A TOOLKIT FOR SUMMER COOLING IN NEW YORK CITY'S PUBLIC REALM

COOL STREETS

PERKINS EASTMAN

ABSTRACT

Today, more Americans die from heat waves each year than from any other extreme weather event—approximately 1,300 such fatalities occur each year. This trend will likely worsen given predicted increases in the intensity, duration, and frequency of heat waves from climate change. By the 2040s, deaths in the United States could rise to as many as 150 each summer day due to extreme heat, accounting for nearly 14,000 deaths per year. Cities will suffer the most—the majority of these mortalities is and will continue to be concentrated in our nation's urban areas. Yet within our cities, discrete segments of the population will be afflicted most.

New York City, in particular, is facing an imminent crisis. As explored in this report, a number of factors contribute to the city's susceptibility to the health impacts of escalating temperatures, from its demographic composition to the heat-trapping effects of its built environment. Already, the city's "heat island effect" can increase temperatures 8°F. In three decades, however, warming trends are expected to multiply New York's number of "dangerously high" days from 11 today to 55 days a year. This could lead to a possible death toll of 4,500 heat-related deaths per year—unless measures are taken to protect their health and well-being.

The potential for the public realm to mitigate this current and looming heath emergency is the subject of Perkins Eastman's 2018 Fellowship for the Human Experience, a research project that focuses on adapting New York City's under-used public spaces to reduce heat-related illness and death for the city's most vulnerable populations. This research and its related Toolkit are designed to help communities and local governments aid their most at risk residents—the elderly, chronically ill, and people under the poverty level—by creating potentially life-saving outdoor cooling places in their neighborhoods. It overlays analysis of where those at greatest risk are most concentrated with the existing Department of Transportation (DOT) NYC Plaza Program, which provides a process for transforming under-used streets in all boroughs into vibrant, social public spaces.

The Toolkit is a set of planning and design tools in two parts: 1) a system for prioritizing locations for intervention to achieve the greatest impact; and 2) a design Toolkit of cooling tactics and techniques that range from lower to higher cost and complexity but with an emphasis on simple, easy-to-apply solutions. Not least, the research and Toolkit worked on the premise that to be effective, cooling strategies must be designed with the people in mind who need the relief. While it may seem counterintuitive to encourage people to spend time outside during a heat wave, the research suggests that accessibility, availability, and activity are key to creating effective community gathering places. Taking into account the social and psychological factors that encourage participation is a principle lacking in New York City's underused indoor "cooling centers," and may factor into the notable number of deaths that occur at home during the city's extreme heat events.

The research concludes by developing a hypothetical case study using an existing DOT plaza in Brooklyn that presents three levels of interventions from inexpensive, minor design elements to more complex, longer-term systems and investments for greater cooling results.

As the potentially devastating impacts from extreme heat become increasingly real in New York City, public spaces offer a critical resource for the health and comfort of vulnerable populations during hot summer days, from DOT Plazas to streets, sidewalks, courtyards, parks, and playgrounds. Whether adapting these spaces as "cool streets" is a grassroots, community effort or a larger civic one, there is an additional potential to build them out as a life-saving infrastructure. Along the way, these "cool streets" can also bring uplifting, attractive places to enhance the well-being of underserved communities.

Human by Design

"Given existing levels of poverty, poor housing quality and low rates of air conditioning coupled with a large and growing population, **NEW YORK IS PARTICULARLY SUSCEPTIBLE TO INCREASING TEMPERATURES AND WILL LIKELY HAVE THE GREATEST INCREASE IN ANNUAL DEATHS RELATED TO HEAT** by a large margin when compared to other large urban centers in the United States. If nothing is done to mitigate climate change, 4,500 New Yorkers could die every summer by the mid-2050s."

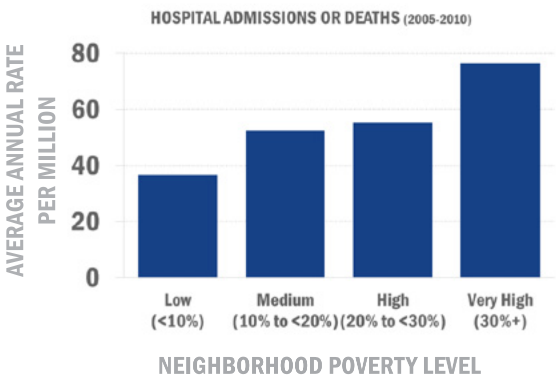
ESCALATING URBAN TEMPERATURES PRESENT DEADLIEST CLIMATE THREAT

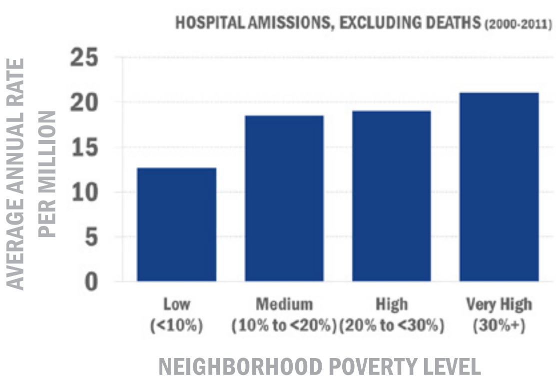
Today, more Americans die from heat waves each year than from any other extreme weather event[1] and an additional 65,000 Americans end up in the emergency room every year due to heat-related illness.[2] According to the Natural Resources Defense Council (NRDC), this trend is only projected to worsen due to the predicted increase in temperatures, as well as the frequency, intensity, and duration of heat waves, resulting from climate change. While today the United States experiences approximately 1,300 premature deaths due to heat annually, it is estimated that **as many as 150 Americans will die each summer day due to extreme heat by the 2040s, accounting for as many as 14,000 premature deaths per year [3]** - deaths that are all preventable. This troubling statistic is compounded by the significant economic burden posed by heat-related deaths and ailments. The 2006 California heat wave, for instance, was responsible for $5.2 billion in health costs due to premature deaths using the "value of a statistical life" approach, as well as an additional $179 million resulting from heat-related illnesses that resulted in medical costs and loss of work productivity.[4] For every extreme event, or death, there are hundreds of other events that affect human ability, impacting our performance at school and at work. These detrimental impacts lead to even deeper economic losses than captured in the study above. It is for these reasons that Perkins Eastman's 2018 Fellowship for the Human Experience focused on opportunities to cool cities during hot summer months, offering a toolkit to create "cool streets" where they are needed the most. The primary purpose of this undertaking is to improve health and wellness in urban environments under the strain of excessive heat, while increasing comfort in the public realm.

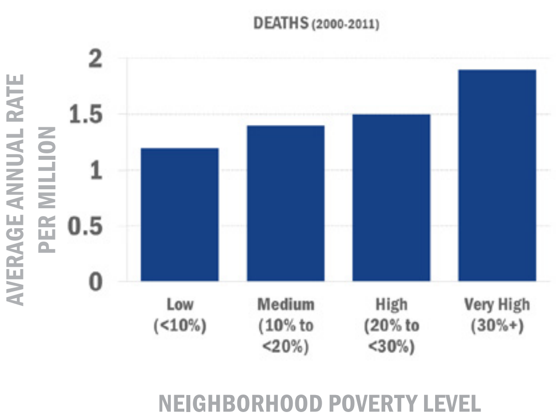
It has been well documented that the physical properties of our cities can intensify extreme heat conditions. **Temperatures in New York City, for instance, can be 8°F higher than surrounding areas** due to a higher ratio of pavement and hard surfaces, the density and design of buildings, the prevalence of vehicle emissions and smog, and the production of waste heat from air conditioning and other mechanical systems. These factors contribute to a phenomenon known as the Urban Heat Island Effect.

The impact of this effect, however, is not evenly distributed across diverse urban populations; rather, the greatest consequences are disproportionately borne by the most vulnerable residents. Elderly individuals are at higher risk of experiencing health impacts related to high temperatures. Extreme heat events can also exacerbate the symptoms of chronic illnesses, like heart disease and diabetes, since it puts excess stress on the heart, lungs, kidneys, and other organs. Poverty, in particular, is often linked to negative health outcomes[5] due to a complex interplay of factors that impact socioeconomically disadvantaged populations. These populations experience risk factors such as obesity, mental health issues, and low mobility at higher rates. In New York City, obesity rates vary greatly between boroughs. In the Bronx, 31% of residents are obese, while in Manhattan, this rate drops to 16%—nearly half that of its northern neighbor.[6] Furthermore, low education levels are associated with higher levels of heat-related morbidity and mortality. It should also be noted that poverty in American cities often affects communities of color more so than Caucasian residents. As a

RATES OF NEW YORKERS TREATED FOR HEAT-RELATED ILLNESS BY POVERTY LEVEL (2000-2011)







Source: Center for Disease Control (CDC)

result, there are significant social justice and equity considerations relating to the impacts of extreme heat in urban settings.

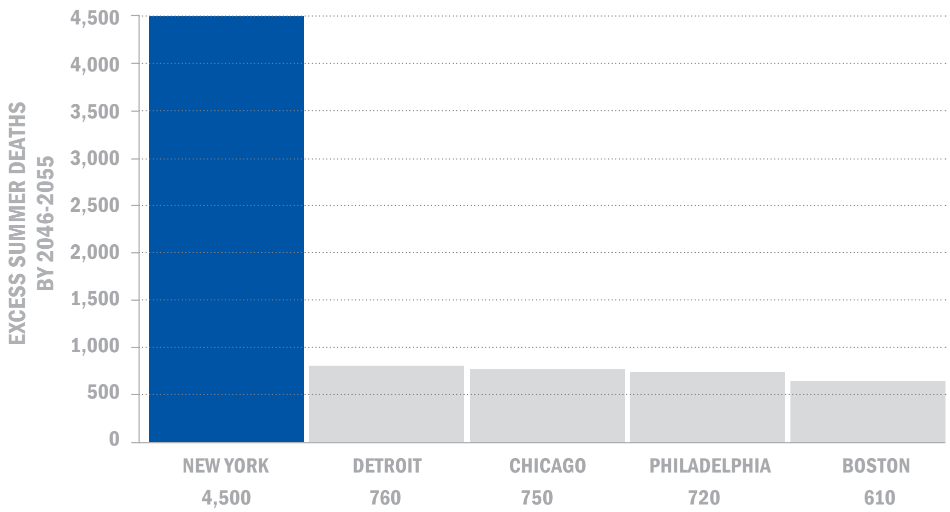
As the most populated city in the United States, New York City is facing major challenges in terms of heat-related illness and death. Given that this northern city—full of older housing stock that is poorly adapted to hot weather—is projected, much like the rest of the country, to experience increasingly devastating heat waves, it will serve as a case study to apply cooling tactics and technologies in public spaces.

A LOOMING CRISIS FOR NEW YORK CITY

In New York City today, there are 450 emergency room visits, 150 hospital admissions, 13 heat-stroke deaths and 115 excess deaths each year related to extreme heat. Excess deaths are calculated as the difference between the number of observed deaths and the average number of deaths expected for a particular location and time of year. In comparison, between 1938 and 2018, there were a total of 170 deaths due to hurricanes, or an average of 2.1 deaths per year.[7] Even though high temperatures kill more people each year than any other extreme weather event, the majority of adaptation funding in New York City has gone toward storm protection rather than mitigating the dangerous effects of heat waves.

While the numbers are staggering, deaths due to heat are often underestimated given the difficulty in determining whether heat was a contributing factor. Each death in the United States is recorded on a death certificate, with the main cause of death noted by a medical examiner. However, heat can worsen existing conditions, such as cardiovascular or respiratory disease. While these diseases would be listed as the underlying or direct cause of death, the effect of heat may have been a contributing factor. For this reason, researchers have concluded that extreme heat events likely contribute to far more deaths than official death certificates suggest.[8] An extreme example can be found in the heat wave that swept

TOP 5 CITIES PROJECTED TO EXPERIENCE INCREASES IN ANNUAL EXCESS SUMMER DEATHS



Source: Natural Resources Defense Council (NRDC)

across Europe in 2003. It was originally estimated that there were 35,000 excess deaths due to this event; however, a peer-reviewed article published in 2008 that compared mortality in the summer of 2003 to the period of 1998-2002 found that this number was closer to 70,000.[9]

Human sensitivity varies greatly with geography, social and economic factors, and cultural norms.[10] This explains why a 100°F day in the Northeast can have more severe health consequences than a 100°F day in the Southeast, where people are physically more accustomed to the heat and air-conditioning is easily accessible.[11] A number of hormonal and metabolic responses are generated by our bodies with longer-term exposure to heat. In hotter climates, for example, the body adjusts to warm temperatures by sweating earlier, more profusely, and with a lower concentration of salt.[12] The influence of geography and cultural norms can be observed by comparing the number of 911 calls for heat-related emergencies in different regions of the United States. 911 calls for these emergencies tend to increase around 95°F in Chicago—but in Phoenix, the threshold is around 113°F.[13] Given its northern location, New York City is not well acclimated to heat, which will pose increasing concerns as temperatures rise due to climate change.

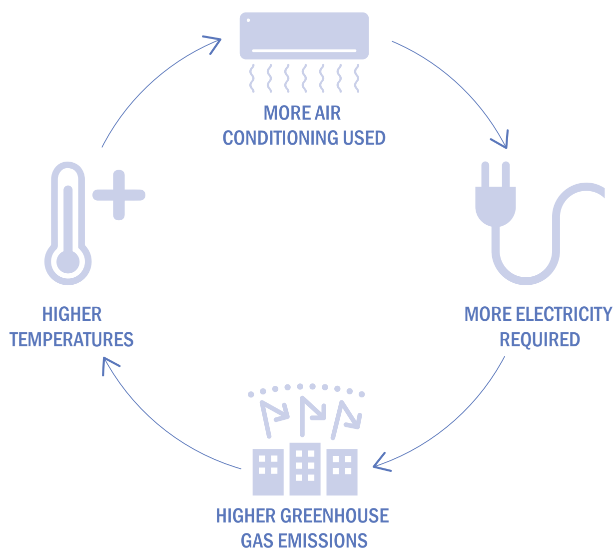
The New York City Panel on Climate Change (NPCC) has forecasted that by the 2050s, the average temperature could rise as much as 5.7°F. **The number of "extreme heat event" days is expected to increase 500% in the next three decades, rising from 11 days a year to 55 days a year within city limits.** Given existing levels of poverty, poor housing quality, and low rates of air conditioning, coupled with a large and growing population, New York is particularly susceptible to increasing temperatures. **If nothing is done to mitigate climate change, 4,500 New Yorkers could die every summer by the mid-2050s.**

More frequent, intense and longer-lasting heat waves will place a heavy burden on the city's electrical infrastructure. Climate change will bring with it increased electricity demands during peak periods; it is estimated that electricity demand increases by 2-4% for every 1.8°F rise in temperature. The possibility of a major blackout coinciding with an extreme heat event is increasingly likely—a scenario that could be potentially catastrophic. Solutions for reducing temperatures in New York City's public realm can help both decrease the risk of blackouts by reducing electricity demand associated with air conditioning, as well as provide additional relief for residents if or when a blackout occurs.

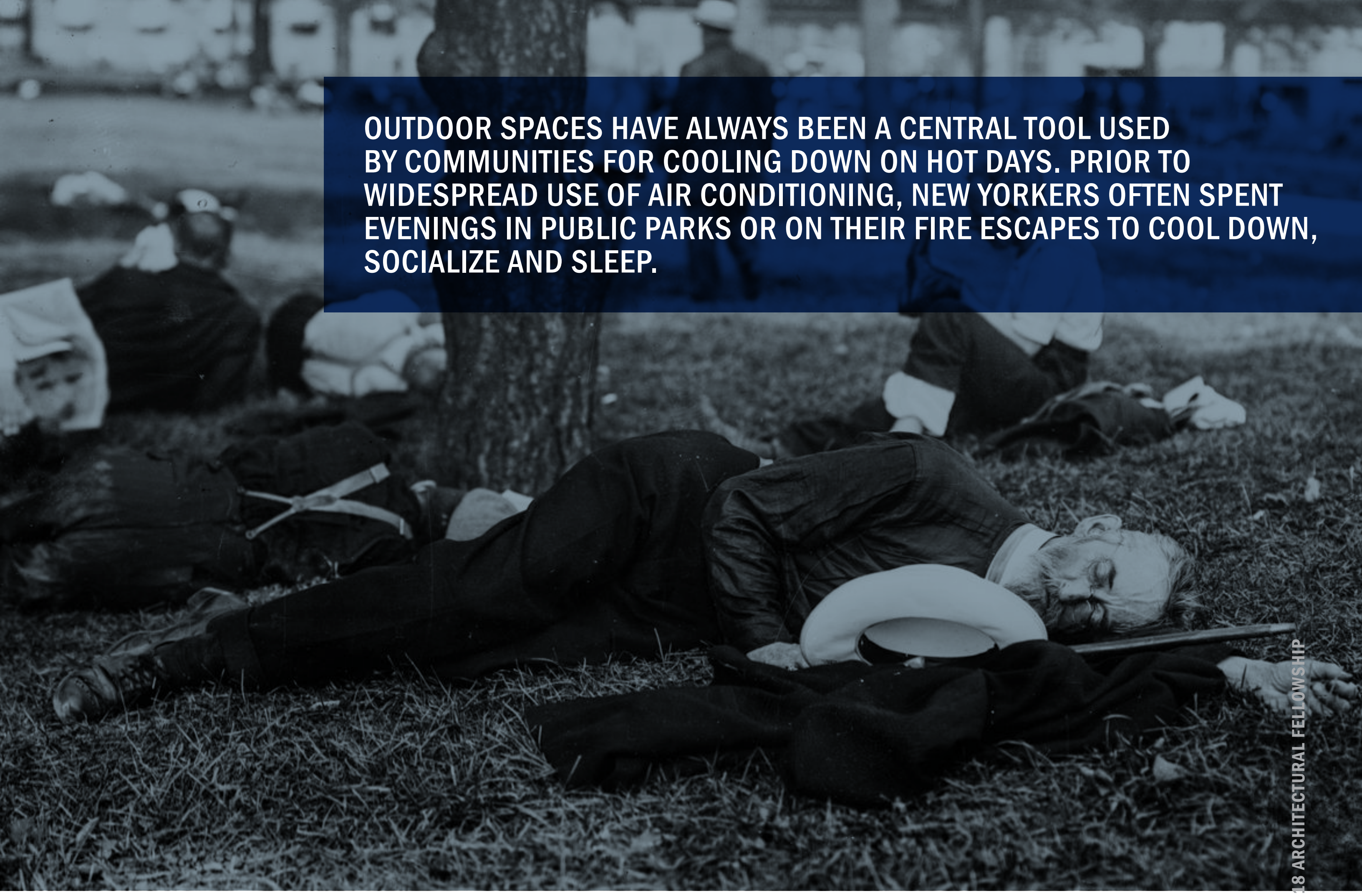
> The impact of extreme heat is not evenly distributed across diverse urban populations; rather, **the greatest consequences are disproportionately borne by the most vulnerable residents.**"

Even when the electricity grid is operating reliably, 11% of New Yorkers do not have a functioning air conditioner and an additional 14% do not use their air conditioning regularly, often due to the cost of operation.[14] While many European counterparts have a history of designing buildings to increase air flow and mitigate heat, New York City relies almost exclusively on air conditioning to cool its interior spaces. So, if a quarter of New York City's population has limited ability to cool their apartments, the question of how public space can be utilized as a place of respite from the heat becomes an important one.

A/C NEGATIVE FEEDBACK LOOP



Risk factors like social isolation and lack of mobility contribute to the significant number of deaths that occur at home during extreme heat events. Deaths that occur at home are often coupled with a lack of access to air conditioning. In 2013, the New York City Department of Health reviewed records for 48 hyperthermia deaths between 2008 and 2011 and found that 85% of the individuals were overcome by heat in their own home. Of the 26 deaths where the presence or absence of air conditioning was recorded, 23 (88%) did not have air conditioning and the remaining three (12%) had an air conditioner that was broken or not in use.



OUTDOOR SPACES HAVE ALWAYS BEEN A CENTRAL TOOL USED BY COMMUNITIES FOR COOLING DOWN ON HOT DAYS. PRIOR TO WIDESPREAD USE OF AIR CONDITIONING, NEW YORKERS OFTEN SPENT EVENINGS IN PUBLIC PARKS OR ON THEIR FIRE ESCAPES TO COOL DOWN, SOCIALIZE AND SLEEP.

COOLING DOWN IN OUTDOOR PUBLIC SPACES

In an effort to prevent heat-related mortalities, the City of New York provides public “cooling centers” when the heat index is deemed to be dangerously high. These air-conditioned spaces are often located in senior centers, community rooms in public housing buildings, or public libraries. However, for various reasons they are typically not well used by vulnerable populations. Part of the problem is that the centers’ availability are often limited to daytime business hours. Since a number of these spaces are not owned or operated by the City of New York, there are limited opportunities for capital improvements. Additionally, they are dispersed throughout the city and, as a result, it can be difficult for residents, especially those with mobility issues, to get to a cooling center without facing significant travel time. And, perhaps most importantly, these centers have not successfully become socially integrated community gathering places.

While it may seem counterintuitive to encourage people to spend time outside during a heat wave, there are a number of benefits to such an approach. This is where outdoor public space becomes promising.

The beauty of creating cool public spaces is that they are free and accessible to everyone, regardless of age, gender, income, or ethnicity. A successful public space promotes human interaction, limiting the risks associated with social isolation during a heat wave. Emergency call boxes could also be installed in these spaces to provide an additional level of security and

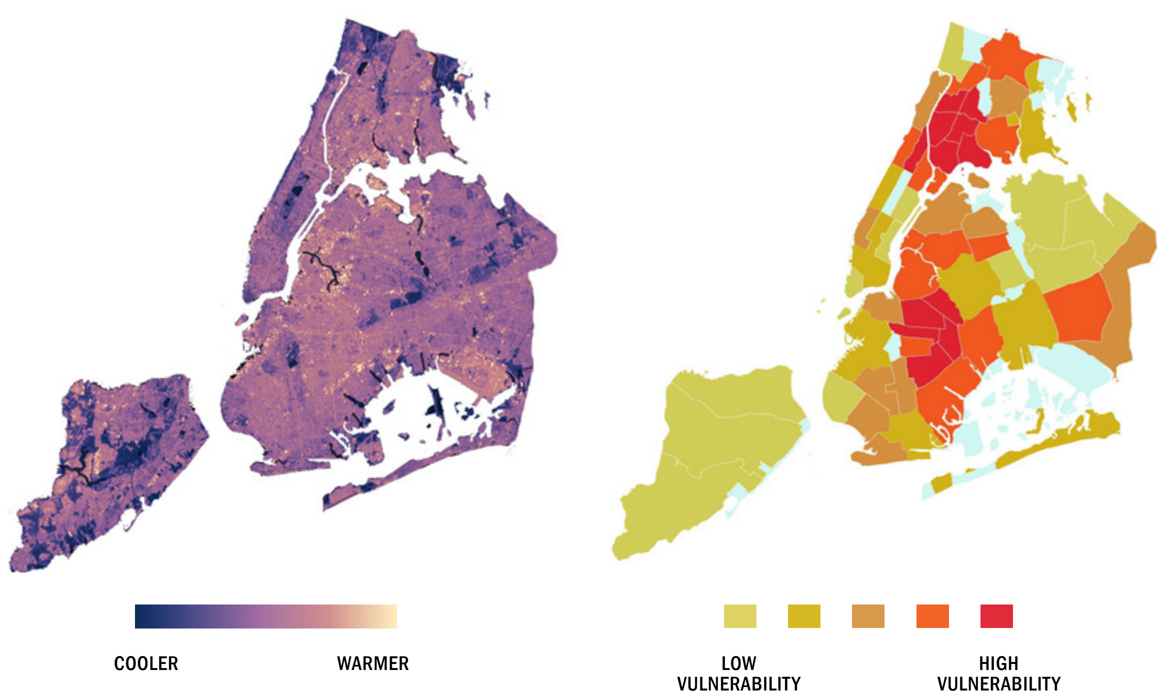
CASE STUDY EXAMPLE:

Using a series of cooling scenarios, the Los Angeles Urban Cooling Collaborative developed a model that accurately reflects five previous heat waves experienced in Los Angeles. The study found that increasing canopy coverage and pavement albedo can significantly reduce temperatures in the city, which in turn can reduce the number of deaths experienced during each heat wave. In their most ambitious scenario (high canopy and high albedo), there was an 18% reduction in deaths from the baseline values. This would account for a total of 11 lives saved - from 61 deaths down to 50 deaths - during just one of the modeled heat waves. If the proposed measures in the study were undertaken across Los Angeles, the number of lives saved during each heatwave could add up to totals in the hundreds or thousands when multiplied over years and decades.[23]

resources should someone become ill. Furthermore, many public spaces are accessible throughout the day and night. This is especially important as nighttime temperatures may remain high in cities like New York, where heat is absorbed in the pavement and hard surfaces on hot, sunny days. When there is no reprieve from the heat at nighttime, concerns related to heat-related illness can escalate. A cool space in which to spend evenings may provide much needed relief for many vulnerable populations.

In addition, a network of cool public spaces can begin to decrease the temperatures experienced in the surrounding areas and, if widely implemented, across the city as a whole. As a result, air conditioning costs can be lowered and the additional stress on the electrical grid can be mitigated through reducing the urban heat island effect. **Reducing temperatures will ultimately improve the wellbeing of the urban population, lowering the death toll and illnesses associated with extreme heat events.**

TEMPERATURE AND HEAT VULNERABILITY IN NEW YORK CITY



Sources: U.S. Geological Survey Landsat; New York City Department of Health and Mental Hygiene

THE OPPORTUNITY: NEW YORK CITY'S UNDER-USED OUTDOOR PUBLIC SPACES

Based on the research conducted by Perkins Eastman, a set of planning and design tools have been developed that can be utilized by communities and the local government to cool cities and improve comfort and safety. This strategy includes two parts: 1) identifying best areas for intervention; and 2) a design toolkit.

> "The beauty of creating cool public spaces is that **THEY ARE FREE AND ACCESSIBLE TO EVERYONE, REGARDLESS OF AGE, GENDER, INCOME, OR ETHNICITY.** A successful public space promotes human interaction, limiting the risks associated with social isolation during heat wave. "

TOOLKIT PART 1:

PRIORITIZING "COOL STREETS" SITES

In 2015, the Department of Health and Columbia University developed a "Heat Vulnerability Index (HVI)" for New York City based on mortality data from 2000 to 2011.[15] The study identified environmental and social factors associated with an increased risk of death during a heat wave. One environmental factor included daytime summer surface temperature, which varies greatly from one neighborhood to the next depending on surface materials and building typologies. The amount of green space, such as tree, shrub and grass cover, is also a contributing factor.

The social factors included both poverty, as measured by the percent of people receiving public assistance, and race, as measured by the percent of non-Latino Blacks residing in a community. Residents with lower incomes are at more risk of heat-related deaths primarily because they have less access to air conditioning. In addition, non-Latino Black residents are at an increased risk of death during heat waves due to historic racism and segregation resulting in an unequal distribution of social and economic resources. This often leads to a higher prevalence of health conditions that can increase the risk of heat-related illness, as well as a lack of access to adequate air conditioning.

To identify the "cool streets" sites with the greatest potential for positive impact, the toolkit provides a set of criteria using New York City's HVI as a foundation overlaid with a site's busyness and accessibility qualities.

Heat Vulnerability Index (HVI)

Given the environmental and social factors that were used to generate New York City's HVI, we can begin to prioritize public spaces in which to pilot "cool streets" tactics. It should be noted that communities with low vulnerability scores are still at risk since every neighborhood will have at-risk residents. These residents may be older adults, have chronic health conditions or severe mental illness, or live alone—all of which increase the risk of heat-related mortality, especially when there is limited access to air-conditioned spaces.

Busyness

Next, areas that already have a significant user group can be overlaid with highly vulnerable areas as identified by the HVI. Public spaces near subway stops provide significant opportunities, since there are many individuals using the space that could benefit from cooling strategies. Other high-traffic areas like major bus stops, popular parks, sports courts, and playgrounds are candidates for "cool streets" interventions.

Accessibility and Availability

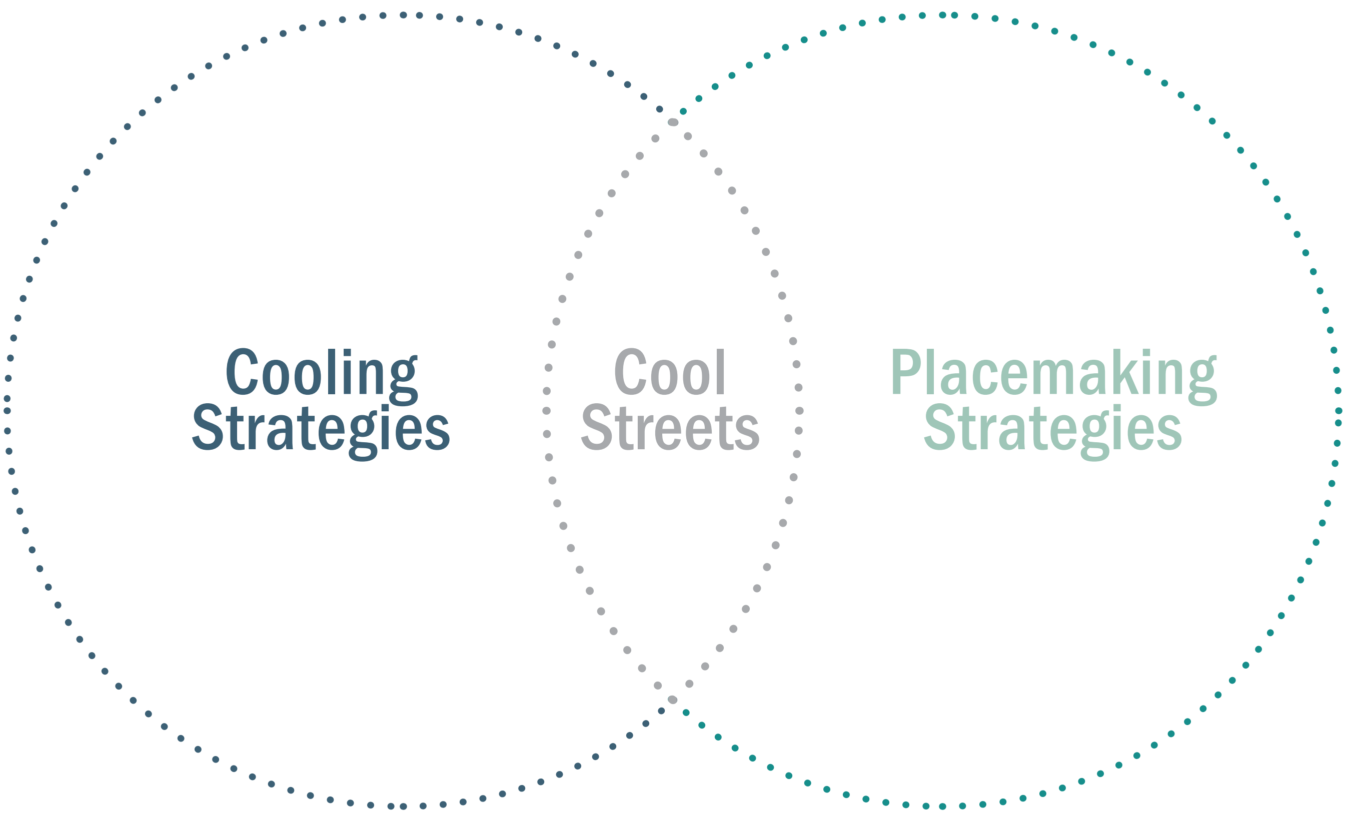
Following this, accessibility and availability should be considered. The Department of Transportation (DOT) Plaza Program can be used to identify existing public spaces throughout the city. An external online study of the plaza locations compared against median household income within a 10-minute walk provides a helpful starting point.[16] Not surprisingly, a number of the plazas located in areas with low median household incomes were also in highly vulnerable areas according to the HVI. While the DOT plazas, which are located throughout the city, may be obvious sites for a "cool streets" program, other publicly-owned park spaces may prove just as promising. Privately-Owned Public Spaces (POPS) also could provide an opportunity for creating cool outdoor areas.

TOOLKIT PART 2:

DESIGN STRATEGIES TO SAVE LIVES

Once a site has been identified, a number of design interventions can be implemented to cool the space and make it more comfortable, usable, and safe. These strategies fall into three categories: passive (do not require energy), active (require energy), and educational (information for the public regarding health and extreme heat events). Any of these strategies on their own, or in combination, can create a “cool street.” In order to ensure a public space is well used by the community, however, more is required than simply employing these strategies. Therefore, a fourth category of “attractors” must be utilized in any “cool streets” project to ensure that the space becomes a true community asset. These “attractors” act as placemaking tools, encouraging people to visit and spend time in the space. It is the overlapping of these two approaches - cooling strategies and placemaking strategies - that creates a successful “cool streets” project.

In addition to categorizing the design interventions, the periodic table on the following page further highlights the cost and effectiveness of each of the strategic “elements”. While this will vary from site to site, it gives a general overview of the practicality or usefulness of each intervention. The columns of the table have therefore been organized, in general, by most effective at the bottom to least effective at the top.



Cooling Strategies

LEAST EFFECTIVE

Paving Technology		Building Massing + Design	Shade	Evaporation	Psychological
		$$ I **V** Ventilation			
$ I **Bp** Block Pavement	$$ II **Pc** Permeable Concrete	$ I **Lv** Location of A/C Vent			
$$ II **Hc** High Albedo Concrete	$ II **Pa** Permeable Asphalt	$ II **Tr** Reduce/Eliminate Traffic	$$ II **Ss** Shade Structures	$$ I **Gw** Green Wall	
$$ III **Rc** Resin-Based Concrete	$ II **Ha** High Albedo Asphalt	$$$ III **Ba** Building Arrangement	$ II **Aw** Awnings	$$ I **W** Surface + Running Water	
$$ III **Vp** Vegetated Pavement	$$ III **Cc** Colored Concrete	$$$ III **Bh** Building Height	$ II **St** Street Trees	$ I **Gc** Grass Cover	$$ I **Wa** Water Access
$ III **Ms** Micro Surfacing	$ III **Wt** White Topping	$$$ III **G** Grid Orientation	$ II **Ts** Temporary Shading	$ I **Ve** Vegetation	$ I **C** Color
$ III **Cs** Chip Seal	$ III **Ca** Colored Asphalt	$$ III **Cm** Cool Building Materials	$$$ III **Tb** Tall Buildings	$ II **M** Misting Systems	$ I **Ci** Cool Image

MOST EFFECTIVE

PASSIVE

Placemaking Strategies

Cost	Effectiveness	Identifier	Intervention
COST ($, $$, $$$)	EFFECTIVENESS (I, II, III)	IDENTIFIER	INTERVENTION
$	II	St	Street Trees

ACTIVE — Energy-Driven Systems

Cost	Effectiveness	Identifier	Intervention
$$	II	F	Fans
$$$	III	R	Refrigerants
$$$	III	I	Ice
$$$	III	Ec	Evaporative Cooling
$$$	III	Cw	Chilled Water
$$$	III	Wa	Water to Air Heat Exchanger
$$$	III	Ea	Earth to Air Heat Exchanger

EDUCATIONAL — Information Sources

Cost	Effectiveness	Identifier	Intervention
$	I	Ew	Emergency Warning System + Signage
$	I	Ec	Emergency Call Box
$	I	Ot	Outdoor Temperature Gauge

ATTRACTORS — Placemaking Strategies

Cost	Effectiveness	Identifier	Intervention
$	I	A	Art
$$	I	Hm	High-Quality Materials
$$	I	L	Human-Scale Lighting
$$$	I	Ar	Architectural Design
$$	II	Pe	Play Elements
$$$	II	T	Toilets
$	I	Tc	Trash Cans
$	I	Nl	Noise Levels
$	II	Ae	Active Edges
$	II	La	Landscaping
$	II	Bp	Bicycle Parking
$$	II	Wi	Public WiFi
$	III	S	Range of Seating Options
$	III	Pr	Diverse Programming
$$	III	Df	Drinking Fountains
$	II	Cf	Car-Free Spaces

1) PASSIVE

Passive approaches do not require energy or electricity to successfully function. As such, they are often easy to implement and cost effective, requiring little maintenance and having few, if any, operating costs. As well, given the concerns surrounding climate change, it is helpful to avoid the generation of greenhouse gases in order to power cooling technology. Furthermore, as was noted earlier in this report, the electricity grid will be less reliable in coming years as air conditioning use increases demand during hotter and longer heat waves. If a cooling technique relies on the electricity grid, there is a risk that the technology fails to work during a heat wave, when it is needed most. Passive solutions would continue to function in the event of a blackout, providing much needed relief from hot temperatures for communities surrounding the “cool street” sites.

PAVING TECHNOLOGY

EVAPORATION

BUILDING MASSING + DESIGN

PSYCHOLOGY

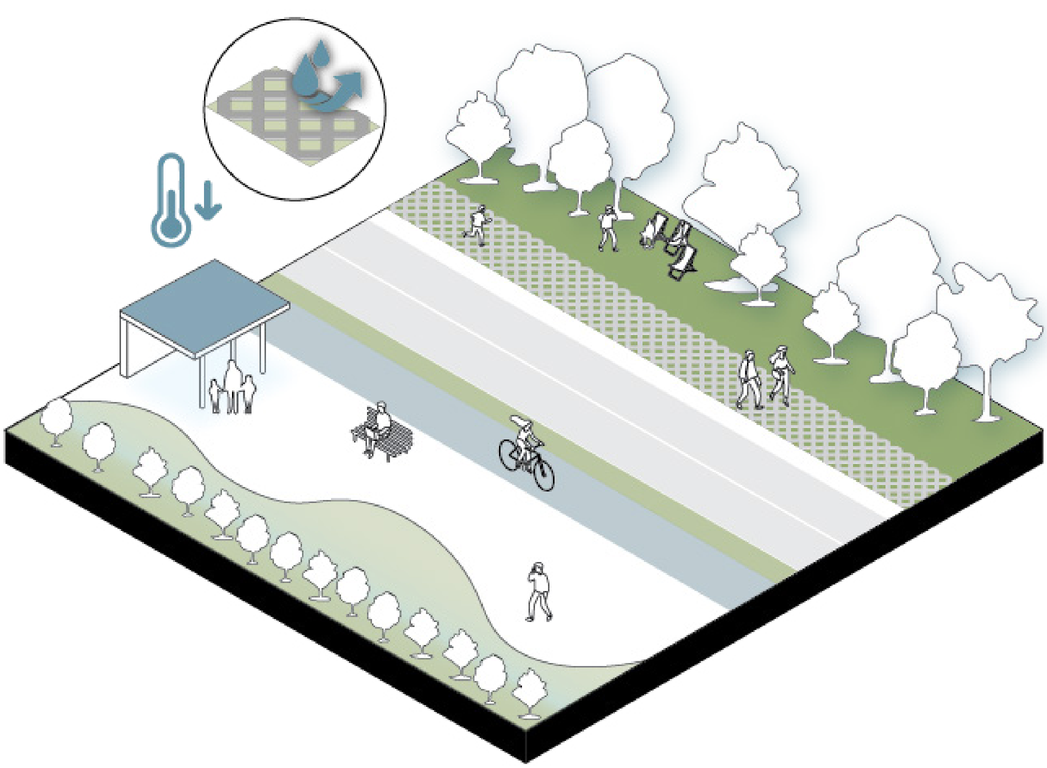
SHADE

a) Paving Technology

Certain materials can increase or decrease the heat island effect. **A variety of "cool paving" technologies help to lower heat conductivity (the amount of heat that is conducted into the material's interior) and heat capacity (the amount of heat stored in the material's volume), and increase solar reflectivity (or albedo)**.[17] With pavement covering up to 50% of a typical urban environment, cool pavement technologies can achieve significant reductions in urban temperatures.

In Los Angeles, many asphalt roads are painted white to reduce the temperature of the road and the ambient air temperature. This is part of a plan to lower the average temperatures across Los Angeles by three degrees over the next 20 years. Other "cool paving" technologies include: high albedo concrete and asphalt, colored concrete and asphalt, permeable concrete and asphalt, chip seal, micro surfacing, white topping, block pavement, and vegetated pavement.

Many of these pavements are permeable, which improves water management and provides additional cooling as the water evaporates.



Application of Passive Elements Incorporating Paving Strategies

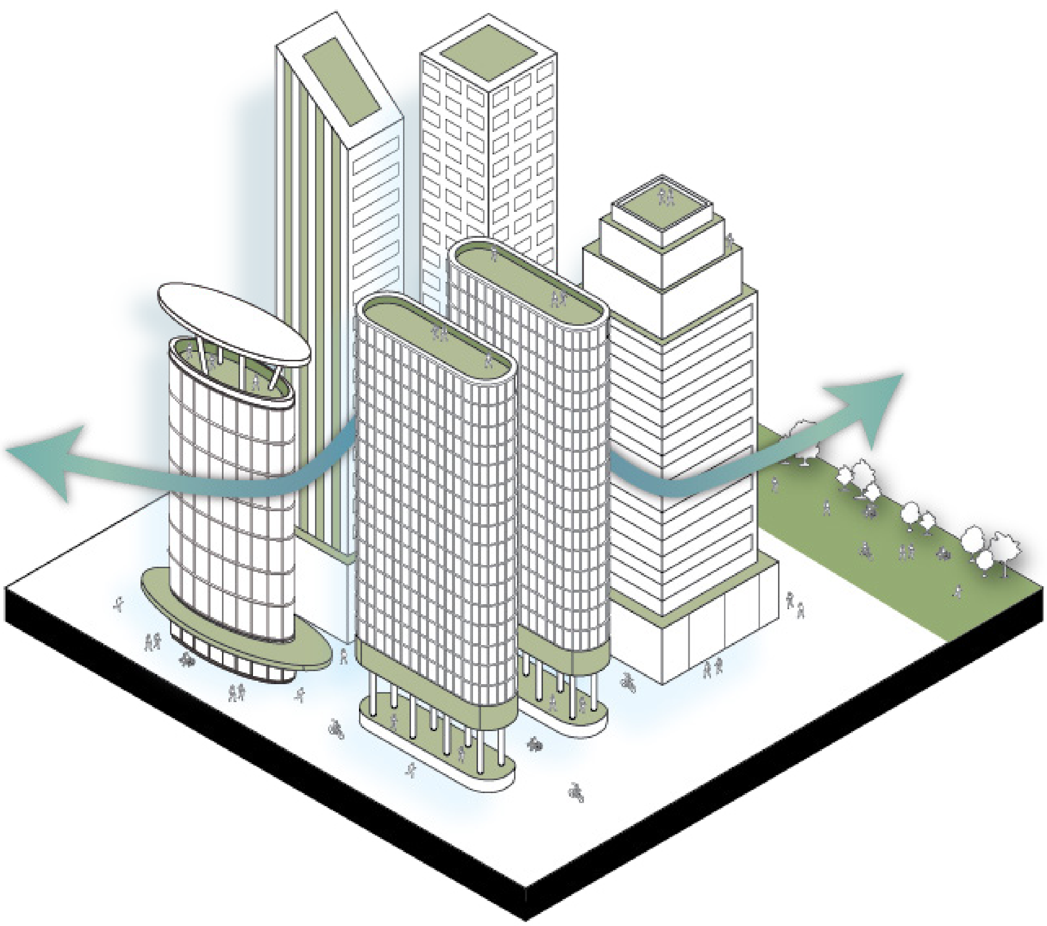
b) Building Massing and Design

While cool pavement can provide heat relief in urban environments, so too can building materials. The edges of our public spaces can heat up with sunlight in the mornings or afternoons, increasing ambient air temperature on the adjacent sidewalks and plazas.

Next, ventilation and air flow should be considered when planning and designing new buildings around public spaces. “Wind catchers,” for instance, have been used for millennia in many parts of the world to cool buildings. In cities like New York, sea breezes can be harnessed to bring cool, fresh air into otherwise hot environments. The orientation of the city grid can either maximize or minimize these cool summer winds.

Building height and building arrangement can also impact the heat of sidewalks and plazas. Taller buildings with narrower streets create shade at ground level. While this may be less desirable in the winter, it is helpful in preventing paving and building material at ground level from absorbing the sun’s rays.

Additionally, mechanical operations can lead to increased temperatures at ground level. Many air conditioning units vent towards the street, pushing hot air from inside the building to the public spaces outside, while centralized air conditioning that vents to the roof may have less of an effect at the street level. Other mechanical operations generate additional waste heat on city streets, such as air-conditioned cars and trucks that remove heat from the vehicle engines and interiors but add to outside temperatures. Therefore, creating “cool streets” that reduce or eliminate traffic can vastly improve the user experience.



Application of Passive Elements Incorporating Building Massing and Design

c) Shade

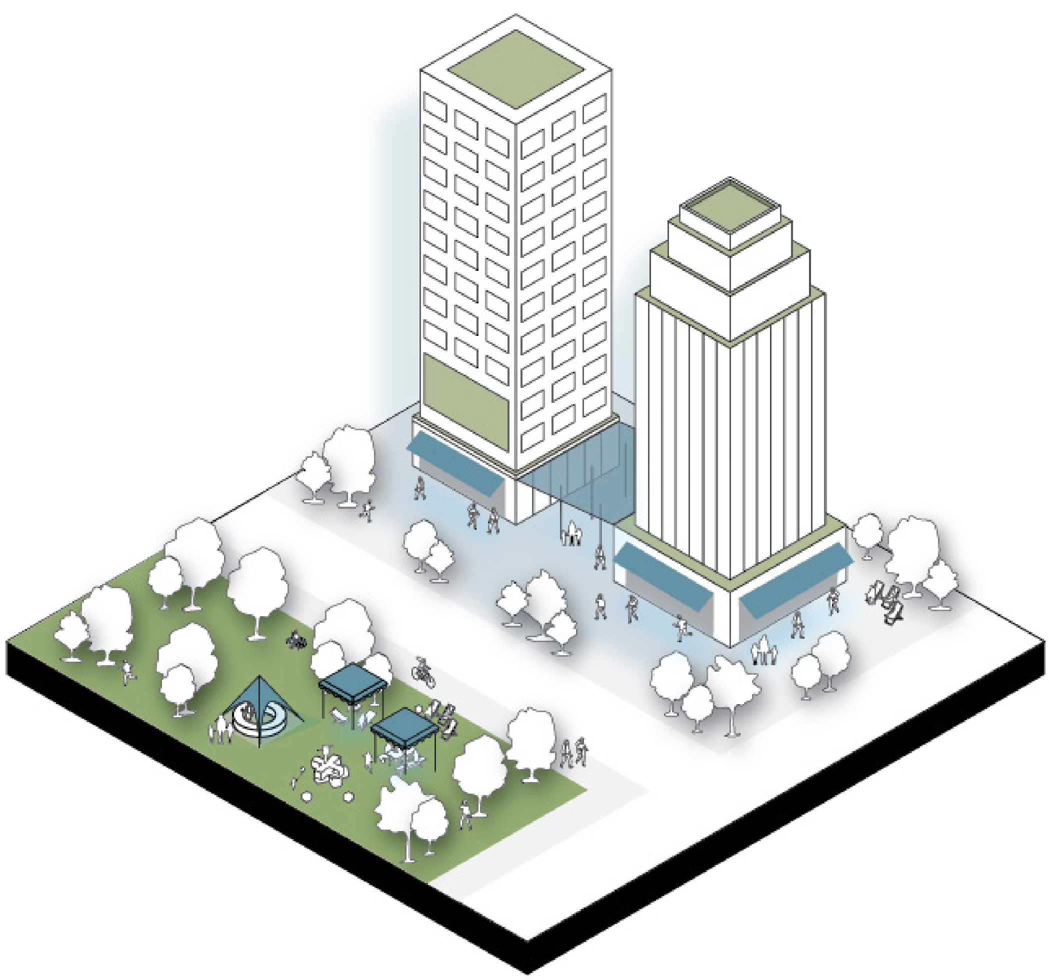
Studies have shown that shaded surfaces can be 20°F to 45°F cooler than unshaded surfaces.[18] As it is highly effective at minimizing temperatures on hot days and can be easily created through a number of avenues, shading is an essential component of any "cool street" project. Permanent shade structures can be installed in areas that are particularly vulnerable. Designs using various materials and layers of shade structures can create patterns, eye-catching shapes, messages and colors, or create a "dappled" effect that mimics the shade provided by trees.

Temporary shade structures provide another option and are often more affordable than permanent solutions. Light materials such as fabrics and canvas can effectively create shade during summer months and be removed in winter to allow for sunlight in the cooler months.

Street trees and vegetation, especially trees with large canopies and strategically-placed plants, provide shade. Deciduous trees provide the benefit of shade in the summer and sun in the winter, once their leaves have dropped.

Buildings themselves can also be designed to maximize protection from the sun during the summer months. Awnings, canopies, arcades, and colonnades can act as an extension of cooler indoor spaces, providing protection from the sun and other elements.

Finally, as mentioned earlier, tall buildings can effectively create shade at the street level, especially when the streets are narrow. The south side of the street typically receives more shade than the north side, which can provide further opportunities when identifying "cool streets" sites.



Application of Passive Elements Incorporating Shade

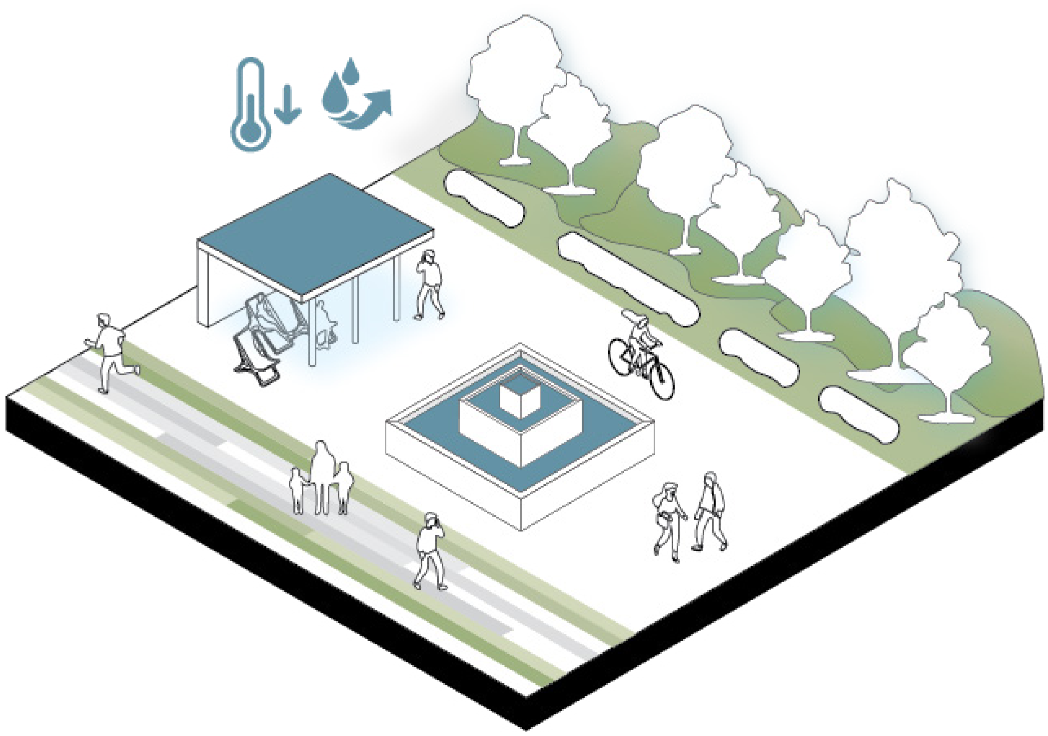
d) Evaporation

Deaths during heat waves are less likely among residents living in areas with more green space. **Ambient air temperature is greatly reduced by vegetation; plantings, grass cover and green walls provide cooling indirectly through the process of evapotranspiration**. In this process, water is moved from a plant's root system to its leaves where it evaporates. As this water turns into vapor, heat is absorbed and the surrounding air is cooled as a result. This is less effective in humid climates, but still provides cooling. Evapotranspiration, either on its own or in conjunction with shading, can reduce peak temperatures by 2°F to 9°F.

Water features such as fountains can also provide the benefit of cooling through evaporation; interactive installations, like splash pads and wading pools, allow people to cool down even more.

Misting systems are becoming increasingly popular in public spaces like playgrounds and parks. When connecting to a water source such as a fire hydrant, these systems do not need electricity to run as the water pressure is adequate enough to operate. As mist hits our skin and evaporates, it cools down our bodies and provides immediate relief. It also cools the air directly by absorbing heat and evaporating. This can reduce temperatures in humid climates as much as 5°F to 10°F.[19]

There are also significant opportunities to tap into the network of fire hydrants throughout our cities. Cool, fresh water is readily available for use in practically any public space. In New York City, the local fire hall will install a free spray cap on your nearest fire hydrant upon request.[20]

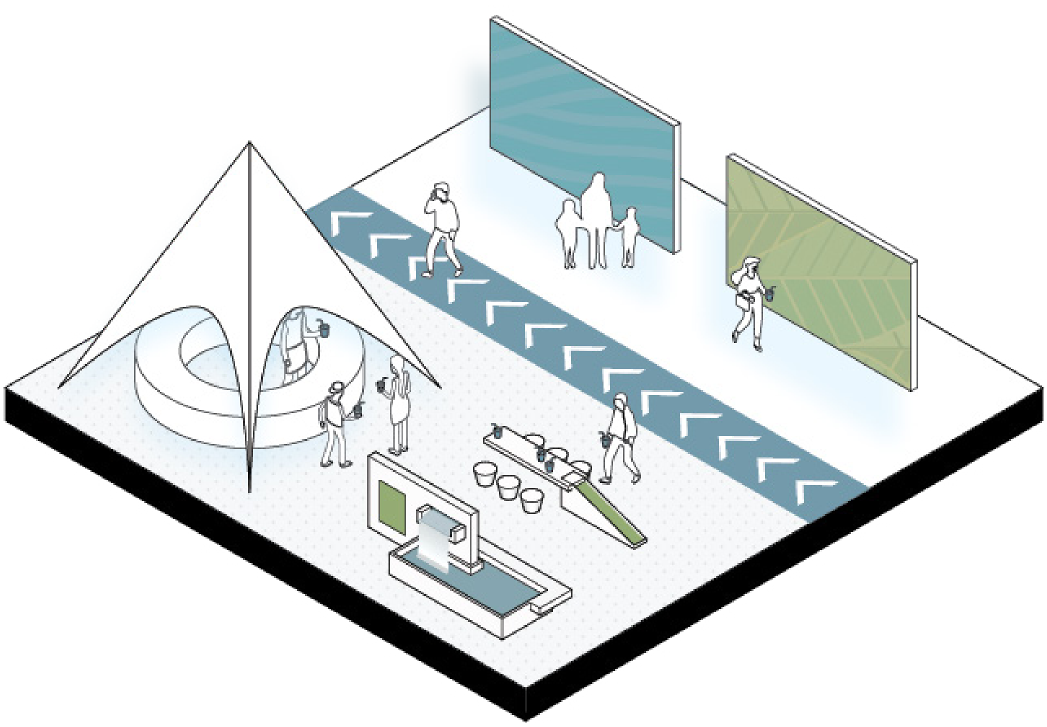


Application of Passive Elements Incorporating Evaporation

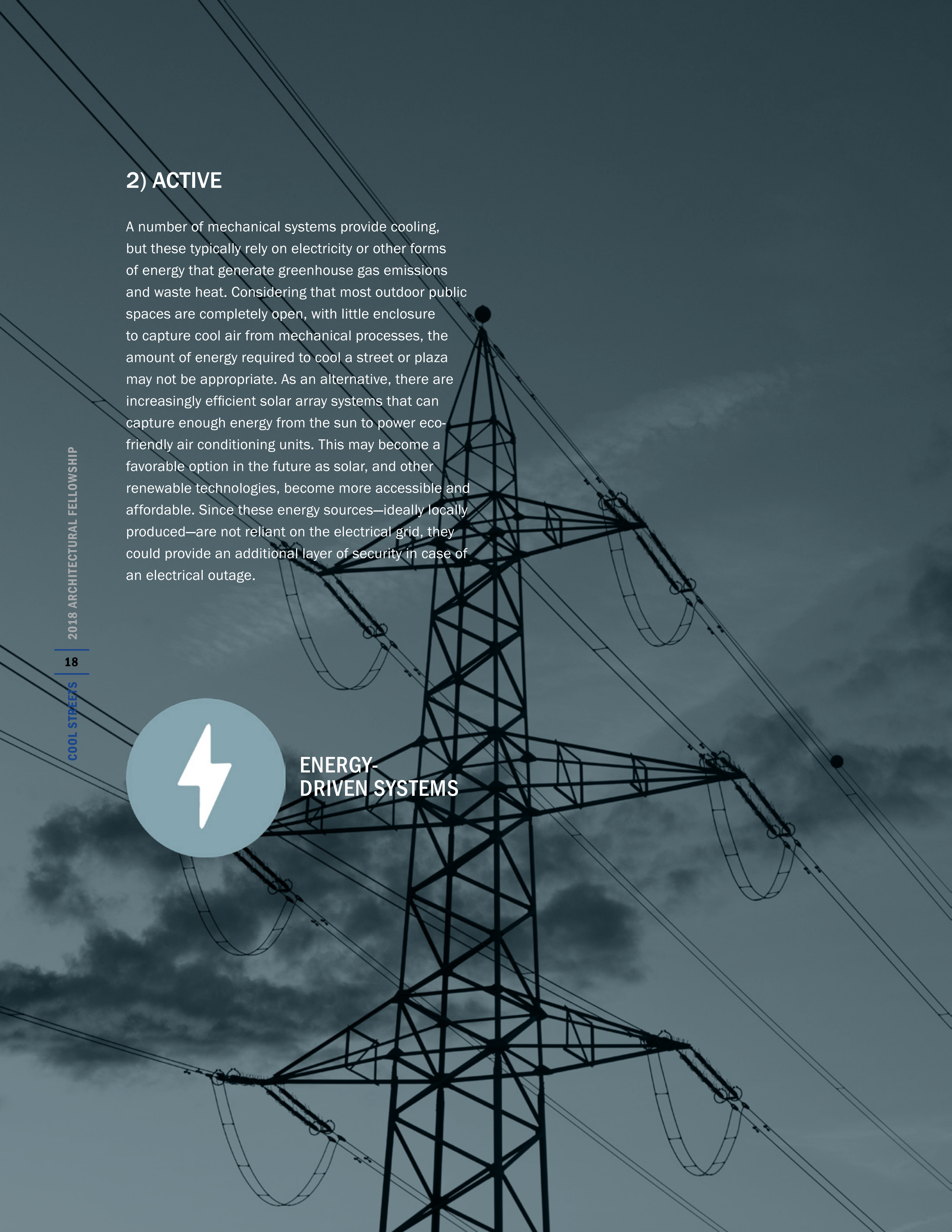
e) Psychology

Even if users do not directly engage with a water feature, they may still experience its cooling benefits through the psychological impact of visual exposure. In a similar way, certain colors may provide a cooling effect. A white surface may reflect more light and feel cooler to the touch, but a light or bright blue color may create the perception of a cooler space.

Further studies on psychological solutions to cooling have revealed that our perception of the temperature of another individual can affect our own physical state. Academic psychiatrist Neil Harrison undertook a study to test our empathetic response to seeing others in cool situations, showing participants a video of someone plunging their hands into ice water. As he measured the participants' own hand temperatures, Harrison observed that they were in fact measurably cooler in response to the video.[21] This strategy may be applied through "cooling" images or art installations that create a sensation of coolness even on a hot day.



Application of Passive Elements Incorporating Psychology



2) ACTIVE

A number of mechanical systems provide cooling, but these typically rely on electricity or other forms of energy that generate greenhouse gas emissions and waste heat. Considering that most outdoor public spaces are completely open, with little enclosure to capture cool air from mechanical processes, the amount of energy required to cool a street or plaza may not be appropriate. As an alternative, there are increasingly efficient solar array systems that can capture enough energy from the sun to power eco-friendly air conditioning units. This may become a favorable option in the future as solar, and other renewable technologies, become more accessible and affordable. Since these energy sources—ideally locally produced—are not reliant on the electrical grid, they could provide an additional layer of security in case of an electrical outage.

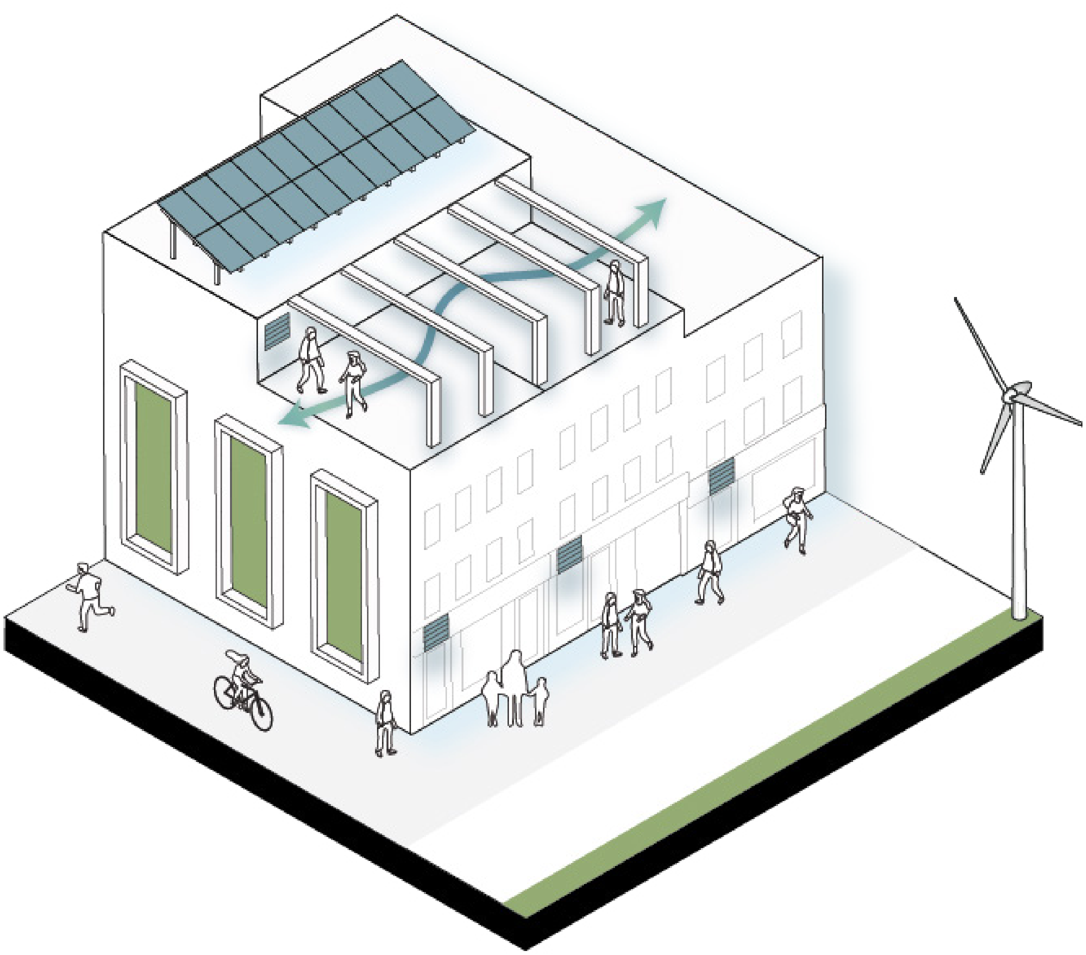
ENERGY-DRIVEN SYSTEMS

a) Energy-Driven Systems

The cooling technology we are most familiar with is "air conditioning." Many of the systems that generate air conditioning rely on refrigerants, chilled water or ice. There, however, are a number of alternative processes that can be qualified under the term "air conditioning." Active evaporative cooling, water to air heat exchangers and earth to air heat exchangers are extremely effective at cooling spaces, but have significant environmental and financial costs associated with their operation.

Negative feedback loops created by air conditioning can have significant implications on temperature.[22] For instance, sitting in a traffic jam on a hot day would be unbearable without air conditioning, and some built environments are only habitable because of our access to air conditioning. This has increased temperatures in urban environments through the urban heat island effect. As well, the generation of heat waste from cars and traffic increases temperatures further, contributing to a vicious cycle of increasing temperatures. **Perhaps more concerning is the fact that we are less acclimatized to hot summer months since our bodies are used to being in cool, and often very cool, indoor air-conditioned environments. This can make our populations more susceptible to heat-related illness or death when exposed to heat outdoors or even indoors during a power outage.**

Another active solution to cooling is the use of an electric fan. In the right environment, a fan can provide relief from heat—but when the temperature and humidity is too high, it can actually make our bodies hotter. If used in a public space, the fan should be programmed to respond to changing heat and humidity conditions.



Application of Active Elements Incorporating Energy-Driven Systems

3) EDUCATIONAL

Accurately and effectively articulating the health impacts of extreme heat events to vulnerable communities is crucial. A citywide survey conducted in 2011 found that among older New Yorkers, as well as among adults aged 18-64 who reported being in poor or fair health and who did not own or regularly use an air conditioning unit, nearly 50% stayed home during heat waves and 30% were not aware of heat warnings. Social isolation can be a major risk factor for vulnerable populations during extreme heat events, and educating populations about the risks and signals can drastically improve health outcomes.

INFORMATION SOURCES

a) Information Sources

A first step to engage the public in discussions around extreme heat is to include outdoor temperature gauges in public spaces across the city. Rather than indicating the ambient air temperature alone, they could also broadcast the heat index, which takes into account temperature and humidity. These thermometers could be paired with an emergency warning system and associated signage. Electronic signage could update regularly with real-time reports on current weather and forecasted temperatures, rating the level of risk to passersby. The more that people see these temperature gauges, the more they will be aware of the temperature in their area and of when it might become risky for health and wellness. The signage could also identify essential health information such as the signs associated with heat illness and what to do if these symptoms are present. This information could play an important role in educating the public on how to prevent heat illness from occurring in the first place. This informational infrastructure could be further enhanced by placing emergency call boxes at sites where “cool street” strategies are being implemented. As was noted earlier in this report, many people succumb to heat when alone in their homes. In addition to attracting those who may not have air conditioning at home, cool public spaces can provide monitoring and support by others in their community, and thereby prevent premature heat-related deaths. However, since heat illness can still occur, these call boxes can provide a necessary point of contact with emergency medical services personnel who can assist.

Furthermore, this emergency information infrastructure could also be helpful during other extreme weather events, and could provide an additional layer of emergency preparedness.

Application of Educational Elements Incorporating Information Sources

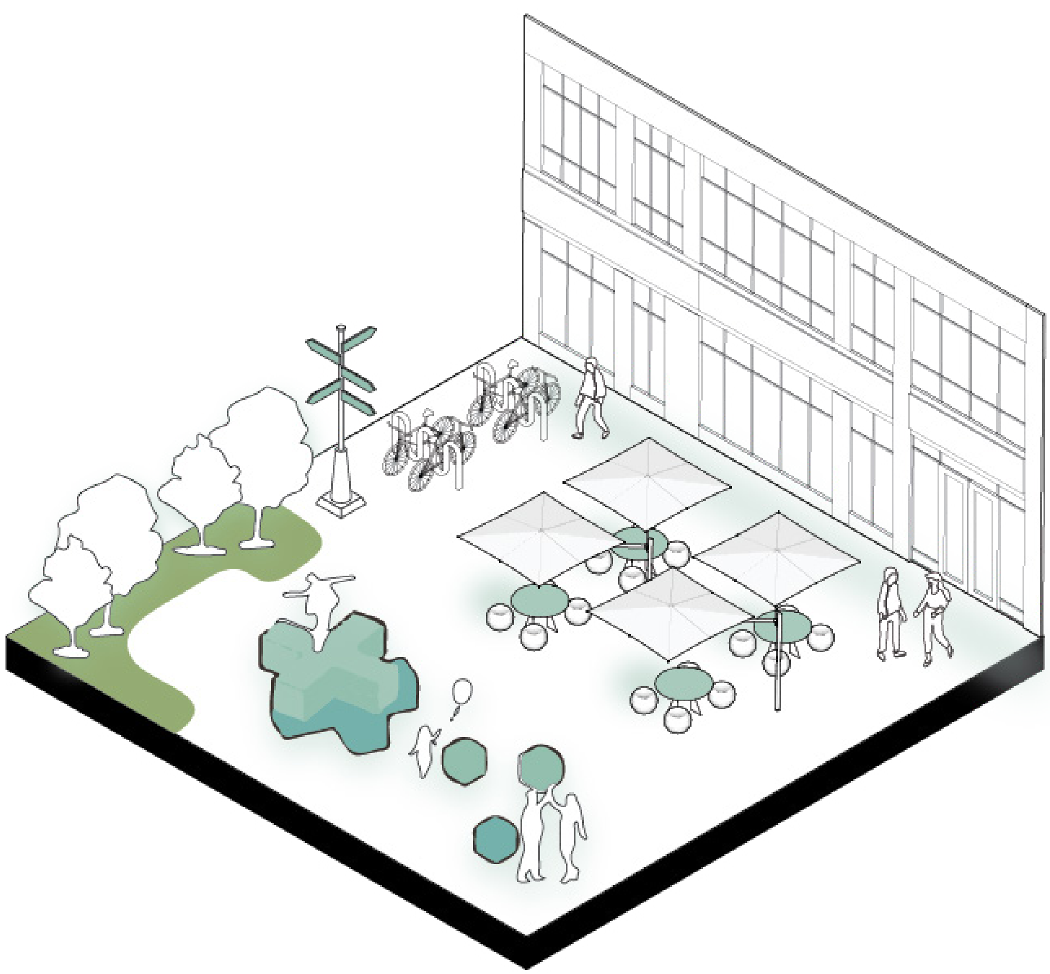
4) ATTRACTORS

For these interventions to be successful, they must attract users. Simply implementing cooling technologies and strategies to reduce temperatures of public spaces will not mean that people will in fact use the space. Therefore, placemaking strategies are critical to support and enable the successful implementation of “cool streets” projects. Engaging, attractive public spaces can also be those that cool us and provide reprieve from hot summer days. It is especially important that these spaces become recognized and embraced by their communities, especially in areas with highly vulnerable populations. The following attractors can help achieve this.

PLACEMAKING STRATEGIES

a) Placemaking Strategies

Placemaking can come in a number of forms. Physically, the surrounding environment is important when considering a public space. The architecture of buildings adjacent to a street or plaza will impact how interesting the space feels. High-quality materials can be utilized within the public realm itself, adding a richness to the user's experience. A number of infrastructure elements can also create a more welcoming environment. Drinking fountains are a crucial element for creating a functional public space in the summer. Human-scale lighting, wayfinding, restrooms, and trash cans all ensure the space is usable and safe. A range of seating options that may be both fixed and flexible allow people to use the space as they desire, regardless of their interests or needs. At the same time, amenities such as adequate bicycle parking and public Wi-Fi further enhance the variety of users who may want to spend time in the site. Play elements in particular encourage diversity of user age groups. Aesthetic attractors such as art and landscaping make experiences in the public realm more enjoyable, encouraging people to stay, rather than simply pass by. Similarly, the creation of car-free spaces can generate a more hospitable environment, especially when there are concerns surrounding noise levels. Finally, **human activity may be one of the biggest attractors for public spaces**. A busy space is sure to invite more users than an empty one. Therefore, active edges can significantly improve the vitality of a public space. However, where active edges aren't an option, diverse and inclusive programming creates even more reasons for people to spend time in these cooler public spaces.



Application of Attractor Elements Incorporating Placemaking Strategies

CASE STUDY: MYRTLE-WYCKOFF PLAZA

The following case study demonstrates the potential applications of cooling strategies described in the previous sections of this paper. Site observations were conducted in July and August 2018, with the goal to develop recommendations for minor, medium, and major interventions for different levels of investment.

Site Selection

Using the selection criteria identified in the first part of the Toolkit, we selected an existing DOT plaza at the intersection of Myrtle Avenue and Wyckoff Street, which is located at the boundary between Brooklyn and Queens.

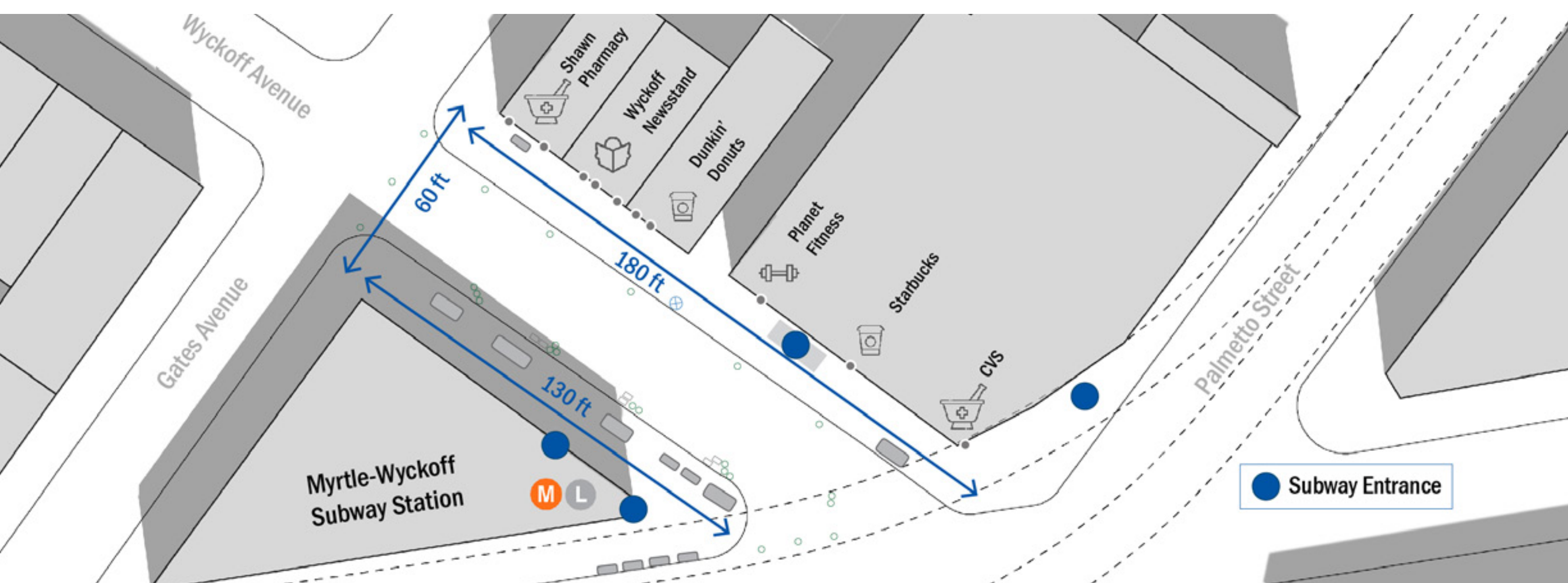
History and Future of the Plaza

This plaza came into existence as part of the Vision Zero program. A number of fatalities occurred at the intersection over the past few years, and there was significant community pressure to redesign the intersection. While the plaza is currently temporary, a large portion of Wyckoff Avenue is undergoing reconstruction. As part of this work, a new permanent plaza will be developed. The plaza is projected to be open in Spring 2021. Polling by the City of New York shows broad community support for the creation of this permanent plaza. Since health and safety are already part of the conversation in this community, a proposed "cool street," which has the potential to save lives, is fitting.

Toolkit Part 1.1: Heat Vulnerability and Demographics

Demographic analysis of the community was undertaken as part of this study, which aligned with the Heat Vulnerability Index findings. The average median household income is below the average in New York City. Bushwick, in particular, is the seventh most impoverished neighborhood in New York City, with more than 75% of children born into poverty. Up to 40% of the elderly population within a 10-minute walk of the plaza is living below the poverty line. And with rents in Bushwick increasing by 44% between 1990 and 2014, the area has experienced an increase in the homeless population. In Ridgewood, Queens, there are high rates of heart disease—a condition that can be exacerbated by extreme heat conditions. With as much as a third of the population living without health insurance, it is likely that individuals would avoid hospital visits. Environmentally, it is clear that the area is also very underserved by parks, measured by acres per 1,000 residents. Perhaps related to this, a high number of 311 heat complaints have been recorded.

MYRTLE-WYCKOFF PLAZA SITE MAP AND FEATURES

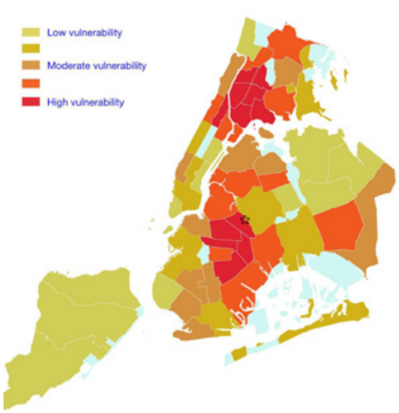


BUSYNESS RATINGS FOR PLAZA ADJACENT USES FROM GOOGLE

Toolkit Part 1.2: Busyness

The plaza is significantly populated throughout the day, meeting the "busyness" requirement discussed in Part 1 of the toolkit. Pedestrian counts recorded as part of this study in mid-July 2018 indicated that more than 250 people pass through the site every 10 minutes during peak times of the day. Both the M line and the L line run through the adjacent subway station, and the Ridgewood Bus Terminal, which is accessed by six different bus routes, is adjacent to the plaza. Commercial uses are found across the street from the subway station, with coffee shops, pharmacies, and a gym bringing people in and out of the space at all times of the day and week. Local vendors selling fruits and vegetables, drinks, food, and trinkets line the "shady" side—or west side—of the street.

IDENTIFICATION OF SITE THROUGH APPLICATION OF TOOLKIT PART 1



HEAT VULNERABILITY INDEX

SUBWAY MAP
(BUSYNESS)

DOT PLAZA LOCATION
(ACCESSIBILITY/AVAILABILITY)

☆ SELECTED SITE

HOT VS. COOL FACTORS IN MYRTLE-WYCKOFF PLAZA

Toolkit Part 1.3: Available and Accessible

Finally, since this public space is part of the formalized plaza program run by the DOT, it fulfills the accessibility/availability criterion outlined in the first part of the toolkit.

Assessments/Observations

The roadway is painted with epoxy gravel, which is lighter in color than the typical asphalt used for roads. However, it is still significantly warmer than other materials on the site. The surrounding buildings are low rise with no more than three to four stories. Given the width of the street, these buildings do not provide a lot of shade in the plaza during summer months. The building material is also not conducive to cooling. The façade of the subway station, for instance, is primarily brick, which absorbs a significant amount of heat that is radiated back into the plaza at night. Air conditioning units from the adjacent buildings also blow hot air back into the plaza, making the space even warmer. As is typical of a DOT plaza, there are moveable tables and chairs, as well as a couple of umbrellas for shade. However, the furniture is made out of metal and as a result can be uncomfortable or even unsafe to use.

As a pilot project under the DOT Plaza Program, there are a handful of planters, but they provide little shade or cooling. There are no trees lining the streets at the site.

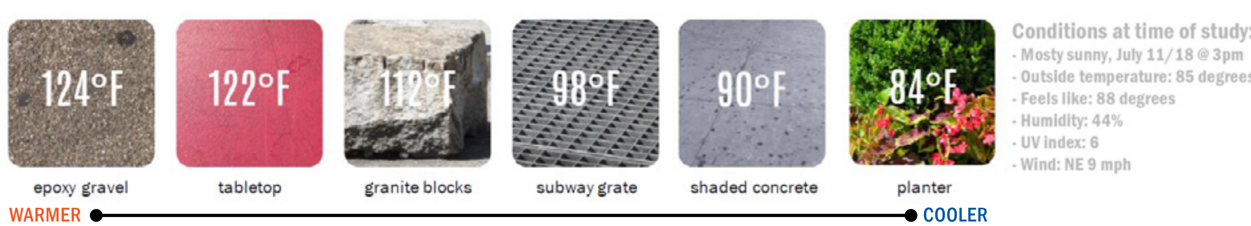
Using a non-contact infrared thermometer, we recorded the temperature of various materials at street level at several times throughout the day. As shown in the diagram below, the epoxy gravel—the standard ground cover for DOT plazas—was the warmest material. **The temperatures highlighted in the adjacent diagram were recorded at 3pm on July 11. At this time, the ambient air temperature was 85°F with a UV index of six, yet the epoxy gravel reached 124°—nearly 40°F warmer than the outdoor air temperature.** Following as a close second were the tabletops of the moveable furniture, another DOT plaza standard. The only material that seemed to be cooling the space were the planters, which clocked in at 84°F, slightly below that of the ambient air temperature.

It was easy to observe that the majority of users would choose to sit either under an umbrella or adjacent to a building to access shade. This was even the case in the mornings when temperatures were lower. The majority of the plaza, however, is quite exposed since the adjacent buildings are low rise. Limited shading, through the use of moveable umbrellas, is provided within the plaza. This observation was reinforced by informal surveys that were undertaken with users of the site, many of whom noted that there was not enough shade in the plaza.

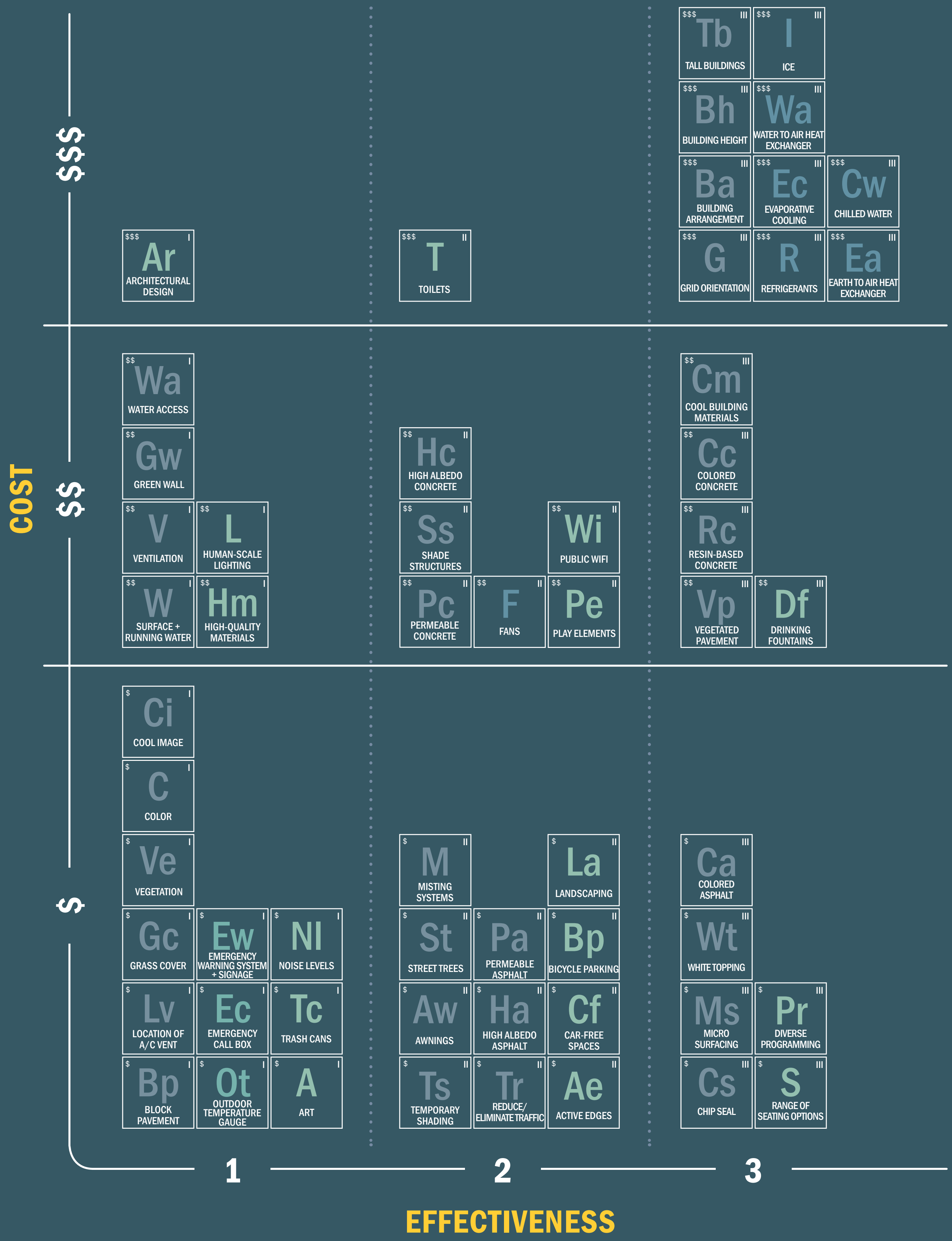
At the same time, however, some elements in the plaza provide relief from the heat. The limited amount of shade in the plaza is welcomed, whether it is from adjacent buildings or the handful of umbrellas in the plaza. As noted above, the plantings also provide some relief from the heat. Finally, the local street vendors sell a variety of cool drinks, including water, for people to rehydrate on warm summer days.

It was interesting to note that the majority of active users had walked to the site. Transit users typically moved through the site without stopping. This shows the success of the DOT Plaza Program to create welcoming places for neighborhoods that can function as a gathering space and promote social cohesion. It also means that there is great potential to create a successful "cool street" project given that it is already a destination for community members, as outlined in Part 2 of the toolkit.

TEMPERATURE OF VARIOUS MATERIALS FOUND AT MYRTLE-WYCKOFF PLAZA



COST VS. EFFECTIVENESS OF TOOLKIT PART 2 ELEMENTS



ACTIONABLE INTERVENTIONS

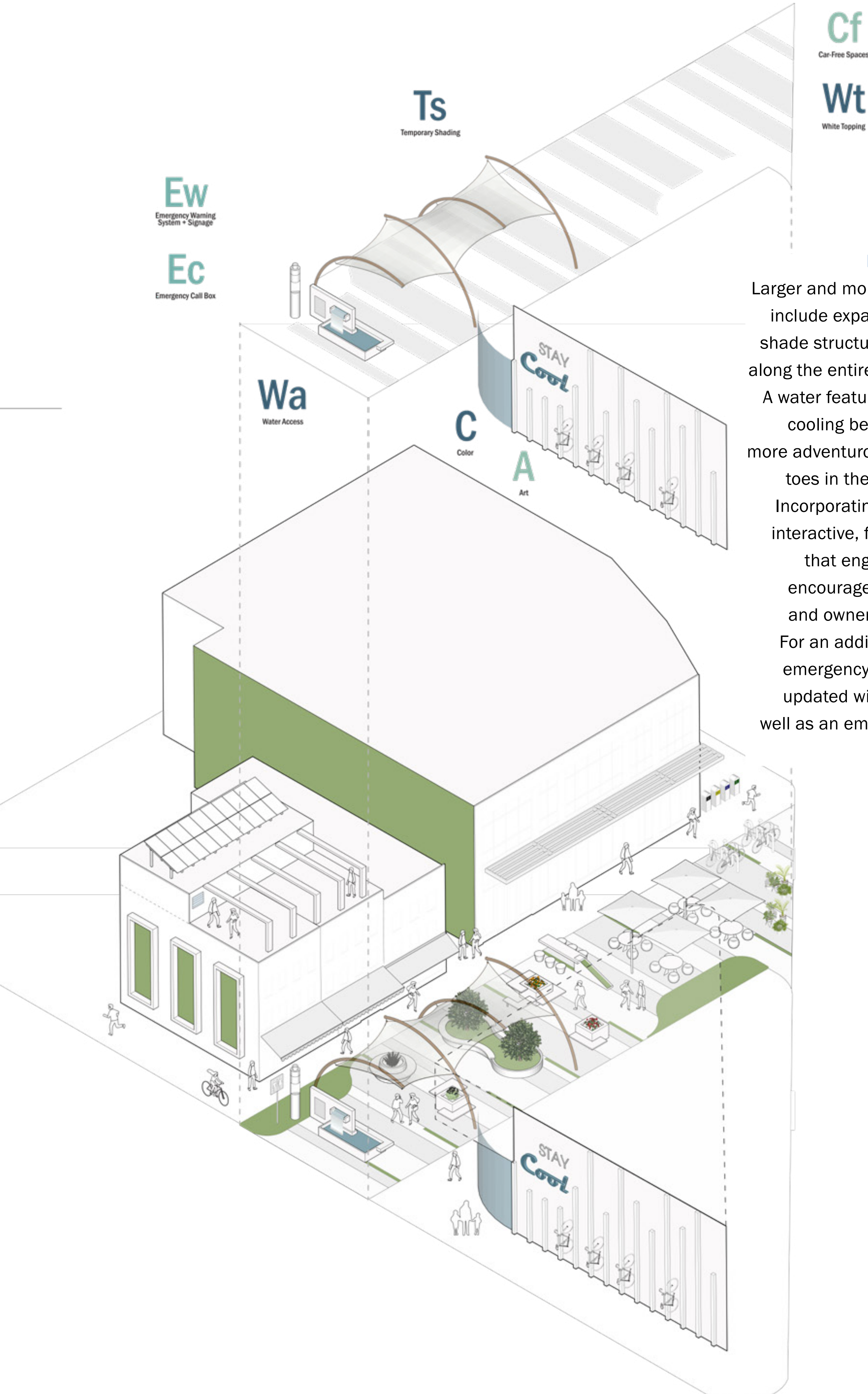
For the Myrtle-Wyckoff Plaza, we developed three sets of recommended design interventions with scale varying from minor, to medium, to major. The level of intervention was determined using an analysis of Part 2 of the toolkit. Elements suggested for the minor intervention are typically low cost and highly effective, whereas the major intervention employs higher cost and potentially less effective strategies.

The table to the left demonstrates an approach to categorizing the elements based on cost and effectiveness. This method can assist governments and communities in developing interventions at an appropriate scale for their needs and capacity. The table may look different for each site, as the cost and effectiveness rating will vary based on context. The ratings found here are simply an estimate for an average site found in New York City, but specific sites may provide unique challenges or opportunities.

Note that elements of each of these interventions can be adopted together to achieve maximum benefits. A “major intervention” is not necessarily more effective than a “minor intervention”—there are a number of highly effective, low cost cooling solutions that can be implemented in the short term.

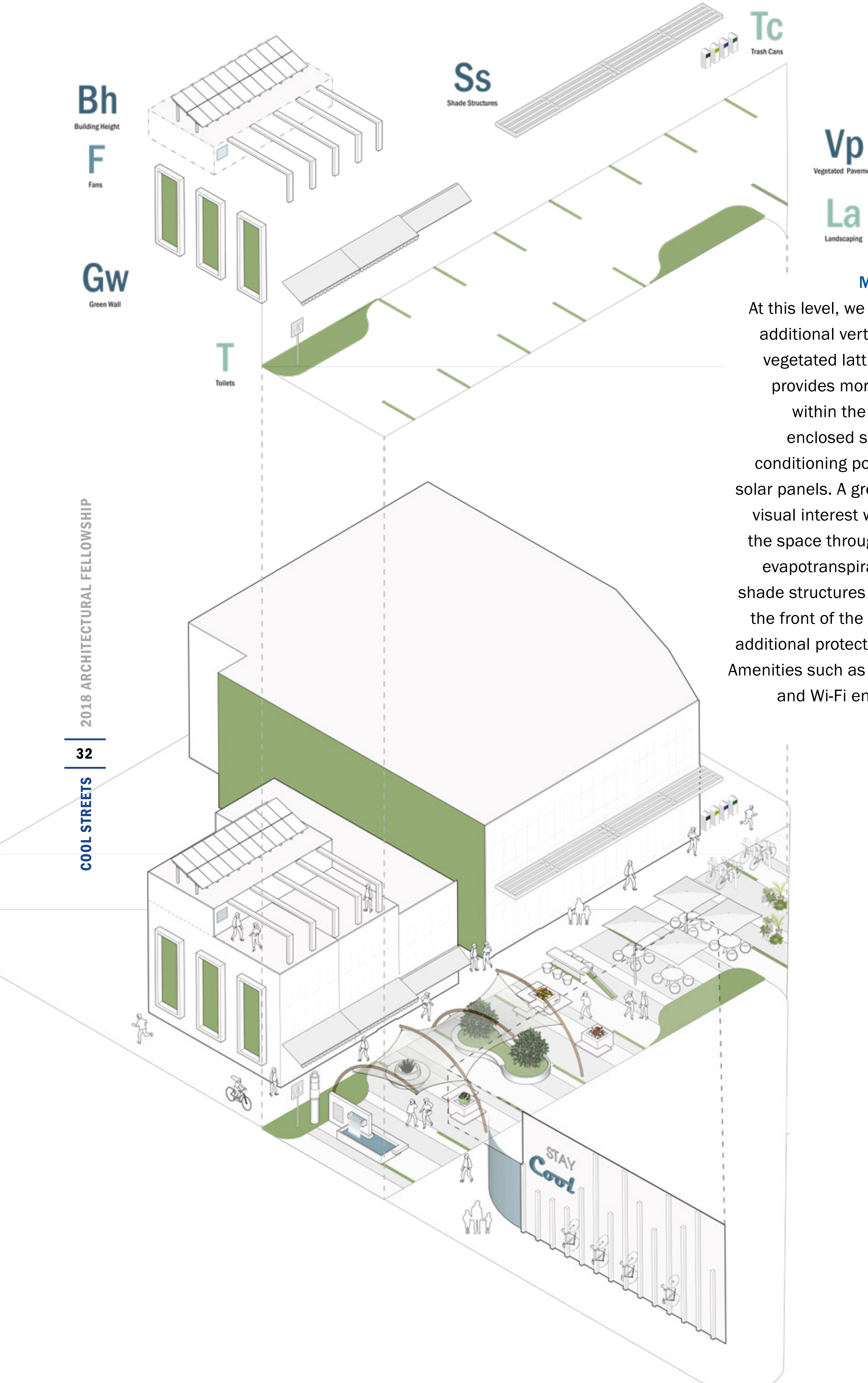
Minor Intervention

Low cost solutions to cooling the plaza include moveable, temporary shade structures to provide relief from the sunny plaza and reduce the amount of solar energy absorbed by the materials beneath. For areas exposed to the sun, white topping (achieved by covering existing asphalt with a layer of cement concrete) can significantly reduce ambient temperatures. Closing the plaza to cars can also help to reduce temperatures. In order to attract people to the space, we recommend incorporating placemaking tactics like flexible seating and minor landscaping.



Medium Intervention

Larger and more costly approaches include expanding the temporary shade structures to provide shade along the entire length of the plaza. A water feature offers evaporative cooling benefits and welcomes more adventurous users to dip their toes in the water while they sit. Incorporating cool colors and an interactive, functional art display that engages the community encourages more use, comfort and ownership over the space. For an additional level of safety, emergency signage that can be updated with heat warnings, as well as an emergency call box, are recommended.



Major Intervention

At this level, we propose creating additional vertical height with a vegetated lattice structure that provides more hours of shade within the plaza. This semi-enclosed space includes air conditioning powered by rooftop solar panels. A green wall provides visual interest while also cooling the space through the process of evapotranspiration. Permanent shade structures that project from the front of the buildings provide additional protection from the sun. Amenities such as public restrooms and Wi-Fi encourage use and gathering.

CONCLUSION

Extreme heat may be the largest challenge that cities face in an era of climate change, yet it does not receive as much attention or discussion as other extreme weather events. Public places hold incredible promise for the health and wellbeing of people worldwide, but in dense cities like New York, when strategically sited, they become essential for mitigating the risks of vulnerable populations from escalating temperatures. Maximizing the benefit of these spaces with design interventions during hot summer days not only improves the public's comfort and enjoyment, but it can also save lives. Many of the strategies identified in this report are relatively simple, low-cost, and easy to apply, and they can be integrated throughout a city's plan – as part of the design of new spaces, or to improve existing ones. When implemented as a network of "cool streets," these welcoming, free places can be part of a stronger, more robust plan for responding to the potentially devastating impacts of climate change in our urban environments.

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AFTERWORD

ARCHITECTURAL FELLOWSHIP FOR THE HUMAN EXPERIENCE

Each summer, Perkins Eastman selects three students to partake in the Architectural Fellowship for the Human Experience. One of these students develops a project on the public realm in particular. Students selected for this position show particular interest in examining the interface between architectural design and public life. The fellowship focuses on a proposed project and produces a body of conceptual design work as part of a collaborative team within the firm. Each fellow's project contributes to an evolving and dynamic dialogue that examines how design can enhance people's lives. The fellow's proposed project typically explores placemaking within today's urban context, as it relates to and/or is informed by technology, public life, and economic factors. For the duration of the fellowship, there are opportunities to workshop the idea as it evolves and receive feedback from professionals working in the field. The final developed project is typically delivered in the form of a design proposal, white paper and/or seminar and is critiqued by both peers and industry professionals.

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