Introduction

The Direction des infrastructures (DI) reports to the Service des infrastructures, du transport et de l’environnement (SITE) and has a mandate to plan, design, build and manage infrastructure work on the territory of the Ville de Montréal (the city). This infrastructure, for which the SITE is responsible, includes the arterial road system, bridges and tunnels, as well as the replacement of pipes in the secondary water and sewer systems, when the Service de l’eau¹ assigns responsibility for such work to the DI. The DI is responsible for implementing methods for re-building infrastructure, under the best conditions and at the best cost, to extend its sustainability and ensure its protection and integrity.

To this end, the compliance and sustainability of the infrastructure depend in large part on the quality of the materials and processes used during their construction. As a result, quality control testing of the materials used and of their installation while the work is being done on the various projects undertaken falls under the responsibilities assigned to the DI, and is assumed by its Division de l’expertise et du soutien technique (DEST).

The DEST’s mission is to offer specialized services to the city’s central departments and boroughs:

- standardization (e.g., evaluation of the quality of new materials used for civil engineering, establishment of technical guidelines concerning quality control testing of materials, production of standardized technical specifications²) for various types of materials (e.g., regular concrete, roller-compacted concrete [RCC], hot mix, recycled materials) and maintaining an up-to-date list of pre-approved material suppliers;
- technical studies (e.g., the evaluation of the condition of bridges, tunnels and roadways, geotechnical studies, vibration studies);

¹ Through the Direction de la gestion stratégique des réseaux d’eau (DGSRE).

² The standardized technical specifications are reference documents specific to the materials generally used for doing the work. The information provided in these documents pertains to the characteristics of the materials, reference standards such as those of the American Society for Testing and Materials (ASTM), the Canadian Standards Association (CSA) or the Bureau de normalisation du Québec (BNQ), installation instructions (e.g., weather conditions) as well as the quality control tests required.

- quality control tests³ for materials, on-site and laboratory analyses and assessments (e.g., core sampling).

Within the DEST, the underlying tasks for this service offer are shared by three groups:

- the group responsible for geotechnical activities;
- the group responsible for road activities;
- the group responsible for material quality control, namely the Section contrôle des matériaux et expertise.

More specifically, for the central departments and the boroughs that call on⁴ the expertise of the DEST for civil engineering projects (infrastructure construction, rehabilitation or re-building), the Section contrôle des matériaux et expertise must specifically make sure that the materials used comply with the specifications of the tender documents and respect the standards and technical guidelines in effect, among other things. This quality control testing of materials takes place on two levels, namely:

- in the laboratory: to confirm that the make-up of the materials (type of material, formula) proposed by the contractor responsible for the work meets the specifications provided in the plans and specifications for the project as well as the city's standards (e.g., the specific standardized technical specifications for the various types of materials used);
- on the site: in order to make sure, in particular, that the materials pre-approved by the DEST are the materials that are delivered and installed, and that the installation conditions are adequate to ensure the sustainability of the work (e.g., weather conditions, condition of the surface to be paved, the temperature required for certain materials, compaction). In this respect, various samples will be taken and various tests will be performed throughout the course of the work (e.g., sampling when the concrete is poured, core sampling, compaction tests).

The services offered within the DEST may concern road work (e.g., roads, sidewalks), parks, water mains and sewer lines, and structures such as bridges, tunnels and buildings. The quality control tests performed (in the laboratory and on site) include testing of materials such as cement concrete and mortar, granular materials⁵ (aggregates), asphalt paving⁶ and metals (e.g., cast iron pipes, sump grates).

³ Definition: tests, material testing.

⁴ The principal parties requiring services from the DEST are the boroughs from the former Ville de Montréal, the DI (SITE), the Direction des grands parcs et du verdissement (Service de la qualité de vie), the DGSRE (Service de l'eau) and the Direction des immeubles (Service de concertation des arrondissements et des ressources matérielles).

⁵ Mixtures of sand, gravel, stone, etc. used specifically for street foundations and filling water main and sewer trenches.

⁶ Mixtures of gravel, sand and hydrocarbon binder (commonly called asphalt) applied in one or more layers to make a road.

2. Purpose and Scope of the Audit

The purpose of the audit was to evaluate the extent to which the quality control tests performed by the DEST or by external firms ensure that the materials used for civil engineering projects comply with the requirements set out in the technical specifications, standards and guidelines. We also wanted to determine whether the non-compliances identified following quality control tests performed on the materials are taken into account by the business units concerned.

This audit work covers primarily the years 2011 and 2012, but it also takes into account the information transmitted to us up to September 2013. For certain aspects, data obtained prior to these years were also taken into consideration.

Our audit work concentrated on the Division de la surveillance des travaux⁷ which, as in the case of the DEST, comes under the jurisdiction of the DI. The Division de la surveillance des travaux is responsible for infrastructure work undertaken within the SITE. In order to support our conclusions, we selected and examined five projects completed in 2011 and 2012 involving the construction of road, water and sewer infrastructure (see Appendix 6.1).

3. Summary of Findings

Our audit work identified sectors requiring improvements. The following sections of this audit report highlight shortcomings with respect to:

- The assignment of mandates to private laboratories and follow-up with respect to the services provided (Section 4.1):
 - The mandates for quality control testing of materials are assigned to private laboratories covered by the master agreement before they have necessarily read the plans and specifications for the project and have submitted, for approval, a detailed program of the quality control tests to be performed as well as an evaluation of the professional fees for the services to be provided;
 - The DEST does not make sporadic visits to the work site to benefit from complementary sources of information that would serve to corroborate the accuracy of the invoices submitted later by the private laboratories mandated.

⁷ It should be noted that this division was created on January 1, 2013. At the time we conducted our audit, the activities of this division were handled by the former division, the Division conception et réalisation des travaux.

- Approval of the compliance of “bulk” materials at the start of the project (Section 4.2.1.1):
 - the formulas and the technical specifications for this type of material are not always verified and approved by the DEST at the start of the project, as stipulated in the technical guidelines in effect;
 - With the exception of verbal communications and presentations, no formal administrative guidelines are given to the stakeholders in question specifying:
 - The maximum time allowed for submitting the formulas and the technical specifications to the DEST for verification and approval,
 - The recommended follow-up mechanisms for corroborating that all of the formulas and the technical specifications were verified and approved by the DEST.

- Compliance and completeness of the quality control tests done during the project:
 - For the bulk materials delivered to and installed on the site (Section 4.2.2.1):
 - No follow-up mechanisms have been implemented to identify, for each of the mandates assigned to the private laboratories, the situations in which laboratory analyses or on-site tests were conducted in keeping with the standards and guidelines in effect,
 - The specific guidelines and the decisions made with respect to the nature of the quality control tests to be conducted for a given project are not always documented,
 - The descriptive specifications included in the tender documents of the master agreements signed do not contain a clause providing for the application of penalties in the event that the work is not done;
 - For the pre-fabricated materials installed (Section 4.2.2.2):
 - The guidelines prepared for the mandated laboratories do not contain any indication concerning the quality control tests for these materials,
 - The site supervisors do not always document the verifications to be carried out towards them.

- Deadlines for communicating the results (Section 4.2.3):
 - The verbal communications concerning non-compliant results are not documented;
 - The work-site and laboratory test reports indicating non-compliant results are, to a large extent, sent to the stakeholders after the prescribed deadline.

- The handling of non-compliances reported and the application of penalties (Section 4.2.4):
 - The decisions made with respect the handling non-compliances reported during the course of the work are not always recorded in the file;

- A copy of the work-site logs and any other support document, prepared by the external firms mandated by the city to perform and supervise the work are not systematically given to the city;
 - The DEST's technical guidelines do not specify any obligation, on the part of the private laboratories mandated, to systematically document the potential consequences arising from the reported non-compliances, in each of the work-site and laboratory test reports produced;
 - When the budget for the three-year capital expenditures program (TCEP) is adopted late, the city cannot maximize its chances of being able to benefit from infrastructure of sustainable quality;
 - The pre-determined unit prices to be used to calculate the financial penalties imposed on contractors, in the event that core sampling indicates the non-compliance of the work done, are not up to date.
- Compatibility of the normative reference documents and service reports used (Section 4.3):
 - The normative reference documents in force include discrepancies or ambiguities and are not updated on a regular basis;
 - The private laboratories mandated by the DEST use their own templates for their test reports, which does not promote the standardization of processes and respect for compliance with quality standards as enacted by the city.
 - Accountability and governance (Section 4.4):
 - The current mode of operation with respect to sharing roles and responsibilities among the various stakeholders concerned makes it difficult for the DEST to ensure follow-up with respect to reported non-compliances;
 - At present, there are no accountability mechanisms with respect to handling non-compliances reported by the DEST, and management therefore has no assurance that the work done on the site meets the expected quality standards.

4. Detailed Findings and Recommendations

For infrastructure projects, the various stakeholders, whose roles and responsibilities differ, must work jointly in order to ensure that the work, regardless of its nature, will be done in keeping with the expected technical specifications and quality standards.

In this respect, during our examination of the five projects covered by our audit (see Appendix 6.1), we divided the stakeholders involved in the processes underlying the work into two main groups.

The first group includes the stakeholders that report to the Division de la surveillance des travaux, including:

- **the project manager**, who is responsible for:
 - coordinating all of the work, taking into consideration the various stakeholders concerned, in order to ensure that everything goes smoothly and the expected results are achieved,
 - tracking the progress of the project in terms of respecting the allocated budget, the established timelines and the expected deliverables,
 - deciding whether or not to accept the work or impose the sanctions provided (e.g., penalties, re-doing work) when the quality control testing of the materials indicates elements that do not comply with the plans and technical specifications;
- **the designated site supervisor**, who may be an employee of the city of or an external firm that is mandated and who is responsible for:
 - supervising the work on the site and taking action with the contractor when required to ensure that quality standards are respected, the work complies with the requirements of the plans and specifications, and the applicable standards and laws are respected,
 - compiling data, making surveys and taking length measurements as well as preparing detailed reports indicating, among other things, the progress and the nature of the work done, the number of hours worked, the equipment and the number of hours it is used,
 - communicating with the mandated private laboratory to make sure a technician is present on the site,
 - validating the compliance and the quantities of the granular materials delivered to the site.

The second group includes the stakeholders within the DEST who are involved specifically with quality control tests of the materials used for a project, such as:

- **the site technician (and his engineer)**, who, for all of the projects examined, came from an external laboratory mandated by the DEST to perform quality control tests on materials. The responsibilities of the site technician include:
 - making sure that the materials used were pre-approved by the DEST,
 - taking samples at the site or performing tests on the materials in keeping with the technical guidelines provided by the DEST and certifying their compliance with plans and specifications,

- drafting work-site service reports (e.g., the technical test report, the logs and the site memos);
- **the mandate engineer**, who reports to the DEST and is responsible for making sure that expert assessment services are provided and that quality control tests are performed on the materials for a project, in keeping with the technical guidelines and standards established by the DEST. The responsibilities of the mandate engineer include:
 - ensuring follow-up with respect to quality control tests performed by external laboratories mandated to perform such tests, with respect to the costs, timelines and expected deliverables (e.g., receiving the work-site service reports and laboratory test reports),
 - verifying the accuracy of the invoices submitted by these firms in order to approve payment,
 - verifying and approving the final reports produced by the external laboratories mandated,
 - giving the Division de la surveillance des travaux project manager the support and expertise needed, upon request;
- **the DEST technical agents**, who must, among other things, accept the materials at the start of the project, which involves approving the technical specifications for the materials or, depending on the situation, the formulas (e.g., the formula for the concrete or asphalt). Following the visits and inspections that are made, these technical agents also take part in preparing a list of suppliers and manufacturing plants that are pre-approved by the DEST. This list is, moreover, provided to the stakeholders on the site and is included in the tender documents. It should be noted that these tasks can also be performed by the mandate engineer.

In order to complete the infrastructure work that comes under the jurisdiction of the SITE, the DEST stakeholders are called on to act at the request of the administrative units concerned (e.g., Division de la surveillance des travaux), so as to mandate an external laboratory to perform quality control tests on the materials and provide the necessary support and expertise when required. When the quality control tests reveal non-compliances, the role of the DEST is to inform the project manager (within the business unit that requested the service), who has the authority to decide whether or not to order the necessary corrective measures with respect to the work done.

In order to evaluate the controls exercised by the DEST to ensure the quality control testing of materials respected the requirements set out in the specifications, regulations or guidelines, the five projects in our sample were selected based on the following criteria:

- The project involved road work (e.g., roads, sidewalks) or water mains or sewer lines;
- The project had been completed by the time of our audit;

- The quality control testing had, inasmuch as possible, been assigned by the DEST to different laboratories (see Appendix 6.1; three different laboratories were finally targeted for the five projects in our sample).

4.1. Assignment of Mandates to Private Laboratories and Follow-Up with Respect to the Services Provided

4.1.A. Background and Findings

As a result of the extent of its activities, the scope of the demand and the fact that several dozen projects are undertaken concurrently, the DEST started using the services of private laboratories as of 2004. Annually, after a public call for tenders is issued, the professional services of several firms (four to five) are retained, based on an evaluation of their technical scores and their distinct price envelopes. This involves the use of a “master agreement” type contract through which the approved firms share a pre-determined portion of the maximum budget approved by city authorities. This type of agreement allows the DEST to use, at the request of the business units requiring such services (boroughs and central departments), the budget credits provided in the contract as the resulting mandates are assigned. Thus, in keeping with needs and at the request and under the supervision of the DEST, the firms retained fulfil various mandates to provide expertise and perform quality control tests on materials, until the budget credits provided for in the agreement are depleted.

The information obtained from the DEST reveals that, during 2012 more than 95% of the quality control services required for materials on work sites were provided by external firms for the sum of \$5.1 million (92.4% in 2011 for \$3.1 million, 100% in 2010 for \$2.8 million).

Although the DEST is responsible for managing the master agreements, it does not have budget credits for this. In fact, the mandates are assigned to the firms by means of purchase orders for which the budget credits come from the projects under the jurisdiction of the business units requesting the services (central departments and/or boroughs).

It should be noted that, for the purposes of our audit work, the mandates for quality control testing of the materials for the five projects selected were issued to the DEST at the request of the Division de la surveillance des travaux, which reports to the DI of the SITE (see Appendix 6.1).

During the design stage, the projects to be undertaken by the DI must provide an estimate for the incidental costs, which pertain, among other things, to quality control testing of materials. For this purpose, the DEST gives the units requesting their services an evaluation

form (table) that can be used to estimate the average cost of the quality control tests to be performed on the materials. More specifically, using a compilation of past costs, this table establishes the percentage of the costs to be allocated to quality control testing of materials, in keeping with the nature of the project (e.g., water mains or sewer lines = x%, PRR⁸ – planning and resurfacing roadways = y %). This estimated amount is then used by the unit requesting the services, namely the DI, to create the purchase order in the city's accounting system. This purchase order will then be used by the DEST to authorize the payment of the invoices submitted by the external firm mandated.

Within the DEST, each of the master agreements is assigned to a mandate engineer who is responsible for following up with respect to allocated budgets as well as the various mandates awarded by the DEST to external firms.

In order to be able to provide a better framework for the work assigned to external firms for material quality control testing, the DEST prepared two documents containing guidelines,⁹ which are systematically given to the firms retained, namely:

- an **administrative guidelines** document that presents the general and administrative instructions for fulfilling the assigned mandate. It is intended to provide details about elements such as the nature of the work to be performed for the quality control testing of materials, the responsibilities of the external firm with respect to those of the DEST, the content expected in the final report to be produced at the end of the work, the submission of invoices and related vouchers (e.g., time sheets, work-site and laboratory test reports);
- a **technical guidelines** document that specifies the nature of the quality control tests the firm must perform with respect to materials such as cement concrete, asphalt paving and granular materials. In particular, it covers elements pertaining to the verification of the formulas (make-up of the materials), approval of the material technical data sheets (e.g., granular materials), the frequency and number of samples to be taken during the work-site quality control tests, as well as communication of the results and handling of the non-compliances identified.

By its very nature, this type of contract requires rigorous control of the sums allocated so as to ensure efficient and economic use of public funds.

At this stage in the process, our audit work involved enquiring into the procedure used by the DEST for awarding mandates, within the master agreements signed, and for ensuring follow-up with respect to the services provided under the assigned mandates.

⁸ [TRANSLATION] Road re-building program.

⁹ These guidelines are updated annually. For the purposes of our work, the 2011 and 2012 versions were primarily used.

First, the information obtained from the DEST personnel responsible for such matters reveals that the mandates are assigned to the various firms retained under the master agreements so as to ensure a rotation among them, with consideration for particular factors that may result in the selection of one firm over another (e.g., specific expertise required for a project, proximity of the work site to the firm's location).

Nevertheless, based on our examination, we noted that the firms are sometimes mandated very late in the process, even sometimes after the work has begun. Although many factors may have an impact on the organization of the work load within the DEST (e.g., the number of requests, the availability of personnel), we nevertheless have questions with respect to the mechanisms implemented to allow the DEST to plan, in a timely manner, for the implementation of quality control testing for projects undertaken by the units requesting the services. Poor planning certainly results in a non-negligible risk that the construction work will be started before a firm has been designated to perform quality control testing on the materials used. According to our examination of the selected projects, for one of the five projects examined (Project 1203), the firm was given its mandate a full four days after work had started on the site (see Appendix 6.2).

We then examined the descriptive specifications (terms of reference) appended to the tender documents of three master agreements signed to retain professional services from private laboratories. For the five projects included in our sample, the budgets allocated for quality control testing of the materials were assigned under budget envelopes available under master agreements for 2009 (call for tenders No. 09-10935 – one project), 2010 (call for tenders No. 10-11296 – three projects) and 2011 (call for tenders No. 11-11668 – one project). Yet, Section 3, [TRANSLATION] “Scope of Professional Services” of the descriptive specifications of each of these three master agreements and, more specifically, Clause 3.2, [TRANSLATION] “Particulars and follow-up of mandates,” specifically states:

[TRANSLATION] The Company shall, for each of the mandates assigned to it, read the plans and specifications for the project and submit a quality control program and a budget estimate for the program to the manager for approval.¹⁰

Among the five projects in our sample, we noted that the DEST assigned the mandate for quality control of the materials in writing (by means of a letter sent by email or fax) to one of the private laboratories under the agreement. However, upon reading the letter sent to the firm in question, we noted that the purpose of the letter was to confirm the mandate that had been assigned rather than to invite the firm to submit a proposal for the work to be done and an estimate for the applicable fees, as provided in the descriptive specifications. In fact, our

¹⁰ Our emphasis.

examination of the files prepared for the five mandates included in our sample, as well as the information obtained from the personnel responsible for the projects, reveal that the DEST did not receive proposals from any of the contracted firms providing detailed information about the nature of the work they proposed to do (e.g., number of samples to be analyzed in the laboratory, number of compaction tests planned, production of interim and final reports).

This procedure raises serious questions with respect to the DEST's ability to corroborate, in advance, that the quality control tests planned by the firm are exhaustive and that they respect the technical guidelines given to them. Moreover, it raises doubts as to the effectiveness of the controls that may be exercised by the DEST in order to ensure that it will subsequently be billed only for the tests that were planned and that it approved. The DEST's procedure does allow it to use supporting documents included with the invoice (e.g., time sheets, site reports and laboratory test reports) to verify the invoices submitted by the contracted firms with respect to such matters as the hours worked, hourly rates charged, the qualification of the members of the work team, the tests performed on the site or in a laboratory. Nevertheless, although the experience and knowledge of the engineers responsible for such matters within the DEST must be taken into consideration, the fact that there is no detailed program for the work to be done makes it difficult to obtain assurance that all of the tests requested, and only those tests, were actually done and invoiced. Overall, we noted that the DEST pays what it is invoiced. Moreover, we will return to this aspect in more detail in Section 4.2.2 of this audit report, when we discuss the compliance and completeness of the quality control tests performed during the course of the project.

These findings concerning the follow-up of the services provided by the firms seem all the more pertinent to us since, according to the information obtained from the managers we met, none of the DEST personnel responsible for contracts or technical agents go to the site to ensure a certain amount of supervision with respect to the work done by the contracted firms. We are of the opinion that, in order to obtain complementary information to corroborate the accuracy of the invoices submitted by the firms (e.g., the presence of the site technician designated by the firm, the actual taking of samples or performance of tests), it could be appropriate to plan sporadic site inspections.

Moreover, we also noted that, at no time did the DEST obtain an estimate from the firm for the costs of the contract to be awarded. We even noted that, for the five mandates examined, the letter sent to the firm immediately confirmed the budget envelope available to the city, namely the amount of the purchase order corresponding to the cost estimate established by a representative of the DI. This procedure does not promote cost-effective management of public funds since the DEST is in no position to determine if the city is paying a fair price for the services requested. In fact, with this procedure, the contracted firms know the budget

available to the city in advance, without having to provide a price for the work requested. The city alone therefore assumes the risk associated with a budget estimate that is too generous, opening the door to the possibility of being overcharged by the contracted firms, particularly since they are not asked to provide any program for the work to be done. At the other end of the spectrum, it is also exposed to the risk associated with establishing a budget that is insufficient, which could endanger the performance of all the quality control tests required, depending on the scope of the project to be undertaken. In this respect, the information contained in the final report prepared by the firm contracted for Project 1223 (see Appendix 6.1) confirms that this risk materialized since the report clearly indicates that, as a result of a budget shortage and with the approval of the DEST, certain samples were not taken and certain laboratory tests were not done.

With respect to the plans and specifications, although the descriptive specifications of the master agreements examined stipulate that the firm must read them beforehand, in order to be able to submit a quality control program and a budget estimate that are appropriate for the scope of the project, our examination of the contracts awarded in this respect for the five projects selected confirms that, for three of the projects, the firm studied the plans and specifications after the DEST confirmed the awarding of the contract (see Appendix 6.2).

As a final analysis, we also wanted to look into the administrative frameworks that could have been implemented with respect to the attribution of contracts within the master agreement.

That is when we learned about an administrative framework approved on September 17, 2010, by the Direction des travaux publics (DTP) of the Service du développement et des opérations (now known as the “Direction des infrastructures” [DI] of the SITE). This administrative framework, which is still in effect, is entitled [TRANSLATION] “Awarding and following up on contracts for professional services.”¹¹ It is intended to establish the process for awarding mandates to firms that provide professional services under contract with the DI. Section 3, [TRANSLATION] “Scope,” stipulates:

[TRANSLATION] This framework applies to the attribution of any mandate resulting from a contract (specific or master agreement) adjudicated to a firm or a consortium of firms called on to provide professional services for urban infrastructure to the DTP.

According to this statement, we understand that the DEST is required to respect the application of this framework; Section 6 of the framework sets out the procedure for awarding mandates to various firms under a master agreement. Sub-section 6.3, [TRANSLATION] “Fee proposal request for a mandate,” specifically states:

¹¹ (PROC – 004.002).

[TRANSLATION] The process for attributing a mandate to a firm is initiated with a “Fee proposal request for a mandate” letter [...] The request contains the information the consultant needs to prepare a fee budget that represents the mandate to be fulfilled.

The framework in question also states that the proposal submitted by the firm must be examined in order to compare the amount of the proposed fees and that of the cost estimate previously established by the DI so that the pertinence of awarding the mandate to the firm in question can be determined.

During the course of our interviews with the managers and employees concerned within the DEST, we brought the content of the administrative framework in effect at the DI to their attention, without obtaining any assurance that they knew of its existence. Instead, these individuals invoked the large number of projects to be handled, the urgency of the work requested by certain units and the difficulty in obtaining a specific timeline from the contractors involved in the projects to justify their procedures, indicating that these factors made it more difficult to apply the methods for awarding mandates provided in the related clause of the descriptive specifications and the administrative framework in effect.

In conclusion, although healthy management practices are provided in the descriptive specifications of the calls for tenders and in the administrative framework in effect at the SITE, we noted that they are not applied at the DEST with respect to awarding mandates for quality control testing of materials to the various private laboratories under contract. Under the circumstances, we believe that it is of prime importance that action be taken on a short-term basis to change the current procedure, so as to promote the effective planning of work, the efficient and cost-effective allocation of public funds and the rigorous control of the services to be provided by these firms.

4.1.B. Recommendation

We recommend that, in order to pay only for the services requested and provided, the Direction des infrastructures take the necessary means, on a short-term basis, to review its procedures with respect to assigning mandates to private laboratories for quality control testing of materials so as to:

- know far enough in advance which projects will require a mandate to be granted to a firm to perform quality control tests on materials;
- obtain, for the purposes of prior approval, a written proposal from the firm in question, including a detailed quality control program as well as an estimation of the professional fees to be charged for the services to be provided, in keeping with the descriptive specifications and the administrative frameworks. To do this, the firm that is given the mandate must obtain, in a timely manner, all of the information required, such as plans and specifications.

Business unit's response:

[TRANSLATION] In order to know far enough in advance which projects will require a quality control mandate, the DEST's Section contrôle des matériaux et expertise will ask its clients to receive the project program for the year in progress. With respect to the DI's projects, the section will consult the program provided in the DI's dashboard. The section will remind its clients that the provisions required to initiate the process for granting a mandate to a firm can only be made once they have approved the purchase order. (Planned completion: March 2014)

With respect to receiving a written proposal including a quality control program and an estimate of the professional fees, the section will use one of the two following procedures, depending on the scope of the mandate to be assigned:

- *For smaller mandates (< \$30,000 in fees), the section will revise its technical guidelines to include all of its requirements for a given project, so that this will become the detailed quality control program for these mandates. The section will estimate the fees using the table entitled [TRANSLATION] Average cost of material quality control as a % of the total cost of the work, based on the nature of the work. This table will be revised annually. Following this, the purchase order that will be issued to the private firm will be issued in \$5,000 amounts, up to the maximum amount of the estimate made by the section, without the private firm ever being informed of the total amount of the estimate or the cost of the work. In the event that the costs are greater than the amount estimated, the section will prepare a written report justifying the overruns.*
- *For larger mandates (> \$30,000 in fees) or special mandates (such as large projects involving special materials or techniques), an initial \$5,000 purchase order will be issued to a firm to start the mandate or approve the quality control work when work starts on the site, then the section will systematically ask for a specific quality control program and a fee estimate. The revised purchase order*

*will be issued after the proposal has been approved by section personnel.
(Planned completion: May 2014)*

4.1.C. Recommendation

We also recommend to the Direction des infrastructures that the Division de l'expertise et du soutien technique make sporadic site visits in order to have access to complementary sources of information that can serve to corroborate the accuracy of the invoices that are later submitted by the external laboratories.

Business unit's response:

[TRANSLATION] The DEST will use the daily logs produced by the work supervisor to corroborate the hours that the private firm's technician is on site, compared with the hours indicated on the invoice. (Planned completion: May 2014)

4.2. Quality Control of Materials

4.2.A. Background and Findings

To ensure the sustainability of the infrastructure, rigorous quality control testing of the materials is essential during the course of the work. This quality control testing will specifically involve making sure that all of the materials and the processes used to install them correspond to the plans and specifications and comply with industry quality standards (e.g., BNQ¹² standards, CSA standards) as well as the city's requirements.

In order to be able to control the source of the materials that can be used when projects are implemented, the DEST's activities include assessing the materials offered on the market and evaluating the suppliers of these products. To do this, the DEST examines, among other things, the certifications held by the supplier certifying that the product satisfies industry standards (e.g., BNQ certification), carries out site inspections of the manufacturer's plant and performs laboratory tests in order to confirm that the materials produced satisfy the specifications of the tender documents and the standards in effect.

Following these steps, the DEST produces and updates three lists:

- **the list of pre-approved suppliers:** this list, which is found in most of the city's technical specifications, contains, for various categories of materials (e.g., premixed concrete, asphalt paving, crushed rock aggregate, pre-fabricated cast iron, steel or concrete materials), the following information:
 - the supplier's name,

¹² Bureau de normalisation du Québec.

- the BNQ certification number,
- the number of the plant the product comes from,
- the location of the plant;
- **the list of pre-approved materials:** this list, which, at the time of our work, was systematically communicated to the stakeholders concerned (e.g., the business units requiring the services, the private laboratories contracted), contains, for various types of materials (e.g., concrete, asphalt), information such as:
 - the supplier’s name,
 - the physical characteristics of the product (e.g., resistance to compression or freezing, density of the aggregate, slump threshold),
 - the number of the formula or the product codes specific to the plants where they are made;
- **the list of batches of pre-approved materials:** such a list exists, specifically for cast iron pipes for which the DEST performs its own tests on samples from batches of pipes produced on the days for which the supplier starts production for the city.

With these clarifications noted, the following sub-sections of this audit report will discuss, in turn, the results of our examination of the five projects in our file in terms of:

- the prior approval of the compliance of the materials to be used;
- the compliance and the completeness of the quality control tests performed during the course of the project, on both the materials and their installation;
- the deadlines for communicating the results of the quality control tests performed;
- the handling of reported non-compliances and the application of penalties, as required.

4.2.1. Approval of Material Compliance at the Start of the Project

4.2.1.1. “Bulk” Materials

4.2.1.1.A. Background and Findings

As we mentioned previously, the DEST has prepared a document containing technical guidelines to guide the private laboratories assigned to perform quality control tests on the materials for the various projects for which its involvement is requested. This document, entitled [TRANSLATION] “Technical Guidelines – Quality control testing of materials and expertise” is generally reviewed every year. For the purposes of this audit report, the technical guidelines for 2011 and 2012 were principally taken into consideration depending on the year in which the project included in our sample was completed.

The document in question includes the guidelines that the private laboratories must follow for performing quality controls tests on “bulk” materials, namely:

- cement concrete;
- asphalt paving;
- granular materials.

Thus, for each of these materials, the guideline specifies the obligations concerning the approval of the composition and the specifications with respect to the materials to be used for the project. In particular, it stipulates that:

[TRANSLATION] Unless specifically indicated otherwise, the Division de l'expertise et du soutien technique of the Ville de Montréal is responsible for verifying and accepting materials at the start of a project (approval of the technical specifications and formulas [...]). The approvals will be sent to the client and the contracted laboratory. They must also be sent to us when the responsibility falls to the mandated laboratory.

The technical guideline (2011 and 2012 versions) also stipulates that the contracted laboratory must validate any change in the material proposed by the contractor. As the case may be, the guideline stipulates that the contracted laboratory must:

- make sure that the supplier and the plant are indicated on the list of suppliers that have been pre-approved by the DEST;
- verify whether the formula for the material is indicated in the most recent edition of the materials that have been pre-approved by the DEST;
- validate and approve the formula if it is not indicated on the list of materials that have been pre-approved by the DEST in keeping with the specifications of the tender documents or in keeping with the change documents approved by the designer;
- send the formula approval form to the DEST with the requirements of the tender documents.

This process, which results in the prior approval of the quality of materials to be used for a project, supposes that there is a control and follow-up mechanism that is intended to ensure that all of the formulas and the technical specifications have been obtained from the contractor, within a reasonable time so as to enable the DEST to make the required verifications and give its approval, if required, before the work is started.

Thus, for the five projects included in our sample and for each of the bulk materials used, we prepared a list of the number of formulas (cement concrete and asphalt paving) or the technical specifications (aggregates) used for the work. We then made sure that these materials had first been approved by the DEST in keeping with the technical guideline in effect.

The three following tables show, in turn, our findings with respect to the following materials: cement concrete (Table 1), asphalt paving (Table 2) and granular materials (Table 3).

Table 1 – Cement Concrete Approval of Formulas

Project No.	Planned use	No. of formulas used	No. of formulas submitted to the DEST for approval	No. of formulas approved by the DEST	No. of formulas rejected by the DEST	No. of formula changes made during the course of the project	No. of formulas indicated on the list of pre-approved materials	No. of formulas validated by the contracted laboratory
1109	Sidewalks	1	0	0	0	0	1	N/A
1152	Sidewalks	1	0	0	0	0	1	N/A
1201	Machine curbs	1	0	0	0	0	1	N/A
	Hand curbs	1	0	0	0	0	1	N/A
1203	Road surface of a snow depot	1	0	0	0	0	0	1
1223	Sidewalks	1	1	1	0	1	1	N/A
	Connecting collars	1	1	0	1	1	1	N/A
Total		7	2	1	1	2	6	1

The external laboratory validated the formula and submitted it to the DEST for approval. Nevertheless, the DEST required an additional test for which the results were never sent. As a result, the formula for the concrete used was never officially approved by the DEST.

For the cement concrete, our examination produced the following findings:

- Of the seven concrete formulas used for the purposes of the projects examined, only two formulas (29%), namely those for Project 1223, were submitted to the DEST for approval. Nevertheless, the technical guideline clearly states that the DEST is responsible for verifying and approving the materials at the start of the project.

After these two concrete formulas were submitted to the DEST for approval (one was accepted, the other rejected), they were then changed during the work on the site. We are of the opinion that the procedure associated with the change made was handled in keeping with the technical guideline in effect.

- Of the five remaining formulas (Projects 1109, 1152, 1201 and 1203), we noted that, with the exception of the formula for the concrete used for Project 1203 for which the formal approval of the DEST was never obtained, the four other formulas used (Projects 1109, 1152 and 1201) were nevertheless indicated on the lists of materials pre-approved by the DEST.

Table 2 – Asphalt Paving Approval of Formulas

Project No.	Planned use	No. of formulas used	No. of formulas submitted to the DEST for approval	No. of formulas approved by the DEST	No. of formulas rejected by the DEST	No. of formula changes made during the course of the project	No. of formulas indicated on the list of pre-approved materials	No. of formulas validated by the contracted laboratory
1109	Base coat	1	0	0	0	0	1	N/A
	Surface coat	1	0	0	0	0	1	N/A
1152	Base coat	1	1	1	0	0	1	N/A
	Surface coat	1	1	1	0	0	1	N/A
1201	Base coat	1	0	0	0	0	1	N/A
	Intermediate coat	1	0	0	0	0	1	N/A
	Surface coat	1	0	0	0	0	1	N/A
1203	Base coat	1	1	1	0	0	1	N/A
	Surface coat	1	1	1	0	0	1	N/A
1223	Section A – Base and surface	1	0	0	0	0	0	N/A
	Section B – Base coat	1	1	1	0	0	1	N/A
	Section B – Surface coat	1	1	1	0	0	1	N/A
Total		12	6	6	0	0	11	N/A

The formula was not obtained for the purpose of approval and there is no indication in the file that allows us to corroborate that it was indicated on the list of materials pre-approved by the DEST.

With respect to the asphalt paving, our examination revealed the following: of the 12 formulas used for the purpose of the projects examined, only six (50% – Projects 1152, 1203 and 1223) were formally approved by the DEST in keeping with the technical guideline. Eleven of the formulas were nevertheless included in the list of materials pre-approved by the DEST. For the twelfth, used for Project 1223, we found no evidence of any form of approval whatsoever.

Table 3 – Granular Materials Approval of Technical Specifications

Project No.	Planned use	No. of materials used	No. of technical specifications submitted to the DEST for approval	No. of technical specifications approved by the DEST	No. of technical specifications rejected by the DEST	No. of material changes made during the course of the project	No. of materials for which the supplier is indicated on the list of pre-approved suppliers	No. of technical specifications validated by the contracted laboratory
1109	Fill	1	1	1	0	0	1	N/A
	Lower foundation	1	1	1	0	0	1	N/A
	Upper foundation	1	1	1	0	0	1	N/A
1152	Fill	2	2	2	0	0	2	N/A
	Lower foundation	2	1	1	0	0	2	N/A
	Upper foundation	1	1	1	0	0	1	N/A
1201	Lower foundation	1	1	1	0	0	1	N/A
	Upper foundation	1	1	1	0	0	1	N/A
1203	RCC slab cushion	1	0	0	0	0	1	N/A
	Upper foundation	2	1	1	0	0	2	N/A
1223	Fill	1	1	1	0	0	1	N/A
	Lower foundation	1	1	1	0	1	1	N/A
	Upper foundation	1	1	1	0	0	1	N/A
Total		16	13	13	0	1	16	N/A

It should be noted first that the granular materials are not covered by a list of pre-approved materials. The technical guideline refers instead to a list of pre-approved suppliers.

Based on our examination with respect to this type of material, we noted the following:

- Of the 16 granular materials used for the projects examined, technical specifications were submitted to the DEST and approved by that latter for 13 of them (81%).
- For the three other materials used (Projects 1152 and 1203), we found no evidence of any formal approval of the technical specifications by the DEST. Nevertheless, for the 16 materials used for the five projects examined (100% of the cases), the supplier was on the list of suppliers pre-approved by the DEST.

In conclusion, it may initially appear acceptable that some materials that should have been pre-approved by the DEST were not, because they were included in the list of pre-approved materials or the list of suppliers that have been pre-approved by the DEST. The fact remains,

however, that the technical guideline was not respected. Under the circumstances, there is, therefore, a risk that the material the contractor proposed to use does not correspond in all respects to that indicated on the DEST's pre-approved lists (materials and suppliers) or in the specifications provided in the tender documents (e.g., plans and specifications).

In fact, the verifications serve to confirm that the material provided is suitable for the use for which it is intended (e.g., concrete formula "x" for sidewalks, concrete formula "y" for a road slab), that it corresponds to the requirements of the plans and specifications and also that its characteristics still correspond to those that existed when the DEST included it in its list of pre-approved materials. This is in fact why the DEST insists, in its technical guideline, on assuming this responsibility with respect to verifying and approving materials.

We were informed by the DEST personnel we met that the procedures had been modified in order to attenuate these risks, namely that the list of pre-approved materials is no longer distributed. Moreover, we noted that the version of the technical guideline that was revised in 2013 with respect to the quality control of materials and expertise no longer refers to the list of pre-approved materials, thereby requiring contracted private laboratories to obtain the prior approval of the DEST.

Furthermore, based on the information obtained from the personnel we met and the examination we conducted, which revealed irregularities (see Tables 1, 2 and 3) concerning the DEST's reception rate for the formulas and the technical specifications submitted for approval, we note that no formalized follow-up mechanism has been implemented to enable the DEST to:

- obtain, before work starts on the site, the formulas and technical specifications in question within a sufficient amount of time to allow it to exercise the controls required to approve them;
- corroborate that, for each project, it has checked all of the formulas or technical specifications that must be submitted to it for verification and approval.

It is our understanding, based on the explanations obtained, that the project manager for the business unit requesting the services is generally the person designated to obtain all of the formulas and technical specifications from the contractor in question to be submitted to the DEST for approval. Nevertheless, although the deadlines for receiving the documents (e.g., five days prior to the start of work) may have been the subject of verbal communication among the various stakeholders in the process and were covered by a presentation made to them, we still believe that the procedure should be clarified by a formal administrative guideline sent to everyone.

Moreover, in order to confirm that all of the formulas and technical specifications were in fact submitted to the DEST for verification and approval, we are of the opinion that arrangements must be made to review the procedures and tighten internal controls. We believe that this might be an opportune time for the DEST personnel responsible for mandates to use the plans and specifications for each of the projects for which they are responsible to prepare a list of all the materials, according to their nature, for which they expect to receive a formula or technical specifications for approval. These corrective measures could also be included in a formal administrative guideline.

4.2.1.1.B. Recommendation

We recommend that, in order to tighten internal controls concerning approval of the compliance of “bulk” materials, the Direction des infrastructures make the necessary arrangements to develop a formal administrative guideline and send it to all stakeholders concerned, with respect to the procedure concerning:

- the deadline established, before work starts, for submitting the formulas and technical specifications to the Division de l’expertise et du soutien technique for verification and approval;
- the recommended follow-up mechanism for corroborating, at the start of each project, that all of the formulas and the technical specifications have been verified and approved by the Division de l’expertise et du soutien technique.

Business unit’s response:

[TRANSLATION] The DI will issue clear guidelines for personnel involved in worksite supervision, indicating that the technical specifications must be received and approved before work starts. (Planned completion: April 2014)

The guidelines issued by the DI will include a requirement to prepare a list of the documents to be submitted at the start of the project, which must be monitored by the personnel involved in supervising the work in progress. (Planned completion: April 2014)

4.2.1.2. Pre-fabricated Materials

4.2.1.2.A. Background and Findings

In addition to the “bulk” materials, quality control also concerns the various types of “pre-fabricated” materials which, depending on the nature of the project, must be installed. For example, this category includes materials such as:

- ductile cast iron pipes;
- reinforced concrete pipes;

- adjustable sump and tree grates;
- concrete sewer manholes;
- concrete street and sidewalk sumps;
- valve chambers.

The DEST is also responsible for assessing the quality of most of the various pre-fabricated materials available on the market before work on the projects starts. The nature of the quality control procedures implemented within the DEST in order to evaluate the physical and mechanical properties of the pre-fabricated materials varies according to the type of material.

If they satisfy expected quality standards, after quality control tests have been performed (e.g., plant inspection, laboratory tests, BNQ certification), the pre-fabricated materials are included in the list of pre-approved suppliers.

For practical reasons, the DEST prefers, for certain types of pre-fabricated materials, including ductile cast iron pipes, to prepare a specific list entitled [TRANSLATION] “List of pre-approved batches.” The pipes included in this category are identified by a coloured paint mark and a batch number, which allows those working on the site to recognize that the material is intended to be used for the city and has been approved by the DEST.

Furthermore, the DEST takes samples of certain types of these pre-fabricated materials. This is the case of reinforced concrete pipes (e.g., sewer lines), for example, for which, for each project, samples are taken on the site and analyzed in the city’s laboratory to ensure compliance and performance, as well as to make sure that the list of pre-approved suppliers is constantly updated.

Ultimately, as is the case for bulk materials, when the work is being done on the site, those responsible for the quality control of the materials will need to make sure that the various pre-fabricated materials used have been pre-approved by the DEST (e.g., the materials have been included in the list of pre-approved suppliers or batches).

For the purposes of this audit report, the aspects concerning quality control testing of the pre-fabricated materials during site operations will be discussed in detail in Section 4.2.2.2.

4.2.2. Compliance and Completeness of the Quality Control Tests Performed During Work in Progress

4.2.2.A. Background and Findings

After making sure, at the start of the project, that all of the “bulk” materials to be used for a project have been pre-approved by the DEST, the private laboratories mandated are then responsible for verifying, while the work is in progress on the site, that the materials delivered correspond to those previously approved and that they are installed in keeping with the tender documents (plans and specifications) as well as the city’s standards and guidelines.

On-site testing will involve, among other things, taking samples of the materials, making sure the conditions are appropriate for installing them (e.g., the temperature of the materials, the ambient air temperature, the preparation of the contact surfaces, the weather conditions) and measuring the compaction of the materials installed, such as asphalt paving and granular materials.

The quality control tests required for a given project are determined by the nature of the work to be done, the types of materials used, the quantity, and the number of days required to install them since these factors can influence the number of samples to be taken and tests to be performed.

With respect to the pre-fabricated materials (e.g., sewer or water pipes), the private laboratories mandated must also, during the course of the work, ensure supervision in order to corroborate that the quality of the materials delivered and installed has first been subjected to the quality control process implemented by the DEST, which was first discussed in the previous section of this audit report.

As previously mentioned, of the five projects that we examined, three involved the construction of water mains and/or sewer lines (Projects 1109, 1152 and 1223), one involved re-building a road and building the curbs (Project 1201) and the last one involved the construction of a RCC surface on the site of one snow depot and an asphalt road on the site of another snow depot (Project 1203).

This section therefore provides the results of our work, which was to verify, for each of the five projects selected, that samples were taken from the bulk materials delivered and that the controls associated with their installation (e.g., the measurement of the desired level of compaction) were all performed in keeping with the guidelines and standards in effect.

We present our findings with respect to the performance of quality control tests on the pre-fabricated materials on the site.

4.2.2.1. Bulk Materials Delivered to and Installed on the Site

4.2.2.1.A. Background and Findings

For each of the “bulk” materials, the DEST’s technical guideline concerning quality control testing specifically specifies the required sampling frequency (number of samples to be taken) of the materials delivered, for the laboratory tests. Note that, complementing this technical guideline, the standardized technical specifications established by the city, based on the nature and the expected use of the various types of materials, may also have to be consulted in order to determine the quality control tests to be performed.

The laboratory analysis of the results obtained from the samples taken will serve to certify that the materials delivered and installed correspond to those that were pre-approved by the DEST and that they satisfy the specifications of the tender documents, in terms of both the identification of the material and its physical properties.

At this stage, our audit work involved making sure, for each of the bulk materials (cement concrete, asphalt paving and granular materials) used for the work involved in the five projects selected, that the number of samples taken from the materials and the tests required during the course of the work on the site respected the procedure set out in the technical guideline concerning the quality control of the materials and in the city’s standardized technical specifications.

4.2.2.1.1. Cement Concrete

4.2.2.1.1.A. Background and Findings

For this material, the quality control technical guideline states, in the chapter entitled [TRANSLATION] “Site technicians’ duties and responsibilities,” that particular attention must be made to verify such aspects as:

- the concrete formula and the plant from which the concrete comes, in order to make sure that the material delivered corresponds to that approved for the intended use;
- the air content and the temperature of the concrete, which must be verified each time before it is unloaded;
- the duration of the pour since the concrete must be poured within a specified time frame (e.g., two hours) to ensure structural quality.

The information and findings resulting from the performance of these quality control tests must be noted by the site technician assigned to the project in daily work-site reports (site logs). For any non-compliance noted following these tests, the site technician must send a memo to the site supervisor and the project manager within the business unit concerned so that they can decide whether or not to take corrective measures. It should be noted at this time that the same procedure applies with respect to the controls concerning asphalt paving and granular materials, which will be discussed in the following sub-sections.

Moreover, the technical guideline also states, with respect to certain planned uses, the frequency with which samples must be taken for compression tests. Specifically, when the concrete is used to make sidewalks and curbs (Projects 1109, 1152, 1201 and 1223), the technical guideline stipulates that one sample must be taken every day, for each concrete formula from the same supplier, regardless of the quantity delivered and the plant from which it comes.

For certain other uses, which are not indicated in the technical guideline, it is necessary to consult the respective standardized technical specifications to determine the sampling frequency advocated by the city. It should be noted that these standardized technical specifications are accessible to everyone on the site.

For the purposes of our examination, we needed to consult one of these documents for the project involving the construction of a RCC surface¹³ on the site of a snow depot (Project 1203). These standardized technical specifications stipulate that two samples of fresh concrete, rather than one, must be taken periodically. According to the information obtained, the notion of “periodic” is not defined with respect to collecting samples. As a result, the DEST individual in charge of the mandate is responsible for determining the expected sampling frequency and informing the contracted private laboratory.

Thus, for each of the five projects selected, which involved the use of cement concrete, we identified and examined all of the work-site test reports, as well as the test reports prepared by the contracted private laboratories, in order to evaluate the extent to which:

- the site technicians took into consideration and noted, in the work-site test reports, all of the factors to be verified at the time the cement concrete was poured (e.g., the temperature of the concrete, the air content, the duration of the pour);
- all of the samples required, in light of the standards and guidelines in effect, were actually taken and analyzed.

¹³ Standardized technical specifications 3VM-30 – [TRANSLATION] Roller-compacted concrete (RCC).

Based on our examination of the site logs produced, we can state that they adequately documented the factors to be verified when the material was installed. The results of our examination of compliance concerning the number of samples to be taken are provided in Table 4, below.

Table 4 – Cement Concrete Compliance of Number of Samples Taken

Project No.	Planned use	No. of days the concrete was poured	No. of samples taken per day	Total no. of samples expected	No. of samples taken and analyzed	Technical guidelines respected
1109	Re-building of sidewalks	2	1	2	2	Yes
1152	Re-building of sidewalks	2	1	2	2	Yes
1201	Re-building of machine curbs	1	1	1	1	Yes
	Re-building of hand curbs	1	1	1	0	No
1203	Construction of a RCC surface on the site of a snow depot A	4	[a]	[a]	5 ^[a]	[a]
1223	Re-building of sidewalks	2	1	2	2	Yes
	Construction of concrete connection collars	1	1	1	0	No

^[a] Although we noted that the contracted private laboratory did collect samples during the days on which concrete was poured, we cannot judge the completeness of this testing. In fact, the standardized technical specifications document (3VM-30) refers to samples that have to be made periodically whereas that notion is not clearly defined in relation to the expected sample frequency and, in this respect, no specific details were documented by the DEST representative responsible for the mandate.

Thus, apart from Project 1203, we noted that, for two of the four other projects examined (Projects 1201 and 1223), for which the quality control tests were assigned to the same private laboratory, some of the samples that were supposed to be taken for quality control tests to be performed on the materials were not made as stipulated in the technical guideline.

Moreover, with respect more particularly to Project 1203, which involved building a RCC surface on the site of a snow depot, particular measurements intended to evaluate the degree of compaction were also supposed to be taken in keeping with the applicable standardized technical specifications (3VM-30). According to the technical specifications, the measurements in question were to be made at 10-metre intervals on each paving machine span. Yet, our examination of the work-site test reports concerning the concrete work revealed that 170 measurements were made whereas, based on the area covered with concrete, the standard stipulated that 559 measurements should have been made. Thus,

although the DEST employees we met are of the opinion that the procedure may have been agreed upon with the firm mandated, no written document to this effect could be found and the quality standards in effect were not respected.

4.2.2.1.2. Asphalt Paving

4.2.2.1.2.A. Background and Findings

With respect to the application of this type of material, the technical guideline concerning quality control specifies that the site technician must pay particular attention to verifying aspects such as:

- the compliance of the formula for the asphalt paving to be applied;
- the condition of the contact surface to be covered;
- the equipment used;
- the temperature of: the ambient air, the surface to be covered and the asphalt paving prior to the application;
- the rate at which the asphalt paving is applied, which consists in the theoretical determination of the thickness applied in keeping with the area to be covered and the quantity of asphalt used.

As in the case of cement concrete, the site technician notes the results of the verifications made in a work-site report in the site log. Moreover, the same procedure as described previously for cement concrete is used to report any non-compliance detected.

The technical guideline also stipulates that the contracted private laboratory must collect samples on the site to confirm the quality of the materials used. Thus, for each day of paving, the frequency stipulated is one sample per 300 tons for the various types of asphalt paving used for the project, up to a maximum of five samples per day. However, if the quantity of one type of asphalt paving is less than 300 tons, two samples must be taken for different tonnages.

Thus, as we also did for the concrete, for each of the five projects selected, which all involved the use of asphalt paving, we identified and examined all of the work-site test reports, as well as the laboratory test reports prepared by the contracted private laboratories, in order to evaluate the extent to which:

- the site technicians took into consideration and noted in the work-site test reports all of the factors to verify at the time the asphalt paving was applied (e.g., the ambient temperature, the condition of the surface to be covered, the application rate);

- all of the required samples or tests were taken and analyzed, as per the standards and guidelines in effect.

Based on our examination of the work-site test reports produced, we can state that they adequately document the factors to be verified when the material was applied. The results of our examination of the compliance regarding the number of samples required for the purposes of laboratory testing are provided in Table 5, below.

Table 5 – Asphalt Paving Compliance of Number of Samples Taken

Project No.	Planned use	No. of days required for paving	No. of samples expected (based on tonnage)	No. of samples taken and analyzed	Technical guidelines respected
1109	Base coat	8	16	16	Yes
	Surface coat	8	16	14	No
1152	Base coat	1	2	0	No
	Surface coat	1	2	0	No
1201	Base coat	1	2	2	Yes
	Intermediate coat	1	2	1	No
	Surface coat	1	2	1	No
1203	Base coat	2	6	4	No
	Surface coat	3	6	3	No
1223	Section A – Base and surface	1	2	0	No
	Section B – Base coat	1	2	1	No
	Section B – Surface coat	1	2	1	No
Total		29	60	43	

In summary, based on these results, we noted that the total number of samples required in order to corroborate the compliance of the quality of the asphalt paving applied was not respected for any of the projects examined.

Moreover, for Project 1152, we found no evidence that any sample was taken. In this respect, the contracted private laboratory justified this situation in its final report by stating that it was a temporary paving. Yet the information we obtained from the project manager at the Division de la surveillance des travaux revealed that it was never a question of temporary paving for this project. Consequently, the samples required for laboratory tests should have been taken. This contradictory information raises questions as to the possibility that the omission was voluntary or that incorrect information was transmitted to the contracted firm. Moreover, we noted that the omission was not detected by the DEST person responsible for the mandate

since, at the end of the work, core samples intended to confirm the quality of the work were taken by the DEST as if it were permanent paving.

At the same time, for Project 1223, we noted a mention in the final report by the contracted laboratory that, as a result of a shortage of budget credits for the purchase order and with the approval of the DEST, the sample of one type of asphalt paving (Section A – base and surface) was not analyzed. Furthermore, for this project, it is clear that, overall, the number of tests required in keeping with the technical guideline were not made for the various types of asphalt paving used.

Moreover, contrary to the 2011 version of the material quality control guideline, the 2012 version states that compaction measurements must also be made during the compacting work for the asphalt paving applied. More specifically, it stipulates that the compaction of the asphalt paving must be determined according to test method LC 26-510¹⁴ using nucleodensimeters. This test method involves randomly choosing six sites on the paved surface where a reading will be taken. Around each of these readings, four other readings must be made and the average of the five readings is used to obtain the final result for each of the six sites selected.

Our audit also involved examining the application of this aspect of the guideline by the contracted private laboratories for the five projects in our sample. It should be noted that these five mandates were assigned to three different private laboratories (see Appendix 6.1). Thus, for Project 1223, the only project in the sample that was undertaken entirely in 2012, we noted that the laboratory (Firm C) used the test method (LC 26-510) in keeping with the guideline (2012 version). The four other projects in our sample were started in 2011. Although we noted that the contracted laboratories from these projects did perform compaction measurements, namely one measurement per 10 to 20 linear metres (Projects 1109, 1152 and 1203) or in keeping with method LC 26-510 (Project 1201), it nevertheless appears that they did not follow the technical guideline in effect (2011 version), which states that one measurement must be taken every 25 linear metres, per paving machine span.

4.2.2.1.3. Granular Materials

4.2.2.1.3.A. Background and Findings

The infrastructure work pertaining to the construction (or reconstruction) of water mains or sewer lines involves the excavation of a trench to provide for the installation of the various

¹⁴ Ministère des Transports du Québec (MTQ) road surface laboratory standard – LC 26-510: “Détermination de la masse volumique *in situ* des enrobés à l’aide d’un nucléodensimètre.”

materials required for the project, including granular materials. In fact, placing granular material (e.g., crushed stone, recycled material) is completed in several steps, including building the foundation on which the pipe will be installed, covering the pipe and filling the trench. This is followed by the work required to re-build the road, during which other granular materials are installed in order to provide the foundation for the road (upper and lower foundations – see Figure A in Appendix 6.3).

With respect to placing this type of material, the quality control technical guideline specifies that the site technician must pay particular attention to verifying the compliance of the granular materials that will be installed or the quarry from which they come.

At the same time, the technical guideline states, among other things, that when the granular materials are placed the site technician must:

- take a sample from each of the granular materials used for each project in order to ensure compliance;
- take compaction measurements of the granular materials placed at various stages during the construction of a structure.

For each of the projects selected, all of which required various granular materials to be placed, we wanted to make sure that samples were taken from all of the materials for the purpose of laboratory testing, in keeping with the technical guideline.

Subsequently, we also examined the compaction measurements to be made when these granular materials were placed. It should be noted, however, that in this respect we limited our examination to the work on the lower and upper foundations of the road (see Figure A in Appendix 6.3). For these foundation layers, the material quality control technical guideline states that one measurement (test) at least must be made every 10 metres over the width of the layer being verified.

Thus, as in the case of the other materials used (e.g., cement concrete and asphalt paving), based on our examination of the work-site test reports prepared by the contracted external laboratories, we can state that they adequately document the determination of the compliance of the granular material to be placed.

The results of our examination of the compliance of the number of samples required for the purposes of laboratory testing and the number of compaction measurements required are provided in Tables 6 and 7, below.

Table 6 – Granular Materials Samples Collected Depending on Use

Project No.	Planned use	No. of granular materials used	Total no. of samples expected	No. of samples taken and analyzed	Technical guidelines respected
1109	Fill	1	1	1 ^[a]	Yes
	Lower foundation	1	1	1	Yes
	Upper foundation	1	1	1 ^[a]	Yes
1152	Fill	2	2	2	Yes
	Lower foundation	2	2	1	No
	Upper foundation	1	1	0	No
1201	Lower foundation	1	1	1 ^[a]	Yes
	Upper foundation	1	1	0	No
1203	Concrete slab – roller compacted	1	1	1	Yes
	Slab foundation	1	1	1 ^[a]	Yes
	Upper foundation	1	1	1	Yes
1223	Fill	1	1	0	No
	Lower foundation	1	1	1	Yes
	Upper foundation	1	1	1	Yes
Total		16	16	12	

^[a] For greater certainty, the contracted private laboratory took a second sample and analyzed it in order to confirm the initial results.

With respect to the completeness of the samples taken for the testing of granular materials used for the projects in our sample, our examination revealed that:

- for two of the five projects examined (1109 and 1203), samples were taken for the purpose of laboratory tests in due form for all of the various types of granular materials used;
- for the three other projects examined (1152, 1201 and 1223) some samples were not taken for laboratory tests.

Table 7 – Granular Materials Compaction Measurements for Foundation Work

Project No.	Zone	Length of street section (approximate)	Thickness of aggregate required in specifications	Number of layers ^[a]	Ratio of measurements planned	No. of measurements expected	No. of measurements taken
1109	Lower foundation	450 meters	500 mm	2	1 every 10 metres	90	70
	Upper foundation		200 mm	1	1 every 10 metres	45	65
1152	Lower foundation	240 meters	500 mm	2	1 every 10 metres	48	48
	Upper foundation		200 mm	1	1 every 10 metres	24	8
1201	Lower foundation	200 meters	500 mm	2	1 every 10 metres	40	54
	Upper foundation		300 mm	1	1 every 10 metres	20	18
1203	A portion of the materials were installed without a site technician assigned to quality control. Therefore, we cannot provide an opinion with respect to the compliance of the number of compaction measurements for this project.						
1223	Lower foundation	160 meters	500 mm	2	1 to 10 meters	32	46
	Upper foundation		200 mm	1	1 to 10 meters	16	10

^[a] The guidelines state that the granular materials must be compacted in layers with a thickness not to exceed 300 mm.

Thus, for the four projects in our selection for which we were able to assess the completeness of the compaction measurements made for the foundation work (1109, 1152, 1201 and 1223), we noted that, in all cases, for either the lower foundation or the upper foundation, not all of the tests (measurements) were made as required in keeping with the guideline in effect.

In conclusion, in order to validate our observations with respect to the non-compliances presented in Tables 4, 5, 6 and 7 concerning the completeness of the quality control tests performed during the course of the work for cement concrete, asphalt paving and granular materials, we submitted the facts noted to various stakeholders, including the individuals responsible for the mandate, the section engineer, DEST technical agents, and the project managers at the Division de la surveillance des travaux.

After verification, these stakeholders not only confirmed the accuracy of our observations, but the DEST stakeholders also confirmed that there was no formal follow-up mechanism to ensure that the contracted private laboratory firms perform all of the quality control tests required in keeping with the guidelines and standards in effect.

In fact, we noted that the private laboratories send the reports of quality control tests undertaken (e.g., test report, work-site test report) electronically to the DEST, using a single

email address. Nevertheless, it appears that no comparison was made of the quality control tests expected and the information provided in the reports sent by the firms in order to verify that all of the samples or tests to be undertaken actually were undertaken.

Since it is responsible for the activities surrounding quality control testing of materials, we are of the opinion that the DEST should set up an appropriate follow-up mechanism to allow it to identify, for each of the mandates assigned to private laboratories and for each of the materials used for the projects in question, the situations in which the required laboratory analyses and tests are not performed. For example, this follow-up mechanism could take the form of a checklist which could be prepared before a project starts, based on the examination of the project plans and specifications and the timeline for performing the work on the site, provided by the contractor. This mechanism would also include an obligation on the part of the DEST personnel responsible for the mandate to document all of the specific guidelines and the decisions made with respect to the quality control tests to be performed for a given project.

We also believe that it would be a good idea to revise the descriptive specifications included in the tender documents for the master agreements used to retain professional services from private laboratories in order to include a clause covering a failure to perform the work in question. This clause, which could provide for the application of financial penalties, would exert pressure on the contracted firms in order to ensure, on the one hand, that all of the quality control tests required by the city as part of the mandate in question are performed and, on the other hand, that the designated personnel are present on the site to perform the tests required, in a timely manner, while the work is being done. The quality of work done is a concern for the municipal administration. It was for this reason that a motion notice was presented to the city council at the meeting held on September 24, 2013, requesting the implementation of a performance evaluation system to provide an adequate assessment of the performance and the quality of the work done and the products supplied by firms with which the city does business.

4.2.2.1.B. Recommendation

We recommend that, in order to enhance its supervision of the quality control tests that must be performed for certain projects, the Direction des infrastructures take the measures it considers appropriate to:

- implement a follow-up mechanism to identify, for each of the mandates assigned to private laboratories, the situations in which required laboratory analyses or work-site tests are not conducted in keeping with the standards and guidelines in effect;
- inform the employees in question (those responsible for mandates) again about the importance of documenting, in the internal file, all of the specific guidelines and decisions made with respect to the nature of the quality control testing of materials to be performed for a given project.

Business unit's response:

[TRANSLATION] The DEST will implement a periodic project monitoring program to follow up on whether the technical guidelines and quality control program have been respected. The results of this monitoring will be recorded in the project file. (Planned completion: May 2014)

The DEST will issue internal guidelines to the effect that all of the decisions concerning modifications made to the quality control program must be written and documented for each project. (Planned completion: March 2014)

4.2.2.1.C. Recommendation

For the same reason, we also recommend that the Direction des infrastructures revise the descriptive specifications included in the tender documents for the master agreements for retaining professional services from private laboratories for quality control testing of materials to include a clause providing for the application of financial penalties in the case that the work done does not comply with the standards and guidelines in effect.

Business unit's response:

[TRANSLATION] The tender documents for the upcoming master agreements are currently being revised by the DEST and the application of financial penalties will be included. (Planned completion: May 2014)

4.2.2.2. Pre-fabricated Materials Installed

4.2.2.2.A. Background and Findings

In addition to the “bulk” materials, certain projects also require “pre-fabricated” materials. For the purposes of the five projects examined as part of our audit, we specifically identified the principal pre-fabricated materials listed in Table 8.

Table 8 – List of Principal Pre-fabricated Materials Installed

Projects				
1109	1152	1201	1203	1223
Reinforced concrete pipe	–	–	N/A	Reinforced concrete pipe
Ductile cast iron pipe	Ductile cast iron pipe	–	N/A	Ductile cast iron pipe
Sewer manhole	–	–	N/A	Sewer manhole
Street sump	Street sump	–	N/A	Street sump
Valve chamber	Valve chamber	–	N/A	Valve chamber
	Sump frame and grate	Sump grate	N/A	–
	Sump head	Sump head	N/A	–
	Sewer cover and frame	Sewer cover and frame	N/A	–

N/A: not applicable – no pre-fabricated material used for this project.

As we stated previously in this report, when we discussed the evaluation and approval of the quality of pre-fabricated materials at the start of the project (see Section 4.2.1.2), it is important to note that this responsibility has been delegated to the DEST, which implemented various processes for evaluating quality, depending on the pre-fabricated material in question. Thus, once the DEST has completed the quality control tests, the pre-fabricated materials are indicated in the list of pre-approved suppliers or the list of pre-approved batches (e.g., ductile cast iron pipes). For certain materials (e.g., reinforced concrete pipes), the DEST also takes samples on site for each of the projects undertaken.

Therefore, the individuals responsible for the quality control testing of the materials on site still have to make sure that the various pre-fabricated materials used are included among those that have been pre-approved by the DEST and to document their actions accordingly.

According to the descriptive specifications included in the tender documents for the master agreements retaining the professional services of private laboratories, those firms are responsible for performing quality control tests on the pre-fabricated materials installed.

Indeed, Clause 3.3 of the descriptive specifications, entitled [TRANSLATION] “Nature of the quality control and assessment work,” Paragraph 3.3.1, [TRANSLATION] “Quality control,” states:

[TRANSLATION] The quality control work includes plant inspections for the manufacture of various pre-fabricated elements for the project [...] as well as the verification of the quality of the materials in city projects. These include primarily aggregate, cement concrete, mortar, asphalt paving, cement components for sumps and manholes, concrete paving blocks and slabs, PVC, cast iron or cement concrete pipes, reinforcing steel, metal components, galvanization and paint, all in keeping with the requirements stipulated in the city's specifications.¹⁵

Contrary to the stipulations of the descriptive specifications for the master agreements, we noted that, in reality, the DEST has retained the responsibilities associated with the evaluation, prior to the work, of the quality of the various pre-fabricated materials available on the market (e.g., plant inspections, laboratory testing).

It is our understanding, however, that according to the same descriptive specifications, the city is entitled to expect the private laboratories, which are contracted to perform quality control tests on materials, to report on the tests that they should have performed in order to make sure that the pre-fabricated materials to be installed have first been approved by the DEST (e.g., by identifying the material on the list of pre-approved suppliers or the list of pre-approved batches). However, according to the information obtained from the individuals we met, with the exception of the reinforced concrete pipes, for which responsibility for quality control testing falls to the DEST, it is the site supervisor who reports to the Division de la surveillances des travaux who is responsible for the on-site verification of the quality of the other pre-fabricated materials installed.

Based on our audit, we can make the following statements:

- The technical guidelines (2011 and 2012 versions) concerning quality control of the materials and expertise, prepared by the DEST for the contracted private laboratories, do not contain any indication concerning the inspection of the pre-fabricated materials. Indeed, only quality control testing for bulk materials is covered;
- The final report produced by each of the private laboratories at the end of the mandate assigned to them for the quality control testing of the materials used for the projects in our sample do not contain any indication that any inspection was made to ensure the compliance of the pre-fabricated materials installed;
- For each of the projects selected, an examination of the files prepared by the project managers (for the Division de la surveillance des travaux) and the site supervision reports

¹⁵ Extract from the descriptive specifications of master agreement No. 09-10935.

prepared by the site supervisors did not provide any evidence of any inspection performed to validate the compliance of the pre-fabricated materials installed. In our opinion, this responsibility should be assumed entirely by the DEST, as is currently stipulated in the descriptive specifications of the master agreements.

In order to obtain assurance that quality control testing is performed on all of the various materials, including the pre-fabricated materials, used for the infrastructure work done within the city, we are of the opinion that corrective measures must be made on a short-term basis.

4.2.2.2.B. Recommendation

We recommend that, in order to obtain assurance that quality control testing is performed on all of the various materials used for infrastructure work, the Direction des infrastructures take the necessary steps to:

- reiterate to the site supervisors the importance of clearly documenting in the site logs they produce all aspects they have examined;
- review, as a result, the guidelines intended for the contracted private laboratories so that, in their final report, these firms also report on the inspections performed with respect to the pre-fabricated materials.

Business unit's response:

[TRANSLATION] The Division de la surveillance des travaux will implement a log to indicate the materials received on the work site and the quality control tests performed. The log will be updated by the work supervisor and verified by the engineer for each work site. The log will be used to document the compliance of the materials delivered with the plans and specifications. (Planned completion: June 2014)

The technical and administrative guidelines issued by the DEST to the firms are currently being revised. They will include a clause stating that private firms must also include the inspections made for pre-fabricated materials in their final report. (Planned completion: April 2014)

4.2.3. Deadlines for Communicating the Results

4.2.3.A. Background and Findings

When a process is established for performing quality control tests on materials, it is important to provide mechanisms to ensure that all of the results of the tests performed for laboratory analyses, as well as those for the tests performed on the site (e.g., material compaction measurements) are shared in a timely manner.

The promptness with which the results are disclosed is very important for those who are responsible for performing the work since they must make decisions rapidly with respect to the corrective measures to be taken in the event that the results of the quality control tests performed are not compliant.

Moreover, this is important for the DEST personnel so that they can act promptly to make their own assessment, as needed, with respect to the treatment of the non-compliances reported, but also so that they can follow up, as the work progresses, on the quality control tests to be performed by the contracted private laboratories, in keeping with the plans and specifications, and the norms and guidelines in effect.

After reading the technical guidelines issued by the DEST with respect to quality control testing of materials (2011, 2012 and 2013 versions), we noted that a procedure was set out for the contracted external firms to submit their results. Inasmuch as the results are compliant, the DEST asks to receive the laboratory analysis reports and the work-site test reports and that they also be sent to the project manager responsible for the work for the business unit making the request, by email, each week. Any non-compliance noted, however, is to be reported immediately, by telephone, to the DEST and the project manager responsible for the work. Following this, a written notice must be sent by email to the same parties at the latest 24 hours after the non-compliance is noted.

In light of this, our audit work involved evaluating the extent to which the results of the tests performed were communicated within the required time. Thus, for each of the five projects in our sample, we prepared a list, based on the information indicated in the final report prepared by the contracted private laboratories, of all of the work-site and laboratory test reports produced. In order to measure the time taken to share the results, we compared the dates on which these reports were produced with the dates on which they were sent, whether by email, during the course of the project, or for the purposes of billing.

The reports produced for the work-site tests and the laboratory tests can individually contain an evaluation of the compliance of several aspects to be verified (e.g., the ambient temperature or that of the surface to be paved), as well as results of the compliances of the various samples or measurements taken with respect to a requirement or a standard (e.g., concrete samples, compaction measurements).

Consequently, for the purposes of our examination to verify whether the established deadlines were respected, we determined that a report referring to results that were exempt of deviations would be classified as “compliant” while a report that presented at least one

deviation would be classified as “non-compliant,” regardless of the number of non-compliances that could be indicated in it.

With these explanations noted, the results of the examination made with respect to all of the non-compliances reported for the five projects selected will be discussed in the next section of this audit report (Section 4.2.4).

Table 9, below, illustrates the results of the examination made with respect to the deadlines for sending reports.

Table 9 – Respect for Deadlines for Sending Work-Site and Laboratory Test Reports

	No. of reports sent		
	Total	<u>Within</u> the required time	<u>After</u> the required time
Compliant results	130 (77%)	40 [of 130] (31%)	90 [of 130] (69%)
Non-compliant results	39 (23%)	10 [of 39] (26%)	29 [of 39] (74%)
Total	169 (100%)	50 [of 169] (30%)	119 [of 169] (70%)

The examination revealed that 169 work-site and laboratory test reports were produced for all of the five projects in our sample. Of those, 130 (77%) presented compliant results, whereas the 39 other reports (23%) presented non-compliant results.

In the case of the reports presenting compliant results, the DEST technical guideline states that they must be sent on a weekly basis. We noted that 69% of them (90 reports out of 130) were sent after that deadline, namely more than 7 days (one week) after the date on which they were produced, and in some cases more than 31 days (one month) after they were produced. On a few occasions, the reports were sent more than 90 days (three months) after they were produced. These times are presented in Table 10.

Table 10 – Time Taken to Send Reports Presenting Compliant Results (90 reports sent after the deadline)

	No. of days			Total
	8 to 30	31 to 90	91 and more	
No. of reports	44	35	11	90
Proportion	49%	39%	12%	100%

We realize that obtaining reports late is not as much of a concern in the case of compliant results as it would be for non-compliant results, considering the consequences that the latter could have on the speed with which decisions could be made in order to ensure the quality of the work as it is being done. Nevertheless, inasmuch as DEST representatives are responsible for ensuring the supervision of the work while it is in progress as well as for ensuring that the expected deliverables are respected, in keeping with the mandate given to the private laboratory, it is important for these reports to be sent within the required timeframe so that they can exercise the necessary controls in a timely manner.

Non-compliant results, on the other hand, must first be transmitted by telephone according to the guideline. For the projects we examined, we sought to corroborate the extent to which this instruction was followed. However, we were not able to determine whether the first step in the established procedure was respected since, according to the information obtained from the various stakeholders we met, within both the DEST and the Division de la surveillance des travaux, no verbal communication is systematically documented.

The second step in the communication process requires that reports presenting non-compliances be sent within 24 hours (1 day) after the non-compliance is detected. We noted that 10 of the 39 reports (26%) presenting at least one non-compliance were sent within the required time.

In the case of the 29 other reports concerning non-compliances (74%), sent after the deadline, Table 11 gives a breakdown of what our examination revealed in terms of when they were sent.

Table 11 – Time Taken to Send Reports Concerning Non-Compliances (29 reports sent after the deadline)

	No. of days			Total
	2 to 4	5 to 30	31 and more	
No. of reports	2	14	13	29
Proportion	7%	48%	45%	100%

As can be seen, the prescribed deadline for sending reports (24 hours) was largely exceeded. In fact, for 48% of the reports (14 out of 19) presenting non-compliances, the reports were sent 5 to 30 days after the non-compliance was detected and, in 45% of the cases (13 out of 29), they were sent more than 30 days after the non-compliances were noted.

The fact that the technical guideline requires work-site and laboratory test reports presenting non-compliances to be sent within the relatively short period of 24 hours after a non-compliance is noted serves, in our opinion, to attenuate the risks associated with the fact that the initial oral communication may not always be made at the best time for stakeholders to make a rapid decision concerning the corrective measures to be taken on the site, as needed.

When these reports are sent late, as indicated by the results of our analysis, we can only wonder about the possibility that, in the event of poor verbal communication of the results, such delays could have had negative consequences on the level of quality expected with respect to the work done on city infrastructure.

In conclusion, based on the late transmissions noted and the discussions we had with those concerned within the DEST, we can only conclude that there is no real follow-up with respect to the contracted firms to ensure that work-site and laboratory test reports are sent within the deadlines set out in the guidelines.

Indeed, as we stated previously in this report, since no formal follow-up mechanism has been implemented within the DEST, it appears that work-site and laboratory test reports are used more for the purpose of authorizing the payment of invoices submitted by the contracted firms than to ensure follow-up of the completeness and compliance of the services to be provided by those firms.

As a result, we are of the opinion that close supervision should be exercised by the DEST in order to ensure that the principal parties concerned are informed promptly about non-compliances reported. To do this, the content of verbal communications should be noted in a file and the formal follow-up mechanisms to be implemented should include a process for verifying that the contracted firms respect the prescribed deadlines for sending work-site and laboratory test reports.

4.2.3.B. Recommendation

We recommend that, in order to ensure close supervision of the services provided by the contracted private laboratories, the Direction des infrastructures integrate the following in the formal follow-up mechanisms to be implemented:

- **that the parties concerned be required to note the content of verbal communications concerning the disclosure of non-compliances reported following work-site testing and laboratory tests in a file;**
- **a verification that the contracted firms respect the prescribed deadlines for sending their work-site and laboratory test reports to the parties concerned.**

Business unit's response:

[TRANSLATION] The DEST will provide internal guidelines implementing a requirement to indicate the follow-up and content of verbal communications concerning reported non-compliances. (Planned completion: March 2014)

The DEST will implement a periodic monitoring program that will specifically include verifying the time taken to submit the various reports. (Planned completion: May 2014)

4.2.4. Handling Reported Non-Compliances and Application of Penalties

4.2.4.1. Handling Reported Non-Compliances

4.2.4.1.A. Background and Findings

Since the quality of the materials used, the conditions in which they are used, and even the methods used when they are installed are all factors that can have a direct impact on the useful life of infrastructure, it is important that non-compliances, when they are reported, be handled with all the necessary care in a timely manner.

Therefore, handling these non-compliances implies that, when they are detected, an evaluation must be made and that ultimately a decision must be made with respect to:

- the measures that may be made to correct the situation;
- the need to order the work to be re-done;
- the possibility of accepting deviations if they are deemed negligible or of accepting them in consideration for financial compensation (penalty) from the contractor concerned.

Considering the nature of the projects in our sample, the non-compliances detected on the sites can be divided into the two following categories:

- Non-compliance noted when the material is received:
 - Formula or technical specifications not approved by the DEST,
 - Temperature of the material too low or too high,
 - Time allowed for unloading the material (e.g., for concrete) exceeded;
- Non-compliance noted during the course of the work:
 - Surface to be covered wet or frozen,
 - Ambient temperature too cold (less than 5°C),
 - Compaction level not attained,

- Thickness or application rate for material not within specifications,
- Inadequate equipment used.

It should be noted at this time that, when the quality control tests performed reveal non-compliances, the role of the DEST (through the contracted external firms) involves informing the project manager (within the business unit making the request), who has the authority to decide whether or not to order the necessary corrective measures. Nevertheless, the DEST could be required to intervene in order to provide expertise with respect to handling the non-compliances reported.

At this stage, our audit work involved examining all of the work-site and laboratory test reports produced by the contracted private laboratories for each of the five projects in our sample. Based on these reports, we prepared a list of all the non-compliances reported and investigated each one in order to find evidence of the decisions made with respect to handling them.

To do this, we first met with the various DEST representatives (e.g., those responsible for the mandate, the section engineer, the section manager) and examined the information provided in the file. Subsequently, we met with the project managers for the Division de la surveillance des travaux in order to examine the information they may have indicated in the file, as well as the site logs kept by the site supervisor assigned to the project. Table 12 below highlights the results of the examination.

Table 12 – Handling Non-Compliances Reported and Respecting Deadlines for Sending Test Reports

Project No.	No. of non-compliances reported			No. of test reports sent		
	Total	<u>With evidence of handling</u>	<u>Without evidence of handling</u>	Total	<u>Within the prescribed time^[a]</u>	<u>After the prescribed time^[a]</u>
1109	23	3	20	18	8	10
1152	10	8	2	10	0	10
1201	8	0	8	7	1	6
1203	2	1	1	2	1	1
1223	2	0	2	2	0	2
Total	45 (100%)	12 (27%)	33 (73%)	39 (100%)	10 (26%)	29 (74%)

^[a] This observation concerns only results communicated through work-site or laboratory test reports, setting aside results that could have been communicated verbally (by telephone). Since no verbal communication is systematically documented, it was not possible to validate the results shared in this manner.

Thus, we were able to find evidence that action was taken to rectify the deviation in only 12 of the 45 non-compliances identified for the five projects examined, namely 27% of the cases.

With respect to the 33 other non-compliances reported, namely 73% of the cases, we found no indication in the files examined that could lead us to conclude that there was evidence that an examination and a decision were made concerning the action to be taken. This applies to both the DEST and the Division de la surveillance des travaux. Moreover, we noted that 29 of the 39 work-site and laboratory test reports produced, namely 74%, were sent after the prescribed deadline.

Also, with respect specifically to Project 1109, for which the project management and the supervision of the work on site were assigned to an external firm, we noted that the Division de la surveillance des travaux did not have any copies of the site logs or other support documents prepared by the contracted firm. As a result, for this mandate, only the work-site or laboratory test reports produced for the purpose of material quality control by the private laboratory mandated by the DEST could be consulted. Thus, although corrective measures may have been required by the various stakeholders concerned during the course of the work, it is nevertheless very difficult, if not impossible, to demonstrate this since nothing was documented to that effect. Under the circumstances, in a critical situation, the city would find it difficult to demonstrate that it had acted prudently and diligently.

In a similar manner, the DEST technical guideline states, specifically with respect to asphalt paving, that the contracted firm must, when a non-compliance is detected, evaluate and indicate in its test report the consequences of the non-compliance without, however, making a recommendation.

Based on our examination of the work-site and laboratory test reports, we noted that, in most of the cases, the representatives of the contracted firms do not record information about the gravity and potential consequences of the non-compliances reported.

We realize that information can be communicated verbally on the site. Nevertheless, since the external firms are delegated to represent the DEST to ensure the quality control of the materials used for the projects, we are of the opinion that it is imperative for the various city stakeholders to be able to benefit from the expertise of these firms in order to support the decisions they make with respect to the nature of the corrective measures that may be accepted or with respect to the need to order the work to be re-done.

We noted that certain firms occasionally indicate the consequences of the non-compliances detected or qualify the deviations noted (e.g., by indicating “deviation acceptable”) in their

final reports. Nevertheless, since these final reports are generally sent to the parties concerned well after the end of the work on the project (sometimes several months later), they serve no purpose in terms of guiding the decision to be made in a timely manner. We are therefore of the opinion that the DEST should take the necessary steps to require the contracted private laboratories to systematically document the consequences arising from the non-compliances reported, in each of the work-site and laboratory test reports produced. It would also be a good idea to review the technical guideline concerning the quality control of materials so as to clearly indicate this requirement for each type of material and not just for asphalt paving, as is the case at present. At the same time, we are of the opinion that all of the stakeholders (e.g., those responsible for the mandate, project managers, site supervisors) involved in the process concerning the quality control of materials should, during the course of infrastructure work, document the decisions made, out of a desire for greater transparency.

On another note, it was brought to our attention, during the various interviews we conducted, that the non-compliance of work can very often be attributed to the fact that the TCEP budget was adopted very late this year. Indeed, in the past, the city authorities approved the TCEP in December. Exceptionally, for 2013, the TCEP was approved in September 2012.

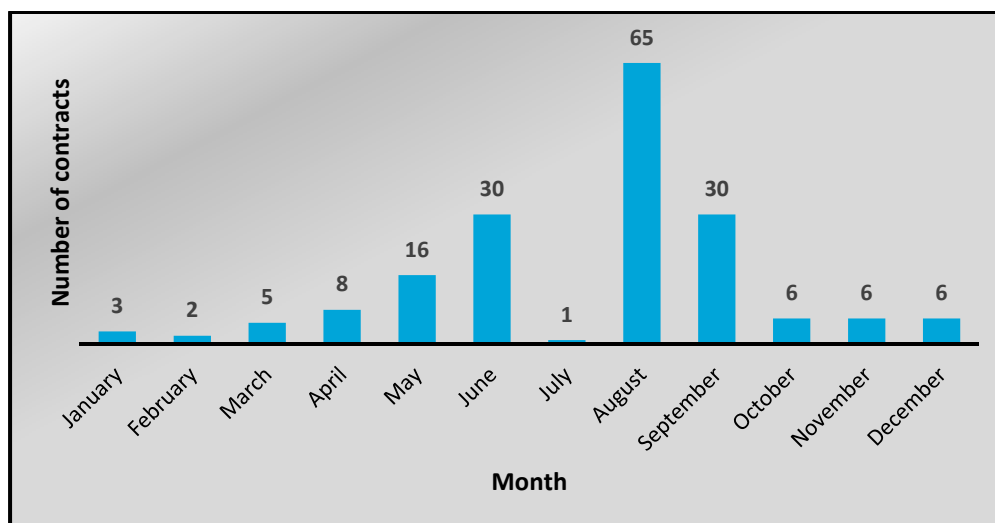
In the opinion of those we interviewed, the fact that the budget credits needed to undertake projects become available late means that work on several projects only starts in November and December, when weather conditions may not be conducive to the use of certain materials (e.g., because it is too cold outside, the risk that the ground may freeze, wet surface). Specifically, with respect to the asphalt paving (hot paving) used for roads, the city's guidelines state that it must be applied to a dry surface and that it cannot be applied when the ambient air temperature is less than 5°C.

In order to be able to corroborate this information, our audit work involved, first of all, enumerating, for 2010, 2011 and 2012, all of the contracts granted by the DI¹⁶ after obtaining approval from one branch of the city authorities.¹⁷ For these three years, we indexed 178 construction contracts. The results of the information collected is provided in Figure 1, below.

¹⁶ Formerly known as the Direction des travaux publics (of the Service du développement et des opérations).

¹⁷ Executive committee, city council, or urban agglomeration council.

Figure 1 – Number of Construction Contracts Approved on a Monthly Basis by City Authorities Involving the DI (for 2010, 2011 and 2012)



We noted that most of the contracts (63% [113 out of 178]) were, in fact, only awarded as of August and subsequent months, more than eight months after the adoption of the TCEP in December of the previous year. According to the information obtained, this can be a result of the time spent:

- designing the work required by the project to be undertaken (e.g., preparing plans and specifications);
- obtaining authorizations that must occasionally come from the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs when the work comes under that department's jurisdiction¹⁸ (e.g., work concerning water and sewer systems);
- issuing public calls for tenders;
- preparing the decision-making record for the purpose of having the contract approved by the authorities concerned.

Obviously, once the contracts are awarded, additional time will be required before contractors can actually start the work on the site (e.g., to hold start-up meetings, to obtain permits to block traffic).

For the five projects selected for this audit, we therefore examined the dates on which the work started and ended so as to evaluate the extent to which the work done on the site may have been done under unfavourable weather conditions. We then noted that the work

¹⁸ We are referring to Section 32 of the *Environment Quality Act*.

involved in three of these projects was done between October and December 2011. Furthermore, for each of them, non-compliances were reported with respect to temperatures that were too low.

There is no denying that the tardy adoption of the TCEP does not allow the city to maximize its chances of being able to benefit from infrastructure of sustainable quality. Moreover, in addition to the problems pertaining to temperature, concentrating civil engineering work at the end of the year has other negative consequences. Since this practice is relatively widespread, it results in a work overload during this period of the year, first for the contractors and then for the quality control laboratories. The same may apply to suppliers of cement concrete, asphalt paving and granular materials. All of these elements may potentially increase the costs for the city and reduce the quality of the work done.

For this reason, in his annual report for the year ended December 31, 2012, the city's auditor general recommended that the city council take the necessary measures to move up the adoption of the TCEP so that the business units can plan their projects in a timely manner. Following the public study of the auditor general's report, held in June 2013, by the Commission permanente sur les finances et l'administration, we noted that the latter endorsed the auditor general's recommendation and in turn recommended that the city council move up the adoption of the TCEP to June of each year so that the business units can have the human, material and financial resources needed to undertake the planned projects. Since these concerns with respect to the TCEP represent a major issue in terms of the smooth progress of infrastructure work, we believe that it is appropriate to reiterate the importance of implementing the auditor general's recommendation in the short term.

All of these observations leave us perplexed with respect to the possibility that the work could have been done without the non-compliances reported being taken into consideration in a timely manner. In the opinion of the DEST experts we met, the seriousness of the consequences of the non-compliances reported may occasionally be difficult to evaluate with certainty given the various factors that can affect the behaviour of materials over time (e.g., climate, traffic, frequent passage of heavy vehicles). Nevertheless, the fact remains that, given the absence of corrective measures taken promptly, the infrastructure concerned could be altered, on a short-, medium- or long-term basis, by the premature appearance of signs of deterioration (e.g., cracks, surface settling) that will in turn cause an overall decrease in the expected useful life of the infrastructure, in addition to the repair costs that this situation could engender and the possible risks to the well-being and safety of citizens.

4.2.4.1.B. Recommendation

We recommend that the Direction des infrastructures stress the importance, to all of those concerned with the quality control of materials, of noting in the files the evaluations and ultimately the decisions made with respect to handling non-compliances reported during the course of the work so as to increase the transparency of the process and to be able to demonstrate that the city acted prudently and diligently.

Business unit's response:

[TRANSLATION] The Division de la surveillance des travaux will implement a non-compliances log for each project. The log will be updated by the engineer and will indicate, without being limited to, the following: the state, the processing time, the date on which the correction was inspected and the decision made with respect to handling the non-compliance. (Planned completion: September 2014)

4.2.4.1.C. Recommendation

We recommend that, in order for the Direction des infrastructures to be able to exercise tight control over the work assigned to external firms with respect to the performance and supervision of the work on the site, it implement the necessary follow-up mechanisms to ensure that a copy of the site log and any other supporting documents, prepared by these firms, be systematically communicated to the DI.

Business unit's response:

[TRANSLATION] The requirement to submit daily reports is already stated in the service agreement that binds the firms to the city (professional service agreement). A notice will be sent to the firms to remind them of this requirement at the start of each mandate. (Planned completion: June 2014)

4.2.4.1.D. Recommendation

We recommend that, in order for the Direction des infrastructures to be able to ultimately benefit from the expertise of the contracted private laboratories with respect to supporting its decisions concerning handling non-compliances reported, it take the necessary measures to:

- require these firms to systematically document, in each work-site and laboratory test report produced, the potential consequences arising from the non-compliances reported;
- revise its technical guideline concerning the quality control of materials so as to clearly indicate this requirement for each type of material;
- make sure that these firms do, in fact, comply with this requirement.

Business unit's response:

[TRANSLATION] The DEST will add clarifications to the relevant quality control forms indicating that the consequences of a possible non-compliance must be specified. (Planned completion: March 2014)

The DEST's technical guidelines are currently being revised and will include a requirement concerning the application of the obligation to document the potential consequences of reported non-compliances for each type of material. (Planned completion: April 2014)

The application of these new guidelines will be systematically verified for all non-compliances by the internal project managers and will also be reviewed as part of the quality control tests performed by the DEST. (Planned completion: May 2014)

4.2.4.1.E. Recommendation

We recommend that the Direction générale stress to the authorities the importance, in the short term, of adopting the three-year capital expenditures program quickly enough to enable the business units to start work earlier in the year.

Business unit's response:

[TRANSLATION] By law, the city manager is responsible for preparing the TCEP. The Direction générale assures us that the next TCEP and its financing will enable the business units to improve their performance under the TCEP, regardless of the date on which it is adopted. (Planned completion: December 2014)

4.2.4.2. Application of Penalties

4.2.4.2.A. Background and Findings

Depending on the nature of the work to be done, specifically when such work involves the construction of roads or sidewalks, the tender documents stipulate that once the work has been completed the city reserves the right to perform core sample tests¹⁹ to verify the compliance of the work before paying the final sums owed to the contractor in question. For work on roads, the tests involve validating the thickness of the asphalt paving applied and the compaction rate whereas for work on cement concrete sidewalks, the tests are intended to confirm the thickness and test the resistance to compression.

In these cases, the tender documents refer to a clause in the [TRANSLATION] Standardized Instructions Book²⁰, which provides for the possibility of calculating a financial penalty for the contractor in the event that the core sampling done by the city indicates that the work done does not comply with the specifications expected. With respect to road and sidewalk work, the applicable clause of the [TRANSLATION] Standardized Instructions Book states:

[TRANSLATION] All of the work that does not comply with the standardized Instructions shall be refused and must be demolished immediately and re-built at the contractor's expense. However, if the manager considers it appropriate, defective work concerning the thickness, the resistance of the cement concrete and the thickness and compaction of the asphalt paving can be accepted by applying the correction factors specified in the [following] article at the relevant, predetermined unit prices.²¹

It should be noted that the core sampling tests are performed within the DEST by a team specializing in such work, at the request of the Division de la surveillance des travaux project manager. After the core sampling tests are done, the DEST sends the reports indicating the results to the project manager who, when non-compliant work is reported, will decide whether to order the work to be re-done or impose a penalty on the contractor.

At this stage in the process, our audit work first involved identifying, for each of the five projects in our sample, those which required core sampling tests; validating, when required, that the tests were performed; and examining the decisions made with respect to possibly re-doing the work or applying a financial penalty in the event that the results obtained were non-compliant. For the cases in which the option of applying a financial penalty was chosen, we validated the accuracy of the calculation of the penalty in question.

¹⁹ Core sampling involves cutting and extracting a cylindrical sample from a road, called a core sample.

²⁰ We are referring to Volume 4 of the [TRANSLATION] Standardized Instructions Book (April 2008), which was in effect at the time of our audit.

²¹ Our emphasis.

In conclusion, our examination revealed that four of the five projects in our sample required core sampling tests. In the four cases, the tests were performed and revealed non-compliances. The option to apply a financial penalty was retained in all the cases. We verified the accuracy of the penalty calculations and detected no errors.

Second, we pushed our investigation further in order to ensure that the penalties imposed were actually deducted from the amounts paid to the contractor in the final progress estimate.

For this purpose and since, at the time of our work, the final progress estimate for only one of the four projects had been submitted for payment, we added seven other projects to our sample (for a total of eight projects), which were selected from a list of 101 projects for which the DEST produced core sampling test reports from 2010 to 2012.

Our examination revealed that, in all of the cases, the penalty established had in fact been deducted from the amounts owed to the contractor in the final progress estimate. It should be noted that, for these seven additional projects, we also verified the accuracy of the calculation used to establish the penalty and no errors were detected.

As a final analysis, we also wanted to determine whether the pre-determined unit prices used to calculate the amount of the penalty were representative of the prices submitted by the contractors retained at the time they submitted their tender. It should be noted that these pre-determined unit prices are indicated in the [TRANSLATION] Standardized Instructions Book mentioned earlier.

Thus for the four projects in our initial sample, as well as for the seven additional projects selected, we re-calculated the penalty based on the prices for asphalt paving and cement concrete found in the contractor's tender documents. We then compared the penalty amount obtained in this manner to the penalty calculated by the city based on the pre-determined unit prices in the [TRANSLATION] Standardized Instructions Book.

The results of the comparison made for the 11 projects examined reveal that, if the calculation had taken into account the prices actually invoiced by the contractors, the amount of the penalties imposed would have been \$247,366 whereas the amount actually imposed by the city in keeping with the calculations was \$109,112, which represents a shortfall of \$138,254 (127%) (see Appendix 6.4). This shortfall could be even more important if we consider the fact that, based on an examination of the results of the core sampling tests performed by the DEST from 2010 to 2012 for the 101 projects mentioned earlier, we noted that two thirds of these projects (67%) presented results that were non-compliant with the expected specifications. It is also important to note that imposing small financial penalties may not

entirely compensate for the fact that the non-compliances detected will have contributed to reduce the useful life of the city's infrastructure and increase the expenses for maintaining and repairing it, not to mention that this is not a deterrent for the contractors in question.

We submitted our observations to the DI representatives responsible for applying penalties in order to obtain explanations as to why such a large difference exists. The information obtained revealed that the pre-determined unit prices noted in the [TRANSLATION] Standardized Instructions Book (Volume 4) were established using an average of the unit prices obtained from the lowest compliant tenderers. However, these unit prices have not been revised since at least 1997 (16 years ago). Some individuals are of the opinion that this revision may even date back to 1980 (more than 30 years ago). Under the circumstances, we are of the opinion that it is urgent for the necessary measures to be taken to ensure that the unit prices used to calculate the penalties for non-compliant work are representative of the prices billed to the city when the work is done. We are of the opinion that this is all the more judicious since the Commission of Inquiry on the Awarding and Management of Public Contracts in the Construction Industry (Charbonneau Commission) has brought to light exaggerations in the prices billed to the city.

In our opinion, this observation concerning the minor financial penalties imposed, combined with the high rate of non-compliances obtained following the core sampling tests done by the DEST, tends to demonstrate an excessive tolerance towards the contractors when, during the course of the work, all of the required thoroughness may not have been exercised to ensure that the quality standards in effect within the city and the industry in general are respected.

4.2.4.2.B. Recommendation

We recommend that, in order to obtain assurance that the penalties imposed on the contractors are representative of the prices billed to the city when the work is done, the Direction des infrastructures take the necessary measures to:

- **revise, in the short term, the pre-determined unit prices used to calculate the penalties in the event that the core sampling tests reveal the work to be non-compliant so as to have a deterrent impact on the contractors concerned;**
- **provide for the implementation of a periodic revision mechanism for these pre-determined unit prices.**

Business unit's response:

[TRANSLATION] The Division conception will compile the data resulting from the calls for tenders issued for the 2014 order book to be able to update the unit prices used for calculating penalties. (Planned completion: July 2014)

As part of the process to harmonize specifications, a recommendation will be submitted to the unit that will be assigned to update the standardized specifications requiring it to update these unit prices periodically. (Planned completion: September 2014)

4.3. Compliance of Normative Reference Documents and Test Reports Used

4.3.1. Normative Reference Documents

4.3.1.A. Background and Findings

In order to ensure that the infrastructure work is performed in keeping with the standards and guidelines in effect, it is important for all of the reference documents (normative documents) prepared within the city and made available to contracted external firms to be kept up to date and to be unambiguous and accurate.

Within the SITE, these normative reference documents can be classified into three categories, as follows.

- **[TRANSLATION] Standardized Instructions Book:** This is a series of six volumes that cover the topics presented in Table 13 in various sections.

Table 13 – Description of the Volumes that make up the [TRANSLATION] Standardized Instructions Book

Volume	Title	Publication date
1	[TRANSLATION] General administrative clauses (Performance of work)	March 2009
2	[TRANSLATION] Administrative clauses that apply to the work and [TRANSLATION] Materials	March 2009 (Section 1-3) April 2008 (Section 1-4)
3	[TRANSLATION] Unit prices	April 2008
4	[TRANSLATION] Road, sidewalk and curb work and [TRANSLATION] Sewer and water system work	April 2008 (Sections 2-5 to 2-9)
5	[TRANSLATION] Lighting and signals	April 2008
6	[TRANSLATION] List of standardized drawings	April 2008

- **Standardized technical specifications:** These are normative documents specifically for the various types of materials used during the construction of infrastructure. They cover various aspects, such as their components, their characteristics, the conditions for installing them and the quality controls required. Table 14 lists the standardized technical specifications.

Table 14 – Description of Standardized Technical Specifications

No. of standardized technical specifications	Title	Publication date
3VM-10	[TRANSLATION] Regular concrete – Compressive strength of less than 50 MPa ^[a]	June 2005
3VM-20	[TRANSLATION] High-strength concrete – compressive strength of 50 MPa ^[a] or more	August 2005
3VM-30	[TRANSLATION] Roller-compacted concrete (RCC)	June 2002
3VM-40	[TRANSLATION] Dry-mix shotcrete	November 2009
3VM-50	[TRANSLATION] Wet-mix shotcrete	September 2009
3VM-60	[TRANSLATION] Self-placing concrete	August 2009
4VM-10	[TRANSLATION] Hot-mix asphalt	April 2013 ^[b]
6VM-9	[TRANSLATION] Granular materials for foundations, beddings and fill	November 2006
6M-VM-10	[TRANSLATION] Test procedure for estimating the compaction of granular fill made of crushed stone, used in cuts and trenches – penetrometer method	May 2006
6VM-20	[TRANSLATION] Recycled granular materials used for roadwork	August 2008
6VM-30	[TRANSLATION] Fill without removal	February 2008
6VM-40	[TRANSLATION] Filling street trenches with excavated or borrowed material	June 2010
7VM-10	[TRANSLATION] Installing concrete or natural stone paving blocks and slabs on a granular bedding	August 2002
7VM-20	[TRANSLATION] Characteristics and installation of granite curbs	August 2002

^[a] Megapascal.

^[b] At the time of our audit work, we used the April 2006 version which was in effect at that time.

It should be noted that these standardized technical specifications, like the volumes in the [TRANSLATION] Standardized Instructions Book listed earlier, are used to prepare the descriptive specifications of the various projects to be undertaken and are an integral part of the tender documents issued for the purpose of awarding contracts.

- **The technical guideline concerning the quality control of materials (2011 and 2012 versions):** As we mentioned earlier in this report, this guideline, which is issued by the DEST, is intended to provide a better framework for work assigned externally by

specifying the nature of the quality control tests that the firms must provide for materials such as cement concrete, asphalt paving and granular materials.

Although our audit work did not involve making an exhaustive review of the adequacy of all of the standards and guidelines contained in the various DI reference documents, we did nevertheless determine that it would be appropriate to point out certain facts noted following the examination of the projects in our sample. Thus, we noted the following elements.

- Most of the normative documents ([TRANSLATION] Standardized Instructions Book and the standardized technical specifications) have not been re-issued for five years now – sometimes even 10 years in the case of certain standardized technical specifications. In this respect, for all of the projects examined, we noted that the [TRANSLATION] General and Specific Technical Instructions Book, included in the tender documents, was weighted down with a considerable number of pages (occasionally up to 20 pages) listing the modifications made sporadically over time to the various sections that make up the volumes of the [TRANSLATION] Standardized Instructions Book. In our opinion, this situation makes it difficult for the contracted firms to track the changes and in certain respects this represents an additional risk that they may overlook the standards and guidelines prescribed by the city.
- Various clauses contained in the sections of certain volumes in the [TRANSLATION] Standardized Instructions Book were not up-to-date. For example:
 - Article 4.02 [TRANSLATION] “Taking samples” of Section 1-4 of Volume 2 (Chapter 4 [TRANSLATION] “Sewer and drain”) specifically states as follows with respect to reinforced concrete pipes:

[TRANSLATION] The contractor must provide and transport to the city’s laboratory, at its own expense, at least 48 hours before installation, the pipe samples taken on the site so that the city can perform the required tests. However, the city reserves the right to require all the additional samples it considers necessary.

In this way, the contractor will provide at least one pipe for each of the diameters used for each manufacturer and one sample is taken per 120 metres of sewer pipe, also for each diameter and manufacturer.

The information obtained from the people we met from the DEST reveals that this article is no longer up-to-date. Indeed, the DEST goes itself to the site to collect the samples required for this type of material. As a result, the contractor does not transport the pipe samples to the city’s laboratory and, in fact, the expenses incurred

for their transportation are assumed by the city. Moreover, the number of samples indicated in the clause is inaccurate since it does not correspond to the specifications of the applicable BNQ standards²² which are not as strict.

- Sections 2-5 and 2-6 of Volume 4 refer to the pre-determined unit prices that have not been updated for calculating the penalties that apply to contractors in the case of defective work. It should be noted that this topic was covered in Section 4.2.4.2 of this audit report.

We realize that revising and re-publishing these documents requires an additional investment in terms of effort. Nevertheless, in order to avoid having to accumulate and follow up on an astronomical number of modifications and to avoid any ambiguity or inaccuracy, both during the work and with respect to the quality control of materials, we believe that it would be appropriate for the harmonization of the standards contained in the various reference documents and the updating of those documents to be integrated in a process that is implemented on a periodic basis.

- The technical guideline concerning the quality control of materials (2012 version) states, among other things:
 - that the determination of the compaction of asphalt paving must be done using nucleodensimeters in keeping with test method LC 26-510²³ (page 11 of the guideline), whereas the following page refers to performing the compaction test every 25 metres and for each paving machine span;
 - that the approval of the formulas for certain asphalt paving performance classes should be submitted to a rutting resistance test²⁴ that is valid for a maximum of three years. Yet, when we examined the 2006 version of the standardized technical specifications entitled [TRANSLATION] “Hot-mix asphalt” (4VM-10), which was in effect when our work was done, we find no mention of any such expiry date. Under the circumstances, since the tender documents underlying the construction contracts granted refer to these standardized technical specifications for the work, the DEST cannot legally invalidate an asphalt paving formula that a contractor proposes to use on the basis that the rutting resistance tests are more than three years old.

²² We are referring to BNQ Standard 1809-300/2004 (R 2007).

²³ According to the information obtained, this test method involves randomly choosing six sites on the paved surface where a reading will be taken. Around each of these readings, four other readings must be made and the average of the five readings is used to obtain the final result for each of the six sites selected.

²⁴ Rutting can be defined as a permanent deformation of the road caused by the repeated passage of vehicle wheels (source: MTQ, Bulletin d'information technique, Vol. 1, No. 16, December 1996).

In conclusion, we are of the opinion that a comparative examination should be made of all of the standards and guidelines included in the reference documents in effect in order to correct any discrepancies or ambiguities for the purposes of attenuating the risks of confusion and errors that they could cause during work pertaining to city infrastructure.

4.3.1.B. Recommendation

We recommend that, in order to attenuate the risks of confusion and errors during the course of work on infrastructure, the Direction des infrastructures take the measures it deems appropriate to ensure:

- that a comparative examination is made of all of the normative reference documents in effect in order to identify and correct any discrepancy or ambiguity;
- that the harmonized updating of all normative reference documents be integrated in a process implemented on a periodic basis.

Business unit's response:

*[TRANSLATION] The Division conception revised its tender documents in fall 2013. The formats for the specifications and the specific documents for the various disciplines have been updated and revised to make them clearer and more specific. The specifications for each call for tenders are systematically covered by a quality control process to prevent discrepancies or ambiguities among the disciplines and with the normative documents. **(Completed)***

*With respect to the normative documents, a complete revision is planned as part of a vast initiative to harmonize specifications, under the supervision of the Service de concertation des arrondissements et des ressources matérielles. The DI will attempt to obtain a timetable from those in charge of this project. **(Planned completion: May 2014)***

4.3.2. Reports Used

4.3.2.A. Background and Findings

During the course of activities pertaining to quality control of materials, it is important for the test reports used by the stakeholders on the site to be designed so as to procure the assurance that the results obtained following testing will in fact have been compared to the quality standards established by the city.

During the course of our audit, we noted that each of the different private laboratories assigned to perform quality control tests on the materials used for the five selected projects used its own work-site test report template to document the information resulting from its observations and tests. In this respect, based on our examination, we noted certain

discrepancies in the content of the reports produced, which raised questions about the current procedure.

Among these disparities, we identified the following:

- Certain firms prepared their report as a checklist, indicating the characteristics and the reference number of the standard applicable to the city for each point separately. This procedure seems very pertinent to us with respect to ensuring the compliance of the controls performed, particularly since we noted that certain firms used reports that referred instead to the standards in effect at the Ministère des Transports du Québec (MTQ).

Although some of these standards can be similar in certain respects, it appears that in certain cases they do not correspond to the standards adopted by the city. For example, we noted that the standard set by the MTQ concerning the ambient temperature for applying asphalt paving is not the same as the city's standard. In fact, according to MTQ standards, a non-compliance must be reported when asphalt paving is applied when the ambient temperature is below 2°C. The city, on the other hand, sets the limit for a non-compliance at an ambient temperature below 5°C. Under the circumstances, the fact that the reports used by certain firms have not been adapted to the city's standards means that these firms will not report a non-compliance in the event that the work is done when the ambient temperature is between 2°C and 5°C.

- The firms do not all clearly describe the test method used to measure the compaction of asphalt in their reports.
- The firms do not all clearly indicate the parts of the structure on which the tests are made (e.g., the base, the paving or the fill in a pipe, the lower or upper foundation of a road).
- The firms do not all provide pertinent qualitative information about, for example:
 - the condition of the excavation and the formwork prior to the installation of cement concrete;
 - weather conditions (e.g., rain, snow).
- The firms do not all clearly indicate the hours the site technician spent on the quality control tests as well as the kilometrage that will be billed.

In conclusion, based on these observations, we believe that it would be beneficial for the DEST to develop its own work-site test report templates which would have to be used by the

contracted private laboratories. In addition to ensuring uniformity and compliance with the quality standards established by the city, this would also make it easier for DEST representatives to review the tests performed by the contracted private laboratories.

4.3.2.B. Recommendation

We recommend that, in order to ensure uniformity and compliance with the quality standards established by the city and to make it easier to review the tests performed by the contracted private laboratories, the Direction des infrastructures:

- **develop its own work-site test report templates;**
- **require the external firms to use these report templates when fulfilling the mandates assigned to them by the city.**

Business unit's response:

[TRANSLATION] Laboratory and work-site report templates were implemented in 2013 by the Section contrôle des matériaux et expertise and were distributed to the firms in 2014; using them is mandatory. (Completed)

4.4. Accountability and Governance

4.4.A. Background and Findings

In order to make it possible to evaluate the extent to which the efforts dedicated to quality control tests and the installation of the materials provide reasonable assurance that the construction work pertaining to city infrastructure is performed in keeping with the standards and guidelines in effect and is of the expected quality, it is important, among other things:

- that the division of roles and responsibilities is adequately defined for the various parties involved when projects are undertaken so that everyone is fully capable of performing his mission;
- that follow-up is ensured and that periodic accountability reporting mechanisms are implemented with respect to the decisions made concerning the handling of non-compliances reported during the course of a project.

Under the procedure currently in effect at the DI, the project manager from the Division de la surveillance des travaux is responsible for coordinating the entire project, from the progression of costs and the respect for the timelines to the decisions concerning quality control tests performed on materials, whether or not work is accepted, and the imposition of sanctions (work to be re-done or financial penalties). The DEST only intervenes upon request to provide support with respect to the quality control tests or the required expertise. As a result of this procedure, it is possible for infrastructure work to be done without the DEST

being called on to orchestrate quality control tests on materials. This situation is deplorable since the costs associated with performing quality control tests on materials are negligible compared to the consequences that could result if such tests were not done, in terms of maintenance and repair work to be done prematurely and the impact on the sustainability of infrastructure.

Despite the fact that the DEST is not a stakeholder in the decisions made during the course of the work on the site, it is nevertheless the administrative unit designated to ensure that quality control tests on materials are performed in keeping with the standards and guidelines in effect. Nevertheless, the current procedure for sharing roles and responsibilities makes it difficult for the DEST to follow up on the non-compliances that it reports (including core sample tests).

Our audit work revealed the fact that at present there is no accountability mechanism to ensure the follow-up of the manner in which the non-compliances reported by the DEST are handled. Consequently, the DEST loses track of the non-compliances reported to the business unit that required the services. Moreover, at present, the DI has no assurance that the work on the site is done in keeping with the expected quality standards. This statement is all the more pertinent since our audit work revealed the fact that the decisions made concerning the handling of non-compliances are not always documented by the individuals concerned, which means that we cannot corroborate what was done following these observations (see Section 4.2.4.1 of this audit report). As a result, it would be appropriate for the Division de la surveillance des travaux to inform the DEST of the reasons for the decisions made concerning the handling of non-compliances submitted to it so that ultimately this information can be used when reporting to management.

In our opinion, in addition to being a matter of good management practices, the implementation of accountability mechanisms would help to make the process more transparent and to create a more sensitive form of pressure to make those involved in doing the work feel more accountable for the decisions made.

In the same manner, we also believe that it could be very pertinent for the DEST to obtain, from the private laboratories, a detailed compilation of all the non-compliances detected in each mandate that is assigned. This information concerning the number and the importance of the non-compliances detected could be very useful when assessing the quality of the work done by the contractor and could serve as a guide for determining the degree of supervision to be exercised in the future when implementing work for other projects.

Likewise, we also believe that it would be beneficial for the DEST to implement a mechanism for compiling the results of the core sample tests it performs. At present, no such compilation is systematically made. Indeed, the results we presented earlier in this report (see Section 4.2.4.2), namely the fact that two thirds (67%) of the core sample tests done by the DEST from 2010 to 2012 (for 101 projects) present results that do not comply with the expected specifications, come from a compilation we made ourselves. In our opinion, this type of statistics serves as a good indicator for SITE management of the quality of the work done by contractors hired by the city.

Moreover, as discussed earlier in this audit report (see Section 4.2.4.2), our audit work also revealed that although the core sample tests are performed by the DEST, as in the case of certain other quality control tests, they are only done at the request of the project manager for the Division de la surveillance des travaux. Under the circumstances, we believe that it would be beneficial for the SITE to set up another, distinct administrative department, called “quality control,” to give senior management reasonable confidence that all of the work pertaining to the city’s infrastructure for which it is accountable meets the expected level of quality. This business unit, which should in our opinion report to the senior manager, would be responsible, among other things, for supervising tests and ensuring that they are performed appropriately at the end of projects, in other words, for applying all of the frameworks that govern quality control. Considering the independence and the objectivity required for “quality control” within an organization such as the city, we are of the opinion that it is legitimate for this administrative unit to be separate from the operating units in order to avoid situations in which its representatives would find themselves to be both judge and litigant. In our opinion, creating such an independent unit would serve to exert pressure on the various stakeholders involved in the project completion process (e.g., the party responsible for the mandate [DEST], the site supervisor and the project manager) to work to make the process more transparent with respect to the tests performed and decisions made. This would also minimize the risks of compromising the quality of the work when problem situations arise (e.g., the urgency of the work to be done). All in all, the application of a quality control system should serve to standardize processes and prevent poor quality as well as to identify non-compliances and apply the corrective and preventive actions required. Through its actions, the entity responsible for quality control will help identify the shortcomings in the system so that the necessary corrections can be made.

4.4.B. Recommendation

We recommend that the Service des infrastructures, du transport et de l'environnement include, in the existing business model, a control mechanism that would provide the assurance, completely independently, that all of the frameworks governing the quality of infrastructure work are respected.

Business unit's response:

[TRANSLATION] The SITE will revise the city's existing frameworks governing the quality of infrastructure work and will distribute them to its employees. (Planned completion: December 2014)

The SITE will implement a spot check program for the projects undertaken by a city department or an independent firm. (Planned completion: February 2015)

4.4.C. Recommendation

We recommend that the Service des infrastructures, du transport et de l'environnement take the necessary measures to implement the relevant accountability measures for the decisions made, concerning the handling of the non-compliances reported by the Division de l'expertise et du soutien technique in order to make the process more transparent and to increase the accountability of those involved in doing the work.

Business unit's response:

[TRANSLATION] The Division de la surveillance des travaux will implement a non-compliances log for each project (see recommendation 4.2.4.1.B.). The DI will issue a guideline requiring the Division de la surveillance des travaux to send this log to the DEST periodically. (Planned completion: May 2014)

4.4.D. Recommendation

We recommend that the Direction des infrastructures take the necessary measures to:

- obtain from the private laboratories the detailed compilation of all of the non-compliances identified for each of the mandates assigned to them. As a result, the tender documents provided under the master agreements as well as the administrative and technical guidelines should be revised to reflect this new requirement on part of the firms that are given mandates;
- implement a mechanism for compiling the results of the core sample tests performed by the Division de l'expertise et du soutien technique;

in order to be better able to evaluate the quality of the work done by the contractors and to serve as a guide with respect to the degree of supervision to be exercised when work is done on future projects.

Business unit's response:

[TRANSLATION] The technical guidelines that will be revised by the DEST will require the firms to keep and send a list of the non-compliances noted and the memos issued during the course of a project; this list will include any follow-up of corrective actions taken and the consequences. (Planned completion: March 2014)

The DEST will compile the core sample test results and give them to the DI periodically. (Planned completion: May 2014)

5. General Conclusion

The audit highlighted shortcomings that are sufficiently significant, in our opinion, to raise reasonable doubt as to the possibility that construction work pertaining to the city's infrastructure may have been done without the assurance that the quality of the materials and their installation were in all respects compliant with the standards and guidelines in effect.

We noted that, since 2004, the Division de l'expertise et du soutien technique (DEST) has had no choice but to use the services of private laboratories which, following a public call for tenders, share a portion of the budget credits allocated for a master agreement. In fact, these firms perform quality control tests on the materials for almost all of the projects (95% in 2012) when the DEST's expertise is called upon. This procedure increases the inherent risk and requires greater caution on the part of the DEST, which must take the form of tighter internal controls intended to provide the assurance that the firms' work is done at the best cost and in keeping with the city's requirements.

Nevertheless, as soon as the mandates are assigned to the external firms, we detected the absence of essential controls (e.g., requiring the firms to provide an evaluation of the professional fees estimated for the services to be provided, a detailed program of the quality control tests to be performed, planning of tests in a timely manner so as to ensure the presence of the contracted firms on site, sporadic visits to the site by city employees). The absence of these controls raises questions as to the possibility that the city may pay too much for the services received, that it may pay for services that are not received, that the quality control tests are not complete and, as a result, that they do not correspond to the standards and guidelines in effect.

The examination of the quality control tests done for a sample of projects revealed several non-compliances with the standards and guidelines in effect which could, at least to a significant degree, be the result of the fact there are no formalized follow-up mechanisms within the DEST for all of the quality control tests to be performed and that the laboratories that are given mandates are not subject to financial penalties in the event the work is not done. Moreover, we would like to point out that, as a result of the tardy adoption of three-year capital expenditures program (TCEP) budgets, the work is done when the ambient temperature is not appropriate, which means that the city does not maximize its chances of benefiting from infrastructure of a quality that would ensure sustainability.

These non-compliances with respect to the standards and guidelines inevitably entail risks that the quality of the materials used or the work done does not correspond to the quality expected and that this may result in the premature appearance of signs of deterioration resulting in an overall reduction in the expected useful life, an inevitable increase in maintenance and repair costs and, of course, the disturbing effects this can have for the citizens, ultimately compromising their safety.

Finally, our observations highlight a problem associated with the sharing of responsibilities between the Division de la surveillance des travaux and the DEST, making it more difficult for the DEST to follow up with respect to non-compliances reported.

Furthermore, at present, there are no accountability mechanisms intended to assure the Service des infrastructures, du transport et de l'environnement (SITE) management that the expected quality standards are respected when the work is done.

As a result, we believe that it would be beneficial for the SITE to set up a “quality control” administrative unit that would report, for the purposes of greater independence, to the senior manager. This unit would be responsible for supervising, at the end of the infrastructure

projects for which it is responsible, the application of all of the frameworks that govern quality controls, in order to ultimately report to the department's senior management.

6. Appendices

6.1. Summary of Projects Selected


Table A – Summary of the Five Projects in our Sample


Project No. Cost of infrastructure work	Requested by	Year project completed	Description of the project	Party responsible for the project (project manager)	Party responsible for quality control of materials
1109 (\$2.5 million)	SITE (DI)	2011 and 2012	Re-building a combined sewer and a secondary water mains	External firm mandated by the Division de la surveillance des travaux	Mandate assigned by the DEST to a private laboratory – Firm A
1152 (\$0.8 million)	SITE (DI)	2011	Re-building a secondary water mains	Division de la surveillance des travaux	Mandate assigned by the DEST to a private laboratory – Firm B
1201 (\$0.4 million)	SITE (DI)	2011	Re-building a mixed road into a flexible road and curb construction	Division de la surveillance des travaux	Mandate assigned by the DEST to a private laboratory – Firm C
1203 (\$0.6 million)	SITE (DI)	2011	Construction of a RCC surface on the site of snow depot A and construction of an asphalt driving surface on the site of snow depot B	Division de la surveillance des travaux	Mandate assigned by the DEST to a private laboratory – Firm B
1223 (\$0.8 million)	SITE (DI)	2012	Re-building a single sewer and a secondary water mains	Division de la surveillance des travaux	Mandate assigned by the DEST to a private laboratory – Firm C


6.2. Chronology of the Steps Involved in Awarding Mandates for Quality Control of Materials for the Selected Projects

Table B – Chronology of the Steps Involved in Awarding Mandates for the Projects in our Sample

Steps in assigning mandates	No. of projects selected				
	1109	1152	1201	1203	1223
Mandate to private laboratory confirmed	August 5, 2011	Sept. 9, 2011	Nov. 2, 2011	Oct. 21, 2011	May 1, 2012
Creation of purchase order	June 22, 2011	Sept. 9, 2011	Nov. 2, 2011	Oct. 21, 2011	April 30, 2012
Contracted firm starts studying plans and specifications	Nov. 24, 2011	Sept. 20, 2011	Nov. 2, 2011	Oct. 17, 2011	May 25, 2012
Construction work started on site	Nov. 25, 2011	Oct. 18, 2011	Nov. 3, 2011	Oct. 17, 2011	May 25, 2012

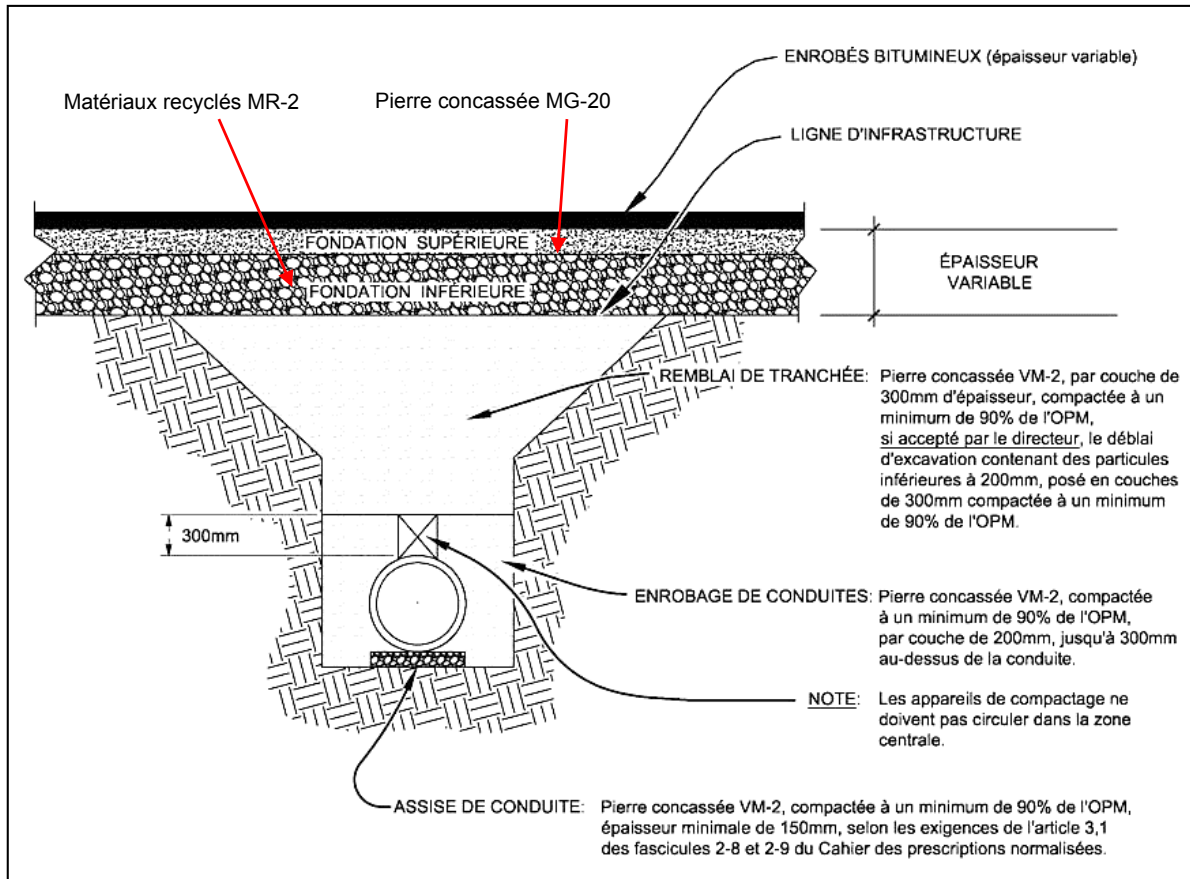
 For this project, the private laboratory was assigned to perform the quality control tests on the materials **the day before** construction work started on the site.

 For these projects, the private laboratory studied the plans and specifications **after** the mandate for material quality controls was confirmed.

 For this project, the private laboratory was given the mandate **four days after** construction work was started on the site.

6.3. Steps Involved in Building Water Mains and Sewer Lines

Figure A – Steps and Materials used for the Construction of Water Mains and Sewer Lines



Source: Figure based on the standardized technical specifications 6VM-40, [TRANSLATION] "Filling street trenches with excavated or borrowed material," June 2010.

6.4. Details of Penalties Imposed for the Sample Projects

Table C – Difference Between the Penalties Imposed and the Theoretical Penalties

11 projects examined	Penalties imposed (in keeping with the pre-determined unit prices)	Theoretical penalties (in keeping with the prices billed by the contractors)	Variance	
			\$	%
1	\$2,630	\$5,219	\$2,589	98%
2	\$4,733	\$8,064	\$3,331	70%
3	\$13,905	\$27,817	\$13,912	100%
4	\$91	\$345	\$254	279%
5	\$3,582	\$9,665	\$6,083	170%
6	\$3,517	\$10,608	\$7,091	202%
7	\$12,807	\$30,603	\$17,796	139%
8	\$9,518	\$18,296	\$8,778	92%
9	\$34,139	\$87,464	\$53,325	156%
10	\$9,329	\$17,933	\$8,604	92%
11	\$14,861	\$31,352	\$16,491	111%
Total	\$109,112	\$247,366	\$138,254	127%