County of Fairfax, Virginia

MEMORANDUM

DATE: July 12, 2023

TO: Fairfax County Board of Supervisors

FROM: Larry Zaragoza, DEnv, Chair
Environmental Quality Advisory Council

SUBJECT: Landscaping and Screening Zoning Ordinance Amendment Comment

The Landscaping and Screening Zoning Ordinance Amendment provides an opportunity to improve landscaping and screening. The Environmental Quality Advisory Council (EQAC) agrees with recommendations to increase tree canopy from the current 5% coverage requirement. However, based on the attached literature review, we recommend that the ordinance set 30% tree canopy as the minimum coverage for parking lots.

Increasing the minimum landscaping requirement to 30% will have at least two key benefits. First, the impact of heat island effects should be reduced. An increase in tree canopy to at least 30% is needed to see a noticeable reduction in ambient and surface temperatures in parking lots. Second, increased tree canopy shading of parking lots can reduce air pollution, stormwater runoff, heat-stress-associated mortality, and illness, while increasing carbon sequestration. Thus, increasing tree canopy is beneficial for human health, the ecological environment, and sustainability development.[i]

Other local governments require parking lot tree canopy shade up to 50% of the surface. As shown in the map at the end of this report[ii], in Fairfax County, 72% of the census tracks have 40% or more tree cover. Of the remaining 71 census tracts (28%), there are 24 census tracts that have low tree canopies and highly vulnerable populations.[iii] If a countywide 30% tree canopy standard for parking lots is deemed impractical, EQAC recommends that the 24 census tracts with low tree canopy and highly vulnerable populations be designated Zoning Overlay Districts[iv] where parking lots would be required to meet the 30% standard. These Zoning Overlay Districts can be implemented to prioritize areas for tree planting and target county aid distribution. Specific citations to articles and references to local requirements are included in the attachment to this memo.

EQAC recommends that the tree canopy requirement for parking lots be increased to 30%. At a minimum, the 24 census tracts with low tree canopy coverage and highly vulnerable populations should be targeted for a 30% standard, while parking lots in other census tracts held to the 20% coverage requirement.

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Attachment: Tree Canopies in Fairfax Parking Lots

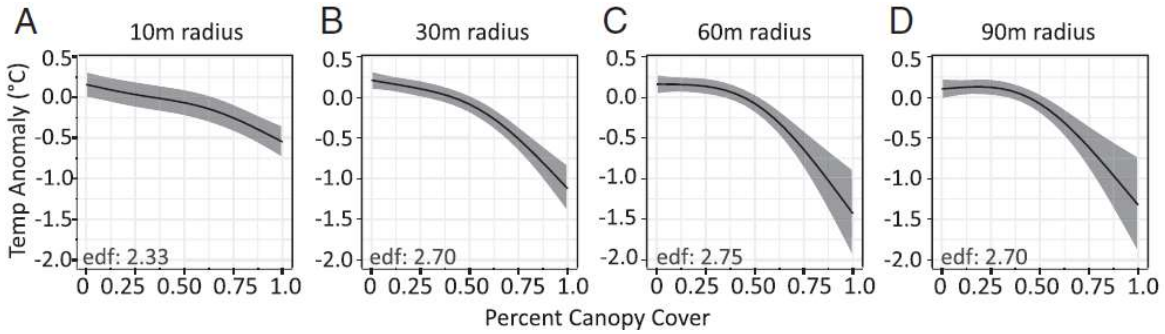
cc: Rachel Flynn, Deputy County Executive
John Morrill, Acting Director, Office of Environmental and Energy Coordination
Tracy Strunk, Director, Department of Planning and Development (DPD)
Bill Hicks, Director, Land Development Services (LDS)
Matthew Hansen, Director, Site Development and Inspections Division, LDS
EQAC

Attachment:

Tree Canopies in Fairfax Parking Lots

Fairfax County is considering requiring owners of parking lots with 10 or more spaces to increase the percentage of tree canopy from 5% to 10%. Part of the rational for the increase is to moderate the effects of heat island effects, i.e., the unhealthy increased temperature of unshaded impervious surfaces compared to shaded surfaces in hot summer days. Reducing heat island effects is a goal of Fairfax's Community-Wide Energy and Climate Action Plan (CECAP) and Resilient Fairfax.[v] The One Fairfax policy[vi] commits the county to intentionally consider how its actions, such as its land use plans, "protect existing stable neighborhoods and green spaces, support sustainability, support a high quality of life, and promote employment opportunities, housing, amenities and services for all people."

Tree cover on urban parking lots impacts surface and ambient temperatures. A small body of research on parking lot tree canopies and heat island abatement in urban areas of a city block or less points toward zoning requirements greater than 10% envisioned by Fairfax County's draft Landscaping & Screening Zoning Ordinance Amendment.[vii] Ziter et al (2019)[viii] found that temperature decreased nonlinearly with increasing canopy cover, with the greatest cooling when canopy cover exceeded 40%. Summer daytime air temperature was substantially reduced with greater canopy cover (≥40%) at the scale of a typical city block (60–90 m), especially on the hottest days. Variability in daytime air temperature within the urban landscape averaged 6.3° F.



An older study[ix] found that for each additional 10% of tree canopy, ambient temperature declined by 1.1°F. That result was corroborated by a Davis, CA retail parking lot study. [x] Ambient temperature difference between the 28% of the parking lot that was shaded and the unshaded remainder during hot August days was approximately 1.8°F to 3.6°F. The researchers noted that customers preferred to park in the shade during the hottest times: 25% parked in the shade in the cooler morning hours and 68% parked in shade in the hotter afternoon. Parking in the sun dramatically raises temperatures inside vehicles. Shaded vehicle cabin temperature during the August afternoon hours was approximately (45°F cooler than the unshaded vehicle. A meta-analysis[xi] of 47 high quality studies of vegetation and green roofs published between 1987 and 2017 found a median summer afternoon effect of 0.6°F of cooling per 0.10 increase in tree canopy cover, although several studies found substantially greater

values. A 2022 empirical study of urban heat island effects that encompassed 601 European cities concluded that a tree cover of at least 16% is required to achieve a 1.8°F drop in urban temperatures.[xii]

Trees reduce surface temperatures by reducing the amount of solar radiation that is transmitted to dark paving surfaces. The amount of radiation transmitted through a tree canopy varies by type of tree, but ranges are 6% to 30% in the summer. Trees in the Davis parking lot study reduced surface asphalt temperatures by as much as 36°F. Vehicle cabin temperatures were lower by over 47°F and fuel tank temperatures by nearly 7.2°F. [xiii] Similar results were reported in a Phoenix, AZ study.[xiv] Surface temperatures of parking areas shaded by trees were 10.8°F cooler than adjacent fully exposed surfaces. The Phoenix researchers further found that surfaces shaded by a photovoltaic canopy was 24°F cooler than unshaded surfaces. A study of eight Hangzhou, China parking lots[xv] found the surface temperature of those with the most shade were 19.1°F cooler than unshaded parking lots.

Increased tree canopy shading of parking lots can reduce air pollution, stormwater runoff, heat-stress-associated mortality, and illness, while increasing carbon sequestration. Thus, increasing tree canopy is beneficial for human health, the ecological environment, and sustainability development.[xvi]

While vehicle emitted volatile organic gases (VOCs, precursors of smog) primarily comes from tailpipe exhaust, approximately 16% results from evaporative emissions when vehicles are not operating.[xvii] Idle vehicle VOC emissions may be more severe in locations where vehicles are concentrated, and where temperatures are high, i.e., parking lots. The cooler the car, the lower the rate of gasoline evaporation from leaky fuel tanks and worn hoses. Studies in Sacramento, CA show that shaded parking lots decrease the quantity of volatile organic gases (ozone precursors) that evaporate from parked vehicles by 2% and the NOx emitted during start-up by 1%.[xviii]

Parking lots can elevate air temperatures, requiring adjacent buildings to use more air conditioning, especially during peak demand summer hours. [xix] Trees, grass and other vegetation tend to stay cool in the summer sun, remaining at or below air temperature, and are less likely to elevate air temperatures. One consequence of unshaded paving is that energy costs associated with air conditioning of adjacent buildings can be higher. Electricity demand in cities during periods of warm temperatures can push supply systems to, and even beyond, their capacity. Increasing tree canopies in urban areas can reduce summer peak energy use between 3% and 4.5%, depending on siting of trees.[xx]

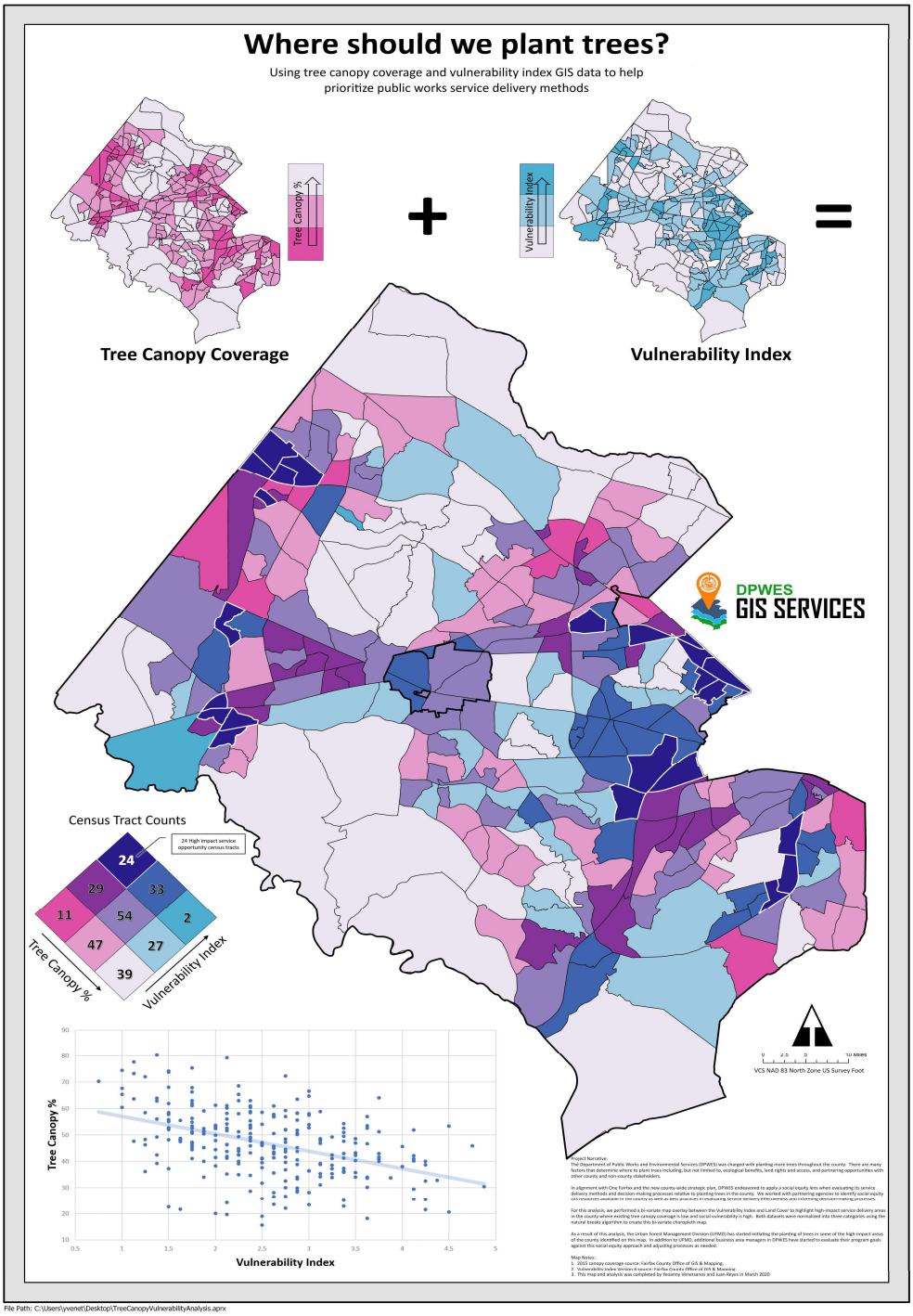
Trees directly remove pollutant gases (CO, NOx, O3, and SO2). The amount and type of filtration varies by climate, tree type, age and growth rate. Studies of Houston and Atlanta[xxi] found that annual removal of particulates by trees was 4.7 tons per square mile for the first and 3.2 tons per square mile for the latter. Generally, areas with many large trees have higher rates of pollutant removal.

Trees can reduce stormwater runoff. Trees intercept a significant amount of rainfall in their canopies, where it evaporates and does not contact the ground. If parking lots are made smaller to accommodate more trees, the reduced amount of impervious surface would collect less water.[xxii]

Numerous local jurisdictions specify parking lots meet shade coverage percentages greater than the draft proposal of 10%. These include 15% for Coral Springs, Florida and 20% for Dania, Florida.[xxiii] Agoura Hills, Sacramento, Woodland, Sacramento County, Modesto and Los Angeles, all in California, have higher parking lot shade requirements. Sacramento's ordinance, adopted in 1983, requires 50% shading coverage of total paved area within 15 years. In Sacramento County, trees in parking lots of 5 to 24 spaces must provide 30% lot shading; lots having 25 to 49 spaces must have 40% shading; and 50% shading must be attained in lots of 50 spaces or more. Woodland specifies that shade trees must be distributed so that 40% of the parking stalls are shaded at high noon when trees are in full foliage.[xxiv]

Summary:

Increasing tree canopies in Fairfax parking lots from 5% to 10% is a positive advancement. The small research literature suggests that a higher percentage would be necessary to achieve a noticeable effect on urban heat islands. Reducing temperatures by 1.8°F would probably require increasing tree canopies to between 15% and 20%. Although other communities require much higher percentages of tree canopy over parking lots, Fairfax must balance heat island abatement with other considerations. The majority (72%) of census tracts in the county have 40% of more tree coverage.[xxv] Of the remaining 71 census tracts (28%), there are 24 census tracts that have low tree canopies and highly vulnerable populations.[xxvi] Those 24 could be required through Zoning Overlay Districts[xxvii] to meet higher standards only to specific areas. These Overlay Districts can be implemented to prioritize areas for tree plantings and target county aid distribution. Therefore, EQAC recommends that the tree canopy requirement for parking lots be increased to 30%. At a minimum, the 24 census tracts with low tree canopy coverage and highly vulnerable populations should be targeted for a 30% standard, while parking lots in other census tracts held to the 20% coverage requirement.



The GIS map[xxviii] prepared by Yeoanny Venetsanos and Juan Reyes from the Fairfax Department of Public Works and Environmental Services in March 2020 identifies in dark blue the 24 census tracts that have low tree canopy coverage and highest population vulnerability to extreme weather.

[i] Shao, Huamei, and Gunwoo Kim. "A Comprehensive Review of Different Types of Green Infrastructure to Mitigate Urban Heat Islands: Progress, Functions, and Benefits." *Land* 11.10 (2022): 1792.
[ii] Venetsanos, Yeoanny and Reyes, Juan, Where should we plant trees. Fairfax Department of Public Works and Environmental Services, March 2020. Email from Allison Homer, Fairfax Office of Energy and Environmental Coordination, June 20, 2023
[iii] https://www.fairfaxcounty.gov/environment-energy-coordination/climate-action/natural-resources
[iv] https://online.encodeplus.com/regs/fairfaxcounty-va/doc-viewer.aspx#secid-2237
[v] CECAP references Parking Reimagined as a means for reducing heat island effects in strategy T 18. https://www.fairfaxcounty.gov/boardofsupervisors/sites/boardofsupervisors/files/assets/meeting-materials/2022/dec13-environmental-cecap-implementation-plan.pdf and Resilient Fairfax recommends zoning and land use changes to reduce heat island effects in strategy CRC3c https://www.fairfaxcounty.gov/environment-energy-coordination/sites/environment-energy-coordination/files/assets/documents/pdf/resilient%20fairfax%20final%20carp_ada_signed.pdf
[vi] https://www.fairfaxcounty.gov/topics/sites/topics/files/assets/documents/pdf/one-fairfax-policy.pdf
[vii] Landscaping & Screening Zoning Ordinance Amendment, presentation to Fairfax Environmental Quality Advisory Council June 14, 2023 https://www.fairfaxcounty.gov/environment-energy-coordination/sites/environment-energy-coordination/files/assets/documents/eqac/landscaping%20and%20screening%20zoa%20-%20eqac%20presentation%206-14-23_a-1a.pdf
[viii] Ziter, Carly D., et al. "Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer." *Proceedings of the National Academy of Sciences* 116.15 (2019): 7575-7580.
[ix] Simpson, J. R., D. G. Levitt, C. S. B. Grimmond, E. G. McPherson, & R. A. Rowntree. 1994. Effects of Vegetative Cover on Climate, Local Scale Evaporation and Air Conditioning Energy Use in Urban Southern California (pp. 345-348). In: 11th Conference on Biometeorology and Aerobiology. San Diego: American Meteorological Society
[x] Scott, Klaus I., James R. Simpson, and E. Gregory McPherson. "Effects of tree cover on parking lot microclimate and vehicle emissions." *Journal of arboriculture* 25.3 (1999): 129-142.
[xi] Krayenhoff, E. Scott, et al. "Cooling hot cities: A systematic and critical review of the numerical modelling literature." *Environmental Research Letters* 16.5 (2021): 053007.
[xii] Marando, Federica, et al. "Urban heat island mitigation by green infrastructure in European Functional Urban Areas." *Sustainable Cities and Society* 77 (2022): 103564.
[xiii] Litman 2002) Litman, L. 2002. Where Are All the Cool Parking Lots? Center for Urban Forest Research. Davis, CA: USDA Forest Service Pacific Southwest Research Station. http://cufr.ucdavis.edu/products/3/cufr_151.pdf
[xiv] Golden, Jay S., et al. "A comparative study of the thermal and radiative impacts of photovoltaic canopies on pavement surface temperatures." *Solar Energy* 81.7 (2007): 872-883.
[xv] Nan, Xinge, et al. "Assessing the thermal environments of parking lots in relation to their shade design characteristics." *Sustainable Cities and Society* 83 (2022): 103931.
[xvi] Shao, Huamei, and Gunwoo Kim. "A Comprehensive Review of Different Types of Green Infrastructure to Mitigate Urban Heat Islands: Progress, Functions, and Benefits." *Land* 11.10 (2022): 1792.
[xvii] Wolf, Kathleen L. Trees, parking and green law: Strategies for sustainability. Stone Mountain, GA: Georgia Forestry Commission, Urban and Community Forestry, 2004.
[xviii] Scott, K. I., Simpson, J. R., and McPherson, E. G., 1999, Effects of tree cover on parking lot microclimate and vehicle emissions, J. Arboric. 25(3):129–142
[xix] NASA – U.S. National Aeronautics and Space Administration. 2003. What's Hot in Huntsville and What's Not: A NASA Thermal Remote Sensing Project. http://wwwghcc.msfc.nasa.gov/land/heatisl/heatisl.htm
[xx] Donovan, Geoffrey H., and David T. Butry. "The value of shade: Estimating the effect of urban trees on summertime electricity use." *Energy and Buildings* 41.6 (2009): 662-668. Akbari, Hashem. "Shade trees reduce building energy use and CO2 emissions from power plants." *Environmental pollution* 116 (2002): S119-S126.
[xxi] American Forests. 2000. Urban Ecosystem Analysis for the Houston Gulf Coast Region. Washington D.C.: author. http://www.americanforests.org/resources/rea/ American For. Rainfall Interception by Sacramento's

Urban Forest. Journal of Arboriculture 24,4:235-244.ests. 2001. Urban Ecosystem Analysis for the Atlanta Metro Area. Washington D.C.: author. http://www.americanforests.org/resources/rea/

[xxii] Xiao, Q., E. G. McPherson, J. R. Simpson, & S. L. Ustin. 1998

[xxiii] Wolf, Kathleen L. Trees, parking and green law: Strategies for sustainability. Stone Mountain, GA: Georgia Forestry Commission, Urban and Community Forestry, 2004.

[xxiv] Wolf, Kathleen L. Trees, parking and green law: Strategies for sustainability. Stone Mountain, GA: Georgia Forestry Commission, Urban and Community Forestry, 2004.

[xxv] https://www.fairfaxcounty.gov/environment-energy-coordination/climate-action/natural-resources

[xxvi] https://www.fairfaxcounty.gov/environment-energy-coordination/climate-action/natural-resources

[xxvii] https://online.encodeplus.com/regs/fairfaxcounty-va/doc-viewer.aspx#secid-2237

[xxviii] Venetsanos, Yeoanny and Reyes, Juan, Where should we plant trees. Fairfax Department of Public Works and Environmental Services, March 2020. Email from Allison Homer, Fairfax Office of Energy and Environmental Coordination, June 20, 2023.