1. Overview and Approach
Step-by-step overview of how scores are calculated based on zoning district open space requirements and examples of common typology scores

2. Cool Factor Strategies (please see worksheet)
Definitions, prerequisites, and scores

3. Case Studies and Testing
Impacts of Cool Factor on multiple zoning districts and project types

4. Questions and Next Steps

Today’s materials are a conceptual draft, not a finalized proposal. The City wants the Task Force’s feedback on what is working and what is missing from the Cool Factor.
Cool Factor Achieves many CRZTF Objectives

- Elevate and Floodproof
- Design to Protect/Recover
- Promote Passive Resilience
- Green Infrastructure
- Preserve Vegetation
- Create Vegetation
- Limit Paved Areas
- Provide Shading
- Use Reflective Surfaces
- Shelter in Emergencies
- Create Emergency Plans
- Implement Area-Wide Strategies (Social Resilience)
- Implement Area-Wide Strategies (Hazards)
Resilient Site Design Objectives:
Manage stormwater on-site + mitigate heat island

<table>
<thead>
<tr>
<th>Objective</th>
<th>Flooding</th>
<th>Cooling</th>
</tr>
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<tbody>
<tr>
<td>3 Integrate Green Infrastructure</td>
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<td>X</td>
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<tr>
<td>4 Preserve Existing Vegetation</td>
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<td>X</td>
</tr>
<tr>
<td>5 Create Vegetation</td>
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<td>X</td>
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<tr>
<td>6 Limit Paved Areas</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7 Provide Shading</td>
<td></td>
<td>X</td>
</tr>
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Focus of the Cool Factor
Review of Task Force Cool Factor Discussion (October 10, 2019)

**Recommended:**

- include site and building strategies that contribute to cooling
- public realm cooling receives a higher credit
- tree canopy shading receives highest weight to support goal of greening the city
Other Resiliency Projects Supporting CRZTF Goals

The Cool Factor is one tool out of many that supports greening the city:

- **CCPR Citywide Plan** *(Ecosystem Strategies)*
- **Stormwater credits** *(Blue/green roof gets credits for cool factor and storm water)*
- **Urban Forest Masterplan** *(Increase in tree canopy)*
- **Envision Cambridge** *(Open space recommendations and plan)*
Introduction
Current open space requirements

Standards for open space do not directly address cooling performance.

Private Open Space. Open to the sky, unobstructed, and meant to be enjoyed by residents. Required for residential developments and must have a minimum 15’ dimension.

Permeable Open Space. Permeable but not necessarily planted. Must account for at least 50% of required open space in low-density residential districts; at least 25% of total lot area in Alewife Overlay Districts.

Green Area Open Space. Must contain planted materials or water features. Required for front yards in some districts.

Publicly Beneficial Open Space. Intended for general public enjoyment (but not necessarily park space). Required in some areas zoned for larger-scale redevelopment.
The Cambridge Cool Factor introduces performance-driven standards which contribute to public realm cooling, the mitigation of heat island effects, and a greener Cambridge.
CRZTF goals + Cool Factor approach

- **Effectiveness**
  value strategies that have demonstrated temperature reduction

- **Differentiation and Choice**
  favor performance driven criteria over prescriptive codes

- **People, Communities and Equity**
  encourage public realm enhancements

- **Flexibility**
  shape an easily implementable and adjustable tool

- **Quality**
  encourage greener open space and site design
A performance based approach

A property owner selects and implements several strategies to reduce heat from a menu of options in order to meet a set score, the *cool factor*.

Hardscape & Structures

Planting areas

Green roofs

Tree canopy

= Cool Factor Score
Cool Factor Menu of Options

- Hardscape Structures
  - Shade Structures
  - Paving with high SRI

- Planting
  - Lawn
  - Low Planting Areas
  - Planting Areas

- Green roofs
  - Extensive Green Roof
  - Intensive Green Roof (less than 2’ tall)
  - Intensive Green Roof (greater than 2’ tall)
  - Small Trees
  - Medium Trees
  - Large Trees
  - Preserved Trees

\[ \text{Performance Value} = \text{Public Realm Multiplier} \]
Possible zoning changes to support Cool Factor implementation

1. To facilitate implementation, accessible green roofs should not be included in the FAR calculation

2. To facilitate implementation, shaded structures over open space should not be included in the FAR calculation
Cool Factor Scoring Method
Scoring Approach

- **Simple**
  Open space should contribute to cooling

- **Differentiated**
  Value derives from open space requirement by zoning district

- **Strong**
  Even sites with no required open space should contribute

- **Clear**
  All projects aim for the same score
Simple
Build on existing zoning to encourage overall cooling performance

TRADITIONAL ZONING

OPEN SPACE  PERMEABILITY  +  SHADE  COOL SURFACES  PLANTING

COOL FACTOR

- min 15' setback requirement
- open space requirement
- min 50% permeability
- min 15’x15’ usable open space

- more shade
- green roof
- light color paving
- more planting
- trees near public realm

SHADE PLANTING
### Differentiated

Each parcel contributes what it can based on amount of open space required.

<table>
<thead>
<tr>
<th>Office</th>
<th>Zoning District</th>
<th>1</th>
<th>2A</th>
<th>2</th>
<th>3</th>
<th>3A</th>
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<td>10%</td>
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<table>
<thead>
<tr>
<th>Business</th>
<th>Zoning District</th>
<th>A</th>
<th>A-1</th>
<th>A-2</th>
<th>A-3</th>
<th>A-4</th>
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<th>B-1</th>
<th>B-2</th>
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<th>C-1</th>
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<td>0%</td>
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<td>30%</td>
<td>0%</td>
<td>0%</td>
<td>?</td>
<td>?</td>
<td>0%</td>
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<table>
<thead>
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<th>C</th>
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<td>0%</td>
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<table>
<thead>
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<th>C1-A</th>
<th>C-2</th>
<th>C-2B</th>
<th>C-2B</th>
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<td>36%</td>
<td>30%</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

**Challenge:** the current zoning does not have a minimum OS requirement for all zoning districts.
**Strong**

Set a minimum of 15% (possibly higher for larger sites).

### Office

<table>
<thead>
<tr>
<th>Zoning District</th>
<th>1</th>
<th>2A</th>
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### Industrial

<table>
<thead>
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<th>B-2</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
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<td>0%</td>
<td>0%</td>
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</table>

### Residential

<table>
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<th>B</th>
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<th>C-1</th>
<th>C1-A</th>
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<th>C-2B</th>
<th>C-2B</th>
<th>C-3</th>
<th>C-3A</th>
<th>C-38</th>
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<tbody>
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<td>50%</td>
<td>40%</td>
<td>36%</td>
<td>30%</td>
<td>15%</td>
<td>15%</td>
<td>15%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Minimum value does not require projects to provide 15% open space. The minimum value, however, is used to calculate the cool factor value each site provide.
Strong

Calculate a site’s target cooling area by multiplying site area by open space requirement.

\[ \text{COOLING TARGET} = \text{PARCEL AREA} \times \text{ZONING OPEN SPACE REQUIREMENT} \]

AT LEAST 15%

POTENTIALLY MORE ON LARGER PARCELS
Clear

All sites should have the same goal, as much cooling as practical.

TOTAL VALUE OF STRATEGIES (weighted by performance value) = 1

COOLING TARGET (set by property type)
Example
Determine the value of all cooling strategies from the score sheet.

\[
\begin{align*}
\text{TOTAL VALUE OF STRATEGIES} & = \text{COOL FACTOR SCORE} \\
4,875 \text{ SF} & = 1.13 \\
4,320 \text{ SF} & = 1
\end{align*}
\]
Cool Factor Strategies Overview
Definitions, prerequisites, performance, scoring
Cool Factor Score Sheet
See score sheet and guidance document

<table>
<thead>
<tr>
<th>Hardscapes and Structures</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Planting Areas</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Green Roofs</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Tree canopy</th>
</tr>
</thead>
</table>
Overview of Strategies
Cool factor encourages a range of strategies toward a goal.

- High SRI paving
- Turf high SRI paving
- Medium tree planting turf high SRI paving
- Medium and large tree planting turf high SRI paving

Public realm benefit
Min 15% permeability
Setback requirement
Min 15'x15' usable...
Overview of Strategies
Hardscape + structures

<table>
<thead>
<tr>
<th>Cool Factor Strategy</th>
<th>Relative Temperature Reduction</th>
<th>Multiplication Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paving with SRI of 39 or higher * Aligned with LEED V4 requirements</td>
<td>Reflective 'cool' materials contributed to at least 1° F and in many cases an excess of 3° F. <strong>On a hot day contributed to reduction of up to 6° F</strong> <em>(Louisville Urban Heat Management, Urban Climate Lab)</em></td>
<td>0.15</td>
</tr>
<tr>
<td>Shade structure with SRI of 39 or higher * Aligned with LEED V4 requirements</td>
<td>Shaded surfaces, may be <strong>20–45°F cooler</strong> than the peak temperatures of unshaded materials. <em>(Environmental Protection Agency)</em></td>
<td>0.3</td>
</tr>
</tbody>
</table>

*additional weight for public realm cooling
The Solar Reflectance Index (SRI.) is a measure of a constructed surface material’s, “ability to reject solar heat, as shown by a small temperature rise.

It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100.”

Source: Berkeley Lab, Heat Island Group
## Comparing SRI/SR Standards

### LEED V4

<table>
<thead>
<tr>
<th>Surface/Structure Type</th>
<th>Initial SRI</th>
<th>3-year Aged SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low slope ≤ 2:12</td>
<td>82</td>
<td>64</td>
</tr>
<tr>
<td>Steep slope &gt; 2:12</td>
<td>39</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial SR</th>
<th>3-year Aged SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shade structure</td>
<td>0.33</td>
</tr>
<tr>
<td>Paving materials</td>
<td>0.33</td>
</tr>
</tbody>
</table>

### City of Los Angeles Cool Roof Ordinance

<table>
<thead>
<tr>
<th>Surface/Structure Type</th>
<th>Initial SRI</th>
<th>3-year Aged SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low slope ≤ 2:12</td>
<td>75</td>
<td>N/A</td>
</tr>
<tr>
<td>Steep slope &gt; 2:12</td>
<td>16</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Somerville Zoning

<table>
<thead>
<tr>
<th>Surface/Structure Type</th>
<th>Initial SRI</th>
<th>3-year Aged SRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low slope ≤ 2:12</td>
<td>82</td>
<td>64</td>
</tr>
<tr>
<td>Steep slope &gt; 2:12</td>
<td>39</td>
<td>32</td>
</tr>
<tr>
<td>Parking cover</td>
<td>39</td>
<td>32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Initial SR</th>
<th>3-year Aged SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shade structure</td>
<td>0.33</td>
</tr>
<tr>
<td>Paving materials</td>
<td>0.33</td>
</tr>
</tbody>
</table>
Understanding SRI range of values for materials

<table>
<thead>
<tr>
<th>SRI VALUE</th>
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<th>0</th>
<th>6</th>
<th>19-32</th>
<th>19-65</th>
<th>21-31</th>
<th>38-52</th>
<th>19-65</th>
<th>86-100</th>
<th>100+</th>
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<td></td>
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<tr>
<td>New asphalt</td>
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<tr>
<td>Aged asphalt</td>
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<tr>
<td>Aged concrete</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brick</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High albedo asphalt shingles</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>New concrete</td>
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<td></td>
<td></td>
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</tr>
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<td>Light colored brick</td>
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<td>Portland cement white concrete</td>
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<tr>
<td>White acrylic paint</td>
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<td></td>
<td></td>
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<td></td>
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</table>
# Understanding material SRI values

<table>
<thead>
<tr>
<th>Standard paver colors</th>
<th>SRI Value</th>
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<tbody>
<tr>
<td>Charcoal</td>
<td>29</td>
</tr>
<tr>
<td>Tan</td>
<td>25</td>
</tr>
<tr>
<td>Brown</td>
<td>33</td>
</tr>
<tr>
<td>Natural*</td>
<td>45</td>
</tr>
<tr>
<td>Red 15</td>
<td>41</td>
</tr>
<tr>
<td>Cream</td>
<td>39</td>
</tr>
<tr>
<td>Limestone Gray</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: Hanover Paver

Meets SRI requirements
## Overview of Strategies

### Planting areas

<table>
<thead>
<tr>
<th>Cool Factor Strategy + Prerequisites</th>
<th>Relative Temperature Reduction</th>
<th>Multiplication Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lawn or turf area</strong>&lt;br&gt;* Minimum 8” soil depth</td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td><strong>Low planting area – includes herbaceous or woody plants less than 2’ tall at maturity</strong>&lt;br&gt;* Minimum 18” soil depth</td>
<td>Between 1 and +2°F of cooling from tree planting and grass cover (Louisville Urban Heat Management Study, Urban Climate Lab)</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Planting area – includes herbaceous or woody plants greater than 2’ tall at maturity</strong>&lt;br&gt;* Minimum 24” soil depth</td>
<td>Taller planting + wider diameter canopy provides more shaded surface</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*additional weight for public realm cooling

*Example of planting types*
Overview of Strategies
Green roof types

**Green Roof**
lighweight with a shallow layer of growing substrate of less than 200 mm deep, requiring minimal maintenance. They generally have lower water requirements and use small, low-growing plant species, particularly succulents.

**Intensive Green Roof**
generally heavier, with a deeper layer of growing substrate, and support a wider variety of plant types. Intensive green roofs need more irrigation and maintenance than extensive roofs, and are highly engineered landscapes, often built directly on structures with considerable weight load capacity.

(https://www.growinggreenguide.org/technical-guide/introduction-to-roofs-walls-and-facades/green-roof-definition/)

** Both green roof types can be accessible to occupants depending on type of building structure**
Overview of Strategies
Green roofs – calculations

Green roof will have minimum area requirement to facilitate most efficient cooling through contiguous planted area.
Possible suggestion 25’ x 25’ for large parcels; or 50% of the total roof area for small parcels.

Hardscapes and walkways should be subtracted from the Green Roof Area, and only the ‘planted areas’ should be counted.
Overview of Strategies
Green roofs and the ‘cool factor area’

For parcels with zero setback requirements and zero open space requirements, green roofs could be counted towards the cooling target.
# Overview of Strategies

## Green roofs

### Cool Factor Strategy + Prerequisites

<table>
<thead>
<tr>
<th>Cool Factor Strategy + Prerequisites</th>
<th>Relative Temperature Reduction</th>
<th>Multiplication Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensive green roof * Minimum 4” soil depth</td>
<td>Green roof temperatures can be 30–40°F lower than those of conventional roofs and can reduce city-wide ambient temperatures by up to 5°F. (Environmental Protection Agency)</td>
<td>0.3</td>
</tr>
<tr>
<td>Intensive green roof, less than 2’ tall at maturity * Minimum 18” soil depth</td>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>Intensive green roof, greater than 2’ tall at maturity * Minimum 24” soil depth</td>
<td>Taller planting + wider diameter canopy provides more shaded surface</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*additional weight for public realm cooling*
## Overview of Strategies

**Tree canopy: new trees**

<table>
<thead>
<tr>
<th>Cool Factor Strategy + Prerequisites</th>
<th>Relative Temperature Reduction</th>
<th>SF per tree</th>
<th>Multiplicatio n Factor</th>
</tr>
</thead>
</table>
| Tree canopy for “small tree species” or equivalent  
  - Canopy spread of 8’-15’, 1” caliper  
  - minimum 600 cu ft of soil/tree | Shaded surfaces may be 20–45°F cooler than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2–9°F (Environmental Protection Agency) | 75 | 0.6 |
| Tree canopy for “medium tree species” or equivalent  
  - Canopy spread of 16’-21’, 1” caliper  
  - minimum 700 cu ft of soil/tree |  | 250 | 0.7 |
| Tree canopy for “large tree species” or equivalent  
  - Canopy spread of 25’-30’, 2.5” caliper  
  - minimum 800 cu ft of soil/tree | Taller planting + wider diameter canopy provides more shaded surface | 500 | 0.8 |

*additional weight for public realm cooling*

**Example of tree species types**
## Overview of Strategies

### Tree canopy: existing / tree preservation

<table>
<thead>
<tr>
<th>Cool Factor Strategy + Prerequisites</th>
<th>Relative Temperature Reduction</th>
<th>Multiplication Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree canopy for “small trees”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Canopy spread of 6’-15’</td>
<td>Shaded surfaces may be 20–45°F cooler than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2–9°F</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>(Environmental Protection Agency)</td>
<td></td>
</tr>
<tr>
<td>Tree canopy for “large trees”</td>
<td></td>
<td>1.4</td>
</tr>
<tr>
<td>• Canopy spread of 16’+</td>
<td>*additional weight for public realm cooling</td>
<td></td>
</tr>
</tbody>
</table>
Cool Factor Site Testing
Parcel test overview

- Tested one ‘typical parcel’ per zoning district
- Exercise driven by zoning open space and set back requirements
- Explored which strategies are feasible per parcel type
- Compared scores across zoning districts to understand if cool factor is effective and scoring seems reasonable
## Cool Factor test on ‘typical’ parcels

<table>
<thead>
<tr>
<th>Zoning District</th>
<th>Land Use</th>
<th>Open space requirement</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential B</td>
<td>Residential</td>
<td>40%</td>
<td>Rindge Ave</td>
</tr>
<tr>
<td>Residential C-1</td>
<td>Multi-family dwellings</td>
<td>36%</td>
<td>Typical parcel</td>
</tr>
<tr>
<td>Business A-2</td>
<td>Residential with Commercial</td>
<td>none</td>
<td>Mass Ave</td>
</tr>
<tr>
<td>Industry B</td>
<td>Office</td>
<td>none</td>
<td>Main Street</td>
</tr>
</tbody>
</table>
Residential C-1
Multi-family dwellings — base zoning

Existing open space requirement
Setback requirement

30%

min 7'-6" min 7'-6"
min 20'-0" min 10'-0"
100'-0"
Residential C-1
Achieving Cool Factor

- planting: 28%
- canopy over planting: 22%
- high SRI paving: 1.0
- canopy over high SRI paving: 1.06
Residential B
Two family or semi-detached dwellings — base zoning

Existing open space requirement

40%

Setback requirement

12'-6"
15'-0"
20'-0"
294'-6"
Residential B
Case Study — achieving Cool Factor

Strategies utilized:
• Low planting area
• Small, medium, large trees

24% planting
21% canopy
Business A2
Base zoning

Existing open space requirement

Setback requirement

0%

Setback requirement

Existing open space requirement

35% high SRI paving
canopy covered

(75% of building)

(75% of building)
Business A2
Achieving the Cool Factor

extensive green roof

intensive green roof

canopy structure

canopy structure

0.8
1.0
1.0
Business A2
Achieving the Cool Factor

- Existing open space requirement = 0%
- Setback requirement
  - Street
  - Open space through setback
- High SRI paving
- Intensive green roof
  - 75% of the building
- Canopy over planting
  - 17% planting
  - 20% canopy over planting
- Canopy over high SRI paving
  - 38% high SRI paving
  - 2% canopy over high SRI paving
- Green roof
  - 35% green roof
- Intensive green roof
  - 35% intensive green roof
Business A2
Case Study

Strategies utilized:
- Green roof
- Low planting area
- Small, medium trees

0.61

6% planting
5% canopy
11% intensive green roof
Industry B
Base zoning

existing open space/setback requirement

through Article 19

0%

15%
Industry B
Achieving the Cool Factor

planting

high SRI paving

canopy over planting

canopy over high SRI paving

1.02

6%

9%

9% high SRI paving
6% planting
landscape strategy
landscape strategy
green roof strategy
INDUSTRY B TYPOLOGY
extensive green roof
(50%)
green roof strategy
intensive 
green roof 
(25%)
Industry B
Achieving the Cool Factor

50%  green roof

25%  intensive green roof
Industry B
Case Study

Strategies utilized:
- Green roof
- Lawn/low planting area
- Tree preservation

5% planting
5% canopy
26% intensive green roof
<table>
<thead>
<tr>
<th>Zoning District</th>
<th>Land Use</th>
<th>Zoning open space req.</th>
<th>Site</th>
<th>Cool Factor Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential B</td>
<td>Residential</td>
<td>40%</td>
<td>Rindge Ave</td>
<td>1.13</td>
</tr>
<tr>
<td>Residential C-1</td>
<td>Multi-family dwellings</td>
<td>36%</td>
<td>Typical parcel</td>
<td>1.0</td>
</tr>
<tr>
<td>Business A-2</td>
<td>Residential with Commercial</td>
<td>None</td>
<td>Mass Ave</td>
<td>0.61</td>
</tr>
<tr>
<td>Industry B</td>
<td>Office</td>
<td>None</td>
<td>Main Street</td>
<td>1.37</td>
</tr>
</tbody>
</table>

Do these scores make sense? Should they be weighted differently?
Key findings, questions, next steps
Key findings

The Cool factor is successful in:

- Making a difference compared with the base zoning requirements for open space
- Weighting -- ‘good projects’ received ‘good’ cool factor scores

It is less clear if the Cool factor can:

- Significantly encourage greening of the public realm
- Encourage cooling strategies on already built projects
Discussion

- Do you agree that the target should be calibrated by zoning open space requirements?
- Should there be a minimum cooling target based on parcel size (i.e. 15%)?
- Does the current weighting system seem reasonable and feasible? Should it be more ambitious?
- Is this a tool that can be applied easily and effectively by property owners and developers?