**Vision:** To be the best place in Canada to raise a child, promote innovation, engage citizens and provide diverse economic opportunities.

**Values:** Honesty, Accountability, Innovation, Leadership, Respect, Excellence, Teamwork

<table>
<thead>
<tr>
<th>TO: Mayor and Members General Issues Committee</th>
<th>WARD(S) AFFECTED: CITY WIDE</th>
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</thead>
<tbody>
<tr>
<td><strong>COMMITTEE DATE:</strong> June 13, 2011</td>
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<tr>
<td><strong>SUBJECT/REPORT NO:</strong> Green Roofs and Living Walls (PW11037) (City Wide) (Outstanding Business List)</td>
<td><strong>PREPARED BY:</strong> Geoff Lupton, Director Energy, Fleet, Facilities and Traffic 905-546-2424, Extension 7372</td>
</tr>
<tr>
<td><strong>SUBMITTED BY:</strong> Gerry Davis, CMA General Manager Public Works Department</td>
<td><strong>SIGNATURE:</strong> Tom Chessman, Manager Office of Energy Initiatives 905-546-2424, Extension 2494</td>
</tr>
</tbody>
</table>

**Council Direction:**

At the Emergency and Community Services Committee meeting held on April 7, 2010 the Committee Clerk was directed to forward the information provided by Maggie Hughes to the Emergency and Community Services Committee respecting the Benefits of Green Roofs and Living Walls to the Director of Energy, Fleet, Facilities and Traffic for review and use while preparing the report regarding this matter to Committee of the Whole (now General Issues Committee).

Public Works staff was directed to provide, in the report respecting the Benefits of Green Roofs and Living Walls, an assessment that illustrates where the City of Hamilton stands in comparison to other municipalities respecting the use of green roofs and walls; and to highlight where the City is ahead/behind other municipalities and why.

**Information:**

**Green roofs** consist of a thin layer of vegetation and growing medium installed on top of a conventional flat or sloped roof. **Extensive green roofs**, which have a thin growing medium, are the most typical. They use shallow planting media (low weight and soil-less) to help minimize costs and the total structural load. Made up of low-weight synthetic planting media, combined with the challenging winds, drought and high-temperature microclimates on an elevated surface, they use hardy, low-height, drought-resistant plant species. **Intensive green roofs** are designed for unique and esthetic amenity or recreational space, including public access. Intensive green roofs feature deeper planting media, irrigation systems, complex landscaping features and a broad range of plant species. Comparatively less maintenance is needed to install and
maintain an extensive green roof than intensive green roofs. City Hall and McNab Transit Terminal are examples of Hamilton’s intensive green roofs.

Related to green roofs, White Roofs (also known as Cool Roofs) use specialized roofing materials that deliver high solar reflectance (the ability to reflect the wavelengths of the sun, reducing heat transfer to the building) and high thermal emittance (the ability to radiate absorbed or non-reflected solar energy).

Living Walls are self-sufficient vertical gardens found on the exterior or interior of a building which are bound in a structural support attached to a wall. The plants receive water from within the structure rather than the ground.

For the purpose of the report, further information provided will be focused around green roof and white roof technology.

Benefits of Green Roofs and White Roofs

Green roofs and White roofs provide the following benefits:

Reduce Urban Heat-Island Impact: Urban Heat-Island Effect is a common phenomenon whereby urban or metropolitan areas are warmer than the surrounding rural/sub-urban areas. This is typically due to building materials (i.e. concrete and asphalt) absorbing and radiating heat. Dense urban surface areas can cause temperature increases as high as 10°C (50°F). Hard, heat-absorbent surfaces retain more heat than areas with vegetation and plant life. This “heat island” phenomenon is the result of ground-level air temperature being much higher than in surrounding rural areas, where the vegetation and plant life cool the air through moisture retention and subsequent evaporation and transpiration through their leaves.

Control Storm Water Runoff: Impervious surfaces, such as concrete sidewalks, paved parking lots, streets and highways, building walls and conventional roofs, dominate urban landscapes. These impervious surfaces direct storm water into storm gutters, sewers and engineered channels. Green roofs with new design criteria can have less run-off and cooler water as compared to a conventional roofing system. Green roofs in general will not, however, mitigate storm water runoff in extreme or sustained rain conditions.

Reduce Air Pollution and GHG Emissions: Vegetation can remove air pollutants and greenhouse gas emissions through dry deposition and carbon sequestration and storage. By lowering air conditioning demand, green roofs can also decrease the production of associated air pollution and greenhouse gas emissions. The deeper planting media of Intensive green roofs will have a greater impact on air pollution versus the more shallow Extensive green roofs. Living walls can reduce airborne particulates by trapping them within the vegetation.

Increase Green Amenity Space: Many urban buildings stand on busy streets and transportation routes and have little green space. Green roofs and living walls can provide a measurable psychological benefit to urban dwellers by adding tangible, accessible, natural space for social interaction, recreation and relaxation.

Lower Energy Consumption: Recent green roof research supports European findings that green roofs (when coupled with additional insulation) can somewhat reduce overall
building energy demand in summer. Energy cooling savings are the result of the cooling effects of evapo-transpiration within the plants and the evaporation of retained moisture from the soil. Green roofs are less effective at preventing the heat loss in the winter as compared to the summer months. Therefore, construction of green roofs can not be justified on energy savings alone, as other building design elements must be present to reduce energy loss.

Maintain Biodiversity: The expansion of urban spaces has led to habitat loss and fragmentation for many animal species. Green roofs and living walls can provide suitable habitat and refuge space for many bird and invertebrate species in urban areas. Green rooftops can be designed to play two key roles: they can be a “stepping stone habitat,” connecting natural isolated habitat pockets with each other, or an “island habitat” that is separate from habitats at grade for less mobile species. Because roofscapes make up 15 to 35 per cent of the urban footprint, they have great potential to mitigate lost biodiversity.

Extend Roof Life: On building roofs, materials such as asphalt coating and membranes are flexible and have a higher rate of change. As conventional roofing materials are exposed to solar radiation over time, the elasticity of the materials is reduced and eventually fails to respond to temperature changes resulting in cracking. Green roofs offer protection to conventional roofing surfaces from solar radiation (ultra violet) and other weather conditions and in effect may act to significantly reduce surface degradation. Existing data suggests that Green Roof systems may extend life expectancy compared to conventional roofs.

Issues with Green Roofs and White Roofs

As with any building technology, there are considerations that must be addressed before installing a green roof such as: initial cost, maintenance costs, structural constraints, accessibility and building use.

The greatest barrier to green roofs is that they are more costly to install than traditional roof structures and have additional ongoing maintenance costs. For Intensive green roof installations, or roofs offering community access, the initial costs and maintenance costs are significantly higher than Extensive green roof installations and also include costs for health and safety measures. For roof retrofits, budgets are typically less for a roof replacement or resurface than the cost of installing a new type of roofing membrane. Cost is a barrier to encouraging private green roof development within the City. The benefits of a green roof are typically enjoyed by the public; however the cost would be borne by the individual. Encouraging altruistic green development is often difficult without incentive programs.

The costs of installing a green roof are unique to the building, as the type, size, use all play a part, however a comparison of typical costs to install are:

- Conventional 4 ply hot tar roof ~ $8 per square foot
- Extensive green roof $15-$25 per square foot
- Intensive green roof $25-$40+ per square foot (depending on aesthetic features such as walkways, curbs etc.)
Structural issues are a concern, particularly in a roof replacement. Many older buildings are not structurally equipped to handle the added weight of a green roof. Also, newer structures constructed of engineered materials are usually designed to just meet the building code loading requirements. Adding additional load for typical green roofs on a retrofit is generally not possible without additional structural investment. Green roofs are more easily integrated at the design phase for a new construction.

The roof must be accessible for green roof installation and maintenance. As both Extensive and Intensive green roofs require some irrigation and regular maintenance of plant species, considerations have to be made surrounding the access to the roof itself.

It is important to remember that not all buildings are suitable for the installation of green roof technology. For both new and existing construction, the location, size and use of the building will impact the decision to install a green roof. For example, installing a green roof in a rural area would not contribute the benefits noted above as it would with installing a green roof in an urban core which has a measurable heat island effect. Alternative renewable energy options such as solar photovoltaic (solar PV) roof or ground systems could be more appropriate in different geographic areas or on certain building types.

**Current City of Hamilton Green Roof and White Roof Installations**

The City of Hamilton has Green Roofs or White Roofs on the following locations:

- City Hall (Green Roof)
- McNab Transit Terminal (Green Roof)
- Westmount Recreation Centre (White Roof)
- Lower Stoney Creek Recreation Centre (White Roof)
- North Wentworth Twin-Pad Arena (White Roof)
- Ancaster Fire Station No. 20 (White Roof)
- Stonechurch Fire Training Complex (White Roof)

**City of Hamilton Policies and Programs Supporting Green Roofs and White Roofs**

Beyond the guiding principles of the provincial and national Buildings Codes, Hamilton currently has several policies and programs that directly and indirectly provide guidance in this area, namely:

i. The City’s Economic Development Office Hamilton LEEDING the Way Program provides LEED Grants for new developments and retrofit projects in the defined Community Improvement Plan area. The program cost shares 50% of the incremental development, design, construction, and certification costs up to 75% of the municipal realty tax increment during the first 5 years after LEED certification. Green Roofs and White Roofs are eligible for this program under the following LEED point Categories:

   - Site Development: minimizes storm water run-off, increases urban density and green space
Water Efficiency: eliminates site irrigation, reduces water consumption, minimize or treat wastewater
Energy Efficiency: reduces building energy consumption
Material Selection: uses renewable construction materials and design and build more durable buildings
Innovation in Design: incorporates innovative environmental features

ii. The City of Hamilton Corporate Energy Policy (Section 2.3.1) references:

- Major Renovations - LEED design efforts and assessment according to base case design versus LEED Silver and Certified levels
- New Construction - LEED design efforts and assessment according to base case design versus the Platinum, Gold, Silver and LEED Certified levels
- Evaluation of Green/White Roofs. As part of the LEED assessment, options for potential LEED credit with evaluation of energy, water/sewage infrastructure benefits, financial, benefits and environmental benefits and viability to the overall project
- The City of Hamilton Corporate Energy Policy (Section 3.3) whereby the feasibility of green or white roof technology is explored as part of the ongoing roof capital replacement evaluations.

iii. The City’s Vision 20/20 Goals supports sustainable design, which would include green roof and living wall technology in its sections on:

- Natural Areas and Corridors
- Improving Quality of Water Resources
- Consuming Less Energy
- Improving Air Quality
- Land Use in the Urban Area

Current legislation does not allow for by-law action within the City of Hamilton. Indeed, all new construction must adhere to the appropriate building codes, and other applicable by-laws and zoning restrictions. Within the scope of Planning and Economic Development, green roof technology could be further encouraged, but not mandated at this time. Current low impact design guidelines from areas such as the “City of Hamilton Airport Employment Growth District Eco-Industrial Design Guidelines” also reinforce the City’s support for sustainable design, whether it is green roofs or other green building technologies.

Green Roofs Policies in Other Municipalities

Some Canadian cities have adopted Green Roof policies to promote and leverage the benefits of these building techniques. During the course of research for this report, Public Works corresponded with the City of Toronto and City of Richmond (BC) on their Green Roofs by-laws, and with the City of Waterloo, and Region of Waterloo on their policy development around green roofs technology.

The City of Toronto implemented their by-law in 2009, after an extensive benefits study in 2005. For example only, an overview of the Toronto by-law is indicated below:
• The Toronto Green Roof By-law is applicable to non-industrial new construction buildings only over 2,000 m² gross floor area; Roofs with floor plates less than 750 m² and residential buildings less than 6 stories or 20 m in height are exempt.

• Variance to coverage requirements may be applied for provided a cash-in lieu payment is made.

• Exclusions are made for roof area used for renewable energy (typically solar) installations.

• Industrial new construction is currently under review. After an initial schedule for mandating Industrial buildings be compliant in January 2011, that has been pushed back to April 2012 due to resistance from this sector.

• The current Toronto graduated coverage of roof space requirements are:

  Table 1 - City of Toronto Green Roof Coverage Requirements

<table>
<thead>
<tr>
<th>Gross Floor Area</th>
<th>Size of Green Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000-4,999 m²</td>
<td>20% of Available Roof Space</td>
</tr>
<tr>
<td>5,000-9,999 m²</td>
<td>30% of Available Roof Space</td>
</tr>
<tr>
<td>10,000-14,999 m²</td>
<td>40% of Available Roof Space</td>
</tr>
<tr>
<td>15,000-19,999 m²</td>
<td>50% of Available Roof Space</td>
</tr>
<tr>
<td>20,000 m² or greater</td>
<td>60% of Available Roof Space</td>
</tr>
</tbody>
</table>

It is important to note that the City of Toronto Act (COTA) played a key role in giving Toronto the authority to mandate green roofs in the form of a by-law. It allowed them to augment the current Ontario Building Code legislation, with their own Toronto Green Roof Construction Standards. Hamilton does not have the legislative authority to mandate new construction projects include green roof elements in their design. Another important element in Toronto is that any green roof development is managed by the Buildings and Zoning department.

Toronto had a great deal of support from the multi-residential development community, particularly those that had voluntarily included green roofs in their new construction and retrofit projects. There is a Toronto Eco Roof incentive for buildings either not included under the by-law, or for retrofit projects for either green or white roofs. Funding is scheduled to continue to 2012. Projects mandated under the by-law receive no incentives from the city. The Industrial sector has been the largest challenge group. Economics for installing green roofs on industrial buildings are a large cost barrier. Due to the push back from industry, as well as from Toronto’s own Economic Development department for concern surrounding promoting growth in this sector, the by-law does not yet apply to the Industrial Sector.

The City of Richmond, BC has some policy around sustainable building, not specifically green roof policy, but did implement a by-law to address development of new commercial and industrial buildings outside of the city centre. Called, Green Roofs and Other Options Involving Industrial & Office Buildings Outside the City Centre, the by-law
initiative was lead by their Planning and Development department to meet development objectives around storm water management. The by-law applies to construction over 2000 m² gross floor area. It is important to note that this by-law does not mandate that all buildings include a green roof component, but rather that it meets specific requirements around reducing roof or ground water runoff, and a variety of alternatives are included in the by-law to meet those goals. Since the by-law passed in late 2008, only 2 or 3 projects have been completed, none of which installed green roofs.

City of Waterloo and the Region of Waterloo both explored green roof policies, with the Region having more success.

The City of Waterloo had initiated a feasibility study in 2004, on implementing a city wide plan for city-owned buildings, both new and old, to convert to green roofs. The study identified the similar benefits detailed in this report. Waterloo installed some green roofs on sites identified in their study, but policy change efforts are ongoing. Waterloo is reviewing their Official Plan to further encourage sustainable design standards, low impact development, innovative green space and is looking at possible incentive programs to achieve these goals. Lately there has been activity around rooftop solar panels. Similar to Hamilton, current policy exists around sustainable building, but not specifically to green roof technology.

The Region of Waterloo has had more success with policy surrounding green roofs. In their strategy in May 2007 they proposed that the Region implement a policy for green roof technology (Extensive type) to be installed on all new construction being built by the Region in so long as it met specific criteria relating to location, available roof space, building use, and could be maintained within budget. They identified that the cost premiums were too high on retrofitting older buildings, and that buildings not slated for urban core, were likely without the same amount of benefit.

In addition to speaking with the cities above, Public Works also completed a cursory review of other cities, including City of Guelph, City of Vancouver (BC) and City of Port Coquitlam (BC) to examine their existing policies and guidelines. Brief descriptions of those are:

The City of Guelph promotes its environmental stewardship, and has installed a green roof and living wall at Guelph city hall. It does not appear they have a specific green roofs policy, but encourage green building design.

The City of Vancouver has several initiatives in place for green building, including promoting sustainable design and LEED certification for all buildings. A new policy was presented to have all “rezonings” be built to LEED Gold certification. There a several high profile buildings with green roof installations, including the Vancouver Convention and Exhibition centre, with its 6 acre Intensive green roof.

The City of Port Coquitlam has a green roofs requirement on new construction over 5000 m² within the city’s general zoning by-law.

Below is a snapshot of the current status of Green Roofs policies in the different municipalities reviewed:
Table 2: Comparison of Green Roofs Policy across Different Municipalities

<table>
<thead>
<tr>
<th>City</th>
<th>Green Roof Policy Type</th>
<th>New Construction</th>
<th>Existing Buildings</th>
<th>Status of Green Roof Activity</th>
<th>Other Green Building Policy/Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Hamilton</td>
<td>Non-specific</td>
<td>N/A</td>
<td>N/A</td>
<td>2 City Building Green Roofs, 1 Living wall and Several White Roofs</td>
<td>LEEDing the Way, Corporate Energy Policy, Vision 20/20</td>
</tr>
<tr>
<td>City of Waterloo</td>
<td>Non-specific</td>
<td>N/A</td>
<td>N/A</td>
<td>3 City Buildings, 5 other buildings all with Green Roofs</td>
<td>Within Official Plan - Sustainable Building policies</td>
</tr>
<tr>
<td>City of Toronto</td>
<td>City-wide By-Law</td>
<td>Yes</td>
<td>No</td>
<td>80 Applications submitted by private development since By-Law passed</td>
<td>Toronto ECO-roof incentive for Retrofit or those not covered under By-Law</td>
</tr>
<tr>
<td>City of Richmond</td>
<td>By-Law Outside of City Centre (green roofs &amp; other options)</td>
<td>Yes</td>
<td>No</td>
<td>2 or 3 buildings completed since By-law passed – used other green options</td>
<td>Within Official Plan - Sustainable Building practices</td>
</tr>
<tr>
<td>City of Guelph</td>
<td>Non-specific</td>
<td>N/A</td>
<td>N/A</td>
<td>City Hall - green roof and living wall, some private industry</td>
<td>Within Official Plan - Sustainable Building practices</td>
</tr>
<tr>
<td>City of Vancouver</td>
<td>Non-specific</td>
<td>N/A</td>
<td>N/A</td>
<td>Several - including Canada's largest</td>
<td>LEED Gold Policy, Re-zonings Policy</td>
</tr>
<tr>
<td>City of Port Coquitlam</td>
<td>By-Law – Zoning &gt;5000 m²</td>
<td>Yes</td>
<td>No</td>
<td>Some private development projects under By-Law</td>
<td>Sustainability Initiative - green building practices for municipal buildings</td>
</tr>
<tr>
<td>Region of Waterloo</td>
<td>Regional Policy for Region-Owned Buildings</td>
<td>Yes</td>
<td>No</td>
<td>Projects underway</td>
<td>LEED Silver for all new Regional facilities</td>
</tr>
</tbody>
</table>

Conclusions

The City does have existing legislation in place to support and encourage the use of green roof technology through sustainable building design, though not a specific green roof policy. This is the case with other municipalities as well.

As indicated above, there are benefits to installing a green roof in urban areas. However, the energy efficiency gained from green roofs, particularly on roof replacements is minimal and results in negligible savings. While there are cooling demand reductions, green roofs offer little heating demand reduction in winter. In addition, the economics for installing green roofs on existing buildings is not feasible with both structural and budgeting constraints. Other efficiency measures can be installed which result in lower energy use, shorter payback periods and an optimal use of limited funds.

It should be noted that other sustainable building techniques can provide similar benefits to installing green roofs. Rooftop solar PV installations, for example, are a renewable energy source, capable in both warm and cooler climates of reducing energy use and can also protect roofing membranes from exposure. They are typically more affordable (when ongoing revenue from the Feed-In-Tariff program is factored in) and have less maintenance costs than a typical green roof installation. When it comes to retrofitting, solar may be easier to implement, and offer a great return on investment.
As seen in the table above, other municipalities recognize that the economics for installation of green roofs are limited to new construction projects where the roofing requirements are budgeted during the design phase.

As further policy development around green building standards are developed, the Planning and Economic Development Department would be the lead for establishing those guidelines. Their staff are both instrumental in promoting and maintaining zoning and construction standards as it relates to the applicable building codes; and meeting the City’s future development and sustainability goals.