



THE ECOROOF INITIATIVE
FOR CLIMATE CHANGE RESILIENCY

JURISDICTIONAL REVIEW
APRIL 23, 2018

Report by: The Miistakis Institute

Submitted to: City Environmental Strategies
City of Edmonton

Table of Contents

ACKNOWLEDGEMENTS	3
INTRODUCTION	4
KEY MOTIVATOR SUMMARY	5
PROGRAM DEVELOPMENT SUMMARY (PROCESS STEPS, CHALLENGES, SOLUTIONS)	7
INCENTIVES SUMMARY.....	16
PERFORMANCE MEASURES AND IMPACT SUMMARY.....	18
LESSONS LEARNED	20
ADDITIONAL COMMENTS.....	22
REFERENCES	23
APPENDIX A: SURVEY RESPONDENTS AND CONTACT INFORMATION	24
APPENDIX B: LIST OF MUNICIPALITIES CONTACTED TO COMPLETE SURVEY.....	25

Acknowledgements



The City of Edmonton provided funding to support the development of the Jurisdictional Review Report as part of the Edmonton Ecoroof and Climate Change Resiliency Initiative.

Introduction

The Edmonton Ecoroof and Climate Change Resiliency Initiative Jurisdictional Review provides a summary of findings from the questionnaire issued to municipal staff in November 2017. The intent of the Jurisdictional review is to provide Edmonton staff with an idea of what is involved in developing an Ecoroof program and learning from others that have been through the process.

Seven municipalities were contacted In November 2017 and four responded and completed the questionnaire. Follow up questions were issued in April 2018. Participating municipalities include Toronto (Toronto completed two separate responses as they have two programs related to ecoroofs), District of Columbia, Portland and San Francisco.

The outcomes of the questionnaire reveal that implementing an ecoroof program requires cross-departmental involvement, some form of regulation or incentive, a well designed monitoring and reporting strategy, and does result in environmental, social and economic benefits (depending on what the program was designed to achieve). While there were challenges identified by the questionnaire respondents, so too were solutions and a suite of benefits from the ecoroof program implementation.

Key Motivator Summary

At the core of any policy and incentive program is an issue to be answered. Often these issues are referred to as key motivators. The table below was developed from the questionnaire responses as well as additional research and provides various jurisdictions' key motivators for developing and implementing an ecoroof program.

A number of jurisdictions started with one key motivator to design their policy frameworks, while also realizing the additional motivators for implementing ecoroof policy programs. This speaks to the multifaceted benefits achieved through strategic ecoroof implementation.

	SWM	BioDiv/ Habitat	UHI	Energy	GHG	Urban Ag	Air Quality	Quality of Life	Jobs / Ec Dev	Climate Change
From jurisdictional questionnaire completed November/December 2017										
Toronto Green Roof Bylaw	●	●	●					●		
Toronto Eco- Roof Incentive Program		●	●	●	●		●	●	●	
District of Columbia	●									
Portland	●	●					●			
San Francisco		●					●	●	●	

	SWM	BioDiv/ Habitat	UHI	Energy	GHG	Urban Ag	Air Quality	Quality of Life	Jobs / Ec Dev	Climate Change
Additional research:										
*Cologne	●									
*Stuttgart							●			
*Linz, Austria								●		
*Basel, Switzerland		●		●						
*Copenhagen, Denmark	●	●	●							●

LEGEND:

- Key motivator for developing an ecoroof program.
 - Additional motivators.
- SWM Stormwater management. Some programs use ecoroofs to prevent/mitigate for floods and/or improve water
- BioDiv/ Habitat Biodiversity and Habitat. Reference could be to either biodiversity or habitat or both.
- UHI Urban Heat Island effect. Motivator relates to reducing the UHI.
- Energy Refers to improving the energy efficiency of buildings.
- GHG Green House Gas reductions.
- Urban Ag Urban Agriculture.
- Air Quality Improving Air Quality.
- Quality of Life Refers to increasing green space, aesthetics, acoustics, health for citizens.
- Jobs/Ec Dev Jobs/Economic Development is related to green job creation and contributions to diversifying the local economy.
- Climate Change Green roofs are used as part of an overall strategy to adapt to climate change.
- * (Connelly, 2014)

Program Development Summary (Process Steps, Challenges, Solutions)

Questionnaire respondents were asked to provide insights into how their programs were developed (what steps did they take to launch a green roof or ecoroof program?), identify some of the challenges with developing an ecoroof program and its implementation, and finally, what solutions they either implemented or would recommend to address the challenges.

Toronto: Green Roof Bylaw

Program initiated: 2006

Program launched: March 2010

PROCESS

1. Background reports on:
 - Benefits to the city
 - Alternatives to green roofs
2. Focus groups and consultations

CHALLENGES: PROGRAM DEVELOPMENT

- Balancing push for green roofs (form advocates) and cost implications for new development
- Industrial buildings found cost prohibitive

CHALLENGES: PROGRAM IMPLEMENTATION

- First bylaw so no precedent

SOLUTIONS: PROGRAM DEVELOPMENT

- Created a cool roof option for industrial buildings

SOLUTIONS: PROGRAM IMPLEMENTATION

- Made technical adjustments as issues emerged

PROCESS

1. Pilot program
2. Program terms and conditions set based on the pilot program
3. Stakeholder consultation

CHALLENGES: PROGRAM DEVELOPMENT

- Identifying ideal grant incentive amount.

CHALLENGES: PROGRAM IMPLEMENTATION

- Reaching roofing professionals to raise awareness of the program.
- In 2013 the program expanded to include the residential sector – helping homeowners understand their options was challenging.
- Also challenging communicating that applications must be approved before work on the roof commences – retroactive grants are not permitted.

SOLUTIONS: PROGRAM DEVELOPMENT

- Tracking costs for projects

SOLUTIONS: PROGRAM IMPLEMENTATION

- Creating an information session for roofing professionals, which provides program overview and how to complete the application form.

PROCESS

1. Developing standards
 - a. Defining what was to be calculated
 - b. Identifying triggers and program rules
 - c. Drafting regulations
 - d. Creating guidebook on program implementation and design specifications
2. Public comment periods
 - a. Two formal/One informal
 - b. Responses to Public comments
3. Implementation actions and support
 - a. Stormwater database
 - b. Financial return calculator
 - c. Template contract
 - d. Discussion boards
 - e. Stormwater Retention Credit Price Lock program (incentive)
 - f. Stormwater Retention Credit Aggregator Startup Grant program
 - g. Stormwater Credit Site Evaluation program

CHALLENGES: PROGRAM DEVELOPMENT

- DOEE had to create many new standards and procedures during design and development of program.
- The stormwater regulations that established the program included a high retention standard and new design specifications.
- The creation of the program required the rulemaking process described above
- Process required substantial work by DOEE staff and leadership.

SOLUTIONS: PROGRAM DEVELOPMENT

- DOEE has a Stormwater Management Guidebook that outlines how projects should be designed according to DOEE's new standards
- During the rulemaking process, DOEE worked with the regulated community to provide trainings about the new regulatory framework

CHALLENGES: PROGRAM IMPLEMENTATION

- Stakeholders identified the need for a robust database in order manage program implementation.

SOLUTIONS: PROGRAM IMPLEMENTATION

- Stormwater Database (SWDB) developed. The SWDB is an online platform that DOEE uses to implement, track, evaluate, and report on the District's various green infrastructure programs, including the stormwater regulations and SRC program.
- The SWDB has the capacity to track the size, location, and performance of each green infrastructure practice that DOEE reviews for regulatory compliance and SRC generation.
- Each SRC can be tracked to the specific green infrastructure practice where it was generated and the year for which it was generated (each SRC represents 1 gallon of capacity for 1 year). Every action in the SRC program (certification, trading, use, etc.) is tracked in the SWDB so DOEE always has full visibility of the program.
- DOEE tracks trading activity and posts price information in a public registry, which is available from the Stormwater Database. DOEE also uses the Stormwater Database to sync green infrastructure data with TMDL modeling. Additionally, the SWDB helps to automate several administrative processes and sends email reminders about deadlines to staff and program participants. This is an example of a way that DOEE reduced a challenge in implementing a first-of-its-kind program.

PROCESS

1. Local demonstration roofs developed; performance monitored
2. Jurisdictional scan of other green roof programs around the world
3. Technical assistance provided on both public and private projects
4. Development of an education and outreach program
5. Local symposium hosted to share research and the latest products, and help strengthen a growing ecoroof industry
6. Grey to Green Initiative (established 2008)* established the Ecoroof Incentive Program
*(City of Portland Environmental Services, 2010)

CHALLENGES: PROGRAM DEVELOPMENT

- Proof of concept for our region
- Cost-benefit
- Showing long-term performance
- Resistance to innovation

SOLUTIONS: PROGRAM DEVELOPMENT

- During the jurisdictional scan, identify cities in a similar climate which have implemented green roofs and get their feedback on successes and challenges
- Commit to monitoring early pilot projects long-term to assess their performance, and variables associated with design elements. Also look for performance monitoring of other regional projects
- Benefits measured against construction costs are most compelling if the developer is the long-term building owner. For example, a green roof protects the roof membrane which can double its life (up to 40 years), and can provide a desirable amenity which decreases vacancy rates. Benefits in terms of things like stormwater management, air quality, habitat, and urban temperatures may warrant incentives or requirements from local jurisdictions to achieve community goals.

- Promote formation of a local workgroup to help with sharing information and to promote education and outreach. Invite participants from all sectors – including researchers, municipal staff, contractors, and consultants. Portland has such an organization called GRiT (Green Roof Information Think-tank). They organize our green roof symposia.
- Use websites, local symposia, and presentations at regional, national, and international conferences to share available resources and the latest research on design and performance.

CHALLENGES: PROGRAM IMPLEMENTATION

- Retrofits typically challenged by structural limitations
- Resistance from developers to adopt new techniques
- Strength of the economy
- Ongoing need to accurately account for the cost-benefit of ecoroofs including all the benefits it provides
- Belief leaks are more common with ecoroofs
- Misperception that ecoroofs and solar can't work together and you must choose one or the other
- Some developers prefer white or blue roofs because they are less expensive.

SOLUTIONS: PROGRAM IMPLEMENTATION

- Develop a separate retrofit standard that uses a lightweight red cinder design (it does not receive full stormwater management credit)
- Identify developers that are open to trying new ideas, and provide venues for them to share their experience with peers
- Creation of a 5-year ecoroof incentive in 2008 happened to coincide with a major economic downturn, and undoubtedly helped spur continued installation. During downturns, attention should continue to be provided to public projects that are still occurring.
- Continue to gather research from local, regional, and national efforts to establish policies and procedures to incorporate the full range of economic benefits, including habitat and improved health due to improved air quality and reduced urban temperatures.
- Establish that leaks can occur on any roof – conventional, white, blue, or green. For all roofs, the quality of construction is a critical factor, as well as the quality of the leak prevention system, and the protection of the waterproof membrane from accidental penetrations.

- Partner with researchers to investigate potential design issues. For example, work with a local university researcher to show that green roofs and solar panels can coexist. The green roof may even increase the panel efficiency by lowering peak roof temperatures.
- Compare cost, but also the benefits and O&M requirements for green, white, and blue roofs. Green roofs provide multiple benefits, including stormwater management, air quality improvement, and habitat. Green roofs protect the roof membrane from sun exposure, and can double the lifetime of the roof. White and blue roofs are focused on single benefits, and don't protect the roof membrane from solar damage. White roofs require frequent cleaning (likely with potable water) to maintain solar reflectivity in our climate. Blue roofs hold standing water on the roof for an extended period and make leak prevention even more important.

PROCESS

1. Host the Green Roof Conference, Cities Alive; Gather like-minded organizations and agencies
2. Research & understand climate, rainfall patterns, rules & regulations for the city, barriers to installing a living roof in SF
3. Tour existing green roofs
4. Conduct cost-benefit analysis
5. Produce best practices and guidelines (living roof manual) from compiled research and interviews
6. Find funding (incentives, stormwater fees etc.)
7. Create a mandate
8. Implementation

CHALLENGES: PROGRAM DEVELOPMENT

- Lack of support and staff time from other agencies
- Challenges where buildings will have solar shaded in the future
- Negatively impacting the cost of affordable housing
- Drought/lack of water creating an issue for planting
- Competing rooftop uses (urban agriculture, open space, etc.)

SOLUTIONS: PROGRAM DEVELOPMENT

- The Cost Benefit Analysis shows the affordable options for different green roof systems compared to normal white roofs.
- The Living Roof Manual provides plant recommendations for plants that are drought tolerane
- We'll continue coordinating with our sister agencies to ensure implementation goes smoothly
- We have added a section in our electronic permit tracking system to gather information on how many living roofs have been installed thus far

CHALLENGES: PROGRAM IMPLEMENTATION

- Which department will calculate area, which will enforce, which will review living roof detail, etc.
- Conducting outreach to developers, architects, and project sponsors on different options for Better Roofs
- Keeping implementation staff up to date on tools and process for Better Roofs
- Balancing rooftop priorities including urban agriculture, open space, etc.
- Gathering data/inconsistent data on living roofs installed

SOLUTIONS: PROGRAM IMPLEMENTATION

- Handling projects on case by case basis as they come up with urban ag, open space, etc. (There's no one-size-fits-all answer for how green roofs count as open space, this varies)
- Providing trainings to staff
- Added Better Roofs as a section within the electronic permit tracking system

Incentives Summary

Several different types of Incentives can be used to encourage the implementation of ecoroofs. Incentives provided typically fall under one of the following categories (Canada Mortgage and Housing Corporation, 2006):

- Direct financial incentives – this type of incentive provides financial assistance with the cost of building an ecoroof.
- Indirect financial incentives – encourage developers and/or building owners to reduce impact through offering fee reductions, tax breaks, density bonuses or fast tracking permits related to an environmental outcome the municipality is trying to achieve. An example is stormwater utility charges in some municipalities may be reduced if an ecoroof is installed that increases the site’s stormwater capacity. Density bonusing is a popular incentive that allows increased development potential (extra floor area above what is permitted) if the developer installs a certain type of ecoroof. Typically these types of incentives cost less for a municipality than direct financial incentives.
- Regulatory measures – while this not necessarily an incentive, it is an important consideration for policy program development. Regulations allow municipalities to achieve specific goals, set minimum standards (such as type of roof, plants used, growing medium thickness, accessibility, etc.).

The following table provides an overview of the incentives offered by questionnaire respondents.

Program Name		Incentives Offered
Toronto Green Roof Bylaw	Indirect financial	Incentive offered to schools and non-profits for green roofs required under bylaw
Toronto Eco-Roof Incentive Program	Direct financial	\$5/sqm of new cool roof membrane (2017) \$100/sqm of green roof installed (2017) Structural Assessment Grant of up to \$1000.00 available for engineer to perform building assessment and report on ability to withhold green roof weight for existing buildings.
District of Columbia Stormwater	Indirect financial	Large construction and redevelopment sites Sites that voluntarily install green infrastructure can generate SRCs to sell to regulated developers (or sell to DOEE through the SRC Price Lock Program).

Program Name		Incentives Offered
Retention Credit (SRC) Trading Program		<p><u>Incentives:</u></p> <p>Rebate: \$10USD-\$15USD/sqft (voluntary installation) (DC.gov: Department of Energy & Environment, n.d.-a), discount on DC water bill of up to 55% for stormwater fee and 4% off the Clean Rivers Impervious Area Charge (voluntary installation) (DC.gov: Department of Energy & Environment, n.d.-b)</p> <p>Discount programs: “For buildings with a footprint of 2,500 square feet or less, funds are available to defray the cost of a structural assessment” (DC.gov: Department of Energy & Environment, n.d.-a)</p> <p>Stormwater Retention Credit Trading Program:</p> <ul style="list-style-type: none"> • “RiverSmart Rooftops Rebate program are also eligible to participate” (DC.gov: Department of Energy & Environment, n.d.-a) • “You can generate and sell Stormwater Retention Credits (SRCs) to earn revenue for projects that reduce harmful stormwater runoff by installing green infrastructure (GI) or by removing impervious surfaces. You can sell your SRCs in an open market to properties that have regulatory requirements for managing stormwater.” (DC.gov: Department of Energy & Environment, n.d.-c) <p>More information about the programs above can be found at http://doee.dc.gov/riversmart.</p>
Portland Ecoroof Program	Regulatory Indirect financial	<p>Stormwater Management Manual (City of Portland, 2016): regulatory requirements for stormwater management for new development and re-development projects – ecoroofs count as an impervious area reduction technique, meaning that area is assumed to be fully managed</p> <p>Floor Area Ratio Bonus in Central City (2001)(City of Portland, 2018): allowed more building square footage depending upon amount of ecoroof coverage</p> <p>City Green Building Policy (2005): Consideration of ecoroofs on all new city buildings, and for all city building roof replacement projects</p> <p>Clean River Rewards (2006): Discount on the stormwater management portion of a ratepayer’s utility bill available for a variety of stormwater management facilities, not just ecoroofs</p>

Program Name		Incentives Offered
	Direct financial	Ecoroof Incentive Program (2009): part of the 2008 Grey to Green Initiative, the program ran from 2009-2014 and offered \$5/sf to qualifying ecoroof projects. \$1.9M was granted to 134 installations;
	Regulatory	Central City Ecoroof Requirement (2018) – an ecoroof requirement is being considered for the central region of Portland that would replace the existing voluntary Floor Area Ratio bonus. It will be voted on in May 2018 by City Council and come into effect June 2018. https://www.portlandoregon.gov/bps/article/661745?
San Francisco Better Roofs Ordinance	Regulatory	No incentives; mandatory compliance with better roofs ordinance (City and County of San Francisco, 2016) to install solar or living roof.

Performance Measures and Impact Summary

Questionnaire respondents were asked to provide information on how they measured their program performance and whether they tracked the impact achieved through the program. The table below provides a summary of the measures and impacts and you may notice the performance measures link back to the key motivators identified earlier in this report.

Program Name	Performance measures used	Impact achieved
Toronto Green Roof Bylaw	% coverage based on Gross Floor Area	500+ green roofs (2017) Close to 100 added per year
Toronto Eco-Roof Incentive Program	Stormwater management (litres) Energy efficiency (kilowatt hours, \$) Greenhouse gas emission reductions (tonnes) Urban heat island reductions (degrees C, as per literature review)	As of October 2016 (Chief Corporate Officer, 2016): 10.5million litres of stormwater diverted with equivalent savings of \$100,000 1,062,445 kilowatt hours of energy per year with equivalent savings of \$135,462 per year

Program Name	Performance measures used	Impact achieved
	<p>Creation of greenspace enhancement and jobs</p> <p>Support for biodiversity (sqm of green roof installed)</p>	<p>Cumulative 200 tonnes of GHG avoided</p> <p>20,095sqm of green roof space</p> <p>12-person-years of new employment due to green roofs</p>
<p>District of Columbia Stormwater Retention Credit (SRC) Trading Program</p>	<p>Each SRC represents one gallon of retention capacity for one year. This allows DOEE to certify in 3-year cycles following a maintenance inspection. To generate SRCs, the site must have a maintenance contract or plan in place that covers the period of SRC certification (i.e. 3 years). There is no permanent maintenance obligation, but the site is committed to maintenance for the period of SRC certification. This provides flexibility to participants, but the maintenance contract/plan and inspection helps DOEE ensure that projects are well-maintained before the site receives SRCs.</p>	<p>The SRC program is still relatively early in implementation but has already achieved results. The first SRC certification occurred in 2014 and the number of SRCs certified has grown each year thereafter. In total, 122,643 SRCs have been traded. 2017 has seen more trading activity than all prior years combined with 75,645 SRCs sold. More information about SRC sales is available in the SRC and Off-Site Retention Volume (Offv) registry at http://doee.dc.gov/src.</p> <p>SRC trades result in the greatest environmental benefit when properties outside of the MS4 purchase SRCs that were generated within the MS4 (because this represents a shift of funding for green infrastructure to the areas where it is most needed). This scenario currently accounts for 66% of SRC use. 21% of SRC use is MS4 to MS4. 10% of SRC use is non-MS4 to non-MS4. 4% of SRC use is non-MS4 SRCs used for compliance within the MS4.</p> <p>The annual report on the SRC program is available at: https://doee.dc.gov/node/1284066</p> <p>Green roof information is available at : https://doee.dc.gov/publication/inventory-green-roofs</p>
<p>Portland Ecoroof Program</p>	<p>1) acres of ecoroof installed;</p>	<p>28.4 acres of extensive green roofs (ecoroofs)/470 installations</p>

Program Name	Performance measures used	Impact achieved
	2) performance monitoring on selected ecoroofs for multiple years.	16.3 acres of intensive green roofs (roof gardens)/149 installations Performance monitoring summary from 2013 available here: https://www.portlandoregon.gov/bes/article/563749 .
San Francisco Better Roofs Ordinance	Area of solar/living roof Cost benefit analysis tool used to calculate living roof benefits Solar calculator	Our consultants, ARUP, completed a Cost Benefit Analysis for green roofs in San Francisco. The report covers the myriad of benefits that green roofs can bring to San Francisco including stormwater retention, habitat and biodiversity, energy savings, real estate benefits, and connection to nature for all. The report contains dollar amounts to each benefit and mentions the effect that the ordinance may have on the city. Reporting will be ongoing as roofs are installed.

Lessons Learned

	Lessons Learned
Toronto Green Roof Bylaw	A strong regulation does work
Toronto Eco-Roof Incentive Program	There is a lot of interest from the residential sector. We heard that the cost of a structural assessment was a barrier for green roofs and this is why we added an additional funding mechanism to compensate for the high cost of hiring a structural engineer.
District of Columbia Stormwater Retention Credit (SRC) Trading Program	The demand side of the SRC market is driven by regulated construction and redevelopment projects. These sites have long permitting and construction timelines (which can be several years). SRC use is not required until the end of construction. As a result, the growth of demand in the SRC market started gradually. DOEE's objective is to use the SRC program to accelerate green infrastructure implementation,

	Lessons Learned
	which is why the launch of the SRC Price Lock program has been important: DOEE creates demand in the SRC market and provides confidence about the revenue from selling SRCs.
Portland Ecoroof Program	<p>1) Education and outreach is essential to a successful program</p> <p>2) designs are highly varied, and the impacts of each of those designs vary as well – soil media, media depth, drainage system used, amount of irrigation, and plant choices can all impact performance for stormwater management, habitat value, and other factors</p> <p>3) effluent water quality should be considered – for example, long-term nutrient export has been noted in some monitored installations. Application of fertilizers and herbicides should be prohibited</p> <p>4) limit irrigation as much as possible – some monitored ecoroofs overwatered and created runoff during non-rainfall days. It also limits the ecoroofs stormwater effectiveness if it's wet from irrigation and then a rain event occurs</p> <p>5) benefits go beyond stormwater management – it's extremely valuable to talk about all the benefit as a whole – stormwater, habitat, air quality, etc. This has been very helpful in working on the potential ecoroof requirement in the Central City.</p>
San Francisco Better Roofs Ordinance	The flexibility of the ordinance is very successful to allow for the best solution for each site. The requirement however is modest and could ask for more area from each project. We also didn't look into a performance area metric.

Additional Comments

Program Name	Additional Comments
Toronto Green Roof Bylaw	None provided
Toronto Eco-Roof Incentive Program	<p>The program undergoes reviews from time to time to improve uptake. The last program review was in 2016 and the report found here can provide additional details: http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2016.PG16.4</p> <p>You can also visit our program website at: https://web.toronto.ca/business-economy/business-operation-growth/greening-your-business/green-your-roof/</p>
District of Columbia Stormwater Retention Credit (SRC) Trading Program	None provided
Portland Ecoroof Program	<p>Make sure to tap “library” database being developed by Green Roofs for Healthy Cities</p> <p>The International Green Roof Association (IGRA) has good case studies online.</p>
San Francisco Better Roofs Ordinance	<ul style="list-style-type: none"> We have an updated ZA bulletin that reflects a calculation change when figuring out how much solar & green roof a project needs when combining both technologies. This question came up recently for a project in the eastern side of the city that was trying to figure out how much of each they needed to comply. <p>It looks complicated, but it’s intent is to support project sponsors who want to do both living & solar on their roof. Better roof options break down to the following:</p> <ol style="list-style-type: none"> Solar only. 15% Living Roof only. 30% Combination. $[1 - (\% \text{ solar provided} / 15\%)] \times 30\% = \text{resulting living roof requirement}$

References

- Canada Mortgage and Housing Corporation. (2006, August). Green roofs: a resource manual for municipal policy makers. *Research Highlight*, (Technical Series 06-113), 4.
- Chief Corporate Officer. (2016). Eco-Roof Incentive Program Review & Update. Toronto, ON: City of Toronto. Pg16.4. Retrieved from <https://www.toronto.ca/legdocs/mmis/2016/pg/bgrd/backgroundfile-97954.pdf>
- City and County of San Francisco. Ordinance No. 221-16 (2016). San Francisco, CA, USA: City and County of San Francisco. [https://doi.org/10.3969/j.issn.1005-152X.2015.09\(2\).027](https://doi.org/10.3969/j.issn.1005-152X.2015.09(2).027)
- City of Portland. (2016). *City of Portland Stormwater Management Manual*. Portland, OR. <https://doi.org/10.1016/B978-1-85617-567-8.50011-1>
- City of Portland. (2018). Title 33, Planning and Zoning: Chapter 33.510 Central City Plan District. Portland, OR: City of Portland. Retrieved from <http://www.portlandonline.com/shared/cfm/image.cfm?id=53363>
- City of Portland Environmental Services. (2010). Grey to Green: Going Green for Clean Rivers. Portland, OR: City of Portland Environmental Services. Retrieved from <https://www.portlandoregon.gov/bes/article/321433>
- Connelly, M. (2014). Policies to Accelerate Adoption of Green Roofs. In *Infraestructura Vegetal De Edificios: Experiencia Internacional Y Nacional* (pp. 1–29). Santiago, Chile.
- DC.gov: Department of Energy & Environment. (n.d.-a). Green Roofs in the District of Columbia. Retrieved March 19, 2018, from <https://doee.dc.gov/greenroofs>
- DC.gov: Department of Energy & Environment. (n.d.-b). RiverSmart Rewards and Clean Rivers IAC Incentive Programs. Retrieved March 19, 2018, from <https://doee.dc.gov/riversmartrewards>
- DC.gov: Department of Energy & Environment. (n.d.-c). Stormwater Retention Credit Trading Program. Retrieved March 19, 2018, from <https://doee.dc.gov/src>

Appendix A: Survey Respondents and Contact Information

Municipality	Date Survey Completed	Program Name	Contact	Job Title	Department
Toronto	None provided	Green Roof Bylaw	Jane Welsh/Shayna Stott and Dylan Aster	Project Manager, Planner; Program Manager	City Planning and Toronto Building
City of Toronto	November 17, 2017	Eco-Roof Incentive Program	Annemarie Baynton	Program Manager	Environment and Energy Division, City of Toronto
District of Columbia	November 29, 2017	Stormwater Retention Credit (SRC) Trading Program	Matthew Espie	Environmental Protection Specialist	Government of the District of Columbia, Department of Energy and Environment
Portland, Oregon	November 29, 2017	Ecoroof Program	Tim Kurtz	Manager, Stormwater Implementation & Technical Assistance	Bureau of Environmental Services
City & County of San Francisco	December 5, 2017	San Francisco Better Roofs Ordinance	Anne Brask	Planner & Urban Designer	San Francisco Planning Department

Appendix B: List of Municipalities Contacted to Complete Survey

Municipality	Green Roof Program Name	Program Contact Name	Title	Questionnaire Completed?
London, England	Greening London	General Email	N/A	No
City of London, UK	Green Roofs	Lisa Russell	N/A	No. Suggested we send to greening London
Toronto, ON	Toronto Green Roofs	Jane Welsh	Project Manager, Strategic Initiatives, Policy & Analysis, City Planning, City of Toronto	Yes
Toronto, ON	Toronto Green Roofs	Dylan Aster	Technical/ Policy Advisor, Office of the Chief Building Official, Toronto Building	Yes
Washington, DC	Stormwater Retention Credit Trading Program	Matthew Espie	Environmental Protection Specialist	Yes
San Francisco, CA	San Francisco Better Roofs	Kay Cheng	Project Manager and Urban Designer, San Francisco Planning Department	No. Anne Brask completed for San Francisco, CA.

San Francisco, CA	San Francisco Better Roofs	Anne Brask	Planner, San Francisco Planning Department	Yes
Portland, OR	Portland Ecoroof Program	Timothy Kurtz	Senior Engineer, Stormwater System Division, Bureau of Environmental Services, City of Portland, Oregon	Yes
Chicago, IL	Chicago Green Roofs	Michael Berkshire	N/A	No