Concrete Asset Information Report
April 2017

Maintenance Division – ROADS
TRANSPORTATION DEPARTMENT
THE CITY OF CALGARY

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CONCRETE ASSET INFORMATION

In the public realm, there are many City-owned assets such as sidewalks, curbs, gutters, lights, utility poles, transformers, pedestals, hydrants, transit shelters, containers, bike racks, benches, trees and plantings. The primary concrete assets in the public realm are sidewalks, curbs and gutters.

Service Provided

The concrete sidewalk, and curb and gutter networks provide two distinct services, but are related assets that are often managed together. The primary pedestrian network is comprised of sidewalks adjacent to roadways, and curbs and gutters that channel excess water from the pavement surface to drains which is critical to protecting the integrity of the pavement and provides a safe driving surface.

These important assets provide:

- A pedestrian network that is safe, accessible and provides for efficient connectivity to destinations;
- A road drainage network that prevents pooling of excess water on the pavement surface and provides a safe driving surface; and
- Support for the roadway structure.

Network Overview

The City of Calgary owns and maintains 5,600 km of sidewalks and 6,600 km of curbs and gutters. The Roads Business Unit (Roads) delivers operations and maintenance activities to the sidewalk, curb and gutter networks. Sidewalk renewals and upgrades may be delivered by Roads or the Transportation Infrastructure Business Unit (TI). New sidewalks, curbs and gutters in subdivisions are constructed by developers and vested with the City upon issuance of a Final Maintenance Certificate (FMC). All utility companies and developers are responsible for restoring concrete assets according to the current Roads standard construction specifications after excavations.

On average, the inventory of sidewalk assets has increased by 70 km per year and curb and gutter assets increased by 90 km per year over the past 10 years. Figure 1 shows the approximate breakdown of tax funded and developer funded new sidewalk assets.

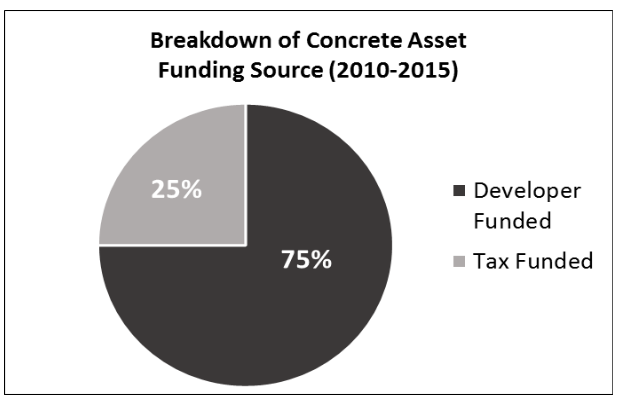

Figure 1: Breakdown of New Concrete Asset Funding Sources

Physical Parameters

Sidewalks are typically concrete material but may also be asphalt or interlocking bricks while walkways are usually asphalt. Curbs and gutters are always concrete. Details of the pedestrian network and the drainage network are described in Table 1.

Description	# Units
Monolithic Sidewalks Separate Sidewalks	4,100 km 1,500 km
Curbs and Gutters	6,600 km

Table 1: Details of Sidewalks and Curbs and Gutters (2015 Asset Data)

The majority of the sidewalks are 1.1m in width or greater. It is estimated that 1.3% of all the sidewalks are less than 1.1m wide.

Table 2 shows a breakdown of concrete sidewalk quantity by location:

	Concrete Sidewalk Length (km)	% of Concrete Network
Centre City	111	2.0%
Commercial/Industrial	417	7.4%
Residential	5,059	90.3%
Other	13	0.2%
Total	5,600	100.0%

Table 2: Breakdown of Concrete Sidewalk Quantity

An analysis was conducted using historical full block replacement data in the City of Calgary to determine the average age of concrete assets at replacement (Figure 2). The analysis indicated the average sidewalk age at replacement is 50 years.

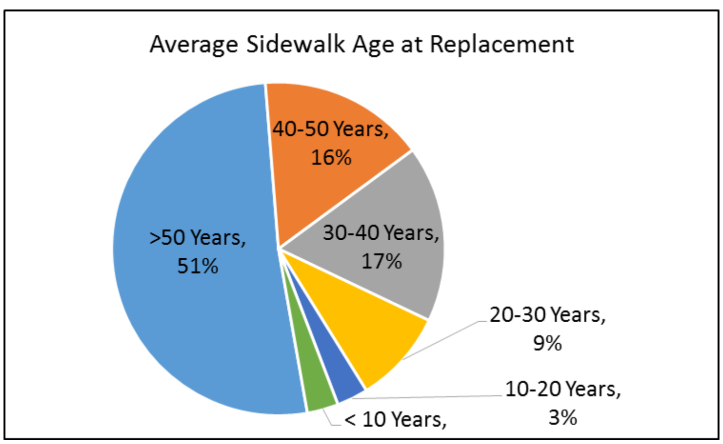

Figure 2: Age of Asset at Replacement

Asset Valuation

The valuation summary of City of Calgary concrete assets is described in Table 3. This valuation summary uses an overall annual straight-line depreciation expense of 2.0% of estimated current replacement cost and is based on the estimated useful life of each asset. Based on asset age and estimated useful life, a number of sidewalk, curb and gutter assets have exceeded their useful life estimates.

Asset Class	Estimated Current Replacement Cost ($M)	Estimated Useful Life (Years)	% of Assets Past Useful Life	Quantity of Asset Past Useful Life	Replacement Value for Asset Past Useful Life ($M)
Monolithic Sidewalk	$2,064	50	32.2%	1,274 km	$663
Separate Sidewalk	$529	50	25.0%	359 km	$131
Curbs and Gutter	$2,497	50	17.3%	1,138 km	$432
Total	**$5,091**	**50**	**24.2%**	**2,771 km**	**$1,226**

Table 3: Asset Valuation of Sidewalks and Curbs and Gutters (2015 Data)

Figure 3 shows the value of concrete assets constructed by date:

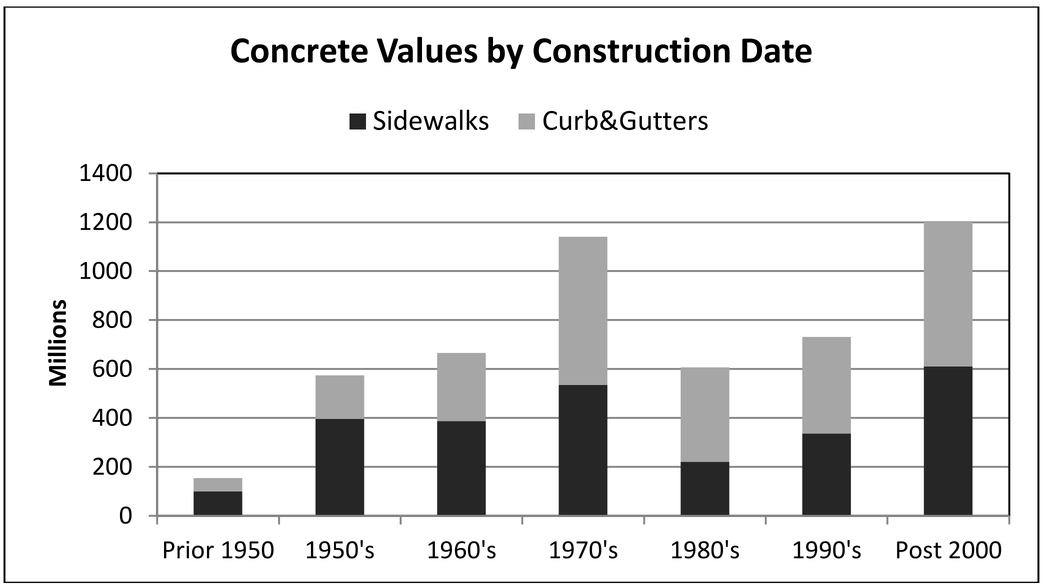

Figure 3: Concrete Values by Construction Date

Asset Condition

The Roads Maintenance Division is responsible for the annual condition survey of sidewalks, curbs and gutters. The annual survey identifies defects and rates the defects from severity 1 to 5, with 5 being the most severe. The information from the annual survey is used to create the subsequent year’s maintenance work plans and identify locations where a full block replacement (renewal work) is needed.

Concrete assets are considered in “Good or Very Good” condition if there is no defect (severity one or two defects). Assets with defect severity three are rated “Fair” condition and will be monitored on an ongoing basis. Assets with defect severity four or five are rated “Poor or Critical” and are prioritized for maintenance or renewal activities.

The current concrete asset conditions were assessed based on the 2015 condition survey results and are described in Table 4.

Concrete Assets	Good or Very Good (< Severity 3)	Fair (Severity 3)	Poor or Critical (Severity 4 and 5)
Sidewalks	95.6%	2.6%	1.8%
Curbs & Gutters	99.3%	0.4%	0.3%
Concrete Total	**97.4%**	**1.5%**	**1.1%**

Table 4: Summary of Concrete Condition Assessment (2015 Data)

The 2015-2018 Action Plan Target for percentage of concrete sidewalk that is Good or Very Good condition is 97% for each year.

In the 2016 Roads Citizen Satisfaction Survey, three questions related to sidewalks were asked. 86% of respondents were either satisfied or very satisfied with the conditions of the sidewalks downtown and in other business areas. 85% of the respondents expressed satisfaction on the condition of sidewalks in neighbourhood roads. In addition, the respondents' ratings suggest that the rating system used by Roads to identify sidewalk needing repairs are consistent with how citizens may identify or select sidewalks for repairs.

Figure 4 illustrates the 2015 sidewalk condition for each community in Calgary. Figure 5 illustrates the 2015 sidewalk condition for each Ward in Calgary.

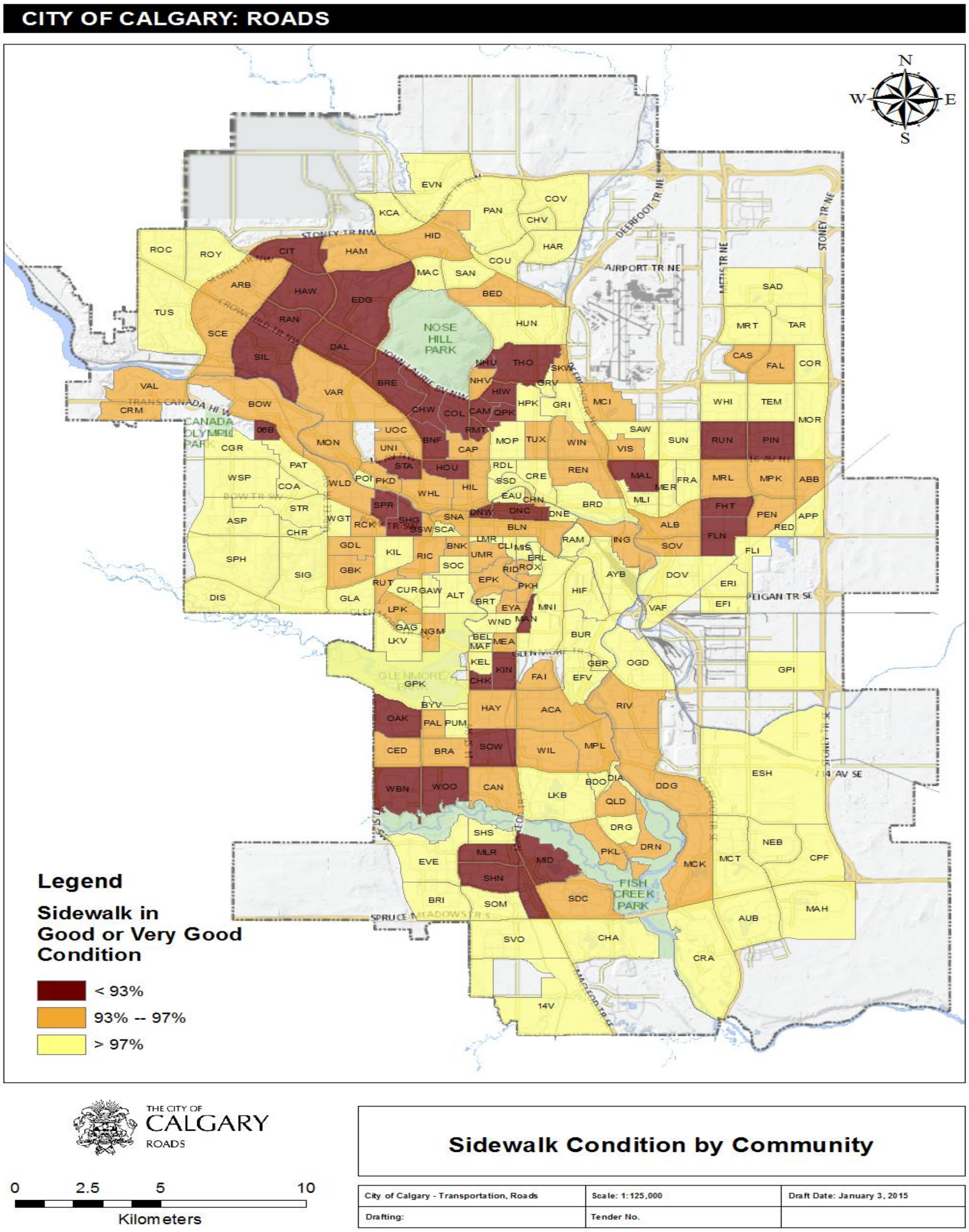

Figure 4: Sidewalk Condition for Each Community (2015 Data)

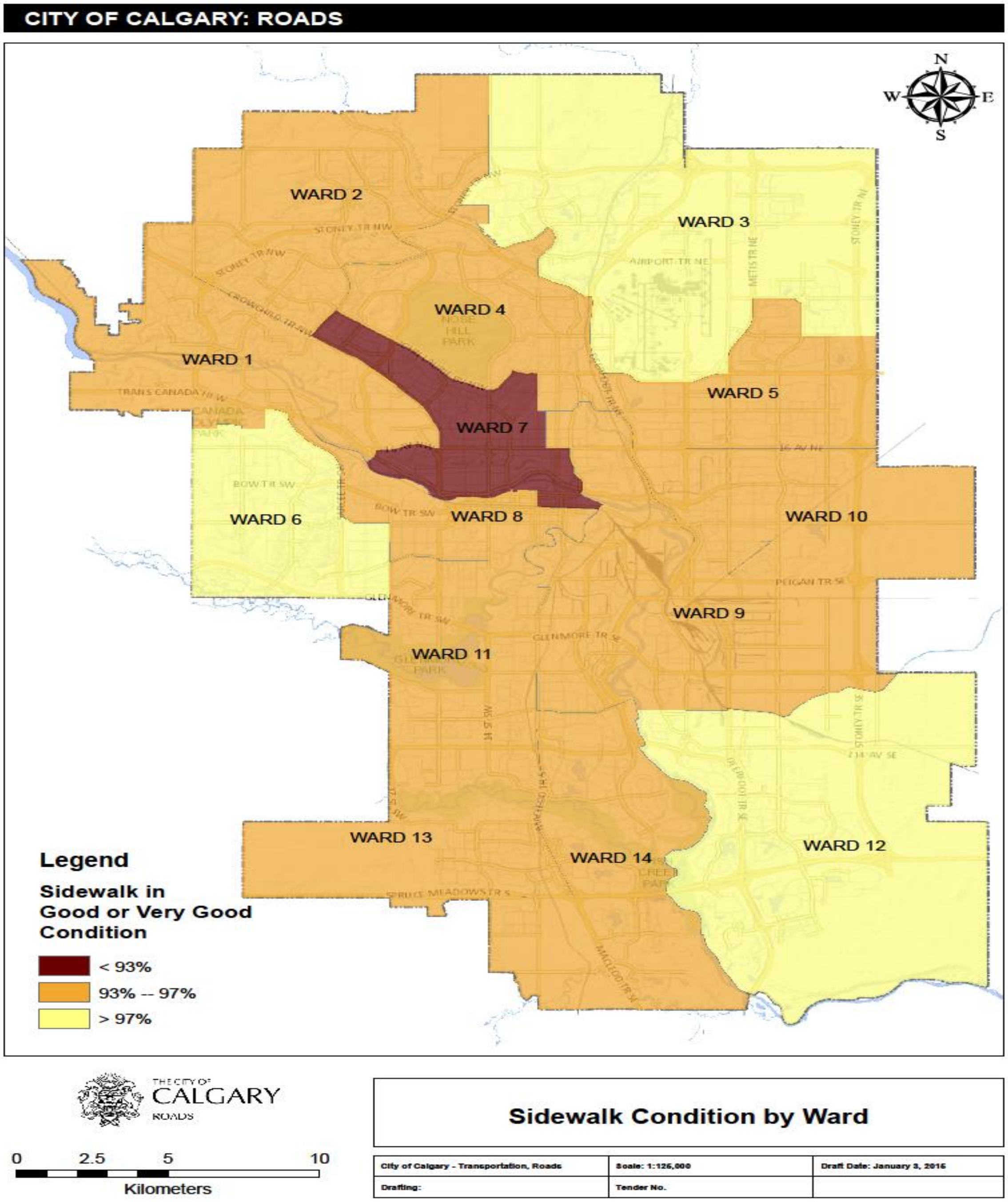

Figure 5: Sidewalk Condition for Each Ward (2015 Data)

The City maintains over 12,200 km of concrete assets with a current replacement value of $5.1 billion. The quantity of concrete assets will continue to increase with over 75% of the increase funded by the developers. The overall quality of the concrete sidewalk is 95.6% in “Good” or “Very Good” condition.

Table 5 shows 2015 sidewalk condition in each Ward:

Ward Number	% in Good and Very Good Condition
1	94.4%
2	96.2%
3	99.1%
4	94.7%
5	96.3%
6	98.5%
7	92.1%
8	94.9%
9	97.0%
10	94.6%
11	95.3%
12	98.4%
13	95.0%
14	96.2%
Average Condition	95.6%

Table 5: Sidewalk Condition by Ward (2015 Data)

Below is a list of communities where Roads have made repairs to concrete sidewalks damaged by frost action in the last eight years or have been identified as areas more prone to frost action.

NW	NE	SE	SW
Brentwood	Winston Heights - Mountain View	Douglasdale	Lakeview
Silver Springs		Riverbend	North Glenmore Park
Citadel		Sundance	Lincoln Park
Hawkwood		Penbrooke Meadows	
Dalhousie			
MacEwen			
Collingwood			
Highwood			

Table 6: Communities More Prone To Frost Action

Service Request Volume

Table 7 shows the number of service requests received by Roads related to sidewalk, curb and gutter. The number of service request have been trending upwards. The total number of concrete service requests has increased by 40% over the past five years.

2011	2012	2013	2014	2015
3,087	3,138	3,491	3,997	4,459

Table 7: 311 Service Request Data

STANDARDS AND SPECIFICATIONS FOR CONCRETE

Concrete Material Specifications

The City of Calgary has developed specifications for Portland Cement Concrete for concrete use on sidewalks, pavements, curbs and gutters. Below is a photo of concrete sidewalk in good condition as per City of Calgary standards.

Figure 6: Example of Concrete Sidewalk in Very Good Condition

Concrete Properties

Minimum requirements for concrete material placed on sidewalks:

Minimum Cement Content (kg/m3)	Maximum Water to Cementing Materials Ratio	Nominal Maximum Coarse Aggregate Size (mm)	Minimum Compressive Strength at 28 Days (MPa)	Air Content (%)
310	0.45	20	32	5-8

Table 8: Minimum Requirement for Sidewalk Concrete Material

Concrete placed prior to September 30 shall attain the minimum allowable compressive strength in 28 days. For concrete placed after September 30 and before May 1, minimum allowable compressive strength shall be attained in seven days.

Supplementary cementing material of Type F is added up to 20%. Starting in 2016, it became mandatory to use synthetic fibers in concrete for City Roads contracts.

Cold Weather Requirements

Air Temperature
When the air temperature is at or below 5°C, or when there is a probability of the temperature falling below 5°C within 24 hours of placing concrete as forecast by the nearest official meteorological office, cold weather requirements for concrete placement shall apply.

Off Season Concrete
Between September 30 and the subsequent May 1, the minimum allowable concrete compressive strength shall be attained in seven days.

Contractors shall adequately cover and protect the freshly placed concrete and cure for a minimum of seven days curing above 10ºC is required as per Canadian Standards Association (CSA) standards.

Compliance Program

The compliance program monitors the quality of concrete materials used for rehabilitation of sidewalk construction or improvements where The City is to be the ultimate owner. The program is intended to provide The City a high level of confidence in the quality of materials and workmanship used on City projects. Quality assurance testing is part of the compliance program to assure specification requirements are met for concrete.

Random testing for concrete includes plastic concrete testing (slump and air) and compressive strength testing at 7 and 28 days. Compressive strength of concrete that is below the specified minimum limit would either trigger penalties or a coring program to determine strength of cores taken from the concrete lot in question.

Daily Dispatching Procedure

The program operates on a daily basis to monitor the quality of concrete placed within the City. Testing technicians are dispatched from material testing laboratories to test concrete and ensure material compliance according to the City's Standards Specifications. Daily messages from the contractors are received through the dedicated City compliance phone line for their concrete pouring. QA testing firms are notified every day before 7:30 am to do testing on jobs assigned to them.

Concrete Compliance Testing

All concrete supplied for City contracts and new subdivisions are tested daily on a random basis by The City for quality assurance testing. All concrete supplied for City contracts and new subdivision has to conform to Canadian Standards Association (CSA) Standards. All concrete testing personnel are certified by the American Concrete Institute (ACI), CSA or Canadian Council of Independent Laboratories (CCIL). The following are tests conducted to monitor the quality of concrete placed:

- Slump Test - To assess workability of concrete and water content.
- Air Content Test - To determine if enough air is (5% to 8%) in the mix for freeze thaw protection.
- Compressive Strength of Concrete Test - 3 cylinders are casted and broken after 7 and 28 days to determine the compressive strength. City's minimum compressive strength requirement is 32 MPa in 28 days. Concrete placed prior to September 30 shall attain the minimum allowable compressive strength in 28 days. For concrete placed after September 30 and before May 1, minimum allowable compressive strength shall be attained in seven days.

Contractors perform inspections and quality control testing necessary to ensure that the work conforms to the requirements of the specifications and the contract.

Verification Testing

Compliance verification testing is done if a contractor challenges compliance testing results. Cores are extracted from sections of concrete deemed unacceptable by the City. Cores are tested by third party consultants. Penalties/Payment adjustments are assessed for non-compliance work as per Specifications.

In 2012, a new verification process was implemented. In addition to analyzing compressive strength of cores, the sample will be analyzed to determine the air void characteristics of concrete in question. A new type of penalty criteria was introduced and was based on the spacing factor of air voids in concrete.

The following table is used for payment adjustments:

Spacing Factor		Low Strength	
Between 0.230 mm and 0.260 mm	50% deduction	Between 0.230 mm and 0.260 mm	50% deduction
> 0.260 mm	90% deduction or remove and replace	> 0.260 mm	90% deduction or remove and replace

Table 9: Penalties and Payment Adjustments for Non-Compliance Work

Compliance Data

In 2015, the City of Calgary tested samples from 52,000 cubic metres of concrete placed in sidewalks. Below are the compliance dashboard reports for 2014 and 2015 concrete by the City of Calgary:

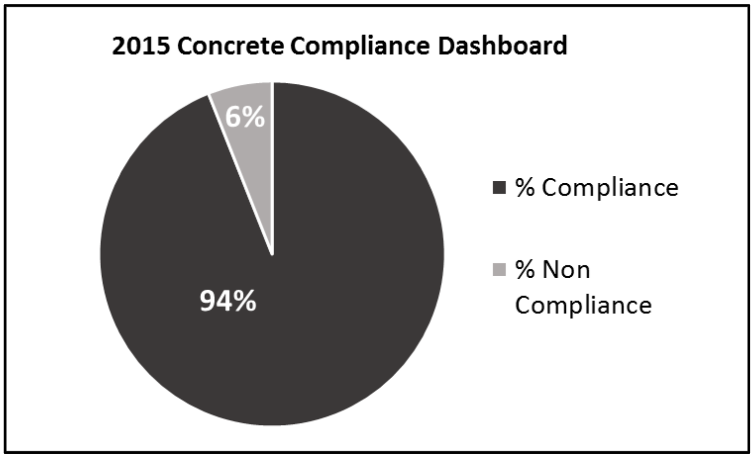

Figure 7: Compliance dashboard report for 2015 Concrete

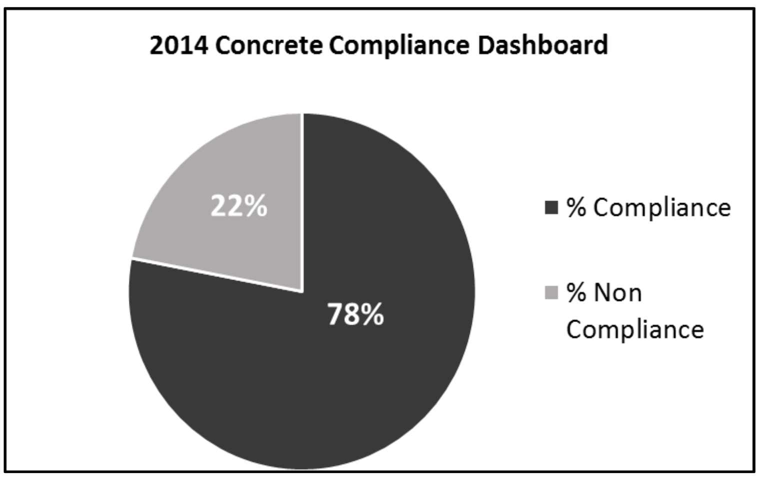

Figure 8: Compliance dashboard report for 2014 Concrete

Design Standards for Sidewalks

The existing monolithic sidewalk design standard for concrete thickness is 100 mm of concrete placed on a prepared subgrade. For subdivisions, no gravel or other material is placed beneath the concrete slab. For all Roads projects, 100 mm to 150 mm gravel of recycled concrete is used as base material beneath the concrete slab. As of 2016, it is mandatory to use fibers in all Roads contracts. Fibers are added to the concrete mix in a plastic state and are effective in reducing shrinkage cracking.

The existing standard can be enhanced with the addition of a gravel base or increasing the thickness of concrete. The City has conducted several reviews in the past that have confirmed that the City of Calgary has lower concrete thickness requirements compared to other Canadian municipalities. A summary of the most current sidewalk designs for various North American municipalities has been summarized in the following table.

Municipality	Concrete Thickness (mm)	Granular Base (mm)
Calgary	100	Not required
Edmonton	120	150
Lethbridge	130	100
Red Deer	115	Not required
Toronto	150	150
Hamilton	125	150
Kitchener	125	125
Guelph	125	75
Windsor	115	50
Kingston	125	100
Regina	130	150
Winnipeg	100	Base course as required
Saskatoon	115	20 mm levelling course
Saint John	100 (150 at driveway)	150
Vernon	120	Minimum 100
Vancouver	100	100
NRC1	Minimum 100	150
Hartford, Connecticut	150	150
Wisconsin DOT	Minimum 100 (150 at driveway)	Minimum 100
Florida Tech	150	150

Table 10: Concrete Thickness Comparison of Canadian Municipalities

Causes of Concrete Sidewalk Failures

Construction Damages

It is common practice in new subdivisions (residential, commercial and industrial), that the underground utilities and surface improvements (paved roads, sidewalks, curbs & gutters, catch basins etc) are in place prior to the commencement of residential and commercial developments. During the construction stage of residential and commercial developments, the surface improvements are subjected to large volumes of construction related vehicle traffic and equipment.

Concrete sidewalks, curbs and gutters are constructed in the new subdivisions soon after the lots are developed to allow easy access and emergency access. Lack of drainage, damage by construction equipment and the traffic associated with home construction (cranes, backhoes digging the basements, gravel trucks, concrete trucks and pump trucks) leads to excessive concrete cracking and crack displacement. The damage results in severe block cracking of concrete and settlement where the subgrade is allowed to saturate.

The City has completed a report in 2008, which identified 40% of concrete sidewalk, curb and gutter replacements at Final Maintenance Certificate (FMC) stage were damaged due to third party activities in new subdivisions.

Shallow Utility Settlement Damages

The damage by shallow utility work occurs when the backfill soils are placed in the utility trenches without compaction effort, especially in winter months when backfill soil is frozen. These settlements can be substantial and when the soils under the sidewalk settles, the concrete will collapse under its own weight.

Frost Heave Cracking

Frost effects occur when frost-susceptible soils in the subgrade freeze with an available source of groundwater (or capillary groundwater), surface water, or their own moisture content. Upon freezing, ice lenses form in the subgrade, causing frost heave. Upon thawing, the ice thaw can result in significant saturations of subgrade soils, which leads to soil weakness and non-uniform settlement. Most of the Calgary area soils are classified as silty clay tills. The potential for frost susceptibility and loss of strength during thaw is considered high. Concrete sidewalks placed directly on this type of soil experience high risk for heaving followed by thawing, soil weakening, and settlement. The most common type of sidewalk cracks associated with frost heave are longitudinal cracks extending through multiple panels.

Concrete Placed in Shoulder Seasons

The winter season across Alberta is quite long and satisfying shorter construction schedules frequently requires placing concrete in winter or shoulder season months. Concrete in plastic state (freshly placed concrete and not fully hardened) is prone to freezing and, unless protected from low temperatures, the damage to concrete by freezing in a plastic state and/or slow strength development leading to cracking will occur.

Tree Root Damage

As trees expand and grow over time, roots that are overgrown and/or near the surface of the adjacent sidewalk may push up the concrete sidewalk slab or cause cracking. Damaged or heaving sidewalks can pose a tripping hazard to pedestrians. Figure 10 shows multiple tree root issues within one block face.

Figure 10: Photo Showing Multiple Tree Root Issues Within One Block Face

The hazards caused by tree roots are usually addressed by the cutting the trip edge, filling the gap to create a ramp or replacing the concrete sidewalk.

Decorative Concrete

The City maintains decorative concrete mostly in the downtown core and in some new subdivisions at roundabouts and crosswalks. Decorative concrete is used to enhance the esthetic of the structure while still serving as an important structural functional. Challenges surrounding decorative concrete are improper control joints, issues with multiple pours and colour variations. Control joints are used to control random cracking on concrete slabs. Joint placements are usually sacrificed for atheistic purposes rather than durability. Multiple concrete pours to build the final surface also affects the durability of sidewalks. Multiple pours mean the concrete is placed in a non-continuous manner. Concrete placed in this manner is more prone to cracking due to thermal expansion and contraction. The decorative concrete mixed with colour is slightly different than the conventional mixes in terms of adding properly selected coloring products and water cement ratio. The placement of such concrete onsite is a challenge because of multiple pours (depending on the surface pattern) that can result in inconsistent color shades and patterns. In addition, proper curing of concrete is important to reduce surface shrinkage cracking and obtain the proper strength.

Figure 11: Decorative concrete in Auburn Bay, Calgary

Spalling

Spalling is a surface deficiency in which concrete is broken up, flaked and becomes pitted. In some cases, chunks of concrete break loose from the surface and can also start to crack. Spalling is a deeper surface defect than scaling, often appearing as circular or oval depressions on surfaces or as elongated cavities along joints. It is caused by a combination of poor installation/construction practices, improperly constructed joints, environmental factors and corroded reinforcing steel. Spalling, at a low level, is mainly a cosmetic problem but severe spalling can lead to structural damage if not dealt with immediately. If left untreated, large enough fragments of concrete could come out which could lead to serious consequences.

Cement Production and Mix Designs

Concrete production and changes to mix designs in recent years has contributed to concrete mixes that are more prone to cracking than 50 years ago. Some of the changes to cement and concrete production were a result of the construction industry's demand for high early strength to deliver shorter construction schedules, and the contractual penalty structures are based almost solely on compressive strength. To satisfy the demand for higher and earlier concrete strength, the cement manufacturers increased the fineness of the cement to provide a more reactive cement and altered the cement chemistry to increase the amount of tricalcium silicate in Portland Cement (contributing to faster strength gain). Another method to assure high early strength development of concrete is to lower the w/cm ratio with the workability achieved by the use of water reducing admixtures. A combination of high cement levels and low w/cm in concrete mix results in higher shrinkage at early age, and microcracks due to shrinkage frequently develop in concrete before contraction joints, either by tooling or by saw cutting, are introduced. In addition, fine cement paste on the concrete flatwork surfaces has a higher tendency to dry out, resulting in dusting of the surface and subsequent scaling.

Inspections

All contract work and internal projects within the Roads Business Unit are inspected on a daily basis. The large amount of concrete placed for all projects makes it challenging to be on every site for each concrete placement. Inspectors have multiple project sites which they effectively manage their time to capture as many inspections as possible and are trained to inspect all civil work.

For subdivisions, consultants working for the developer inspect all activities. City sub-division officers work closely with these consultants. Typically site visits occur approximately two to three times per week during active construction. In between CCC and FMC stage, the site visits are two to three times per month. At the FMC stage, daily inspections are conducted to ensure all deficiencies are identified prior to acceptance. Roads manages the compliance program and provides compliance or non-compliance statements for concrete based on the quality assurance results. If the concrete fails to meet the specifications, there is either a financial penalty or the concrete is replaced at no cost to the City. Quality control testing is mandatory on all Roads projects and must be submitted with mix designs to Roads Materials & Research.

Roads has up to 30 inspectors assigned to concrete projects, as many projects occur during the construction season (May to September). Programs include miscellaneous concrete repairs, Roads excavation permit repairs, surface overlay concrete repairs, Local Improvement full block replacement program, wheelchair ramp program, development permit driveway program, Various Street Improvements program, sub-divisions, mudjacking repairs, and any special request for concrete work needed within the City of Calgary. The inspections are conducted from pre-construction inspections to construction completion.

Construction Division

In the Construction Division, there are two groups that support concrete inspection services and a summary of the resources available within those groups.

City Forces

- Roads has four Foreman for inspecting concrete projects completed by City Forces. This includes three for the quality after the pouring is completed. One Foreman for inspection during the pouring stage and managing the pouring crew. Up to three Foreman will inspect during various stages in the construction process.

Contracted Services Division

- Three to four project inspectors during construction projects and after completion for quality.
- Three inspectors will review inspection reports submitted to Roads. They conduct frequent site visits to provide technical support and approve material designs submitted to Roads on projects.

Development and Projects Division

The personnel listed below conduct daily inspections on projects and developments that are under the responsibility of the Development and Projects Division:

- Three Subdivision Officers
- Up to four Project Inspectors
- Five Roads Indemnified Agreement / Surface Improvements Inspectors
- Four Various Concrete Construction & Block Replacement Construction Coordinators / Inspectors
- Two Local Improvement Paving Construction Coordinator / Inspector

Roads Maintenance

Once a year, Roads Maintenance will conduct a condition survey to locate and inspect the defects on the sidewalk, curb and gutter networks.

- Nine Foreman and nine Technicians inspect conditions of sidewalk network once a year for defects.

Warranty Process

After construction completion of concrete sidewalks, curbs and gutters, it is subject to an inspection prior to the issuance of Construction Completion Certificate (CCC). After the CCC is issued, the two-year warranty period begins. At the end of the two-year warranty period, the concrete sidewalks, curbs and gutters are subject to Final Maintenance Certificate (FMC) inspection, prior to the assets being handed over to the City. All damaged concrete identified during FMC inspections are replaced by the contractors at no cost to the City. Concrete replaced at FMC has no additional warranty. The warranty period for concrete assets is two years and is common for many municipalities.

Recommendations / Improvements

1) Train staff to provide adequate pedestrian accommodation during sidewalk construction. Dedicated staff have been assigned to conduct a five level inspection. The goal is to maintain access at all times. Providing detours, delaying projects, pouring concrete multiple times in the same section, building ramps and closing one corner at a time are strategies that will be employed.

2) Continue to work with the Building Industry Land Development organization (BILD) and Alberta Roadbuilders to review the current concrete specifications to improve the durability of concrete assets.

3) Encourage all City employees to report damage to City assets by third party when observed. A memorandum will be sent from Roads to all other Business Units requesting their assistance by reporting these incidents through 311. As part of this memorandum, Roads will indicate that expertise is available in-house to assist with concrete related concerns and issues.

4) Encourage contractors to look for ways to protect City assets during construction using products that bridge over curbs and sidewalks to minimize damages. During best practice seminars, Roads will invite suppliers with innovative products that industry users can trial to minimize damage to concrete assets.

5) Continue to identify concrete sidewalks, curbs and gutter projects that are adjacent to pending large developments, infills or projects by other Business Units. Roads will reschedule these projects to prevent new concrete from damaged during construction.

6) Improve the tracking of deficiency repairs prior to issuance of CCC and FMC.

7) Continue to use the Roads' electronic map system (eMAPS) to identify projects that are in the same area which will improve the coordination between projects.

8) Improve the condition survey process to include asset management concepts.

BUDGET AND FUNDING ANALYSIS

Budget

Roads is responsible for the provision of safe and well maintained concrete sidewalks and this is accomplished through a number of concrete programs. Repair of damaged sidewalks is generally funded through Roads operating budgets and the replacement of sidewalks or installation of new sidewalks is funded from capital budgets. Details of the breakdown of these Roads' program budget related to concrete sidewalks, curbs and gutters is shown in Table 11.

Activity	2015 Expenditures ($M)	2016 Budget ($M)	2017 Budget ($M)	2018 Budget ($M)
Maintenance (Operating)	$9.09	$9.19	$9.29	$9.30
Asset Renewal (Capital Lifecycle)	$6.97	$5.98	$1.44	$1.47
New Asset /Upgrade Asset (Capital Upgrade)	$2.45	$1.65	$2.20	$2.15
Total	**$18.52**	**$16.83**	**$12.93**	**$12.92**

Table 11: Roads' Program Expenditures and Budgets Related to Sidewalks, Curbs and Gutters

Maintenance

The International Infrastructure Management Manual (IIMM) defines operation as "the active process of utilizing an asset that will consume resources such as manpower, energy, chemicals and materials." Maintenance includes both planned and reactive activities to ensure assets achieve their useful life and remain useable. Roads currently delivers the following maintenance services with respect to sidewalks, curbs and gutters:

- Sidewalk displacement cutting
- Mudjacking / Densification
- Concrete frost protection repairs
- Excavation permit repairs
- Miscellaneous sidewalk repair

The breakdown of the budget and expenditures are shown below:

Activity	2015 Expenditures ($M)	2016 Budget ($M)	2017 Budget ($M)	2018 Budget ($M)
Mono Sidewalk Maintenance	$5.04	$4.77	$4.85	$4.86
Temp Sidewalk Maintenance	-	$0.53	$0.55	$0.55
Mudjacking/Densification	-	$0.30	$0.30	$0.30
Frost Protection	$0.58	$0.36	$0.36	$0.36
Mono Sidewalk Permits	$2.79	$2.23	$2.23	$2.23
Pavement Rehabilitation	$0.68	$1.00	$1.00	$1.00
Total	**$9.09**	**$9.19**	**$9.29**	**$9.30**

Table 12: Roads' Maintenance Program Expenditure and Budgets Related Sidewalks, Curbs and Gutters

The 2016 budget for sidewalk maintenance is $9.19 million and the funding is dependent on approved operating budgets.

Asset Renewal

Asset renewal is the replacement or rehabilitation of assets in order to sustain service levels relating to condition and function. The Roads Business Unit delivers two concrete renewal programs:

- Local Improvement Program – replaces full block face of sidewalks, curbs and gutters mainly in residential area.
- Surface Overlay Program - replaces curbs and gutters along arterial roads that are undertaking pavement surface overlay projects.

The goal of the asset renewal program is to ensure the pedestrian network is safe, efficient and the drainage network functions well to protect roadway pavement.

The breakdown of the asset renewal budget and expenditures are shown below:

Capital Program	2015 Expenditures ($M)	2016 Budget ($M)	2017 Budget ($M)	2018 Budget ($M)
Surface Overlay Concrete	$1.20	$1.38	$1.44	$1.47
Local Improvement Paving and Sidewalk (Program 147-148)	$5.77	$4.60	-	-
Total	**$6.97**	**$5.98**	**$1.44**	**$1.47**

Table 13: Roads' Asset Renewal Expenditure and Budgets Related Sidewalks, Curbs and Gutters

Concrete assets become candidates for Surface Overlay - Concrete replacement when the curbs and gutters along pavement surface overlay projects cannot be repaired. The replacement will occur if there is surface overlay on the adjacent roadway.

Concrete assets become candidates for full block replacement in the following scenarios:

- Assets older than 25 years and 50 per cent of the block face has defects; or
- Recommendation from maintenance District Foreman based on concrete condition.

Roads is currently delivering concrete full block replacement projects by community. The $2.0 million 2017 budget allocation for block replacement was advanced to 2016 during capital recast process. There is no funding allocated for 2018 for block replacement.

New Asset / Upgrade Asset

New sidewalks, walkways, medians and curbs and gutters are constructed in order to facilitate the movement of pedestrians and accommodate the rise in demand for capacity. The existing pedestrian network is upgraded to improve safety and accessibility. Examples of new and upgrade projects for the pedestrian and drainage networks include:

- Upgrade of existing roadways and pedestrian corridors that requires new sidewalks, concrete medians, curbs and gutters;
- Construction of roadways in new communities that require sidewalks, engineered walkways, concrete medians, curbs and gutters by design standard and specification;
- Construction of missing sidewalks (missing links), bus stop aprons and wheelchair ramp retrofit projects; and
- Pedestrian safety and community traffic calming programs that require new sidewalks, concrete medians and curbs and gutters.

The breakdown of the budget and expenditures are shown below:

Capital Program	2015 Expenditures ($M)	2016 Budget ($M)	2017 Budget ($M)	2018 Budget ($M)
City Wide Active Modes Program (Program 126-103)	$0.64	$0.40	$0.50	$0.45
Industrial Sidewalk Retrofit (Program 126-176)	$0.22	-	-	-
Various Streets Improvements (Program 127-140)	$0.33	$0.45	$0.70	$0.70
Various Concrete Construction (Program 128-134)	$1.26	$0.80	Up to $1.00	Up to $1.00
Total	**$2.45**	**$1.65**	**$2.20**	**$2.15**

Table 14: Roads' Asset Renewal Expenditure and Budgets Related Sidewalks, Curbs and Gutters

Major upgrades to the network are selected and prioritized based on key directional and policy documents, along with feedback collected through public engagement. The addition of subdivision infrastructure is driven by the growth of the City within the Corporate Growth Management Framework. Sidewalks, walkways, concrete stairs, medians, curbs and gutters constructed as part of subdivision developments must be constructed according to the City of Calgary's current Roads Construction Standard. Roads inspects completed subdivision concrete assets prior to issuing a Construction Completion Certificate (CCC) and after a minimum of two years, prior to issuing a Final Maintenance Certificate (FMC). The resolutions of any defects that occur prior to FMC are the responsibility of the developer.

Maintenance Budget Comparison between Jurisdictions

Table 15 below provides a comparison of sidewalk budgets between Calgary, Edmonton, Saskatoon and Toronto.

City	Sidewalk Asset (km)	Budget ($M)	Budget per km of sidewalk	Comments
Calgary	5,600	$16.8	$3,000	
Toronto	7,820	$16.6	$2,123	
Edmonton	5,325	$5	$930	Community renewal program that replaces the concrete assets. The cost of the community renewal program is not included in the $931 per km of sidewalk
Saskatoon	2,483	$5	$2,014	

Table 15: Concrete Sidewalk Budget Comparison for Canadian Municipalities

Funding Analysis

Roads utilizes funding from a number of programs to repair and replace over 30 kilometres of concrete sidewalks, curbs and gutters per year. With an inventory of 5,600 kilometres of concrete sidewalk, present programs have been designated to address a portion lifecycle replacement and the remaining funds are directed to repair sections based on the defect survey. With no changes in funding, it would take approximately 151 years to replace all existing concrete sidewalks.

Based on our 2015 sidewalk condition survey, Table 16 shows the approximate cost to repair all the existing concrete sidewalks, curbs and gutters at each severity level.

All Sidewalk Severity Level	Percentage of asset Total	Approximate Cost to Repair ($M)
3 (Fair)	2.6%	$56.5
4 (Poor)	1.4%	$29.3
5 (Critical)	0.4%	$5.4
Total	**4.17%**	**$91.2**

Table 16: Roads' Approximate Cost to Repair Sidewalk at each Severity Level

The cost to repair all the concrete sidewalk currently in fair, poor or critical condition is $91.2 million. Estimates to repair assets with respect to future deterioration is not included in this estimate. It is estimated that 2% of the concrete sidewalk will deteriorate beyond the good to very good condition annually.

The current budget of $16.83 million improves the overall condition by 0.65%, but is insufficient to address the 2% annual deterioration, the continual increase to the asset inventory, and cost inflation. The table below shows the effect of increasing the concrete budget.

Budget Increase	Total Concrete Investment	Estimated Effect on Overall Concrete Condition*
$0	$16.83 million	0.65%
$2.0 million	$18.83 million	0.73%
$5.0 million	$21.83 million	0.85%
$10.0 million	$26.83 million	1.04%

*Table 17: Effect on Overall Concrete Condition. *Increase in overall condition does not include 2% annual deterioration.*

Assuming annual budgets for concrete repairs and concrete renewal remain at the approved 2017 budget levels for the next four years, the concrete condition would fall to 90% by the year 2020.

Currently, there is no program to address missing links. High priority missing sidewalk infrastructure are currently funded by the City Wide Active Modes and Various Concrete capital programs.

Figure 12 below shows concrete lifecycle funding deficit in the future.

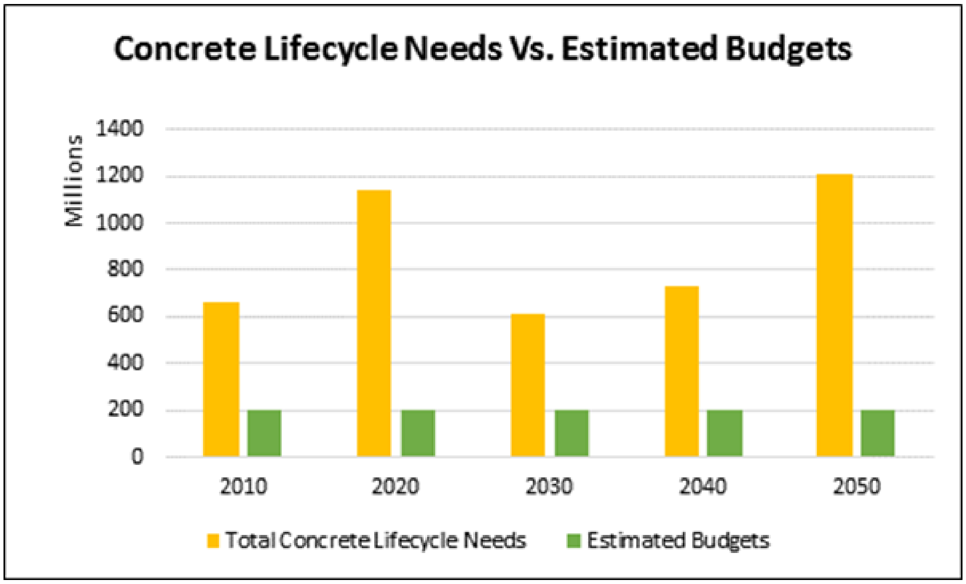

Figure 12: Concrete Lifecycle Needs compared to Available Budget

ENVIRONMENTAL CONSIDERATIONS

The production of cement, which is a component of concrete, is a greenhouse gas (GHG) intensive process. The Cement Association of Canada has indicated that in Alberta, carbon pricing is already applied to the cement industry. Carbon pricing is included in the price of cement in Alberta as the cement manufacturing plants are regulated provincially under the Specified Gas Emitter Regulation (SGER).

Under SGER in Alberta, only cement plants are impacted to carbon pricing on those emissions over and above 100,000 tonnes of carbon dioxide (CO2). The carbon price is a small component of the total cost of cement, and thus an even smaller component of the cost of concrete.

Approximately, one metric tonne of CO2 is emitted for every metric tonne of cement produced. The amount of cement in concrete is dependent on the performance requirement of the concrete but in general, it is seven to eight percent. As a result, approximately 0.125 tonne of CO2 is embodied for every tonne of concrete produced.

The Government of Alberta's Carbon Levy, which started January 1, 2017, will not apply to industrial plants currently regulated under the SGER legislation, but will have an impact on the cost of concrete since it will apply to major fuels in the province. The carbon levy will be applied to diesel fuel which is consumed in transporting cement and aggregates from the manufacturers to the concrete redi-mix operators, and diesel is also consumed in the concrete mixing trucks to deliver concrete to building sites.

The cement and concrete industries are currently investigating the impact of the Carbon Levy and how the carbon pricing will affect the total price of concrete to customers. The current price on concrete is variable, but generally falls into the range of $100-$300 per cubic meter.

In terms of carbon footprint, the embedded energy and greenhouse gases associated with building materials are not included in the City of Calgary's greenhouse gas inventory. The carbon price is applied to the manufacturers of building materials, and thus the emissions are accounted for by these companies and should not be included in the City of Calgary GHG inventory to avoid double-counting. Inquiries to staff at the City of Toronto and the City of Edmonton confirmed that these cities also do not count the embedded energy and emissions associated with any structure or building materials.