

Chapter 2

Transportation and Infrastructure Renewal: Selection and Quality Management of Bridge Projects in Central and Western Districts



Overall Conclusions

- The Department of Transportation and Infrastructure Renewal's bridge information system does not give management all the necessary information needed to make decisions to select bridge replacement, rehabilitation, and maintenance projects.
- The Department of Transportation and Infrastructure Renewal appropriately monitors whether bridge projects meet established standards during construction, but fails to properly monitor warranties.

Selection and Quality Management of Bridge Projects

- If the Province were to replace all provincially-owned bridges, it would take approximately 200 years at the current rate of replacement
- The Department's information system does not provide complete and accurate information to support management in making decisions on bridge projects
- Management does not have documented criteria to objectively rank and assess projects
 - Three bridges were in poor condition and management could not explain why they were not on the district priority listing
- The Department has effective processes to verify that bridge projects meet established standards; however, warranty monitoring is lacking
 - 75% (9 of 12) of projects were not inspected at the end of the warranty period
- Inspectors did not complete all regular inspections as required
 - 23% (7 of 30) of bridges tested were not inspected as required in 2018-19
 - Two of seven bridges with issues noted had no follow-up inspection
 - 27% (7 of 26) of level two inspections tested were completed at least a year late
- The Department has, and follows, standards to guide bridge replacement, rehabilitation, and maintenance projects
- Management has a documented inspection policy, but does not ensure staff follow policy requirements
- No annual quality assurance audits have been completed since October 2017
- The Department has not defined training requirements for inspectors



Recommendations at a Glance

Recommendation 2.1

The Department of Transportation and Infrastructure Renewal should review its processes and systems used to track bridge information and inspections. The Department should identify and take appropriate action to ensure information about bridges, including recommended repairs and maintenance history, is complete, accurate, and accessible.

Recommendation 2.2

The Department of Transportation and Infrastructure Renewal should implement a process of using consistent criteria to assist management to determine bridge priorities at the district and provincial levels.

Recommendation 2.3

The Department of Transportation and Infrastructure Renewal should complete bridge inspections as required by Department policy.

Recommendation 2.4

The Department of Transportation and Infrastructure Renewal should implement regular monitoring of information system data, inspection results and documentation, and project files to ensure there is complete and accurate information on the condition of bridges and to monitor compliance with Department policies and processes.

Recommendation 2.5

The Department of Transportation and Infrastructure Renewal should annually review the *Project Engineer's Field Manual* and the *Standard Specification: Highway Construction and Maintenance* manual. Updates should be made as needed based on the outcome of the reviews.

Recommendation 2.6

The Department of Transportation and Infrastructure Renewal should implement a process to monitor bridge-related warranties.

Recommendation 2.7

The Department of Transportation and Infrastructure Renewal should document training requirements for inspectors and monitor to ensure training is completed as required.

2 Transportation and Infrastructure Renewal: Selection and Quality Management of Bridge Projects in Central and Western Districts

 **The number of bridges exceeds current financial capacity for repairs and replacement**

- 2.1 The Department of Transportation and Infrastructure Renewal is responsible for approximately 4,200 bridges throughout its Western, Central, Northern, and Eastern districts in Nova Scotia. Generally, it is not responsible for municipal bridges or bridges owned by other parties. The Department defines a bridge as a structure greater than three meters in span that provides a roadway or walkway for the passage of vehicles, pedestrians, or cyclists across an obstruction or gap. Annually, the Department spends approximately \$45 million across the four districts to maintain, repair, and replace bridges.
- 2.2 In its January 2019 draft needs assessment for bridges, the Department estimated that \$2.1 billion is required over the next 10 years to reduce the current bridge infrastructure deficit. This level of funding would allow for preservation work on bridges in good condition, maintenance work on bridges in fair condition, and replacement of bridges in poor condition. We did not audit the accuracy of the Department's estimate.
- 2.3 Management told us they typically replace between 15 and 20 bridges a year, and that modern bridges have a design life of approximately 75 years, while older bridges have a design life of 50 years. If the Province were to replace all 4,200 provincially-owned bridges, it would take approximately 200 years at the current rate of replacement. As an alternative, the Department could choose to reduce the number of bridges requiring replacement by identifying bridges which are close in proximity to each other to determine if this is the most efficient use of limited resources.
- 2.4 While we recognize there are many competing priorities, these numbers make it clear the Department needs to make careful decisions on which bridges should receive attention first.

 **The Department's information system does not provide complete and accurate information about bridges**

- 2.5 The Department does not have a process to centrally record work completed on bridges, even though the Department's information system is capable of recording maintenance history. We found that staff did not consistently record maintenance activity; they could record repairs in spreadsheets, paper format, or in the information system. Having records in a variety of



formats in the districts does not easily provide for full and complete records being available to decision makers. The Department should have complete information about the maintenance history of bridges including work and repairs completed to assist staff to properly assess the condition of a bridge, and to support management decision making.

- 2.6 Staff are not clearly or consistently documenting the recommended work resulting from their inspections. Each district has its own format for tracking deficiencies and recommended work using spreadsheets which staff update over time, but this information is not maintained in the information system. This means there is no centralized, easily accessible, permanent record of repairs recommended from each inspection. When we reviewed inspection files, we found it difficult to determine which recommended repairs related to which deficiency, or the action the Department took to address the deficiency. This further reduces the completeness of information available on any specific bridge.
- 2.7 Users of the information system can create inspection records for inspections they did not complete and are not trained to complete. For instance, staff who are only trained to complete a level one inspection can create a record indicating a level two inspection occurred. This happened for 5 of the 30 bridges we selected for testing from the Central and Western districts; a level one inspector had created a level two inspection in error. Head office staff told us that although inspectors can flag inspections created in error, the system does not consider this when calculating the next required inspection date. This can lead to the system incorrectly scheduling the next inspection.
- 2.8 The Department's listing of bridges in the information system contains errors. We identified 28 of approximately 2,100 bridges in the Central and Western districts which staff should have removed from the information system because either the bridge was closed or the structure did not meet the Department's definition of a bridge. Inaccurate information in the system could result in inaccurate reports on the number of structures the Department is responsible to inspect, or the frequency of inspections.
- 2.9 We identified six bridges which are either municipal bridges or bridges owned by other parties. Management told us the responsibility for these structures had not been clearly determined between the Department and the bridge owners. This leads to a risk that neither party is inspecting these bridges to ensure they are safe to use.



Recommendation 2.1

The Department of Transportation and Infrastructure Renewal should review its processes and systems used to track bridge information and inspections. The Department should identify and take appropriate action to ensure information about bridges, including recommended repairs and maintenance history, is complete, accurate, and accessible.

Department of Transportation and Infrastructure Renewal Response: The Department will review the processes and systems used to track bridge information and inspections and determine appropriate actions for ensuring information about bridges, including recommended repairs and maintenance history, is complete, accurate and accessible. This will include an investigation of software upgrades and updating of policies and procedures. This review, and any subsequent implementation, will be in place within 24 months. The Department is also hiring a maintenance planner who will prioritize maintenance, inspections and upkeep of all highway infrastructure including bridges. This position should be in place within 6 months.



Management does not have documented criteria to objectively rank and assess projects

- 2.10 Management does not have documented criteria to objectively rank and assess projects. Criteria could include bridge condition, traffic volume, travel time to the nearest detour, or whether the bridge is on a main route for emergency vehicles. Without documented criteria, it is impossible to assess decisions made in the past and it creates a risk that management may not identify bridges that are the highest priority for repair or replacement.
- 2.11 In addition to the lack of criteria, the poor quality of information available from the Department's information system further reduces the Department's ability to make consistent and supportable decisions. Staff cannot be reasonably expected to have complete and detailed knowledge of the approximately 4,200 bridges across the province.
- 2.12 The lack of comprehensive information also elevates the risk that management will incorrectly prioritize or overlook bridge maintenance and repair projects. We identified 75 of approximately 2,100 bridges in the Central and Western districts with a rating of two or lower in the information system. The Department considers any bridge with a rating of four or lower as being in poor condition, meaning these 75 bridges are in the lower half of the poor-condition category.
- 2.13 We reviewed inspection results, district work priorities, and other documentation for these 75 bridges to better understand the situation and were satisfied with the information provided for 72 bridges – the bridge was on a closed road or the bridge had been replaced or repaired to improve its condition. However, district management could not provide a satisfactory



explanation for the remaining three bridges. We noted that management had put weight restrictions in place on two of the three bridges to mitigate the risks associated with it being in poor condition, but we are concerned there was no further information available to show that the Department had made a conscious decision to leave these bridges off its five-year capital plan, or take other action to improve the condition of the bridge. This is the sort of situation that can occur when there is not sufficient information available to allow criteria-based evaluation to support decision making.

- 2.14 Management has an annual process to establish priorities for major bridge replacements and capital maintenance for the next five years. District management is responsible to identify priority projects. They told us they consider inspection results of bridge condition, available funding, and timing of other planned work such as paving. Management in the districts told us they would like to have more information available to help with the management decision-making process.
- 2.15 Annually, management from each district submit their priority projects to the head office. Head office management and staff, in consultation with district management and staff, develop the annual five-year capital plan which the Department publishes on its website.
- 2.16 We found that management is appropriately incorporating district priorities when determining the five-year capital plan priorities. We selected a sample of 10 priority projects submitted by management from the Central and Western districts. Head office management reasonably addressed all 10 projects. They accepted four projects as submitted and documented explanations for changes to the timing and extent of work approved for the six remaining projects.

Recommendation 2.2

The Department of Transportation and Infrastructure Renewal should implement a process of using consistent criteria to assist management to determine bridge priorities at the district and provincial levels.

Department of Transportation and Infrastructure Renewal Response: The Department will ensure the process currently in place is formalized and made provincially consistent for the decisions around bridge repairs and replacement. This will include the parameters used in the prioritization process. This process will be implemented for the 2021-22 Capital Plan.



Inspectors did not complete all regular inspections as required

- 2.17 Inspectors did not always complete level one visual inspections each year as required under Department policy. A level one inspection provides a general overview of bridge condition and identifies any obvious structural problems



or safety concerns. The Department’s inspection procedure requires all bridges be visually inspected between April 1 and July 31 of each year. Prior to August 2017, the Department did not require a level one inspection if the bridge had received a more thorough level two inspection in the same year. The results of our testing are shown below.

Level One Inspection Results from a Sample of 30 Bridges in the Central and Western Districts from April 1, 2016 to September 30, 2018			
	2016-17	2017-18	2018-19
Bridges requiring a level one inspection	24	30	30
Bridges with a level one inspection completed	19 79%	30 100%	23 77%
Bridges without a level one inspection completed	5 21%	0	7 23%

2.18 In addition, management did not complete a follow-up inspection for two of the seven bridges when staff identified concerns during the initial inspection and requested a follow-up inspection take place.

2.19 Inspectors did not always complete the indepth level two inspection as required. The Department’s inspection procedures require all bridges have an indepth level two inspection every two to six years, with the frequency based on factors such as the type of road the bridge is on and the condition of the bridge. The level two inspection provides a more detailed examination of the bridge during which inspectors identify structural problems or safety concerns which may not be evident during a level one inspection. The results of our testing are shown below.

Level Two Inspection Results from a Sample of 30 Bridges in the Central and Western Districts from April 1, 2016 to September 30, 2018	
Number of level two inspections required	26
Number of level two inspections completed on time	19 73%
Number of late level two inspections (at least a year later than required)	7 27%

The seven bridges with late level two inspections were late between 1 and 11 years.

2.20 The Department’s inspection policy requires inspectors to complete additional verification inspections on higher risk bridges in the years they do not complete a full level two inspection. Inspectors complete the verification inspection to confirm that the bridge’s condition has not changed since the last indepth inspection. Fourteen of the bridges we tested required verification inspections during our audit period. Four of the 14 bridges did not receive verification inspections as required.



Recommendation 2.3

The Department of Transportation and Infrastructure Renewal should complete bridge inspections as required by Department policy.

Department of Transportation and Infrastructure Renewal Response: The Department will review the processes and systems used to track bridge inspections and determine if any additional resources are required to ensure Department policy is met. This review, and any subsequent implementation, will be in place within 24 months.



The Department has an inspection policy, but weaknesses exist with monitoring of policy requirements

- 2.21 The Department has documented policies for bridge inspections. Department policies include clear roles and responsibilities for inspections and clearly-defined inspection schedules. Inspectors in the Central and Western districts are required to take photos and complete an inspection template to note any deficiencies identified during the inspection. In our testing of a sample of 30 bridges from the Central and Western districts, we found that inspectors completed the templates as required.
- 2.22 We found issues with documenting and monitoring inspections. The policy requires inspectors to document level one inspections in the information system within 10 days of the inspection. Management did not monitor this requirement and we were unable to test this timeframe requirement because the system does not clearly indicate the timeframe between the inspection date and the date it was recorded in the system. In addition, there is no required timeframe for inspectors to enter level two inspections in the information system. This creates a risk that inspection information may not be available to management in a timely manner to support decision making and prioritizing projects.
- 2.23 Department inspection policies do not define a timeframe to complete a follow-up inspection if inspectors identify issues during a level one inspection, or when a level two verification inspection requires a new level two inspection. Without established and monitored timeframes, there is a risk that inspectors will not identify and correct safety concerns or other issues in a timely manner.
- 2.24 The Department does not have a monitoring process in place over data in the information system or for the inspection of bridges. As noted above, the information system contains errors and, depending on the district, varying levels of information. Regular monitoring of the data and inspection results should identify data quality issues and instances of inspectors having not completed or documented inspections in accordance with Department policy and expectations.



- 2.25 For significant construction projects, the Department has an internal quality assurance process which requires an annual audit of the project files to make sure the files meet the requirements defined in the contract and the standard specification. The Department did not complete the required annual reviews. Management told us they expect staff to review three major construction projects annually, but said staff have not completed reviews since October 2017 due to there being vacancies. Regular monitoring helps management to know if staff are complying with Department policies and procedures, and whether contractors are meeting the Department's quality standards.

Recommendation 2.4

The Department of Transportation and Infrastructure Renewal should implement regular monitoring of information system data, inspection results and documentation, and project files to ensure there is complete and accurate information on the condition of bridges and to monitor compliance with Department policies and processes.

Department of Transportation and Infrastructure Renewal Response: The Department will review the processes and systems used to track bridge inspections and determine if any additional resources are required to ensure information system data, inspection results and documentation, and project files are complete and accurate. The Department will also monitor compliance with policies and processes. This review and any subsequent implementation will be in place within 24 months. The Department is also hiring a maintenance planner who will prioritize maintenance, inspections and upkeep of all highway infrastructure including bridges. This position should be in place within 6 months.



The Department has effective processes to verify that bridge projects are completed to established standards; however, warranty monitoring is lacking

- 2.26 The Department has documented its specifications in its *Standard Specification: Highway Construction and Maintenance* manual which incorporates nationally accepted standards for the quality of bridge projects.
- 2.27 The Department includes references to the standard specifications in contracts for tendered bridge projects. Contractors are required to complete work to the standards specified in the contract. The contracts include project-specific provisions such as warranty periods and requirements for quality and testing of materials.
- 2.28 The Department has clearly-defined roles and responsibilities for overseeing the quality of bridge projects. The Department's policy manual states that a project engineer or a district bridge engineer is responsible for ensuring work is completed in accordance with project plans and Department specifications. Other responsibilities described in the manual include the engineer's



responsibility to ensure materials used in the work meet the requirements of the Department's standard specification.

- 2.29 The Department has an effective process to verify that bridge projects meet established quality standards. We tested 15 replacement and rehabilitation bridge projects from the Central and Western districts. For each project, we selected three deliverables included in the contract and confirmed that staff had verified that the work met the Department's quality standards. Forty-two of the 45 deliverables required verification by staff, and in each instance, we found that staff had clearly documented that the requirement met the quality standard defined in the standard specification or appropriate corrective action had been taken if the work did not meet the quality standard.
- 2.30 We also determined if external consultants were used to assess quality standards in the standard specification as required. Thirty-nine deliverables required the Department to use external consultants; 38 either met the Department's quality standard or had appropriate corrective action if the initial work did not meet the quality standard. The one remaining deliverable had no documentation showing the external consultant had verified the work, but we determined staff had documented that they were satisfied with the quality of the work and therefore, we did not consider this to be a significant finding.
- 2.31 Management and staff did not annually review or update the project engineer's manual as required. The last revision to the manual was in May 2006. The manual requires staff to annually review and update it as necessary to reflect changes in specifications or procedures. Regular review and updates to the manual reduce the risk that staff have unclear or outdated expectations.
- 2.32 The committee responsible for annually reviewing the section of the standard specifications which includes bridges has not met since December 2016. Staff told us there were no significant issues in either 2017 or 2018 requiring updates to the standards. The minutes from the most recent meeting in December 2016 include eight items with a status of ongoing. We found no further information on the status of those ongoing issues. Regular review and revision to the standard specifications helps to make sure there are clear and current quality standards available when completing work on bridges.

Recommendation 2.5

The Department of Transportation and Infrastructure Renewal should annually review the *Project Engineer's Field Manual* and the *Standard Specification: Highway Construction and Maintenance* manual. Updates should be made as needed based on the outcome of the reviews.

Department of Transportation and Infrastructure Renewal Response: The Department has recently completed an update of the Standard Specification



Manual and will continue to review annually as needed. The Department feels the Project Engineer's Field Manuals do not require an annual review. TIR will review and determine a more practical update cycle. There is a quality assurance position which has been vacant but will be filled within 6 months. This position will also be responsible for updating the Project Engineer manual.

- 2.33 Staff did not complete the required check of contractors' work for 9 of the 12 (75%) projects we tested. These were projects entering or completing their one-year and/or three-year warranty period. The failure to monitor warranties could result in the Department eventually paying for repairs that a contractor should have corrected under the warranty.

Recommendation 2.6

The Department of Transportation and Infrastructure Renewal should implement a process to monitor bridge-related warranties.

Department of Transportation and Infrastructure Renewal Response: The Department has already started implementation of a monitoring process related to bridge warranties which includes a notification procedure. This will be in place within 6 months and monitoring will ensure effectiveness.



Management does not have defined training requirements for inspectors

- 2.34 Department policy requires inspectors to receive training, but it does not define the type of training required. Management told us they require level one inspectors to take training delivered by the Department and level two inspectors to take a one-week training course offered by the United States Department of Transportation Federal Highway Administration. We selected a sample of 3 of the 18 inspectors in Central District and 3 of the 10 inspectors in Western District who are responsible for completing level one and level two inspections. We determined inspectors had taken the training which management told us was required; they had also taken additional training relating to bridge inspections and maintenance.
- 2.35 Staff told us a training refresher is recommended for level two inspectors every five years. The training records for Western District indicated the last refresher for level two inspectors was in July 2012, more than 6 years ago. The training records also showed one inspector received their initial training in March 2002 and did not have refresher training until 2012, leaving a ten-year span over which the inspector did not receive any refresher training. Central District did not have a system to track inspector training, although they were able to provide evidence that training took place. It is important for the Department to define training requirements and to ensure staff are trained to perform inspections in accordance with guidelines.



2.36 Management periodically conducts training sessions with all inspectors responsible for level two inspections. The training has all inspectors complete an inspection on the same bridge and compare their results. This is a good practice to ensure inspectors are consistent in how they assess the condition of bridges. However, there is no policy outlining the requirement for the training or how often it should be done.

Recommendation 2.7

The Department of Transportation and Infrastructure Renewal should document training requirements for inspectors and monitor to ensure training is completed as required.

Department of Transportation and Infrastructure Renewal Response: The Department bridge inspectors already receive adequate training to complete inspections as required by policy. The Department will formally document training requirements for inspectors to be included in the bridge inspection policy. This will include reporting when training has been completed and when further training or refresher training is required. This will be updated within 6 months.



Appendix I

Reasonable Assurance Engagement Description and Conclusions

In spring 2019, we completed an independent assurance report of selection and quality management of bridge projects at the Department of Transportation and Infrastructure Renewal. The purpose of this performance audit was to determine whether the Department of Transportation and Infrastructure Renewal had adequate processes to effectively and efficiently manage the selection and quality of bridge projects.

It is our role to independently express a conclusion about whether management of the selection and quality of bridge projects complies in all significant respects with the applicable criteria. Management at the Department of Transportation and Infrastructure Renewal acknowledged their responsibility for management of the selection and quality of bridge projects.

This audit was performed to a reasonable level of assurance in accordance with the Canadian Standard for Assurance Engagements (CSAE) 3001 – Direct Engagements set out by the Chartered Professional Accountants of Canada; and Sections 18 and 21 of the Auditor General Act.

We applied the Canadian Standard on Quality Control 1 and, accordingly, maintained a comprehensive system of quality control, including documented policies and procedures regarding compliance with ethical requirements, professional standards, and applicable legal and regulatory requirements.

In conducting the audit work, we complied with the independence and other ethical requirements of the Code of Professional Conduct of Chartered Professional Accountants of Nova Scotia, as well as those outlined in Nova Scotia's Code of Conduct for public servants.

The objectives and criteria used in the audit are below:

Objective:

1. To determine whether the Department of Transportation and Infrastructure Renewal appropriately identifies and selects bridge projects.
2. To determine whether the Department of Transportation and Infrastructure Renewal appropriately monitors whether bridge projects meet established standards.

Criteria:

1. The Department should have appropriate standards for bridge projects.
2. The Department should have an effective process to assess the condition of the Province's bridges.
3. The Department should justify, rank, and select bridge projects using criteria which considers user needs, cost-effectiveness, safety, and long-range plans.
4. The Department should have effective processes to verify bridge projects are completed to established standards.
5. The Department should take appropriate corrective action when quality issues are identified on bridge projects.

Generally accepted criteria consistent with the objectives of the audit did not exist. Audit criteria were developed specifically for this engagement. Criteria were accepted as appropriate by senior management at the Department of Transportation and Infrastructure Renewal.



Our audit approach consisted of interviews with management and staff; a review of policies, plans, and practices at the Central and Western districts of the Department of Transportation and Infrastructure Renewal and the head office in Halifax; and examination and testing of: bridge inspection records, compliance with quality standards, project ranking and selection activities, and corrective action the Department took when bridge quality issues were identified. We did not examine detailed project management activities completed on bridge projects. Our audit period covered April 1, 2016 to September 30, 2018. We examined information outside of that period as necessary.

We obtained sufficient and appropriate audit evidence on which to base our conclusions on May 1, 2019, in Halifax, Nova Scotia.

Based on the reasonable assurance procedures performed and evidence obtained, we have formed the following conclusions:

- The Department of Transportation and Infrastructure Renewal's bridge information system does not give management all the necessary information needed to make decisions to select bridge replacement, rehabilitation, and maintenance projects.
- The Department of Transportation and Infrastructure Renewal appropriately monitors whether bridge projects meet established standards during construction, but fails to properly monitor warranties.



Appendix II

Background information on the Province of Nova Scotia's Bridges

The Department spends approximately \$32 million to replace and rehabilitate and approximately \$13 million to maintain the Province's bridges. In its January 2019 draft needs assessment, Department management estimated \$210 million per year is needed over the next 10 years to get the Province's bridges to a desired, sustainable condition. The \$210 million estimate includes \$150 million per year to replace poor-rated bridges, \$40 million per year to maintain fair-rated bridges, and \$20 million per year for preventative maintenance on bridges in good condition. We did not audit the accuracy of the Department's estimate.

The needs assessment further provided a summary of the number of bridges in each of the good, fair, and poor categories.

Condition	Rating	Number of Bridges	Description of Bridge Condition as Defined by the Department
Good	6-9	2,122 (51%)	<ul style="list-style-type: none"> Bridges in excellent to satisfactory condition The bridge may show some minor problems or deterioration Bridges commonly need preventative maintenance
Fair	5	1,447 (34%)	<ul style="list-style-type: none"> Bridges rated as fair condition All primary structural elements are sound, but may have some deterioration Bridges commonly need maintenance and rehabilitation to extend their service life in a cost-effective manner
Poor	4 or less	618 (15%)	<ul style="list-style-type: none"> Bridges rated as poor or worse condition The bridge may have advanced deterioration or fatigue cracks These structures commonly need rehabilitation or replacement
Total		4,187	

Source: Transportation and Infrastructure Renewal's 2019 Draft Needs Assessment of Bridges in Nova Scotia; condition description provided by Department staff.