Elisabeth Haub School of Law

Environmental Law & Policy Hack

Competition Inaugural Problem

Providing Los Angeles with Vegetative Solutions to Global Climate Change and The Heat Island Effect

By Anna Chen and Kelsey Keane of Benjamin N. Cardozo School of Law

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1. About the Author

Anna Chen

Anna is a second-year law student. Her interest in environmental policy stems from the summer that she spent doing ecology research at a northern Michigan field station. Living in a cabin, observing plants and animals, and visiting diverse landscapes instilled in her a great appreciation for the inherent value of all living things. Having had the opportunity to learn about environmental conservation from both ecological and legal perspectives empowers her to one day work at the intersection of environmental science and the law.

Kelsey Keane

Kelsey is a second-year law student. Her interest in environmental policy is very closely tied to her interest in building sustainable, affordable housing and city planning. As an undergraduate, Kelsey chaired environmental committees within the Department of Student Success and advocated for local farm to table produce in the student dining halls. Kelsey hopes to work in city governments to build sustainable and cost-effective infrastructures and combat housing shortages.

2. Executive Summary

The devastating effects of global warming are increasing at alarming rates.[1] The global temperature of combined land and water has increased at an average rate of 0.13ºF per decade

[1] *See e.g.,*Earth Science Communications Team, *The Effects of Climate Change*, NASA, https://climate.nasa.gov/effects/ (last visited Sept. 29, 2020) ("Scientists have high confidence that global temperatures will continue to rise for decades to come, largely due to greenhouse gases produced by human activities.") [hereinafter *The Effects of Climate Change*]; Melissa

since 1880.[2] Increasing global temperatures, compounded by the Heat Island Effect, pose a dangerous threat to our nation's cities. "Heat islands are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies."[3] Heat Islands increase energy consumption, elevate emission of air pollutants, and endanger residents health and safety.[4] After a heat wave in 2006, at least 140 people died due to heat-related illnesses, and 17,100 more were hospitalized.[5] Increasing temperatures cause more deaths per year than any other weather hazards, despite the preventability of the Heat Island Effect.[6]

The following policy proposal focuses on mitigating the Heat Island Effect in Los Angeles and addressing global climate change with vegetative infrastructure. Vegetative solutions like tree canopies and green roofs can significantly reduce the temperatures experienced by residents, thereby reducing mechanical cooling use and greenhouse gas

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Denchak, *Are the Effects of Global Warming Really that Bad*, Nat'l Res. Def. Council (Mar. 15, 2016), https://www.nrdc.org/stories/are-effects-global-warming-really-bad ("[C]limate project [the Earth] will be at least eight degrees warmer by 2100.").

[2] Lindsey, *Climate Change: Global Temperature* (citing NOAA National Centers for Environmental Information, *State of the Climate: Global Climate Report for Annual 2019*, National Centers for Environmental Information (Jan. 2020)), https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature (discussing the combined land and ocean temperature change per decade).

[3] *Heat Island Effect*, EPA (Aug. 24, 2020) https://www.epa.gov/heatislands#:~:text=Heat%20islands%20are%20urbanized%20areas,as%20forests%20and%20water%20bodies. ("Heat islands are urbanized areas that experienced higher temperatures than outlying areas.")

[4] *Id*.

[5] Hospitalizations includes emergency room visits. *Heat-related mortality and morbidity,* Cal. EPA (2019) https://oehha.ca.gov/media/epic/downloads/19humanhealth_14jan2019.pdf.

[6] *Id.* ("Deaths and illnesses from heat exposure are severely underreported and vary from year to year.").

emissions. Implementing vegetative solutions can give rise to certain challenges especially in southern California, such as inciting wildfires, quickly depleting water sources, and combating environmental racism. This proposal aims to address those challenges through innovative partnerships, careful city planning, and water conservation.

3. Current Climate in Los Angeles

3.1. Statutory Impact

At a federal level, little has been done to address the negative effects of climate change. Despite failed legislation to reduce carbon emissions, such as the American Clean Energy and Security Act,[7] President Obama and his administration developed several executive orders and welcomed a United States Supreme Court ruling in *Massachusetts v. EPA* that provided for the classification of carbon dioxide as a "pollutant" to be regulated under the Clean Air Act.[8] However, President Trump overturned several of former President Obama's executive orders and signaled a different path with Congress, "showing little interest in supporting aggressive climate change policies."[9] President Trump even went as far as withdrawing from Paris Accord,[10] in holding economic interest over environmental interests, when stating that, "[T]he United States

[7] The American Clean Energy and Security Act, an act introduce by the 111th Congress, endeavored to create clean energy jobs, reduce global warming, and establish energy independence. H.R. 2454, 111TH CONG. (2009).
[8] *Massachusetts v.* EPA, 549 U.S. 497 (2007); 42 U.S.C. §§ 7401–7671Q.
[9] John M. W. Moorlach, *Climate Change Policies in California* https://moorlach.cssrc.us/content/climate-change-policies-california (last visited Sept. 29, 2020) [hereinafter Moorlach, *Climate Change Policies in California*] (citing Robinson Meyer, *The Giant Trump Climate Order is Here*, The Atlantic (Mar. 28, 2017) https://www.theatlantic.com/science/archive/2017/03/trump-climate-eo/520986/).
[10] The Paris Accord, or Paris Agreement, serves as a multi-state agreement to substantially reduce the risks and impacts of climate change negotiated within the United Nations Framework Convention on Climate Change. U.N. Doc. FCCC/CP/2015/L.9/Rev/1 (Dec. 12, 2015).

will cease all implementation of the non-binding Paris Accord and the draconian financial and economic burdens the agreement imposes on our country."[11]

As a result, California has taken to a leadership role in implementing state legislation aimed at combating global warming and the continuing impacts of climate change in our society.[12] Initial steps towards a global warming solution were taken in 2006 when the California State Senate passed the Assembly Bill (AB) 32, or the Global Warming Solutions Act ("the Act"), which purported "to place caps on carbon dioxide and other greenhouse gases, including those in automobile emissions."[13] More specifically, the Act created a multi-year program to reduce emission to 1990 levels by 2020.[14] By 2016, the state of California expanded its efforts to reduce greenhouse gas emissions with the passage of Senate Bill (SB) 32.[15] The SB 32 raised its effort to reduce greenhouse gas emissions to 40 percent below 1990 levels by 2030.[16] Upon recognizing the urgency for states with large vehicle fleets to adopt stricter vehicle emissions standards than EPA's national standards at the time, California senators requested the EPA to grant California a waiver.[17] Such a waiver would allow California to enact for itself vehicle

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[11] Moorlach, *Climate Change Policies in California* (citing President Donald Trump, Statement by President Trump on the Paris Climate Accord (June 1, 2017)).
[12] *See California Senate passes Global Warming Solutions Act*, History.Com (Aug. 30, 2006) https://www.history.com/this-day-in-history/california-senate-passes-global-warming-solutions-act#:~:text=On%20August%2030%2C%202006%2C%20the,those%20found%20in%20automobile%20emissions [hereinafter *California Senate passes Global Warming Solutions Act*] ("The bill's passage solidified California's role as a leader in enacted legislation aimed at combating global warming.").
[13] *Id.*
[14] *Id.*
[15] A.B. 32, 109TH CONG. (2006).
[16] *Id.*; *California Senate passes Global Warming Solutions Act* ("California is now demonstrating impressive outcomes from the implementation of its climate policies. After the first decade of AB32 implementation, California's economy is growing while carbon pollution is declining.").
[17] The Case for the California Waiver, 110th Cong. (2007).

emissions standards that are stricter than those of the Clean Air Act.[18] In 2008, EPA granted this waiver of Clean Air Act preemption to California.[19] Today, 13 other states have adopted California's vehicle standards under Section 177 of the Clean Air Act.[20]

On a local scale, Los Angeles County has implemented the 2020 Community Climate Action Plan ("CCAP"), 2020 CCAP Implementation Ordinances, and the General Plan Annual Progress Report which all serve to reduce the impacts of climate change by reducing greenhouse gas emissions from community activities.[21] Specifically, the CCAP Implementation Ordinances, under Title 22, serve to develop the City of Los Angeles to be more compatible for implementation of cool roofs and cool pavement, infrastructure for electric vehicles, tools for vehicle idle reduction, and secondary uses for high-voltage power lines.[22]

3.2. Rising Heat Trends in Los Angeles

Since the 1990s, California's near-surface temperature has increased by approximately 2°F annually.[23] Projection models, developed by the UCLA Institute of the Environment and Sustainability, show continuous temperature increases in the state of California through the end

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[18] *Id.*
[19] *See California Greenhouse Gas Waiver Request*, EPA, https://www.epa.gov/regulations-emissions-vehicles-and-engines/california-greenhouse-gas-waiver-request (last visited Sept. 28, 2020) ("EPA granted. Waiver of Clean Air Act preemption to California for its greenhouse gas emission standards for motor vehicles beginning with the 2009 model year.").
[20] *States that have Adopted California's Vehicle Standards under Section 177 of the Federal Clean Air Act*, Cal. Air Res. Bd. (Aug. 19, 2019) https://ww2.arb.ca.gov/sites/default/files/2019-10/ca_177_states.pdf.
[21] *Community Climate Action Plan*, Los Angeles Cty. Dep't Reg'l Planning (2020) http://planning.lacounty.gov/ccap.
[22] LOS ANGELES, CAL., CODE § 22 (2020).
[23] *State Climate Summaries: California*, NOAA National Centers for Environmental Information, https://statesummaries.ncics.org/chapter/ca/ (last visited Sept. 28, 2020) ("Average annual temperature has risen by approximately 2ºF since the early 20th century.").

of the 21st century: an increase of between 35.1°F and 37.4°F in a low, global greenhouse gas emissions scenario; 37.6°F and 39.7°F in a medium emissions scenario; and 40°F and 42.4°F in a high emissions scenario by 2100.[24]

Other projections further predict the inevitability of continued temperature increases in Los Angeles without intervening mitigation efforts from government agencies.[25] According to these projections, in a "business-as-usual" scenario,[26] Downtown Los Angeles will see an increase in annual-mean surface air temperature by the mid-21st century--somewhere between 1.3°F to 6.5°F.[27] Further, projections suggest that Downtown Los Angeles will see a significant increase in its number of extremely hot days;[28] 2.3 to 10.2 more extremely hot days annually.[29]

Contrarily, projections of mitigation efforts illustrate potential to curb the effects of global warming in the near future.[30] Under a mitigation scenario,[31] Downtown Los Angeles will see about half as many extremely hot days.[32] Further, the mitigation scenario projections suggest that Downtown Los Angeles' annual-mean surface air temperature will only increase by 0.6°F to 5.0° F by the mid-21st century.[33] The data encompassed by the mitigation scenario are

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[24] Daniel R. Cayan et al., Climate change scenarios for the California region, 87 Climatic Change 21 (2008).
[25] Alex Hall, *Mid-Century Warming in the Los Angeles Region Part I of the "Climate Change in the Los Angeles Region" project*, UCLA Dep't of Atmospheric and Oceanic Sci., https://www.coolrooftoolkit.org/wp-content/uploads/2012/07/LA-Heat-Storm.pdf [hereinafter Hall, *Mid-Century Warming in the Los Angeles Region*].
[26] The business-as-usual scenario considers the situation where greenhouse gas emissions continue to increase at the past decade's rates.
[27] Hall, *Mid-Century Warming in the Los Angeles Region* at 44.
[28] Hot days are those days with a maximum temperature above 95°F.
[29] Hall, *Mid-Century Warming in the Los Angeles Region* at 21.
[30] *Id.* at 3.
[31] A mitigation scenario is one in which emissions decline over the next few decades due to a global effort to mitigate greenhouse gases.
[32] *Id.* at 21.
[33] *Id.* at 44.

substantially lower than the "business-as-usual" projections.[34] Based on these projections, mitigation efforts are an essential tool in combatting rising temperatures in the City of Los Angeles.[35]

3.3. Funding[36]

In the 2019-2020 Annual Fiscal Year Budget Report[37] (hereinafter, the "Budget"), the City of Los Angeles apportioned $3,223,904,392 for spending on Home and Community Environment.[38] Home and Community Environment allocates funding into eleven categories: "(BA) Building Regulation; (BB) City Planning and Zoning; (BC) Blight Identification and Elimination; (BD) Public Improvements; (BE) Stormwater Management; (BF) Wastewater Collection, Treatment and Disposal; (BH) Solid Waste Collection and Disposal; (I) Aesthetic and Clean Streets and Parkways; (BL) Environmental Quality; (BM) Neighborhood Improvement; (BN) Housing."[39]

Further, Los Angeles Mayor, Eric Garcetti, has demonstrated his commitment to funding and supporting green initiatives through "L.A.'s Green Deal, Sustainable City pLAn."[40] This initiative allocates approximately $55.2 million to the City's environmental improvement

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[34] *Id.*
[35] *Id.*
[36] *See* Appendix B- Available Funding Chart
[37] The Annual Fiscal Year Budget Report is submitted by the Mayor, adopted by the City Council and distributed by the Controller and City Administrative Office each fiscal year at 600. This document reflects the City of Los Angeles' budget for the 2019/2020 fiscal year.
[38] Eric Garcetti*, City of Los Angeles Budget, Fiscal Year 2019-2020*, City of L.A. (2019) [hereinafter Garcetti, *City of Los Angeles Budget*].
[39] *Id.* at 41 and 602.
[40] Eric Garcetti, *L.A.'s Green New Deal*, Sustainable City pLAn (2019) (explaining an expanded plan to "[secure] clear air and water and [stabilize] climate").

projects.[41] The City of Los Angeles has begun implementing this initiative, which purports to uphold the following four key principles: (1) maintain a commitment to uphold the Paris Climate Agreement; (2) deliver justice by delivering an inclusive green economy; (3) implement green jobs; and (4) showcase to the world what an urban Green New Deal looks like.[42] Specifically, this plan pledges to utilize funds to plant 90,000 trees by Year 2021, recycle 100% of waste water by Year 2035, and capture and source local water.[43] It also undertakes the commitment to implement green jobs, such as "jobs in businesses that produce goods or provide services that benefits the environment or conserve natural resources."[44] Supplemental monies are made available for these environmental improvements through a partnership with the Los Angeles Department of Recreation and Parks ("RAP").[45] RAP has pledged to align with LA's Green Deal, Sustainability pLAn and the Mayor's specific environmental goals by allocating a total of $64,044,000 to the City's Land Maintenance to provide general upkeep, cleanliness, and maintenance of park grounds and facilities.[46]

Moreover, the City has selected organizations dedicated to cooling the streets. To advance its street cooling goals, the City of Los Angeles has allocated $3,000,000 in cool

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[41] *Id.* at 32 (providing $23 million to Green Together: Northeast Valley, $200,000 to South L.A. Climate Commons Collaborative, and $32 million to Watts Rising).
[42] *Mayor Garcetti Launches L.A.'s Green New Deal*, City of Los Angeles (Apr. 29, 2019) https://www.lamayor.org/mayor-garcetti-launches-la%E2%80%99s-green-new-deal.
[43] The City of Los Angeles endeavors to plant 90,000 trees across Los Angeles, "rooting them in neighborhoods that have been most impacted by high emissions and high temperatures," "recycle 100% of all wastewater for beneficial reuse by 2035" and "source 70% of L.A.'s water locally and capture 150,000 acre ft/yr of stormwater by 2035." *Id.* at 44–123.
[44] The City of Los Angeles pledges to "create 300,000 green jobs by 2035; and 400,000 by 2050. *Id.* at 11, 132.
[45] Michael A. Shull, *Overview of the Adopted Fiscal Year 2019-2020 Department of Recreation and Parks Operating Budget*, City of L.A. Dep't of Recreation and Parks (2019).
[46] *Id.* at 7.

pavement technologies, as a part of its "Cool LA" initiative.[47] This amount will be distributed between multiple types of street cooling technologies directed by the Bureau of Street Services, StreetsLA.[48] StreetsLA is a publicly funded division of the Department of Public Works with an annual budget of approximately $210 million, which is used to conduct street improvements, implement the City's Cool Pavement Program, and plant street trees.[49] To date, "StreetsLA manages nearly 700,000 street trees growing along 6,500 miles of public roads."[50]

Finally, TreePeople is a grassroots community organization that partners with government organizations to build an equitable tree canopy and local water supply while supporting research and policy proposals for the City.[51] In 2018, TreePeople raised $2,950,287 from donors, to use towards urban forestry and urban cooling initiatives.[52]

The policy initiative proposed in this document will accomplish, in part, many of the goals suggested in the Budget, LA's Green Deal Sustainable City pLAn, athe Cool LA initiative; funding from these initiatives can be utilized to support this proposal.[53]

3.4. Water Mismanagement[54]

Water shortages and droughts have plagued southern California for decades.[55] Though climate change has contributed to warmer temperatures, it is not the only impetus for long-

[47] Garcetti, *City of Los Angeles Budget* at 8.
[48] *Id.*
[49] *Id*.
[50] *Id*.
[51] TreePeople Financial Statements, TreePeople (Dec. 21, 2018).
[52] *Id.* at 22.
[53] See the chart in Appendix B for an outline of all available funds.
[54] Water mismanagement, precisely in California, refers to irresponsible amounts of water syphoned from the Colorado River annually.
[55] *Drought in California,* U.S. Drought Portal (Sept. 22, 2020) ("Since 2000, the longest duration of duration of drought in California.").

lasting droughts or water shortages in California; water mismanagement and lack of precipitation driven by natural atmospheric cycles are the two main causes for water scarcity.[56]

Residents of California, Wyoming, Colorado, New Mexico, Utah, Nevada, and Arizona share water from the Colorado River.[57] Specifically, the Colorado River "sustains 40 million people in those states, supports 15 percent of the nation's food supply, and fills two of [the] largest water reserves in the country."[58] The Colorado River experienced a particularly wet year when it was originally divided amongst the states leading to "[t]he states vastly overestimate[ing] the river's annual flow."[59] Maintaining a reliance on a single-source water supply is contrary to drought preparedness and can lead to an increase in wildfires.[60] This proposal suggests vegetative solutions to the Heat Island Effect; however, a major concern of vegetative solutions is the extensive water use. It is, therefore, imperative to use drought-resistant and low-water plants throughout all of the proposed solutions below.[61]

3.5. Turf Replacement Program for Water Conservation

Los Angeles has developed programs to help make the most out of southern California rainfall. Water conservation helps reduce overall regional water demand on a single water source, as described in *Section 3.4* of this proposal. Conservation can ensure a greater amount of

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[56] Amanda Zamora, Abrahm Lustgarten & Lauren Kirchner, *California's Drought Is Part of a Much Bigger Water Crisis. Here's What You Need to Know*, ProPublica (June 25, 2015, 12:30pm) https://www.propublica.org/article/california-drought-colorado-river-water-crisis-explained (last visited Sept. 27, 2020).
[57] *Id.* ("Wyoming, Colorado, New Mexico, Utah, Nevada, Arizona and California all share water from the Colorado River.").
[58] *Id.* at ¶ 1.
[59] *Id.* at ¶ 10.
[60] *Id.* at ¶ 5.
[61] See *Appendix A.*

reliable water supply for the region. Sustainable landscaping is a key aspect of conservation and is thus crucial to the vegetative solutions in this proposal.[62]

Decentralized strategies for collecting and distributing water, such as rainwater harvesting and stormwater capture, provide "a diverse mix that reduce[s] dependence on any single source."[63] Implementing vegetative solutions to the urban heat crisis in drought-afflicted areas like California, does not impede responsible water management. Green spaces can be irrigated with recycled water and stormwater harvesting.[64]

The vegetative goals in this proposal must be aligned with the City's existing conservation efforts. Further, street trees planted to block the sunlight and reduce sidewalks and parkway heat should be "Low Water Trees."[65] Community gardens and other new green spaces should use other water conservation techniques such as specific water-retaining soils, special watering devices, stormwater capture, and low-water plants. The type of soil used in gardens greatly alters the amount of water absorbed into the earth or that runs off the soil. Using 2-4" mulch above the soil surface mitigates weeds and infiltrates rain water.[66] Wood mulch with grass

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[62] Nicki Meier, *Water Retention Landscape Techniques for Farm and Garden*, Permaculture Res. Inst. (Aug. 8, 2013), https://www.permaculturenews.org/2013/08/08/water-retention-landscape-techniques-for-farm-and-garden/.

[63] *Transferring Lessons from Australia's Millennium Drought to California: ACCELERATING ADAPTATION TO DROUGHT, FLOOD & HEAT*, TreePeople, 4 (Feb. 2016).

[64] *Id.* at 37.

[65] *See* Appendix A; Low *Water Trees*, L.A. Dep't of Water and Power http://www.ladwp.cafriendlylandscaping.com/listplants.php?index=1 (last visited Sept. 27, 2020).

[66] *See Tour: Watershed Garden*, Cal. Friendly Landscaping http://www.ladwp.cafriendlylandscaping.com/GWImage.php?index=2&source=gtc (last visited Sept. 30, 2020) ("Incorporate compost 6" into your soil to retain water, reduce compaction, feed earthworms, and provide valuable nutrients to your plants.")

clippings retain water for longer and thus does not require as much rainfall per year to keep plants healthy.[67]

Watering devices are also a crucial aspect of water conservation in gardens. Low-pressure irrigation systems deliver "water directly to where the plant needs it, with little or no evaporation, overspray and runoff."[68] Prioritizing rainwater capture can take the pressure off of irrigation systems.[69] Rain barrels can capture stormwater and slowly distribute water into irrigation systems during dry spells.[70]

City parks have already begun implementing some of these strategies to preserve water. "Turf removal strategies include replacement with organic and hardscape materials, such as drought tolerant plants, mulch, decomposed granite, gravel, permeable pavers. The Department of Water and Power estimates that each square foot of turf removed will save up to 32.4 gallons each year."[71] New parks and community gardens can incorporate these same water-saving strategies.

Planting trees intermittently throughout parks and gardens can advance conservation efforts. "Shade from trees slows water evaporation from thirsty lawns. Most newly planted trees

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[67] Marie Iannotti, *What Is Mulch?*, The Spruce, https://www.thespruce.com/what-is-mulch-1402413 (last updated Sept. 17, 2020).
[68] Douglas Kent, *California Friendly: A maintenance guide for landscapers, gardeners and land managers*, The Metropolitan Water Dist.of So.Cal., 12 (Mar. 2017).
[69] *SIX ELEMENTS OF A CALIFORNIA FRIENDLY LANDSCAPE*, The Met. Water Dist. of So. Cal., 3 (July 2013), https://www.coronaca.gov/home/showdocument?id=2192 ("High pressure causes breaks and misting and wastes water.").
[70] *Id.*
[71] Amy A. Garcia, *DOUBLING DOWN on Water and Energy Conservation*, Parks and Rec., 58 9Apr. 2016).

need only fifteen gallons of water a week. As trees transpire, they increase atmospheric moisture."[72]

3.6. Current Fire Crisis

Wildfires have burned throughout California for centuries and have become a natural part of the state's landscape. [73] However, in recent decades, especially in Southern California, the area burned in the state has increased.[74] In terms of acres burned, this year's wildfire season in California has already become the largest wildfire season ever recorded in the state.[75] California wildfires are inevitable and must be addressed when proposing vegetative solutions.

There is an important distinction between wildfires that are driven primarily by Santa Ana winds ("SA fires") and those that are driven primarily by hot and dry weather ("non-SA fires").[76] SA fires occur from October through April, whereas non-SA fires occur from June

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[72] *TOP 22 BENEFITS OF TREES*, TreePeople, https://www.treepeople.org/tree-benefits (last visited Sept. 27, 2020).
[73] *See* Scott L. Stephens, Robert E. Martin, & Nicholas E. Clinton, *Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands*, 251 Forest Ecology and Mgmt. 205 (2007); *2020 Incident Archive*, Calif. Dep't of Forestry and Fire Protection, https://www.fire.ca.gov/incidents/2020/ ("Fires ignited by lightning and Native Americans have been a component of the majority of California ecosystems for thousands of years.").
[74] *See* Yufang Jin, *Identification of two distinct fire regimes in Southern California: implications for economic impact and future change*, 10 Envtl. Res. Letters 1 (2015) (citing Yufang Jin, *Contrasting controls on wildland fires in Southern California during periods with and without Santa Ana winds*, J. of Geophysical Res., Vol. 119 (2014)).
[75] *See* Priya Krishnakumar & Swetha Kannan, The worst fire season ever. Again., L.A. Times (Sept. 15, 2020), https://www.latimes.com/projects/california-fires-damage-climate-change-analysis/ (holding that California has the largest wildfire season by stating "the last 10 years have shattered records. 2020 tops them all").
[76] *See* Yufang Jin, *Identification of two distinct fire regimes in Southern California: implications for economic impact and future change*, 10 Envtl. Res. Letters 1, 2 (2015) [hereinafter Jin, *Identification of two distinct fire regimes*] (citing Yufang Jin, *Contrasting controls on wildland fires in Southern California during periods with and without Santa Ana winds*, J. of Geophysical Res., Vol. 119 (2014)) ("Non-SA fires typically occurred in more remote inland areas, and the

through September.[77] Although SA fires tend to cause more fatalities, damage more buildings, and reduce property value, non-SA fires generally burn more acres.[78]As a result, the state of California spent significantly more money and resources fighting non-SA fires.[79] The policies proposed here aim to mitigate the increasingly hot climate in the City of Los Angeles and, therefore, may only primarily mitigate the occurrence and intensity of non-SA fires.[80]

4. Policy Recommendations

The dark infrastructure in urban areas cause cities to experience the damaging Heat Island Effect because it generally has a lower albedo.[81] The higher the albedo of a surface, the more that the surface reflects (rather than absorbs) radiation.[82] An albedo increase of just 0.13 can decrease air temperature in the Los Angeles basin by 2°C to 4°C.[83] Though vegetation generally has low albedo, vegetative solutions can still significantly mitigate the Heat Island

majority of these locations burned just once during the past 50 years, though a few ares along heavy traffic corridors and with relatively strong summer winds burned more frequently.").
[77] *Id.* at 2 ("[N]on-SA fires that coincide with hot and dry weather mostly in June through September.").
[78] *Id* at 8, tb. 1.
[79] *Id.* at 8–9 ("[T]he cumulative amount spent fighting SA fires during 1995-2009 ($390 M) was well below that spent on non-SA fires ($743 M).").
[80] Jin, *Identification of two distinct fire regimes* at 2.
[81] *See* Sandra Totten, *LA area has highest urban heat island effect in California*, Southern Cal. Pub. Radio (Sept. 21, 2020), https://www.scpr.org/news/2015/09/21/54511/la-area-has-highest-urban-heat-island-effect-in-ca/; *Heat Island Compendium*, EPA, https://www.epa.gov/heatislands/heat-island-compendium (last visited Sept. 19, 2020). Albedo is a measure of the amount of light that a surface reflects- than light surfaces. *Albedo*, N.C. Climate Off., https://climate.ncsu.edu/edu/Albedo (last visited Sept. 20, 2020).
[82] *Id.*
[83] Haider Taha, *Urban climates and heat islands: albedo, evapotranspiration, and anthropogenic heat*, 25 Energy Buildings 99, 4 (1997) (citing Haider Taha *Modeling the impacts of large-scale albedo changes on ozone air quality in the South Coast Air Basin*, Atmospheric Env't (1995)).

Effect though the processes of "evapotranspiration cooling."[84] Evapotranspiration occurs when water evaporates from a leaf after intercept irradiation from the sun's rays.[85] Evapotranspiration cools the air and blocks the sun from reaching the darker surfaces such as building and roadways.[86]

Integrating vegetative solutions into urban landscapes can significantly mitigate the Heat Island Effect[87] by providing shade, shielding buildings from winds, and absorbing solar irradiation.[88] In addition, the evapotranspiration, shade from trees decreases surface and air temperatures reducing the cost of cooling buildings in warmer months.[89] In colder months, trees and plants shield buildings from cold winds reducing building-warming energy use.[90] Finally, vegetative solutions can mitigate the Heat Island Effect by absorbing and removing significant amounts of carbon dioxide from the air, or carbon sequester.[91]

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[84] *Vegetation: Its Role in Weather and Climate*, N.C. Climate Off., https://climate.ncsu.edu/edu/Vegetation (last visited Sept. 23, 2020) (Forests are beneficial because they use copious amounts of carbon dioxide, as well as mitigating heat through transpiration.").
[85] *Id.*
[86] *Id.* ("[P]lants don't contribute to overall warming because the excess warmth is offset by evaporative cooling from transpiration.").
[87] *See Using Trees and Vegetation to Reduce Heat Islands*, EPA, https://www.epa.gov/heatislands/using-trees-and-vegetation-reduce-heat-islands (last visited Sept. 19, 2020) ("Trees and other plants help cool the environment, making vegetation a simple and effective way to reduce urban heat islands.") [hereinafter *Using Trees and Vegetation to Reduce Heat Islands*]; Octavian S. Ksenzhek & Alexander G. Volkov, *Plant Energetics* (1998).
[88] *Using Trees and Vegetation to Reduce Heat Islands*.
[89] *Id.;* Peak temperatures of shaded surfaces can be 20-45°F cooler than that of their unshaded counterparts. Hashem Akbari, *Peak power and cooling energy savings of shade trees*, 25 Energy and Buildings, 139 (1997).
[90] Tim Tyson, Urban Forestry Division, Streets LA, https://streetsla.lacity.org/urban-forestry-division (last visited Sept. 19, 2020).
[91] *See Carbon Sequestration to Mitigate Climate Change*, U.S. Geological Surv., https://pubs.usgs.gov/fs/2008/3097/pdf/CarbonFS.pdf (last visited Sept. 23, 2020).

The following proposals suggest ways to integrate vegetation into Los Angeles infrastructure to mitigate global warming.

4.1. Green Walls & Green Roofs

Green Walls Reduce Building Energy Load

Green walls are exterior walls covered with vegetation ranging from wall shrubs to climbing plants.[92] By installing green walls into public housing, the City could save significantly in energy costs, while improving property values and mitigating extreme heat.[93] Green walls reduce the surface temperatures of buildings through evapotranspiration and shade.[94] Green walls are divided into two categories: green facades, which consist of vegetation rooted at the base of a wall, in soil, or in a large planter; and living walls, which consist of vegetation rooted in containers that are fastened to a wall.[95]

As an initial matter, living walls are generally more expensive to install than green facades but have greater long-term benefits to the City of Los Angeles.[96] Specifically, living walls reduce a greater amount of energy expenditure and promote biodiversity.[97] Living walls

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[92] Ross W.F. Cameron et al., *What's 'cool' in the world of green façades? How plant choice influences the cooling properties of green walls*, 73 Building and Env't 198 (2014).
[93] *Id.*
[94] Carolyn Oldham & Azrina Karima, *Performance of green walls in Mediterranean climates: A literature review*, Sch. of Engineering, The U. of Western Austl. (Aug. 2018), https://www.researchgate.net/publication/341927653 ("The green wall systems can also cool the surroundings through a combined effect of shading of sunlight and evapotranspiration.").
[95] *Id.*
[96] *See* Peter J. Arsenault, *Green Walls: Integrating Nature into Buildings*, Continuing Educ. Ctr., https://continuingeducation.bnpmedia.com/courses/tournesol-siteworks/green-walls-integrating-nature-into-buildings/4/ (last visited Sept. 28, 2020)(" A living wall will inevitably be more expensive to maintain than a green façade due to the complexity of the system.").
[97] *Id.*

reduce the amount of energy it takes to cool a building by 75%, whereas green facades only reduce energy expenditures by 26%.[98] Living walls have containers and growing materials built into the wall itself that create an additional insulation layer.[99] Additionally, living walls support great plant diversity, which boosts ecosystem productivity.[100] Plant diversity provides a more natural ecological habitat, which in turn reduces the amount of water and pesticides needed to support a living wall.[101] "Services provided by [diverse] ecosystems include carbon sequestration, climate regulation, nutrient cycling and pollination."[102] Living walls, as opposed to green facades, save the City more money in energy cost and require less maintenance cost as a result of built-in biodiversity.[103]

Living walls cost approximately $125 per square foot, with maintenance cost averaging $300-$1000 per month.[104] The City of Los Angeles owns 792,000 properties throughout the

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[98] Carolyn Oldham & Azrina Karima, *Performance of green walls in Mediterranean climates: A literature review*, Sch. of Engineering, The U. of Western Austl., 7 (Aug. 2018), (citing Julia Coma & Alvaro de Garcia, *Thermal characterization of different substrates under dried conditions for extensive green roofs*, 144 Energy and Buildings 175 (2017)[hereinafter Oldham, *Performance of green walls in mediterranean climates: A literature review*]).
[99] *See* Oldham, *Performance of green walls in mediterranean climates: A literature review* at 7 ("The green wall creates a static air layer between it and the adjacent wall, that acts as a thermal later.")*;* Maria Manso & Joaõ Castro-Gomes, *Green wall systems: A review of their characteristics*, 41 Renewable and Sustainable Energy Reviews 863 (2015).
[100] Oldham, *Performance of green walls in mediterranean climates: A literature review* at 8.
[101] *Id.*
[102] *Why Conserve Plants?*, Botanic Gardens Conservation Int'l, https://www.bgci.org/about/about-plant-conservation/ (last visited Sept. 29, 2020); *see also Water for the Future: The West Bank and Gaza Strip, Israel, and Jordan,* NAP 67 (1999) (discussing the effects of biodiversity cleaning and saving water).
[103] Oldham, *Performance of green walls in mediterranean climates: A literature review* at 10–12.
[104] *See e.g., Frequently Asked Questions*, Suite Plants, https://www.suiteplants.com/living-wall-faq (last visited Sept. 28, 2020); *How Much Do Living Walls Cost?*, Greenscape (Nov. 8, 2017 10:53am), https://www.greenscapeinc.com/blog/how-much-do-living-walls-cost (last visited Sept. 29, 2020).

City.[105] If the City were to install 12 square feet of living wall onto a third of the government-owned buildings within the next year, it would cost the City approximately $396,000,000. The City can pay for these walls with funding from: (1) from Mayors Land Maintenance Fund of $64,000,000; (2) monies allocated for Building Regulation in the amount of $593,726,254; and (3) monies allocated for Environmental Improvements in the amount of $92,121,384 to cover the costs of these walls.[106] This would leave $353,847,638 in the budget to be applied to the more cost-effective method of green roofs, discussed below.

Green Roofs Reduce Building Energy Load

Building vegetation on roofs ("green roofs") can cool the surface temperatures of roofs and surrounding air, as well as the buildings below them.[107] Green roofs absorb solar radiation and supply buildings with a layer of insulation, thereby reducing internal building temperatures.[108] Further, extreme heat reduces energy required to cool the roofs, which saves money and reduces greenhouse emissions from buildings.[109]

A two-year study compared the cooling potential of a Green Roof to an adjacent roof made of a light grey-colored bitumen ("Reference Roof").[110] "The membrane on the Reference Roof absorbed the solar radiation and reached close to 158°F in the afternoon, while the surface

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[105] Alissa Walker, *This interactive map shows LA's publicly owned properties*, Curbed LA (Jul. 3, 2019 12:00pm), https://la.curbed.com/2019/7/3/20681291/map-public-property-los-angeles (displaying map with properties from six public agencies).
[106] *See* Section 3.3, Funding; *See* Appendix B.
[107] S.F. Ahmed, *Performance Evaluation of Hybrid Green Roof System in a Subtropical Climate Using Fluent*, 2 J. of Power and Energy Engineering 113 (2014).
[108] Susan Loh, *Green Roofs--Understanding Their Benefits for Australia*, 27 Env't Design Guide 1 (2009).
[109] *Id.*
[110] Karen Liu & Brad Bass, *Thermal Performance of Green Roofs Through Field Evaluation*, Nat'l Res. Council Can., 4 (Oct. 18, 2016).

of the Green Roof remained around 77°F."[111] The dramatic differences in surface temperature, as well as in shading, evapotranspiration, and insulation abilities between the two roofs facilitated massive differences in the respective building's energy demands in the spring and summer.[112] Between April and September, the average daily energy demand for mechanical cooling operation was approximately 20,500 BTU/day for the Reference Roof but only 5,100 BTU/day for the green roof, a 75% reduction in cooling energy.[113] If widely adopted in an urban landscape, green roofs can mitigate the heat island effect, thereby further reducing energy expenditure on cooling.[114]

Further, green roofs reduce building energy costs by mitigating temperature fluctuations.[115] In the study mentioned above, the Green Roof reduced 95% of the heat gain into the building and 26% of the heat loss from the building, as compared to the Reference Roof.[116]

Roofs generally receives more solar radiation than do the vertical surfaces of buildings making green roofs an especially efficient vegetative solution to reduce a building's internal temperatures.[117] However, green roofs in hot and arid regions, such as Mediterranean climates, are hostile for plants due to high temperatures, wind exposure, and drought.[118] Further, structural limitations of buildings reduce water availability and irrigation options for vegetation.[119] It is,

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[111] *Id.* at 2.
[112] *Id.* at 5.
[113] *Id.* at 5.
[114] *Id.* at 1.
[115] *Id.* at 5.
[116] *Id.* at 5–6.
[117] *Id.* at 4.
[118] Fabio Raimondo et al., *Plant performance on Mediterranean green roofs: interaction of species-specific hydraulic strategies and substrate water relations*, 7 AoB Plants 1, 1 (2015) ("Green roofs are rather hostile environments for plant growth, because of shallow substrate, high temperatures and irradiance and wind exposure").
[119] *Id.* at 1 (holding that there are impacts on water availability vegetation).

therefore, important to carefully select drought-resistant plant species for use on Mediterranean climate green roofs, such as two drought-resistant shrub species--*Arbutus unedo L.* and *Salvia officinalis L.*[120] [121] In addition, succulents are commonly used on green roofs for their high drought tolerance and relatively fast growth.[122] Additionally, planting vegetation in substrates with high water-holding capacity improves survival rate of green roof plants in Mediterranean climates.[123]

Green roof installation ranges from $7 to $20 per square foot, depending on the growing medium, irrigation needs, and plant variety, with average maintenance cost remaining around $1.50 per square foot.[124] The average residential roof is about 1,700 square feet.[125]

With an average cost of $15 per square foot, installing a single green roof costs around $25,500. The City of Los Angeles could install 6,939 green roofs comprised of *Arbutus unedo L.*, *Salvia officinalis L.*, and *Sedum* onto public buildings and still leave $177 million in the budget for future land maintenance, building regulation, and environmental improvements.[126]

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[120] *Id.* at 1.
[121] *See* Appendix A Low *Water Trees*, L.A. Dep't of Water and Power
[122] *Id.* at 2.
[123] *Id.* at 2.
[124] *See e.g., What is a Green* Roof, Technical Preservation Services, https://www.nps.gov/tps/sustainability/new-technology/green-roofs/define.htm (last visited Sept. 28, 2020); *NYC Parks Green Roof: A living laboratory for innovative green roof design*, NYC Parks, https://www.nycgovparks.org/pagefiles/84/NYC-Parks-Green-Roof.pdf (last visited Sept. 28, 2020) ("The estimated cost of this roof is between $25 and $30 per square foot."); Mia Taylor, *What a Green Roof Costs You on the Way to Saving Everything*, TheStreet (May 22, 2015 7:00am), https://www.thestreet.com/personal-finance/mortgages/what-a-green-roof-costs-you-on-the-way-to-saving-everything-13161050 ("[T]he university found that the green roof would cost $464,000 to install versus $335,000 for a conventional roof in 2006 dollars.").
[125] *See e.g., Roofing Calculator,* Roofing Calc.com*,* https://www.roofingcalc.com/roof-replacementcost/#:~:text=The%20average%20residential%20roof%20size,the%203%2Ddimensional%20roof%20surface (suggesting the average size of a residential roof).
[126] *See* Section 3.3, Funding; Appendix B.

4.2. Street Trees

Planting trees along streets provides a canopy of shade for pedestrians and prevents dark pavements from soaking up the sun's rays.[127] Street trees are an efficient and cost-effective way to cool the City of Los Angeles. “The city’s urban forest shades our homes and streets, reduces energy usage, minimizes the ‘heat island effect,’ helps clean the air, and improves property values making City neighborhoods cooler, more livable, and sustainable.”[128] There are multiple existing programs that plant and maintain the City’s street trees along public roads, parkways, center medians, and other public ways.[129]

Planting a canopy of trees is one of the most economical ways to cool urban areas.[130] “Street trees can reduce annual energy costs anywhere from $2.16 per tree per year to $64 per tree per year, depending on local climatic conditions. The effect of trees on energy savings varies by climate. A 25 percent increase in tree canopy cover was estimated to reduce cooling energy use by 57 percent in Sacramento, California (temperate to hot climate), 25 percent in Lake Charles, Louisiana (hot/humid climate) and 17 percent in Phoenix, Arizona (hot/dry climate).”[131] In 97 cities across the United States, tree canopies “save 245-346 lives annually, and help avoid more than 50,000 doctor’s visits due to heat annually. The total heat-related benefits from trees are $1.3-2.9 billion annually.”[132] Further, trees beautify neighborhoods, provide energy savings,

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[127] *See* University of Wisconsin-Madison, *Trees are crucial to the future of our cities*, ScienceDaily (Mar. 25, 2019), https://www.sciencedaily.com/releases/2019/03/190325173305.htm.
[128] *What We Do,* Bureau of Street Services, StreetsLA, https://streetsla.lacity.org/what-we-do (last visited Sept. 30, 2020).
[129] *See* Section 3.3, Funding; *See* Appendix B.
[130] Edith de Guzman, Dr. Laurence S. Kalkstein, & David Sailor*, Rx for Hot Cities*, TreePeople, 1 (2020).
[131] *Id.* at 20.
[132] *Id.* at 19.

offer a pleasant park setting for recreational activities, and add value to the property. Research shows that trees add 15 to 25 percent to property values."[133] Investing just $4 per resident in tree planting efforts could improve the health of millions of people.[134]

Most importantly, trees are critical tools in combatting climate change and cool the exceedingly hot city streets.[135] A single, mature tree absorbs 48 pounds of CO2 from the air each year.[136] A tree-lined sidewalk can reduce the temperature by 20°F- 45°F.[137]

The Heat Island Effect harms Black and Latinx neighborhoods at a higher rate than white or higher-income neighborhoods.[138] As a result of this striking inequity, Black and Latinx people are more likely to suffer complications from sustained heat waves and a higher mortality rate.[139]

A crucial aspect of the plan proposed in this document is investing in lower-income communities to mitigate the oppressive heat waves and the related health issues that arise from

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[133] *Id.* at 35.
[134] *Id.* at 19.
[135] *22 Benefits of Trees*, TreePeople, n.04 (2020) https://www.treepeople.org/tree-benefits (last visited Sept. 20, 2020) ("Average temperatures in Los Angeles have risen 6ºF in the last 50 years as tree coverage has declined and the number of heat-absorbing roads and buildings has increased.").
[136] *Tree Improve Our Air Quality*, Urb. Forestry Network, http://urbanforestrynetwork.org/benefits/air%20quality.htm#:~:text=On%20average%2C%20one%20acre%20of,pounds%20of%20CO2%20per%20year ("Trees reach their most productive stage of carbon storage at about 10 years at which point they are estimated to absorb 48 pounds of CO2 per year.").
[137] Steve Mouzon, *The powerful virtuous cycles of street trees*, Pub. Square (Aug. 31, 2020).
[138] *See* Meg Anderson & Sean McMinn*, As Rising Hear Bakes U.S. Cities, The Poor Often Feel It Most*, NPR (Sept. 3, 2019, 5:00am), https://www.npr.org/2019/09/03/754044732/as-rising-heat-bakes-u-s-cities-the-poor-often-feel-it-most ("Those exposed to that extra heat are often a city's most vulnerable: the poorest and, our data show, disproportionately people of color.").
[139] Irina Zhorov, *Tackling the heat island problem in concrete jungles*, NPR (June 28, 2017), https://whyy.org/segments/tackling-the-heat-island-problem-in-concrete-jungles/ ("From 2000 to 2016, the National Oceanic and Atmospheric Administration documented 1,916 fatalities nationwide due to heat. The actual number could be higher because heat isn't always documented as a contributing factor in deaths when it should be.").

experiencing extremely high temperatures regularly. By emphasizing planting trees in lower-income Black and Latinx communities, the City can efficiently improve the health for residents in these areas and lessen the oppressive heat felt in these communities.

Cities like New York and San Francisco spend about $70 per tree per year.[140] The City of Los Angeles has historically invested significantly less than similar large cities ($30 per year).[141] Mayor Garcetti made tree planting and maintenance a cornerstone of his "Sustainable City pLAn" by plantings 90,000 new trees by 2021.[142] Los Angeles has also allocated $400,000 for tree planting and maintenance. Further, with the budget of $210 million from StreetsLA's budget and approximately $3 million raised by TreePeople, the City can invest a total of $213,400,000 in new trees and tree maintenance.[143] At $70 a tree, the City could plant over 1 million new trees this year and leave the remaining half of the allocation for tree maintenance.

4.3. Vegetative Permeable Pavement

Vegetative permeable pavement is porous and allows air, water, and vegetation into its gaps.[144] Installing more vegetative permeable pavements in Los Angeles can mitigate the Heat Island Effect by evapotranspiration.[145]As sun hits the vegetation in the permeable pavement, moisture evaporates which draws heat out of the pavement.[146] Vegetative permeable pavement

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[140] Caleigh Wells, *Trees Need A Little More TLC ($50 Million Would Do The Trick*, LAist (Dec. 18, 2018 6:00am) https://laist.com/2018/12/18/las_trees_need_a_little_more_tlc_50_million_would_do_the_trick.php (last visited Sept. 30, 2020).
[141] *Id.*
[142] *See* Section 3.3, Funding; *See* Appendix B.
[143] *Id.*
[144] Climate Protection Partnership Division, *Reducing Urban Heat Islands: Compendium of Strategies—Cool Pavements*, EPA, 2 (May 2017) [hereinafter *Reducing Urban Heat Islands*].
[145] *Id.* at 8.
[146] *Id.*

works best in areas with adequate moisture in the summer, but even in dry climates, vegetative permeable pavement is cooler than conventional, impermeable pavement due to vegetation's ability to absorb solar energy.[147]

Grassy permeable pavements can mitigate summer heat in a Mediterranean climate.[148] Three types of permeable pavements include: grass block pavers, porous concrete, and plastic grid pavers.[149] Grass block pavers are lattice-pattern concrete pavers that allow light and water to reach vegetation in diamond-shaped openings.[150] Grass block pavers cost around $3 on average per square foot and on average 68°F less than asphalt and dark impermeable pavers.[151] Porous concrete is asphalt or concrete that is mixed without fine particles to allow for the passage of stormwater through the surface of the pavement.[152] Porous asphalt costs an average of $1 per square foot while porous concrete cost around $3 per square foot.[153] Porous pavements are not necessarily cooler regular pavement, but they allow for stormwater to seep through to plant roots under paved areas.[154] Plastic grid pavers are plastic grids with void spaces that can be filled with either gravel, or soil and grass.[155] They allow rain water to seep through to plant roots under

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[147] *Id.* at 8–13.
[148] *See* Alessandra Battisti, *Climate Mitigation and Adaptation Strategies for Roofs and Pavements: A Case Study at Sapienza University Campus*, 10 Sustainability 1 (2018).
[149] *Permeable Pavement: What's it Doing on My Street?,* Cal. Coastal Commission, 1 (March 2007) [hereinafter *Permeable Pavement*].
[150] *Id.* at 1.
[151] *Id.* at 6–7; H Li, *The use of reflective and permeable pavements as a potential practice for heat island mitigation and stormwater management,* Env. Res. Lett., 5–7 (2013).
[152] *Permeable Pavement* at 3.
[153] *Id.* at 14–15.
[154] *Porous Asphalt Pavements with Stone Reservoirs*, U.S. Dep't of Transp., 3 (Apr. 2015) ("[T]hey are designed to management and treat stormwater runoff.").
[155] *Reducing Urban Heat Islands* at 19.

paved areas, reduce flooding, and lower the surrounding air temperature through evapotranspiration.[156] Plastic grid pavers cost around $2 per square foot.[157]

A study conducted by the Environmental Protection Agency ("EPA") predicted that if pavement reflectance throughout Los Angeles were increased from 10 to 35 percent, the air temperature could potentially be reduced by 1°F, which would result in $90 million a year in savings from temperature reductions attributed to increased pavement albedo in the Los Angeles area.[158]

Los Angeles City Budget allocates $3 million dollars towards cool pavement projects known as "cool slurry".[159] With just half of Los Angeles' cool slurry budget, the City could install 750,000 square feet of permeable pavement.

Permeable pavements require maintenance once every 10 years[160] thus, it is recommended porous and vegetative concrete only be used in areas with minimal vehicle traffic, such as overflow parking lots, emergency vehicle access roads, driveways and back roads. There are other non-vegetative solutions that significantly reduce the heat absorbed into pavement that can be applied to more heavily trafficked roads.[161]

4.4. Partnership with City's Parks Department

A partnership with the City of Los Angeles Recreation and Parks Department ("RAP") could mitigate the Heat Island Effect because: (1) RAP employees are trained in California tree

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[156] *Id.*
[157] *Permeable Pavement* at 19.
[158] *Reducing Urban Heat Islands* at 23.
[159] *See* Section 3.3, Funding; *See* Appendix B.
[160] *Permeable Pavement* at 25.
[161] Other non-vegetative solutions are not addressed in this proposal as this proposal promotes vegetative solutions only.

maintenance and can prune vegetation to reduce the likelihood of fire; (2) RAP employees can aid in community engagement; and (3) RAP can incorporate tree planting and other vegetative maintenance events into its youth programing and other events.[162]

RAP is dedicated to reducing the harmful ramifications from the Heat Island Effect in Los Angeles.[163] RAP already spends resources on cooling stations and replaces turf with drought resistant plants to save water.[164] By implementing the programs proposed below, RAP can reduce its own need to run cooling stations and take part in cost-effective ways to cool the City while engaging with the communities it serves.[165]

RAP employees are uniquely positioned to maintain the vegetation advanced by this proposal. Los Angeles' RAP "[t]ree maintenance is performed in two ways: by Department staff supervised by International Society of Arboriculture Certified Arborists, and/or by a contracted tree company administered and overseen by Department Certified Arborists. The Forestry Division also oversees proper species selection in the Department's Reforestation Program."[166] In addition to overseeing and maintaining trees in parks, the Urban Forest Program already has a Bureau of Street Services, Street Tree Division operating within its budget.[167] By utilizing existing RAP street tree programing and combining it with the goals of this proposal, the City can more efficiently reduce the Heat Island Effect. Specifically, RAP is already connected with

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[162] *Saving Water in LA*, City of L.A. Dept. of Rec. & Parks (2014) https://www.laparks.org/water.
[163] *Id*.
[164] Garcetti, *City of Los Angeles Budget* at 3.
[165] *Saving Water in LA*, City of L.A. Dept. of Rec. & Parks (2014) https://www.laparks.org/water.
[166] James K. Hahn, *Urban Forest Program*, City of L.A. Rec. & Parks Dep't, 6 (Oct. 2004) https://www.laparks.org/sites/default/files/forest/pdf/UrbanForestProgram.pdf.
[167] *Id*.

experts who can properly train City parks employees to maintain street trees and guide the planting effort with California-friendly (i.e., drought-resistant) trees.[168]

RAP employees can also engage within their local communities; there is a myriad of free programs set up for kids ages 5-17 with a focus on arts and culture.[169] Adding a program for children and teenagers that want to gain experience in Arboriculture or work to reduce the effects of climate change in their City would not only bring awareness to the Heat Island Effect but also bring the community together to solve these issues.

Roughly 1 in 4 American teenagers have participated in climate activism.[170] RAP has the training and the expertise to channel that activism into City-wide programing.[171] The Department could set up regular "days of action," on which the City's youth can plant trees, green roofs, green walls, and prune tree canopies. A day of action for older children, in conjunction with LAKids programing for children, can spur enthusiasm for vegetative solutions to the Heat Island Effect.

Los Angeles Parks Department has allocated $268.56 million for Department operations. Additionally, the City has allotted $35,336,935 for Public Improvements, $87,803,818 for clean streets, $92,121,384 for Environmental Quality Improvements, $169,041,609 for Blight Identification and Elimination, and $13,205,912 for Neighborhood Improvement.[172] The City could utilize these funds to implement these initiatives in lower-income communities.

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[168] *See* Appendix A.
[169] *LAKids*, City of L.A. Dep't of Rec. & Parks (2020) https://www.laparks.org/lakids (last visited Sept. 30, 2020) [hereinafter *LAKids*].
[170] *Most American teens and frightened by climate change, poll finds, and about 1 in 4 are taking action*, The Washington Post (Sept. 16, 2019) https://www.washingtonpost.com/science/most-american-teens-are-frightened-by-climate-change-poll-finds-and-about-1-in-4-are-taking-action/2019/09/15/1936da1c-d639-11e9-9610-fb56c5522e1c_story.html.
[171] *LAKids*.
[172] Garcetti, *City of Los Angeles Budget* at 602.

As stated in *Section 4.2*, one tree costs about $70 per year to plant and maintain. A semi-annual day of action on which teenagers and young adults plant trees, or prune and garden street trees and parks would be an inexpensive way for the City to conduct parks outreach, plant trees, and engage the community in dealing with climate change. A semi-annual program with approximately 200 participants planting five trees each would only cost the City $140,000--well underbudget in the Neighborhood Improvement and Environmental Quality Improvements categories. This program could mitigate budget-spending by seeking volunteers to lead tree planting and enlisting a few employees assist with day-of administrative work.

Los Angeles has a shockingly low number of parks and greenspace throughout the City.[173] "Los Angeles has a median of 3.3 acres of park space per 1,000 people, well below the median of 6.8 acres per 1,000 people in other high-density U.S. cities."[174] The Trust for Public Land even ranked Los Angeles 74th out of 100 on its list of cities "park scores, which are based on a city's park acreage, facilities and investment, and residential access."[175] High-density neighborhoods in Los Angeles shoulder the burden of the City's park shortage.[176] "[A] lack of parks in higher density, lower income areas like Koreatown and Harvard Park often translates to residents lacking any access to outdoor recreation opportunities."[177]

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[173] *Access to Parks and Green Space*, Neighborhood Data for Soc. Change, https://usc.data.socrata.com/stories/s/Access-to-Parks-and-Green-Space/uap8-77nz/ (last visited Sept. 27, 2020).
[174] *Id.*
[175] *Id.*
[176] *Id.*
[177] *Id.*

The costs of creating and maintaining new parks as a program is more difficult to estimate.[178] "Cost estimates for park creation take into account many factors: the size and shape of the park, existing public ownership of the site or potential exchange sites, existing site conditions, development features, complexity of design, and construction of support facilities like underground parking. For downtown parks …, costs ranged from $481,333 with no land acquisition and few park features, to $9,981,250 per acre including a wide range of park features and performance."[179] If RAP were to create a program in which LAKids are involved in building and maintaining a park on City-owned land with minimal park features (mostly plants and some seating, tables, and few playground equipment) over the course of a year, spending approximately $500,000 (approximately $20,000 higher than the estimate cited above), the City would still be significantly under budget. There are approximately 2,200 City-owned vacant lots.[180] The City could allocate monies from any of the categories listed above or take a small portion from each and begin construction on a new park each year as a RAP program. This would only cost the City $500,000 per year and drive progress on its environmental goals illustrated in Mayor Garcetti's Sustainability pLAn.[181]

The Parks department can make use of new green spaces created by this proposal for its other programs. LAKids programing currently focuses on art and culture.[182] Programs include visual arts, film, music, performing arts, textiles/design, and culture.[183] All of these programs can

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[178] *Downtown Parks: Funding Methods, Management Structures, and Costs*, The Tr. for Pub. Land, 6 (Apr. 1, 2018), https://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/ccpe-DowntownParkFinance-inMN.pdf.
[179] *Id.* at 6.
[180] Alissa Walker, *This interactive map shows LA's publicly owned properties*, Curbed LA (July 3, 2019), https://la.curbed.com/2019/7/3/20681291/map-public-property-los-angeles.
[181] *See* Section 4.2, Street Trees
[182] *LaKids.*
[183] *Id.*

be enhanced by access to green space. Children can practice drawing or painting different kind of plants, and they can use smaller green spaces to perform or practice plays and dances. By increasing green space, particularly in underprivileged neighborhoods, the RAP can conduct its already-existing programs in Black and Latinx neighborhoods while simultaneously reducing the Heat Island Effect in Los Angeles' most vulnerable neighborhoods. This would come at no new cost to the City, as it already conducts these programs.

4.5. Community Gardens

While increased vegetation is crucial to reducing the Heat Island Effect in Los Angeles, vegetation requires maintenance, such as pruning to avoid inciting fires.[184] The City can create community gardens that absorb CO2, provide shade, and cool buildings. The community surrounding the garden can maintain and care for the vegetation to reduce fire hazards and improve mental health. Community and rooftop gardens can help create greenspaces that absorb CO2 and reduce cooling costs for the buildings that support them. There are approximately 22,000 vacant lots in Los Angeles, about 10 percent of which are owned by the City.[185] Most of the empty lots throughout the City are located in South Los Angeles.[186] "Almost 3,000 lots sit vacant in South Los Angeles. In comparison, West L.A. has 134 vacant lots and the Wilshire

[184] *Reducing Fire Risk on Your Forest Property*, Pac. Northwest Extension, 6–7 (October 2010) ("Pruning is particularly effective in young stands, where crowns may still be low to the ground.").
[185] *See* Alissa Walker, *This interactive map shows LA's publicly owned properties*, Curbed LA (July 3, 2019), https://la.curbed.com/2019/7/3/20681291/map-public-property-los-angeles.
[186] *See* Deepa Fernandes, *Groups work to turn South LA lots into children's playgrounds*, Southern Cal. Pub. Radio (Apr. 30, 2015), https://www.scpr.org/news/2015/04/30/50927/groups-work-to-turn-south-la-lots-into-children-s/.

Miracle Mile district has 310 vacant lots."[187] Some community organizers are already turning the vacant lots into community space. The Los Angeles chapter of Trust for Public Land spent six years and $5 million dollars transforming a blighted vacant lot into Serenity Park.[188] If the average cost of turning a vacant lot into a robust park is around $5 million, the City has enough money allocated in its budget for this year alone to transform thirty-four vacant lots into parks and public green space.[189] This does not include funding from outside organizers like The Trust for Public Land or from other state and federal grants available for projects like these.[190]

The importance of accessible public green space cannot be overstated. Beyond the environmental benefits of reducing the Heat Island Effect and absorbing CO2,[191] there is a growing body of research on the Nature Deficit Disorder.[192] "This expanding body of scientific evidence suggests that nature-deficit disorder contributes to a diminished use of the senses, attention difficulties, conditions of obesity, and higher rates of emotional and physical illnesses."[193] Nature Deficit Disorder is more common in lower-income Black and Latinx communities due to the lack of green spaces.[194] It is vitally important to both reduce the

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[187] Bianca Barragan, *Los Angeles's Tens of Thousands of Vacant Lots: Mapped*, Curbed LA (May 4, 2015), https://la.curbed.com/2015/5/4/9964284/los-angeles-vacant-lots-map [hereinafter *Los Angeles's Tens of Thousands of Vacant Lots: Mapped*].
[188] Deepa Fernandes, *Groups work to turn South LA lots into children's playgrounds*, Southern Cal. Pub. Radio (Apr. 30, 2015), https://www.scpr.org/news/2015/04/30/50927/groups-work-to-turn-south-la-lots-into-children-s/.
[189] *See* Section 3.3, Funding; *See* Appendix B.
[190] *Five Grants to Fund Your Community Green Space*, Nature Sacred (Dec. 3, 2015), https://naturesacred.org/community-green-space-grants/.
[191] *See* Section 4.1, Green Walls.
[192] See Section 4.1, Green Walls; Meg St-Esprit McKivigan, *'Nature Deficit Disorder' Is Really a Thing*, N.Y. Times (June 23, 2020), https://www.nytimes.com/2020/06/23/parenting/nature-health-benefits-coronavirus-outdoors.html.
[193] Richard Louv, *What is Nature-Deficit Disorder?*, Richard Louv Blog (Oct. 15, 2019), http://richardlouv.com/blog/what-is-nature-deficit-disorder/.
[194] *See* Section 4.2, Street Trees; Section 4.4, Partnership with City Parks Department.

oppressive heat in lower-income communities by planting trees and other vegetation that will provide shade for cooling and provide space for play and interaction with nature.

Housing advocates in Los Angeles want to use the vacant lots to build affordable housing and homeless shelters.[195] The goal of increasing green space to reduce the Heat Island Effect does not have to contradict the goal of reducing homelessness through affordable and long-term shelter access. If the City plans to build shelters in vacant lots, the new housing can be built to accommodate green roofs and rooftop gardens.

Homelessness can lead to a myriad of mental and physical health deficiencies. Specifically, Post-Traumatic Stress Disorder, depression, and alcoholism.[196] Children that experience homelessness develop a myriad of mental disorders due to prolonged stress.[197] Rooftop gardens, particularly on shelters and low-income housing, can provide massive benefits to the communities that they serve. Expanding access for homeless or low-income families to gardens and accessible green spaces for children could greatly increase the mental health of shelters residents. Touching soil and gardening reduces depression and anxiety, and to increases life satisfaction, quality of life, and sense of community.[198] Moreover, the children in these

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[195] *Los Angeles's Tens of Thousands of Vacant Lots: Mapped*.
[196] *See e.g., Trauma*, Substance Abuse and Mental Health Services Admin., (Apr. 15, 2020) https://www.samhsa.gov/homelessness-programs-resources/hpr-resources/trauma (last visited Sept. 27, 2020); Peter Tarr, *Homelessness and Mental Illness: A Challenge to Our Society*, The Brain & Behav. Res. Found. (Nov. 19, 2018), https://www.bbrfoundation.org/blog/homelessness-and-mental-illness-challenge-our-society.
[197] *Reducing Toxic Stress in Childhood*, Substance Abuse and Mental Health Services Admin., https://www.samhsa.gov/homelessness-programs-resources/hpr-resources/reducing-toxic-stress-childhood (last visited Sept. 27, 2020).
[198] *See e.g.,* Masashi Soga et al., *Gardening is beneficial for health: A meta-analysis*, 5 Preventive Med. Rep. 92 (2017); Carly J. Wood et al., *A case–control study of the health and well-being benefits of allotment gardening*, 38 J. of Pub. Health 336 (2016); Bonnie L. Grant, *Antidepressant Microbes In Soil: How Dirt Makes You Happy*, Gardening Know How (last updated June 19, 2020).

communities usually do not have access to nature or outdoor spaces and can suffer from nature deficiency, could have healthier lifestyles and more robust childhoods as a result of access to rooftop gardens and green roofs. Further, rooftop gardens and green roofs keep buildings cooler and can reduce cooling cost for the City.[199]

The City allotted $89,524,628 to Housing and Community Investment.[200] Housing and Community Investment encompasses affordable housing trusts, rent stabilization trusts, community service grants, housing production funds, low- and moderate-income housing funds, and other sources.[201] The City has designated $12 million of Housing and Community investment as a "General Fund".[202] Further, in 2016 the City's voters approved a $1.2 billion shelter construction program.[203] Shelter construction costs about $531,373 per unit.[204] With the General Fund alone, the City could construct four new housing units for the homeless population. If the City were to include $1.2 billion from the voters, the City could potentially build 2,424 new units. Further, if the City combines the issues of homelessness and lack of green space by building rooftop gardens on shelters and affordable housing, the City can utilize Housing and Community funds, and the grants available for community gardens to increase their budget and save money on future cooling costs.[205]

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[199] *See* Section 4.1, Green Walls.
[200] *See* Section 3.3, Funding; Appendix B.
[201] Garcetti, *City of Los Angeles Budget* at 42.
[202] *Id.*
[203] Chris Woodyard, *Some of Los Angeles' homeless could get apartments that cost more than private homes, study finds*, USA TODAY (Oct. 7, 2019 11:00pm), https://www.usatoday.com/story/news/nation/2019/10/08/los-angeles-la-california-homeless-shelter-housing-apartments-condos/3882484002/.
[204] *Id.*
[205] *Five Grants to Fund Your Community Green Space*, Nature Sacred (Dec. 3, 2015), https://naturesacred.org/community-green-space-grants/.

5. Conclusion

The Heat Island Effect poses a serious threat to Los Angeles residents. Without further mitigation efforts from the local government, the City's temperatures will continue to rise, threatening the health and safety of its residents and costing the City billions of dollars in health and mechanical cooling expenses. This proposal has outlined specific and economical ways to mitigate the Heat Island Effect exacerbated by global warming: green walls and roofs; permeable pavements; tree canopies; park and green space expansion; and community gardens. Implementing these programs can mitigate the stifling heat felt by the City's residents by up to 45°F and save the City $1.3-$2.9 billion annually.

With the $2,000 reward from winning the Elisabeth Haub School of Law Environmental Law & Policy Hack Competition Inaugural Problem, we can start organizing partnerships between Parks Department, housing officials, and Mayor's Office to begin implementing the most cost-effective aspects of the proposal, namely, Street Trees and Green Roofs.

Appendix A- Low-Water and Drought-Resistant Plants[206]

Perennials, Shrubs, and Ornamental Grasses	Trees	Turf and Ground Cover	Vines
Agave species (Agave)	Arbutus unedo (Strawberry Tree)	Buchloe dactyloides (Buffalograss)	Bougainvillea species (Bougainvillea)
Alyogyne huegelii (Blue Hibiscus)	Chitalpa tashkentensis (Chitalpa)	Cynodon dactylon (Hybrid Bermudagrass)	Macfadyena unguis-cati (Cat's Claw)
Arctostaphylos species (Manzanita)	Geijera parviflora (Australian Willow)	Zoysia 'Victoria' (Victoria Zoysiagrass)	Vitis californica (California Wild Grape)
Artemisia species (Sagebrush)	Laurus nobilis (Sweet Bay)	Acacia redolens 'Desert Carpet'	
Ceanothus species (California Lilac)	Olea europaea 'Swan Hill' (Swan Hill Olive)	(Dwarf Prostrate Acacia)	
Chamelaucium uncinatum (Geraldton Waxflower)	Pinus eldarica (Afghan Pine)	Achillea species (Yarrow)	
Cistus species (Rockrose)	Prosopsis chilensis (Chilean Mesquite)	Baccharis species (Coyote Brush)	
Dudleya species (Live Forever)	Quercus agrifolia (Coast Live Oak)	Cotoneaster dammeri (Bearberry Cotoneaster)	
Echeveria species (Hens-and-Chickens)		Lampranthus species (Ice Plant)	
Encelia californica (California Encelia)		Lantana montevidensis (Trailing Lantana)	
Galvezia speciosa (Island Bush Snapdragon)		Myoporum parvifolium (Myoporum)	
Grevillea species (Grevillea)		Sedum species (Stonecrop)	

[206] *Low Water Trees*, L.A. Dep't of Water and Power, http://www.ladwp.cafriendlylandscaping.com/listplants.php?index=1 (last visited Sept. 27, 2020); *Low-Water and Drought-Resistant Plants, California Water Service*, https://www.calwater.com/conservation/low-water-drought-resistant-plants/ (last visited Sept. 29, 2020).

Heteromeles arbutifolia (Toyon)
Lavandula species (Lavender)s
Leucophyllum species (Texas Ranger)
Lobelia laxiflora (Mexican Bush Lobelia)
Mahonia nevinii (Nevin's Barberry)
Melalueca nesophila (Pink Melaleuca)
Myrtus communis (Common Myrtle)
Nassella species (Needlegrass)
Penstemon species (Penstemon)
Rhus species (Sumac)
Rosmarinus officinalis (Rosemary)
Salvia, selected species (Sage)
Sisyrinchium bellum (Blue-Eyed Grass)
Tapetes lemmonii (Copper Canyon Daisy)
Verbena, selected species (Verbena)

Appendix B- Funding

Function and Subsection	Operating Budget	Total Funds Allocated
Building Regulation	$542,858,096	$593,726,254
City Planning and Zoning	$69,288,408	$96,216,040
Blight Identification and Elimination	$105,490,033	$169,041,609
Public Improvements	$93,026,428	$35,336,935
Stormwater Management	$17,005,335	$98,005,717
Aesthetic and Clean Streets and Parkways	$63,254,661	$87,803,818
Environmental Quality	$69,685,469	$92,121,384
Neighborhood Improvement	$11,284,927	$13,205,912
Housing	$52,842,325	$120,132,225
Housing and Community Investment	90,564,885	89,524,628
L.A.'s Green Deal, Sustainable City pLAn	N/A	$55,200,000
plAn's Land Maintenance Fund	N/A	$64,044,000
Cool Slurry	N/A	$3,000,000
StreetsLA	N/A	$210,000,000
TreePeople	N/A	$2,950,287

Appendix C- Certification

We hereby certify that the brief for Cardozo School of Law ADR Competition Honor Society is the product of the undersigned. We further certify that the undersigned have read the Competition Rules and that this brief complies with these Rules.

Date October 1, 2020

Anna Chen

Team Member

Kelsey Keane

Team Member