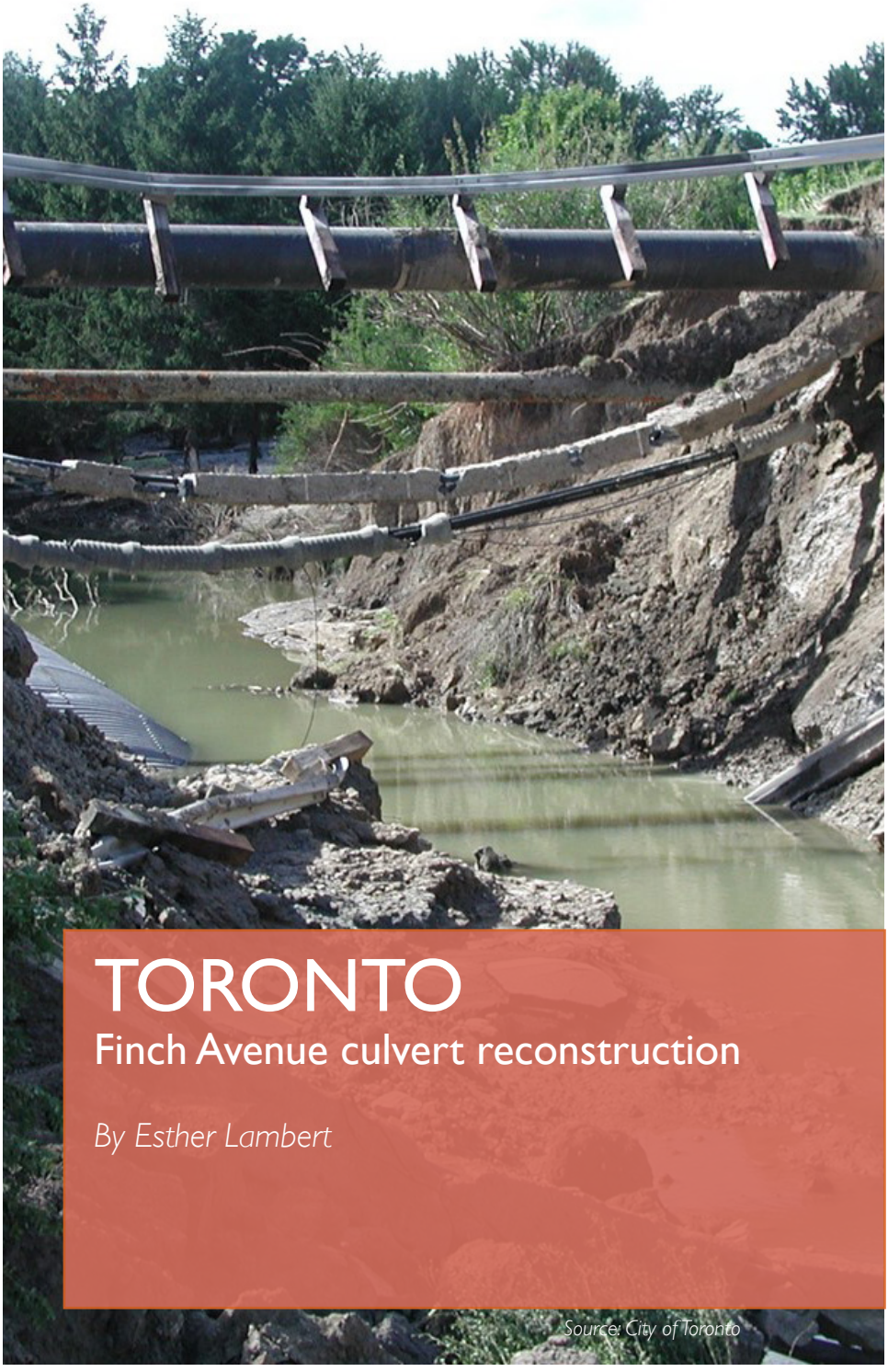

TORONTO

Finch Avenue culvert reconstruction

By Esther Lambert

Source: City of Toronto

THE SCIENCE

The City of Toronto learned a great deal about the importance of building infrastructure with future climate and weather in mind after the collapse of its Finch Avenue culvert following a few hours of intense rainfall in 2005. A reconstruction plan was developed that incorporated design changes backed by best practice and a culvert management system, which are helping to reduce the risk of flood damage and recovery costs for residents, businesses, and the environment.

As an essential component of municipal drainage systems, culverts serve the dual purpose of conveying water under a road and providing a crossing path for various vehicles, pedestrians, and cyclists. The Finch Avenue culvert, originally built with a corrugated steel pipe (CSP), was reconstructed with reinforced concrete pipes (RCPs) as RCP culverts are less prone to catastrophic failure. With an expected service life of 75 to 100 years, RCPs experience a more gradual failure, allowing sufficient time for repair before any sudden calamitous failure. They are a recommended option for many Canadian towns and cities, like Toronto, that are expecting an increase in extreme rainfall.

THE TRIGGER

The Finch Avenue culvert collapse was caused by an extreme rainfall event on August 19, 2005, that brought a significant amount of rain over a short period of time. The existing corrugated steel culvert was undermined by water and debris accumulating behind it. Debris from the upstream stretch of Black Creek gathered downstream and blocked the culvert, resulting in a buildup of pressure and its eventual breach and collapse.

Reconstruction of the culvert and associated infrastructure cost the City millions of dollars and led to a road closure at Finch Avenue for over a year. This contributed to gridlock and added to congestion. The full extent of social and financial impacts to residents and businesses on adjacent routes were inestimable. The City's bridge management group recommended the replacement of the steel pipe with a concrete one.

THE APPROACH

The reconstruction process was guided by three main elements. First, following consultations with the Toronto and Region Conservation Authority, the City of Toronto's Engineering and Construction Services Division prioritized resiliency in the new culvert design, and conducted research to determine best practice. It decided on the more costly yet more climate-resilient concrete option. Second, the City changed design standards to reflect projected climate changes. The culvert was built to withstand 100-year storms as opposed to 50-year storms, which was the former standard. As such, one of the major considerations was the hydraulic capacity of the infrastructure for larger storm events. The chosen design also included additional features like spillways to allow water to vacate the road if over-topping occurred. Finally, during the time of the culvert collapse, the City's Environment and Energy

Figure 12: *The Finch Avenue culvert collapse was caused by an extreme rainfall event on August 19, 2005, that brought a significant amount of rain over a short period of time. (Source: City of Toronto)*

Division was developing its climate change strategy, and there was a push to support climate change in asset management, which served as additional support for the climate-smart culvert design.

THE OUTCOME

The Finch Avenue culvert collapse and subsequent reconstruction brought to light some deficiencies within the City's culvert design and management system and inspired key changes. Culverts were designed for 50-year storms, while current climate science supports design for 100-year storms. The new culvert takes that into consideration. Prior to the collapse, there was an absence of a comprehensive inspection system for culverts to include standardized procedures and inspections. To address this, after each major rainfall event, operations and maintenance personnel are dispatched to all the major culverts to inspect and to communicate the findings, as well as to address any deficiencies requiring immediate attention. In addition, the Transportation Services Division also developed an inventory management system for its many smaller culverts that are under three metres in width. Each culvert was rated, which allowed the development of a multi-year funding plan for inspections and rehabilitation. This system has helped prevent or avoid culvert failures, flooding, and potential losses.

The new system of operating has also opened lines of communication with other City departments such as the Parks, Forestry and Recreation Division responsible for maintaining vegetation of embankments, and the Toronto and Region Conservation Authority that does periodic inspections around the rivers. Internal training of staff on what to look for when inspecting culverts was also a major outcome. Furthermore, the need for a vulnerability assessment was recognized and the PIEVC protocol was applied to key culverts across the city, which revealed that many were underdesigned.

One of the major challenges faced by the City in implementing its approach to culvert rehabilitation and management had been in convincing Council of the devastating impacts that climate change can have on infrastructure and the need for an increase in budgets to address those challenges. Each City division considered their assets and how they were being impacted by climate change. This information was brought to Council who then recognized the importance of integrating resilience in all capital and maintenance plans for all City infrastructure, which allowed divisions to secure additional funding to upgrade their assets.

A WORD FROM TORONTO

Mr. Nazzareno Capano, Manager of Transportation Policy & Innovation in the Transportation Services Division, highly recommends that cities and communities assess the vulnerability of their infrastructure. He stated, "I would suggest undertaking climate change vulnerability assessments for major pieces of infrastructure as it will help identify potential risks and guide the development of programs and procedures to mitigate the future impacts of climate change." With its 'no-regrets' approach to managing infrastructure, Toronto seems to be one of the leaders in that regard. Mr. Capano stressed the importance of putting in place whatever is needed now to prevent adverse impacts of climate change in the future, by first establishing where the priority is and by working with local conservation authorities for support. He also highlighted the need to get the support of Council by presenting a case for taking actions that will enhance the climate resilience of municipal infrastructure.