

City of Cambridge Climate Resilience Zoning Task Force

DRAFT FINAL REPORT

APRIL 30, 2021

Introduction

Role of Task Force

The Climate Resilience Zoning Task Force (CRZTF) was created to bring together diverse stakeholders to identify development standards that would increase the capacity of development in Cambridge to withstand and adapt to impacts from climate change. The Climate Change Vulnerability Assessment (CCVA) and ongoing Climate Change Preparedness and Resilience (CCPR) planning has been underway since 2012, and the Envision Cambridge comprehensive planning process (2019) began combining the City's multidisciplinary work on climate change with a vision for the future growth and development of Cambridge. The Douglas Brown, et al. Zoning Petition (2017) also demonstrated citizens' interest in this important issue. The City Council issued a Policy Order requesting the formation of an advisory committee to work through resiliency elements raised during the Envision process and through the Brown petition.

The City Manager appointed 20 members to the Task Force to ensure that a diversity of perspectives would be included in the discussions. The Task Force included residents from neighborhoods throughout the city, a union/trades representative, representatives from academic institutions, affordable housing builders, small business representatives, property owners, subject matter experts, and City staff. By bringing together stakeholders from across the Cambridge community, the vision was that the Task Force would reach consensus around an effective approach to regulating urban development in a way that would mitigate the identified impacts and risks of on-going climate change.

Task Force members were supported by staff in the Community Development Department (specializing in Zoning and Development and Environmental Planning) and Department of Public Works, and by consultants who were also involved in the CCVA, CCPR, and Urban Forest Master Plan.

The purpose of the Task Force was to discuss the specific climate change vulnerabilities identified in the CCVA, review recommendations from the ongoing CCPR planning effort and other related initiatives including the Urban Forest Master Plan, and recommend development standards to incorporate into Cambridge's Zoning Ordinance. The Task Force focused on two specific impacts of climate change: flooding from sea level rise, storm surge, and precipitation, and rising temperatures exacerbated by the urban heat island effect.

The goal of the Task Force was to recommend zoning amendments that could be translated into a formal zoning petition by City staff and be presented to the City Council for consideration and adoption. The Task Force considered all types of development and all parts of the city. The final zoning recommendations are citywide in scope and would create standards for all new development, large and small, and specific types of additions and alterations to existing buildings and uses. The Task Force also considered both prescriptive- and performance-based approaches to creating new zoning standards,

38 ultimately gravitating toward performance-based standards. The Task Force also provided
39 recommendations for actions that the City could pursue separately in the future.

40 **Process and Work Plan**

41 The Task Force met 19 times between January 2019 and March 2021. All meetings were open to the
42 public and a website with information about the Task Force was actively maintained to ensure
43 transparency. The City Council, through its Health and Environment Committee, had an active and
44 ongoing role in shaping the work of the Task Force. Throughout the course of its discussions, the Task
45 Force held two joint meetings with the Committee to provide updates on its progress and solicit
46 feedback.

47 The work plan was as follows:

January – March 2019	Review climate resilience plans & studies, understand zoning basics
April – September 2019	Examine flooding & heat impacts, formulate principles & objectives
October 2019 – March 2020	Discuss potential range of zoning strategies
October 2020 – January 2021	Formulate draft recommendations
February – March 2021	Come to consensus on final recommendations

48 Note that meetings were suspended between March and October 2020, due to City policy on non-
49 essential public meetings during the COVID-19 State of Emergency.

50 **Background Information and Resources**

51 After establishing its work plan and ground rules, the Task Force spent the first phase of its process
52 reviewing and discussing information relevant to its work. These included City-led climate change
53 initiatives, other planning studies, and community-based initiatives. Members also learned about what
54 can and can't be effectively regulated through zoning and the types of zoning strategies used in
55 Cambridge. This phase included a tour of the Alewife area to see in-person examples of older and more
56 recent development and to identify and discuss resilience issues in the context of buildings and sites.

57 **City's Climate Planning Initiatives**

58 Since it joined ICLEI – Local Governments for Sustainability in 1999, Cambridge has taken an active role
59 in both preparing for climate change and reducing its causes. The following recent planning efforts were
60 the most relevant to the Task Force's work:

- 61 • [Climate Change Vulnerability Assessment \(CCVA\)](#): Completed in 2017, this technical study
62 explored Cambridge's physical and social vulnerabilities to increasing temperatures, more
63 intense storms, and storm surge flooding associated with sea level rise. [Part 1](#) of the CCVA
64 Report focused on risks posed by ever-increasing temperatures and precipitation while [Part 2](#)
65 focused on risks from rising sea levels and coastal storm surges. The CCVA serves as the
66 technical foundation for the City's other climate-related work, and its findings will be updated
67 over time as climate change models evolve.

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- Resilient Cambridge Plan: This ongoing initiative is a roadmap for the City government, its residents, businesses, institutions, and key stakeholders to implement strategies in response to climate change threats. The City completed two area-specific CCPR plans, [one](#) with a focus on the Alewife area and [the other](#) on the Port neighborhood. These area-specific studies inform an upcoming citywide plan called Resilient Cambridge to be issued by June 2021. CCPR work products that were particularly helpful for the Task Force’s work included the four categories of strategies and the “Better Buildings” strategies developed for a “Preparedness Handbook” for the Alewife area. The Task Force shared the same team of consultants and City staff, so was able to benefit from this collaboration.
 - [Net Zero Action Plan](#): Completed in 2015, this plan sets a road map for neutralizing greenhouse gas emissions from Cambridge. While the CCVA and CCPR focus on how to prepare the city for impacts from climate change, the Net Zero Action Plan focuses on reducing the city’s contribution to the climate crisis. Some recommendations from this initiative have already been adopted into the Zoning Ordinance. The City is currently conducting a comprehensive 5-Year Review of the Plan in order to evaluate the program impact to date, consider options to adjust the Net Zero Action Plan framework, and adopt an updated framework that reflects current climate science, policy, technology, and equity considerations.

85 **Other City-Led Planning Initiatives**

86 In addition to its climate-specific planning efforts, other recent studies have addressed the need to
87 understand and respond to a changing climate:

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- [Envision Cambridge](#): Completed in 2019, the City’s most recent citywide, long-range comprehensive planning study sets broad goals and recommendations on the topics of climate and the environment, community wellbeing, the economy, mobility, housing, mobility, and urban form. In addition to the citywide plan, the Envision planning process also produced the [Alewife District Plan](#) in 2019, which focused on an area that is especially vulnerable to flooding and heat and suggested some ways to incorporate climate resilience into urban design.
 - [Urban Forest Master Plan](#): From 2018 to 2020, the Department of Public Works led a task force that focused on creating a strategic plan to evaluate, maintain and expand the urban forest canopy in Cambridge. The work is particularly relevant to the Task Force because trees contribute to climate resilience by reducing the urban heat island effect and mitigating stormwater runoff. The Cambridge Urban Forest Master Plan Technical Report was released in November 2019 and the City of Cambridge Urban Forest Report: Healthy Forest, Healthy City was published in September 2020. The lead consultant for the Urban Forest Master Plan also advised the Climate Resilience Zoning Task Force and one representative serves on the task forces for both initiatives. The Health Forest Healthy City initiative has been formally launched.

103 [Ten Year Sewer and Drain Infrastructure Plan](#): The City has developed a strategic plan to manage the
104 infrastructure improvements of the sewer and storm water mains, manholes, catch basins, pumping
105 stations and Combined Sewer Overflow (CSO) outfalls that carry waste and storm water to treatment
106 plants and discharge locations. This 10-year plan serves as a guidance document to prioritize
107 construction and rehabilitation of these complex systems. The goals of the Plan include addressing high-
108 risk infrastructure conditions, managing stormwater quality and quantity, reducing flooding, and

109 protecting neighborhoods, among others. These various planning initiatives work together to maximize
110 co-benefits to Cantabrigians.

111 **Douglas Brown, et al., Zoning Petition**

112 In 2017, a group of residents (including Task Force members Doug Brown and Mike Nakagawa)
113 proposed a zoning amendment based in part on the CCVA work. The amendment would have expanded
114 the current Flood Plain Overlay District to include areas projected to be vulnerable to future flooding.
115 All development or site work in that district would be subject to new requirements outlined in the
116 petition, in addition to the existing requirements. The petition also proposed a “Green Factor” scoring
117 system for all development subject to the Project Review Special Permit requirements.

118 There was broad agreement on the goals of this petition, which sought to use development standards in
119 the Zoning Ordinance to build a more resilient Cambridge. While there were concerns raised about how
120 to ensure effective implementation of some of the proposed standards, the performance-based
121 approach of the proposed Green Factor was positively received by City staff, the Planning Board, and the
122 City Council, with suggestions for further study and testing. This petition catalyzed support for the
123 creation of a multi-stakeholder task force to study potential zoning standards that would complement
124 the City's suite of climate resilience initiatives. As a result, the City Manager created the Climate
125 Resilience Zoning Task Force.

126 **Task Force Study and Findings**

127 The following section summarizes information that was presented to and discussed by the Task Force,
128 along with some of the key points that emerged from the Task Force’s discussion.

129 **Overall Climate Impacts and Climate Planning**

130 The CCVA used global climate model simulations to generate temperature, humidity, precipitation, and
131 sea level rise projections specifically for the city. The scenarios were developed using the best available
132 science with the understanding that assumptions, methodologies, and resultant projections will need to
133 be revised over time in light of new data or technologies, or changes in the environment itself. The
134 CCVA projections are not intended to be a precise prediction of future conditions but are more of a
135 “climate stress test” to understand how people and the built environment would be impacted by these
136 changes.

137 The CCVA developed projections for two planning horizons, 2030 and 2070, and two categories of
138 impacts, heat and flooding. City staff recommended that the Task Force focus on 2070 projections since
139 buildings constructed today are expected to have at least a 50-year lifespan.

140 Drawing on the findings of the CCVA, the CCPR is focused on both reducing risks and preparing for
141 unavoidable risks. It takes a multipronged but coordinated approach that focuses on performance. As a
142 result, the project team identified four key categories of resilience strategies:

- 143 A. Closer Neighborhoods: Strategies to strengthen community, social, and economic resilience;
- 144 B. Better Buildings: Strategies to protect buildings against projected climate change impacts;
- 145 C. Resilient Infrastructure: Strategies to ensure continued service or a speedy recovery from
- 146 community-wide infrastructure systems;

147 D. Greener City: An enhanced living environment integrating air quality, waterways, green
148 infrastructure, and the urban forest as a system resilient to climate impacts.

149 The Task Force focused exclusively on zoning mechanisms to complement other actions recommended
150 in the CCPR. Task Force members recognized that zoning could help the City achieve its goals but cannot
151 resolve every issue identified in the CCPR.

152 **Flooding**

153 *Climate Projections, Risks, and Outcomes*

154 The Task Force reviewed key impacts associated with the two main kinds of flooding that Cambridge
155 faces: precipitation-driven flooding and flooding from a combination of sea level rise and storm surge
156 (SLR/SS). Overall, the CCVA found that Cambridge will face increasing rates of precipitation and a
157 greater frequency of larger storms.

158 **Precipitation:** Currently, flooding in Cambridge is driven by precipitation, which causes rivers to overtop
159 their banks and streets to fill with water when drainage infrastructure is unable to immediately
160 discharge floodwaters. According to CCVA projections, precipitation-driven flooding in Cambridge will
161 become more frequent, cover broader areas of the city (including areas where it has not frequently
162 occurred in the past), and have a greater depth. However, this type of flooding is mostly short-term in
163 nature, and generally does not last for more than a day.

164 **Sea Level Rise/Storm Surge:** Flooding caused by rising ocean levels, both long-term sea level rise and
165 water surges during storm events, does not currently impact Cambridge because it is protected by the
166 Amelia Earhart Dam and the Charles River Dam. CCVA projections show that this regional infrastructure
167 will likely protect Cambridge through 2030; however, projected 2070 SLR/SS levels have the potential to
168 overtop the Amelia Earhart Dam in Medford if it is not raised, which would result in storm surges
169 affecting the Alewife-Fresh Pond area. This type of saltwater flooding could last for more than a day and
170 could impact buildings differently than freshwater flooding.

171 **Projected Flood Elevations:** The CCVA determined the elevation of projected flooding for locations
172 throughout the city based on three sets of variables: the nature of flooding (precipitation driven or
173 SLR/SS), the probability of flooding (10% probability of occurring within a year, sometimes called a “10-
174 year flood,” or 1% probability of occurring within a year, sometimes called a “100-year flood”), and the
175 timeframe of the projection (2030 or 2070). While these probabilities appear low, the cumulative risk is
176 significant. For instance, a 10% annual probability event has a 96% probability of occurring within a 30-
177 year period, and a 1% annual probability event has a 26% probability of occurring within a 30-year
178 period.

179 To communicate the CCVA flooding projections in a useful way, the City created an online, interactive
180 tool called the [FloodViewer](#) where users can select land parcels on a map and view all projected flooding
181 elevations.

182 *Flooding Impacts*

183 Based on the findings of the CCVA, increased flooding will impact buildings and sites (such as houses,
184 office buildings, and parks); infrastructure (such as roads, electricity, and water and stormwater
185 systems); and critical services facilities (such as hospitals, fire stations, and community centers). The

186 Task Force focused most of its discussion on how zoning standards can mitigate these risks, including the
187 following:

- 188 • Structural damage to buildings requiring remediation or replacement.
- 189 • Disruption to the habitability of the housing stock, since flooding can result in public health and
190 safety concerns due to mold, contamination, and other consequences. These impacts can be
191 more severe in basement-level living spaces, which can be more difficult to keep dry after a
192 flooding event. The risks can also be more severe for lower-income households with fewer
193 housing options and less ability to repair or replace damaged property.
- 194 • Economic disruption due to business closures and property needing to be replaced. These
195 disruptions could disproportionately impact small businesses without the financial resources to
196 withstand sudden losses.
- 197 • Social disruption caused by damage to community resources such as public schools, daycare and
198 youth centers, pharmacies, food pantries, social service centers, and municipal resources that
199 are relied upon by vulnerable populations.

200 *Mitigation Strategies*

201 While Cambridge cannot reduce its flood risk through City-led actions alone, changing how the City
202 regulates development will improve citywide resilience. The CCPR planning process promotes a set of
203 mitigation strategies in the Better Buildings category, including the following:

- 204 • Design new buildings using 2070 flood projections, given that buildings are likely to last for 50+
205 years.
- 206 • Elevate the grade surrounding the building or the building itself above the 10% probability flood
207 elevation.
- 208 • Protect all usable spaces below the 10% probability flood elevation (with exceptions) so that
209 will not be flooded (i.e. “dry floodproof” using barriers).
- 210 • Design all usable spaces (with exceptions) in a building that are below the 1% probability flood
211 elevation to experience flooding but recover from any impacts (i.e. “wet floodproofing” using
212 certain materials).
- 213 • Elevate vulnerable utilities, such as electrical boxes and shut-offs, above the 1% probability
214 flood elevation where possible or protect them if below that elevation.

215 City staff have already begun to incorporate CCVA projections and some of the above-mentioned CCPR
216 strategies into its review of development proposals. For example, applicants for special permits from
217 the Planning Board are asked to study and mitigate future flood risks based on CCVA projections
218 identified in the FloodViewer. Outside of zoning, the Department of Public Works (DPW), which is
219 responsible for applying stormwater management standards and other regulations that control impacts
220 of development on public infrastructure and resources, now relies on 2070 projections to inform its
221 review. While this guidance has improved the resiliency of new development to flood risks, these
222 standards are not codified in the Zoning Ordinance.

223 *Key Points in Task Force Discussions*

224 Over the course of several months, the Task Force discussed the benefits, costs, and challenges of
225 different development strategies as framed by the City’s current climate planning efforts. Some key
226 considerations that helped focus which strategies to prioritize to relative to flooding included:

- Basements and low-level first floors are the most vulnerable parts of buildings to flooding; flooding in these living spaces can lead to mold, poor indoor air quality, and contaminated water.
- Certain types of habitable uses should not be allowed below a certain flood elevation.
- It is easier to regulate new construction than it is to regulate renovations to existing buildings.
- Regulations could pose a financial burden that would make renovations cost-prohibitive for some residents; as a result, property owners need some flexibility to be able to make their own choices about how to weigh the costs and benefits of different mitigation options.
- Development standards can have an impact on stormwater management, but zoning regulates land use and development, not larger infrastructure systems, which limits the nature of the interventions.
- Since flood projections are subject to change and the impacts from precipitation and SLR/SS flooding varies throughout Cambridge, it is important to match the zoning requirements to the level of risk and give property owners some flexibility to choose how to protect against or recover from flooding.
- Incremental solutions, such as solar-ready roofs, and strategies that provide co-benefits, including a pathway to net zero renewable energy, improve future resiliency while acknowledging current standards.

245 Heat

246 *Climate Projections, Risks, and Outcomes*

247 The Task Force also reviewed key impacts associated with heat and humidity. According to CCVA
248 projections, the average ambient air temperature will be warmer, but will also fluctuate between
249 greater extremes of heat and cold. Heat waves will be more frequent and longer in duration, which
250 means that building energy use will shift from predominantly heating to predominantly cooling by mid-
251 century. Each year, Cambridge currently experiences less than two weeks' worth of days over 90°F,
252 known as high heat days. The CCVA found that by 2070, there may be nearly three months' worth of
253 high heat days. In addition, the heat index, which is a function of temperature and relative humidity, is
254 projected to increase significantly. This will make hot temperatures feel even hotter and could
255 exacerbate the likelihood of heat exhaustion and heat stroke. Heat waves and poor indoor air quality
256 will become increasingly challenging public health concerns and high heat days will place stress on
257 infrastructure, such as roads and utilities.

258 While heat is an issue citywide, its impacts vary throughout the city due to the urban heat island effect,
259 which magnifies ambient air temperature, making the air feel hotter than it would be otherwise. Areas
260 in Cambridge with minimal tree canopy and large amounts of impervious surfaces, such as pavement
261 and dark roofs, tend to capture and retain heat. This is especially prevalent in the Alewife Quadrangle
262 and East Cambridge, but heat islands exist throughout the city. Climate projections show that the urban
263 heat island effect will expand in area and become more intense over time.

264 *Mitigation Strategies*

265 Through CCPR, the City has identified three significant strategies to mitigate the impacts of rising
266 temperatures by reducing heat island effects: using high solar reflective index (SRI) building envelopes
267 and roofs, increasing vegetation while decreasing impervious surfaces, and promoting shade by
268 expanding the urban forest canopy and using non-vegetative shade structures.

- 269 • High-SRI building envelopes and roofs: One study done in the area near Alewife and North
270 Cambridge shows that if 50% of roofs were painted white to have a high SRI, the average
271 ambient air temperature could decrease by 2.4°F with a maximum temperature reduction of
272 4.5°F;
- 273 • Vegetation and impervious surfaces: Converting impervious surfaces to vegetation using green
274 infrastructure techniques also reduces ambient air temperature since reducing impervious area
275 decreases air temperature and green infrastructure effectively reduces impervious area. Testing
276 the maximum extent practicable of this conversion in the same area near Alewife and North
277 Cambridge demonstrates that there could be an average temperature decrease of 1.7°F with a
278 temperature reduction in the range of 0.1-6°F;
- 279 • Shade: The CCPR plans found that a 1% increase in the tree canopy relates to 0.12°F of cooling.
280 It also found that increasing canopy cover to 30% citywide would lead to significant cooling of
281 38% of the city land area and that tree canopy provides the most significant cooling effects
282 above 60% coverage. The UFMP acknowledges that while trees are more effective than shade
283 structures, shade structures can provide shade immediately while new tree plantings require
284 many years to achieve significant shade. As a result, shade structures act as a complementary
285 heat reduction strategy to trees.

286 *Key Points in Task Force Discussion*

287 The Task Force discussed how Cambridge’s urban form influences temperatures and how it could be
288 modified to promote cooling. Some key considerations that helped focus which strategies to prioritize
289 for heat mitigation included:

- 290 • All areas of the city will experience an increase in the ambient air temperature, so cooling
291 strategies should provide citywide benefits in addition to targeting priority areas;
- 292 • A performance-based requirement for heat resilience that gives a property owner a menu of
293 options from which to choose allows for the most flexibility and choice;
- 294 • Vegetation is not always a feasible way to provide shade, so structures such as overhangs and
295 canopies should be considered;
- 296 • The City should promote tree maintenance and encourage contiguous canopy coverage;
- 297 • Standards adopted into the Zoning Ordinance should strive to meet the goal of the UFMP to
298 increase tree canopy coverage citywide, though they will need to balance other City priorities
299 such as urban design guidelines, housing affordability, and the city’s historic character.

300 **Other Aspects of Resilience**

301 The Task Force focused primarily on urban development strategies to mitigate flooding and heat, as they
302 are the source of the most significant impacts from climate change that Cambridge will face, and they
303 can be addressed directly through development standards. However, the Task Force also discussed
304 other planning strategies that could be referenced in zoning.

305 *Emergency Planning*

306 Emergency planning involves better preparing residents for emergency scenarios by providing resources
307 that educate them and connect them with their community in the instance of an emergency event. It is
308 distinct from emergency response, which provides immediate services to those impacted by disaster or

309 trauma to limit the negative impacts they experience. The goal of emergency planning is to improve
310 human comfort and safety during an emergency with stand-alone or passive life support systems.

311 Task Force members agreed that new construction or substantial investments in renovations should
312 incorporate emergency planning to help residents—particularly vulnerable residents—shelter in place.
313 For instance, these projects could include a resilient community room that is elevated above potential
314 flooding and has a backup energy supply, food and water, and a communication system. They could
315 also have emergency egress and programming that enhances social resilience. Task Force members also
316 discussed how emergency planning requires thinking about sharing resources and shelter among
317 buildings.

318 While emergency planning falls outside the scope of development standards that can be mandated
319 through zoning, it could be included as a topic to be discussed when development proposals are
320 required to undergo a holistic design review process, such as a Planning Board special permit or an
321 advisory development consultation.

322 *Passive Resilience*

323 The concept of “passive design,” encourages buildings to be designed to maximize interior comfort
324 while requiring minimal energy use. This is effective as a climate change mitigation strategy because it
325 reduces greenhouse gas emissions, but also promotes climate resilience because it increases a building’s
326 ability to withstand heat and to keep occupants safe in the event of power outages or extreme weather
327 events.

328 Passive design strategies involve careful attention to building envelope assemblies, building systems,
329 and materials, which are regulated by the building code and generally outside the scope of zoning.
330 However, there are ways that such approaches can be encouraged. For example, the “Passive House”
331 rating system is incorporated into the city’s Green Building Requirements as an alternative to the LEED
332 rating system. As above, passive design strategies could be a consideration for developments that
333 undergo a holistic design review process.

334 **Zoning Approaches**

335 Zoning is a form of land use regulation that controls the type and intensity of land use, including the size
336 and scale of buildings, as well as site and building characteristics such as setbacks and open space.
337 Along with other regulations such as building codes, stormwater regulations, and historic preservation
338 reviews, zoning is a key aspect of how Cambridge shapes its built environment. Far from being a rigid,
339 one-size-fits-all tool, zoning offers municipalities different approaches to land use regulation. How
340 zoning is crafted depends on the outcomes that Cambridge wants to achieve, including the types of
341 projects that it wants to encourage or discourage.

342 Zoning mainly controls new development and alterations to existing development. Existing uses and
343 buildings may be maintained even if the zoning is changed, but would have to conform with new zoning
344 standards if they are modified or expanded, with a presumption that development will transition from
345 less-conforming to more-conforming over time. While zoning may influence the choices that a property
346 owner makes, it only regulates and does not dictate change. As mentioned above, there are many other
347 regulations and factors that influence development. In addition, zoning is more effective when it sets

348 specific, quantifiable standards that are easy to measure and do not change. Zoning is less effective at
349 regulating more qualitative standards and criteria that involve changes over time.

350 *How Zoning Works*

351 Cambridge is divided into base zoning districts that regulate basic aspects of development, such as use,
352 building height, floor area, number of housing units, open space, setbacks, and parking. Each district has
353 a set of uniform rules that correspond to its unique development characteristics. Some districts are
354 more permissive – allowing a wider range of uses, or larger buildings – while others are more restrictive.
355 Any new development standards would need to interact with existing standards in a logical way.

356 In addition to base zoning, there are citywide development standards that apply all (or most) base
357 zoning districts as well as area-specific overlay districts that overlap with all or parts of base zoning
358 districts. Citywide rules serve particular policy objectives, and include Green Building Requirements
359 (Section 22.20), Inclusionary Housing and Incentive Zoning (Section 11.203), and Project Review (Article
360 19.000). Area-specific overlay districts modify the base zoning in locations that are subject to particular
361 planning concerns, and include Planned Unit Development (PUD) districts, mixed-use overlay districts
362 (e.g., Central Square and Harvard Square), and the Flood Plain Overlay District. Each approach to
363 applying development standards has benefits and drawbacks (see Table 1).

364 *Types of Development Standards*

365 The following are some general approaches to crafting development standards that were discussed by
366 the Task Force:

- 367 • Prescriptive approaches create precise rules that can be simply and straightforwardly applied
368 with administrative review. Maximum building height or minimum parking requirements are
369 some examples. These approaches do not offer flexibility – they are either met or not met.
- 370 • Performance standards require a specific outcome that could be met through different means,
371 without mandating a single way of achieving that outcome. The Green Building Requirements,
372 which are based on holistic design rating systems, are an example. These approaches offer some
373 flexibility, but usually require an analysis or study to demonstrate compliance, which can be an
374 additional burden for smaller-scale development.
- 375 • Some zoning requirements mandate a review process by which a City body, such as the Planning
376 Board or Board of Zoning Appeal, determines whether particular criteria are met. The main
377 example of this in Cambridge’s zoning is the Project Review Special Permit (Section 19.20).
- 378 • Some zoning requirements incorporate incentives, which allow some additional flexibility
379 beyond the base zoning requirements to serve some public objective. A large-scale example is
380 PUD overlay zoning, which allows increased height and density in a particular area but requires a
381 more intensive Planning Board review and approval process and the incorporation of public
382 benefits, such as open space, identified in plans for the area. At a smaller scale, the incentive
383 approach is used to relax setback requirements to install insulation on an existing building to
384 improve energy performance (Section 5.24.2.1).

385 See Table 2 for a direct comparison of the benefits and drawbacks of each of these types of
386 development standards.

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	Benefits	Drawbacks
Base Zoning Districts	Tailored to the land use character of the district (height, scale, density); uniformity across a district	Might not be consistent throughout the city; current district boundaries might not be ideal for a particular standard
Citywide Rules	Consistent application of a citywide standard; uniformity across multiple zoning districts	Can create widespread non-conformity issues; must be compatible with underlying district regulations
Area-Specific Overlays	Same as citywide overlay, but more customizable/targeted	Confusing to interpret/apply in combination with base zoning; must be compatible with underlying district regulations; fragmentation creates tension with uniformity

388 Table 1. Each approach to zoning has its benefits and drawbacks.

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	Benefits	Drawbacks
Prescriptive	Easily understandable; straightforward to apply/enforce	No allowance for flexibility; some issues can't be expressed as simple standards
Performance	More direct in addressing some issues/impacts; opportunity to meet standards in different ways	Requires more professional expertise; potential for ambiguity, unforeseen consequences
Discretionary	Case-by-case review allows for input, improvement, mitigation; relies on good judgment	Discretionary decisions can be challenged; relies on good judgment
Incentives	Easily understandable; encourages "better than the minimum" approach	Challenge to agree on balance between incentive and benefit; doesn't guarantee a particular outcome

390 Table 2. There are advantages and disadvantages to the different types of development standards.

391 **Guiding Principles and Objectives**

392 After reviewing and discussing the background information described above, but before developing
 393 zoning recommendations, the Task Force discussed and reached consensus around a set of principles
 394 and factors to guide its discussions. With this framework in mind, it then identified more specific land
 395 use and development objectives that the final recommendations would aim to achieve.

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Principle	Factors
<p>1. Focus on people, communities, and equity</p>	<ul style="list-style-type: none"> • Consider human needs in relation to the physical environment; • For residential development, focus on health, safety, and livability of people’s homes; • For commercial development, focus on economic impacts that broadly affect people’s lives; • Acknowledge the differing capacities for risk of people across the income spectrum; • Foster greater social connectiveness and mutual support.
<p>2. Account for differentiation and choice</p>	<ul style="list-style-type: none"> • <i>Differentiation</i>: Apply different strategies to different land use scenarios (e.g., new buildings can be elevated while elevating existing buildings or systems is more difficult; open space and tree plantings will have different effects in areas with different prevailing patterns of development); • <i>Choice</i>: Provide options to allow for economic choices (e.g., cost of floodproofing to withstand damage vs. cost of replacement; installation of structural sun-shading devices vs. green infrastructure).
<p>3. Balance strategies to address new construction and existing development</p>	<ul style="list-style-type: none"> • Target policies to new construction or existing development depending on how much of the population will be affected; • Evaluate what changes to existing buildings can reasonably be expected if they are incentivized and what changes are less likely to be feasible; • Assess implications of the recent trend toward more intensive use of basement space in existing buildings.
<p>4. Use performance-based standards as well as prescriptive standards</p>	<ul style="list-style-type: none"> • Adopt standards that allow for a range of possible solutions; • Set performance standards for larger development that undergoes a higher level of review; • Set prescriptive standards where they can be applied universally across a broad range of land use and development scenarios; • Use tested and established frameworks where possible (e.g., LEED resilience credits as a starting point); • Incorporate programmatic approaches (e.g., emergency preparedness plans) where practical.
<p>5. Allow flexibility in changing circumstances</p>	<ul style="list-style-type: none"> • <i>Incrementalism</i>: Promote present actions that can lead to future improvements (e.g., designing roofs to anticipate the future installation of green infrastructure), mindful of the balance of risks and costs;

	<ul style="list-style-type: none"> • <i>Ratcheting</i>: Modify standards to become more or less strenuous as climate projections and associated risks change over time; • <i>Learning</i>: Periodically review what strategies have worked, if desired outcomes are being achieved, and if changes are needed to achieve outcomes or adjust to new data; • <i>Patience</i>: Recognize that the built environment changes slowly so evaluating the effectiveness of zoning interventions requires time to see impacts and benefits unfold.
6. Support actions with co-benefits	<ul style="list-style-type: none"> • Implement strategies that mitigate both flooding and heat; • Prioritize strategies that have other benefits such as reduced energy demand (e.g., passive livability), improved water quality (e.g. increased pervious surface), air quality, open space, habitat, or recreation when possible; • Balance strategies that improve flooding and heat resilience with other city priorities.
7. Seek effectiveness	<ul style="list-style-type: none"> • Choose strategies that are the best suited to address the issue or impact; • Use zoning to complement non-zoning tools and other actions the City is undertaking (e.g. CCPR); • Affect enough sustainable development to have a meaningful impact on residents and the built environment; • Aim for benefits at the individual property, abutter, neighborhood, and city scale that will exceed costs over the life of a structure.
8. Make decisions based on best available data and science	<ul style="list-style-type: none"> • Build a base of knowledge for future decision-making by continuing to collect and evaluate information about climate change and its impacts; • Plan for climate science to evolve and our understanding of impacts to become clearer with time; • Use forward-looking data, acknowledging uncertainties while anticipating that future climate conditions will be warmer and wetter.

401

402

403

404 **Land Use and Development Objectives to Mitigate Flooding and Heat Impacts**

405 **1. Elevate and Floodproof**

406 *Protect flood-sensitive uses such as residential units and critical building systems by elevating above*
 407 *future design flood elevations or dry floodproofing where below future design flood elevations*

- 408
- 409 **2. Design to Recover**
- 410 *Design buildings to withstand or recover from projected flooding (e.g. wet floodproofing, temporary*
- 411 *barriers, water-resistant or replaceable materials)*
- 412
- 413 **3. Green Infrastructure**
- 414 *Use green infrastructure (e.g., swales, wetlands, green roofs) in addition to gray infrastructure (e.g.*
- 415 *storage tanks) to manage stormwater on-site*
- 416
- 417 **4. Preserve Vegetation**
- 418 *Preserve existing vegetation (e.g. trees, ground cover, planted roofs)*
- 419
- 420 **5. Create Vegetation**
- 421 *Create new vegetated areas (e.g. trees, ground cover, planted roofs) and design so that plantings can*
- 422 *thrive over time*
- 423
- 424 **6. Limit Paved Areas**
- 425 *Limit amount of paved area, increase permeable area*
- 426
- 427 **7. Provide Shading**
- 428 *Provide shade with trees or structural shading where trees are infeasible, especially over paved areas*
- 429
- 430 **8. Use Reflective Surfaces**
- 431 *Use solar-reflective surface materials for roofs, buildings, and paved surfaces to the extent possible*
- 432
- 433 **9. Promote Passive Resilience**
- 434 *Incorporate “passive resilience” features including high performance building envelope, shading,*
- 435 *natural ventilation, and limit air leakage*
- 436
- 437 **10. Shelter in Emergencies**
- 438 *Provide spaces for sheltering and services during extreme events*
- 439
- 440 **11. Create Emergency Plans**
- 441 *Create emergency plans with protocols to implement during an extreme weather event, where*
- 442 *practical*
- 443
- 444 **12. Implement Area-Wide Strategies**
- 445 *Achieve the above results across larger areas (e.g., protective berms, elevated infrastructure, larger-*
- 446 *scale green infrastructure, pooled open space, neighborhood preparedness plans)*
- 447
- 448 **13. Produce Co-Benefits**
- 449 *Promote objectives with other environmental benefits, such as reducing energy demand, greenhouse*
- 450 *gas emissions, and auto trip generation; and increasing renewable energy production*

451 **Recommendations**

452 The final phase of the Task Force’s process involved working to develop recommended changes to the
453 Cambridge Zoning Ordinance that are informed by the Principles and Factors described above and would
454 achieve the Land Use and Development Objectives described above. The recommendations are
455 grouped in the following categories:

- 456 • **Category 1: Flood Resilience** – Codification of standards based on 2070 projected flooding
457 elevations that are consistent with current City practices.
- 458 • **Category 2: Heat Resilience** – Creation of the performance-based Cool Factor and establishment
459 of new standards based on City plans.
- 460 • **Category 3: Adjust Current Zoning Standards** – Removing obstacles in current base zoning
461 standards that prevent or discourage resilience measures that are recommended in the City’s
462 Climate Change Preparedness and Resilience planning.
- 463 • **Category 4: Planning Board Review** – Addition of new standards that are applicable to major
464 new development regulated by Article 19.000 (including Green Building Requirements in Section
465 22.20), generally developments of 25,000+ square feet.
- 466 • **Category 5: Future Study** – Other initiatives that could directly or indirectly advance resilience
467 planning, and efforts to undertake as new zoning is implemented.

468 The consensus of the Task Force was to set new flood resilience and heat resilience standards in the
469 case of new buildings, but not to impose requirements that could be burdensome to owners of smaller
470 sites making alterations or additions to existing buildings. Task Force members recognized the
471 importance of promoting climate resilience citywide through zoning; however, they believed that the
472 City needs to further study how requirements could be tailored to smaller parcels to ensure that they do
473 not place undue burdens on small property owners.

474 **Category 1: Flood Resilience**

475 *Overview*

476 To address the impacts of flooding on Cambridge, the Task Force identified development standards
477 based on the Long-Term Flood Elevations (LTFE) identified in the Cambridge FloodViewer. By using
478 future projections rather than flood risk maps prepared by the Federal Emergency Management Agency
479 (FEMA), the City will be able to protect buildings and sites that experience riverine flooding, localized
480 flooding, and flooding due to sea level rise and storm surge (SLR/SS). The Task Force decided to use the
481 LTFE projections because most buildings built today are designed to last for 50 years, which is in
482 alignment with the timeframe of the projections. The Task Force recommends that these standards are
483 updated at regular intervals as the science evolves and projections change, as long as there is advance
484 notice before they become effective.

485 *Standards and Application*

486 The Task Force recommends requiring flood protection for all new construction occurring on sites below
487 the projected flood elevations as identified in the Cambridge FloodViewer. Flood protection is defined
488 differently for different uses and is based around the build/protect/recover standards identified in CCPR.
489 Alterations to non-conforming buildings would be allowed per Article 8.000, but some cases would

490 require a special permit or variance. For buildings that are below the 1%-probability LTFE, the following
491 standards apply:

- 492 • Protect vulnerable residential living space and critical building systems by elevating vulnerable
493 uses above the 2070 1%-LTFE;
- 494 • Design other built spaces to recover without irreparable damage by dry-floodproofing
495 vulnerable uses between the 2070 10%- and 1%-LTFE.

496 For buildings that are below the 10%-probability LTFE, the following standards apply:

- 497 • Protect principal-use spaces intended for regular active use by elevating buildings or grade
498 above the 2070 10%-LTFE and dry-floodproofing most usable spaces below the 2070 10%-LTFE;
- 499 • Design other accessory spaces (e.g., storage) to recover without irreparable damage by wet-
500 floodproofing most usable spaces between the 2070 10% and 1%-LTFE.

501 The Task Force is recommending these standards because they will codify existing City-recommended
502 practices and because they give property owners greater flexibility while still protecting buildings and
503 people.

504 *Task Force Comments*

505 The Task Force was supportive of these standards because they are targeted to areas that are projected
506 to experience flooding and because they offer a certain amount of flexibility and choice. Some Task
507 Force members suggested that the City establish a mechanism for property owners to appeal the
508 FloodViewer projections. Other Task Force members suggested that historic structures may need
509 special considerations and that it would be useful to allow modifications through a Planning Board
510 special permit process. Some Task Force members asked that language be added to Article 19.000 that
511 encourages developers of large projects to protect to the 1%-LTFE where possible, since the higher
512 standard increases a building's flood resilience.

513 The Task Force seeks to ensure that the goals of the Affordable Housing Overlay (AHO) are not
514 compromised by these standards. Since the AHO does not currently allow development to proceed as-
515 of-right if it requires a zoning variance, some Task Force members suggested allowing modifications for
516 projects that are developed under the AHO.

517 **Category 2: Heat Resilience**

518 *Overview*

519 A key component of the Task Force's recommendations is the use of the performance-based Cool Factor
520 to measure the heat resilience of a development proposal. The Cool Factor is a Cambridge-specific
521 alternative to popular green area ratios, such as Seattle's Green Factor and Somerville's Green Score. It
522 calculates a weighted score based on site features including mature tree preservation, new tree
523 planting, ground-level vegetation coverage, green roofs, shade structures, and the use of high-solar-
524 reflectivity paving materials. Property owners are given the flexibility to choose which Cool Factor
525 strategies are most appropriate for their project, as long as they meet the minimum weighted score
526 requirement. The Task Force is recommending this strategy because traditional zoning does not
527 adequately encourage overall cooling performance of buildings and sites. In addition, members

528 acknowledged that Cambridge already has strong, performance-based regulations for stormwater
529 management that combines green and grey infrastructure, so a combined approach to managing
530 flooding and heat is not necessary.

531 *Standards and Application*

532 The Task Force recommends adopting the Cool Factor as the City’s primary standard for measuring the
533 heat resilience of development projects. The Cool Factor would be applied in the following ways:

- 534 • For new construction of 25,000+ square feet, the Cool Factor shall apply to Project Review
535 projects through the Section 19.50 Building and Site Plan Requirements. The open space
536 requirement identified in Section 5.30 of the Zoning Ordinance will serve as the multiplier; if
537 that requirement is less than 20%, then 20% will be used instead.
- 538 • For alterations of 25,000+ square feet, the Cool Factor shall apply to Project Review projects
539 through the Section 19.50 Building and Site Plan Requirements. The open space requirement
540 identified in Section 5.30 of the Zoning Ordinance will serve as the multiplier; if that
541 requirement is less than 20%, then 20% will be used instead. If the existing condition is non-
542 conforming, the property owner may compensate for any reduction to the existing Cool Factor
543 score instead of meeting the requirement to have a score of 1 or above.
- 544 • For new construction that is less than 25,000 square feet, the Cool Factor shall apply through
545 base zoning. The open space requirement identified in Section 5.30 of the Zoning Ordinance will
546 serve as the multiplier; if that requirement is less than 20%, then 20% will be used instead.
547 Special permits may be allowed for specific scenarios.

548 There was interest among some Task Force members to apply the Cool Factor to alterations and
549 renovations that are under 25,000 square feet; however, the Task Force decided that more analysis was
550 needed to understand the impacts of doing so. Overall, Task Force members supported having all
551 properties in Cambridge contribute to cooling but thought that the City needed to conduct additional
552 research to identify an appropriate citywide standard that acknowledges different zoning scales and
553 contexts.

554 *Task Force Comments*

555 Task Force members suggested establishing a process to revisit the Cool Factor scoring in a few years
556 after the City and property owners have had experience implementing the standard. Some Task Force
557 members preferred setting a minimum cooling multiplier of 25% but were able to agree to a 20%
558 minimum. They suggested that it might be appropriate to increase the cooling multiplier in the future.
559 Task Force members also noted that the City needed to work out the specifics for how property owners
560 could compensate for a reduction in their existing Cool Factor score.

561 **Category 3: Adjust Current Zoning Standards**

562 *Overview*

563 New zoning requirements should work in tandem with development standards that are already in place.
564 Therefore, in addition to creating additional requirements that development must meet, it is important
565 to ensure that other zoning requirements do not constrain or discourage the outcomes that are desired.
566 There are certain standards in the current Zoning Ordinance that could be revised or removed because

567 they create impediments to achieving the Task Force’s Principles and Objectives. Removing these
568 requirements would provide incentives for property owners to change buildings and sites to be more
569 resilient without imposing new regulatory burdens.

570 *Standards and Application*

571 The Task Force recommends the following changes to the Zoning Ordinance:

- 572 • Exempt outdoor shade canopies from GFA, height, setback, and open space limitations. This
573 would apply to new construction or alterations where shade canopies are proposed.
- 574 • Exempt exterior flood-resilience measures (e.g., stairs, ramps) from GFA, setback, and open
575 space limitations. This would apply to new construction or alterations where site flood
576 protection measures are proposed.
- 577 • Exempt usable green roof areas and rooftop access headhouses from GFA and height limitations
578 as-of-right. This would apply to new construction or alterations where green roofs are
579 proposed.
- 580 • Allow a compensating increase in height limit (up to 4’) if the ground story is elevated up to the
581 2070 1%-LTFE. This would apply to new construction or alterations where site flood protection
582 measures are proposed.
- 583 • Exempt basement area from GFA limitations as-of-right, if protected from flooding below 2070
584 1%-LTFE. This would apply to new construction or alterations where site flood protection
585 measures are proposed.

586 *Task Force Comments*

587 The Task Force was very supportive of these five recommendations. One Task Force member expressed
588 concern with exempting shade structures from height and setback requirements, but ultimately all Task
589 Force members agreed to these recommendations.

590 **Category 4: Planning Board Review**

591 *Overview*

592 Section 19.20 of the Zoning Ordinance establishes a process by which the Planning Board reviews major
593 development for consistency with the urban design objectives of the City and to mitigate adverse
594 impacts on city traffic. Typically, the special permit only applies to buildings equal to or greater than
595 50,000 gross square feet, though in some districts review is required for projects equal to or greater
596 than 20,000 gross square feet. Applicants are required to submit a variety of studies, plans, and
597 narratives, and the Planning Board is required to make specific findings based on criteria stated in the
598 Zoning Ordinance. These Special Permits only apply to a limited number of developments, but most new
599 development in Cambridge (by floor area) falls into this large project category. The holistic review
600 process, with public input and approval based on a set of established criteria, provides an opportunity to
601 conduct site-specific review of how a development is planned and designed for resilience.

602 *Standards and Application*

603 The Task Force recommends adding two standards to Article 19.000 that would apply to projects
604 applying for a special permit from the Planning Board:

- 605 • Require applicants for a Project Review Special Permit to submit a Resilience Narrative with
606 their application that includes projections for flood risk and heat risk as well as a description of
607 mitigation strategies, including flood protection, heat island mitigation, passive resilience
608 measures, and operational preparedness.
- 609 • Add a Resilience Objective to the Citywide Urban Design Objectives in Section 19.30 that notes
610 that development should be planned to respond to anticipated effects of climate change, with
611 indicators related to flood protection, heat island mitigation, passive resilience measures, and
612 operational preparedness. This objective would be used by the Planning Board in its review of
613 all applications for a special permit.

614 The goal of the Resilience Narrative recommendation is that it would require applicants to consider
615 resilience measures early in the development of their projects. It also ties into the Task Force’s
616 recommendations for flood resilience and heat resilience. Similarly, the Resilience Objective gives City
617 staff and Planning Board members a specific standard by which to measure applications for a special
618 permit.

619 *Task Force Comments*

620 The Task Force supported these recommendations because they prioritize resilience and create
621 consistency in how the Planning Board reviews special permit applications with respect to resilience
622 priorities. Some Task Force members noted that the indicators will need to be specific and fact-based in
623 order to improve the resilience of projects. They suggested including drawing sheets in the submission
624 package and requiring applicants to identify a full range of resiliency measures for all of the key aspects
625 identified of both the Resilience Narrative and the Resilience Objective. Some Task Force members also
626 suggested that applicants are required to reference how their projects conform with specific City plans
627 and goals outlined in policies such as the UFMP and the CCPR.

628 **Category 5: Future Study**

629 The Task Force acknowledged that climate science is dynamic, so members suggested that these
630 amendments to the zoning ordinance are evaluated for their performance at a future date. In
631 particular, they recommended studying the success of these amendments in meeting the Task Force’s
632 Principles and Objectives, with a focus on climate resilience effects as well as impacts on housing
633 production, historic preservation, and small business viability. Task Force members also suggested
634 revisiting climate projections and recommendations from CCPR to determine if additional approaches
635 should be considered, such as expanding the Cool Factor as mentioned above.

636 As the Task Force discussed possible recommendations to the Zoning Ordinance, members also
637 acknowledged that there were related issues that needed to be addressed but were outside of the
638 scope of zoning. For example, Task Force members discussed the importance of preserving Cambridge’s
639 built cultural heritage through standards that balance historic preservation with resiliency. Members
640 also noted the role that urban design guidelines could play to guide climate-resilient development in the
641 city.

642 In addition, the Task Force discussed how revising the City’s parking requirements in Article 6.000 of the
643 Zoning Ordinance would also make Cambridge more resilient to climate change. By taking such steps as
644 eliminating minimum parking requirements, lowering maximum parking requirements, and reducing

645 parking ratios, the City would decrease the amount of land used for the storage of vehicles. This would
646 likely reduce the amount of impervious surface and create more opportunities for green infrastructure,
647 which would improve the City’s ability to withstand the impacts of increased flooding and increased
648 heat. However, the Task Force decided not to include these strategies in its final recommendations
649 because members chose to focus more specifically on buildings and sites.

650 Implementation and Next Steps

651 The Charge and Operating Procedures that have guided the Climate Resilience Zoning Task Force set an
652 expectation that City staff would translate these recommendations into a zoning petition. City staff
653 intends to provide opportunities for Task Force to provide input when the zoning language is drafted.
654 Since amending the Zoning Ordinance requires the Planning Board, Ordinance Committee, and City
655 Council to hold public hearings, there will also be opportunities for continued public comment and
656 involvement. In addition, updated science and the City’s experience implementing these
657 recommendations could drive a need for revising any zoning provisions recommended by the Task
658 Force.

659 Appendix

- 660 • Charge and Operating Procedures
- 661 • Cool Factor score sheet
- 662 • Cool Factor guidance document