SITE REDESIGN AT CROZET ELEMENTARY

PUBLIC OPINION EFFECTS ON ENVIRONMENTAL IMPACT OF CROZET DEVELOPMENT

A Thesis Prospectus
In STS 4500
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The Faculty of the
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In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science in Civil Engineering

By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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The United States have been on a consistent trend of increasing urbanization since the early 1800s, with approximately 83% of the population living in urban areas as of 2020 (O'Neill, 2022). Virginia is no exception to that trend, with 2020 US Census results showing urban regions had the highest amounts of growth over the last decade while rural regions have seen populations decreasing (Price, 2021). This urbanization offers many benefits but also many drawbacks as while urban areas can be centers of innovation and production "they can also have high levels of pollution, social exclusion, environmental degradation, and cause unintended consequences outside of the urban boundaries" (Seto et al., 2017, p. 8935). The Crozet area in Albemarle County, Virginia is one such location experiencing rapid population growth, seeing a population increase of 22.23% between 2011 and 2019 compared to a county average of 9.62% (Imagine Crozet, 2021) and a state average of only 7.9% (Price, 2021). This rate of growth has prompted the development and construction of new infrastructure sufficient to meet the population's needs. Many local residents are concerned about the sustainability of this growth and worry about the impacts on the community and environment.

The technical project and tightly coupled STS research project proposed in this prospectus look to examine the intersection of these issues, investigating both the construction of necessary infrastructure in Crozet and the effects of public opinion on development with a focus on environmental impacts. On the technical side, the capstone team is to develop a new design for a local elementary school, aiming to meet new requirements based on population growth while still considering environmental impacts for new construction. On the STS side, the focus will be on researching the history of public perception and opinion on the development in the Crozet area and the effects, or lack thereof, of this public opinion on the corresponding environmental impacts. This research will be done through a Social Construction of Technology

framework (Pinch & Bijker, 1987). These projects will be completed during the Fall 2022 and Spring 2023 semesters, with a general timeline for the school year shown below in Figure 1.

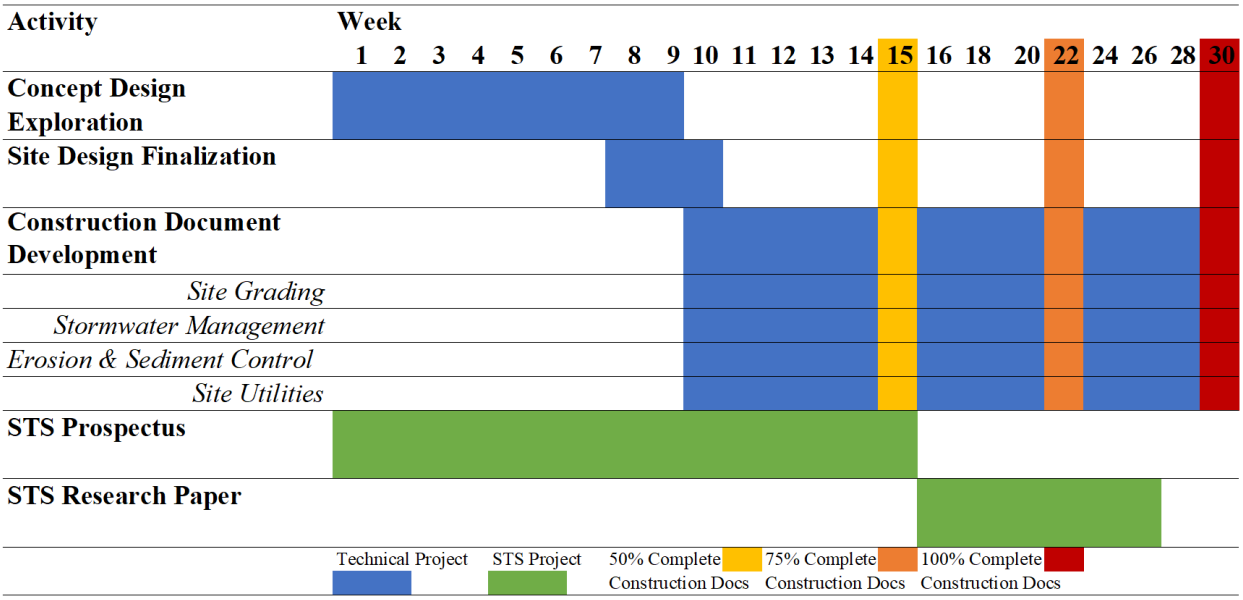

Figure 1: UVA civil capstone Gantt chart. This figure visualizes the expected timeline for major milestones reached on the technical and STS project in the fall and spring semesters. (Coppi, 2022)

PARKING REDESIGN AT CROZET ELEMENTARY

Crozet Elementary School in Albemarle County, Virginia, is expected to see an increase in the student population of approximately 219 additional students in the 2022-2023 school year due to redistricting between Crozet Elementary and the overcrowded Brownsville Elementary, which both serve the wider Crozet area (Albemarle County Public Schools, 2021). This overcrowding has been caused by a consistent trend of growth in the Crozet area as a whole, with the total population having risen from 5565 people in 2010 to 9224 people in 2020 according to the most recent census (U.S. Census Bureau, n.d.). The local educational infrastructure is just one aspect where improvements must be made to handle the continued growth in the area, as Crozet Elementary was already 30 students over capacity in 2020 and Brownsville Elementary was nearly 150 students over capacity (Knott, 2020).

With this projected larger student body, an additional academic wing has become necessary along with parking, access and playground areas to support the addition (VMDO, n.d.). While the chosen design for the Crozet Elementary addition has already been finalized and is currently nearing completion of construction (Albemarle County Public Schools, n.d.), the capstone team has been tasked with the yearlong project of developing an alternative design focusing on the site parking. Despite the alternative design not being physically implemented in the future, the team must still approach the problem as if they were the professional engineers tasked with improving the Crozet area's educational infrastructure. The capstone team consists of myself and fellow civil engineering students Michael Barbuti, Justin Dibsie, Joshua Robin, and Zachary Robinson. This project will be completed under the guidance of T. Donna Chen, a professor of transportation systems in the Department of Engineering Systems and Environment at the University of Virginia.

The project will also be done in collaboration with the professional engineers from the design firm Timmons Group, specifically those working out of the local Charlottesville office. Timmons Group will offer their guidance on proper methods to complete the alternative design, seeking not to influence or direct the capstone team towards Timmons's own preferred design but to steer the team away from making any obvious mistakes out of inexperience. Timmons Group will also offer relevant tools or resources considered standard for a professional design firm office that may not normally be available to undergraduate students, as well as instruction on how to use relevant civil design software such as Civil3D.

The original architectural footprint of the elementary school as well as the projected footprint of the building addition can be seen in Figure 2 on page 4, marked in pink and cyan respectively. The school buses originally parked in two rows directly in front of the school,

marked in Figure 2 in yellow. This configuration means that students boarding the farther row of buses are not visible to teachers and staff overseeing dismissal from the school sidewalk. During dismissal at the end of the school day, the path for school buses attempting to depart, marked in blue, and the path for parents entering the pick-up loop, marked in red, intersect at the northern end of the parking lot. This can lead to conflict and confusion on who has right of way if there are no staff present to control the flow of traffic.

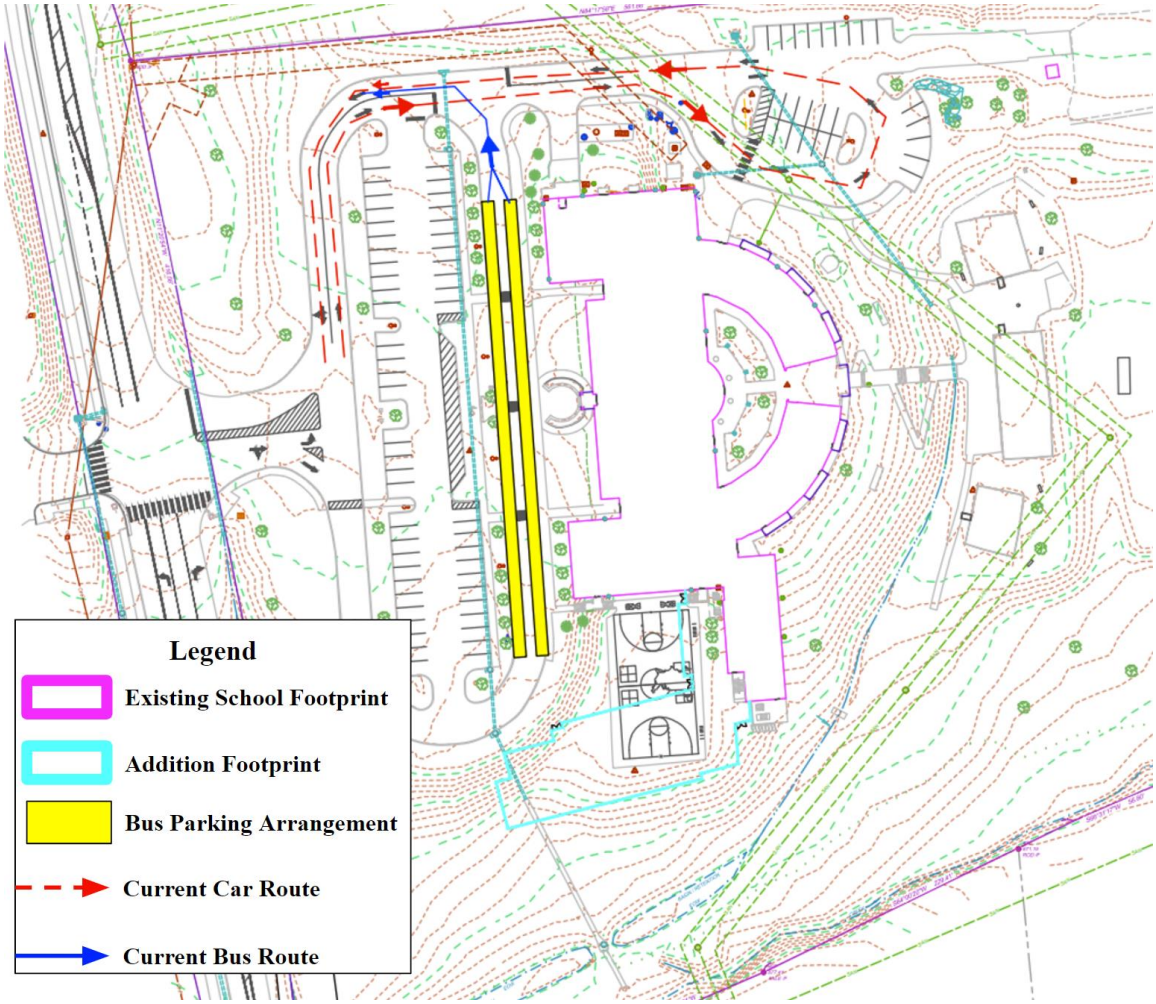

Figure 2: Crozet Elementary topographical survey: This survey shows the original topography of the elementary school, with the current building outlined in pink and the addition in cyan. The current bus parking is highlighted in yellow with the bus route outlined in blue and the car route outlined in red. (Adapted by Coppi (2022) from Medley, 2020)

The goals of the parking redesign are as follows: (a) increase the total number of parking spaces for buses and cars, up from the original 86 spaces to a total of 136 standard parking spaces and 12 designated bus spaces; (b) separate the circulation routes for buses and cars, primarily during school pick-up and drop-off times as the current design causes frequent conflicts and inefficiencies; (c) develop a complete set of construction documents for the design that incorporates plans for site grading, stormwater management, erosion and sediment control, and utilities, and adheres to VDOT and Albemarle County standards throughout, as outlined by the Albemarle County Design Standards Manual (2015). Any facilities that are removed by the addition, such as the current outdoor basketball court and rain gardens must be relocated in the alternative design. The primary milestones the capstone team is hoping to achieve is to reach 50% completion of construction documents by the end of the fall semester, and then to reach 100% completion by the end of the spring semester. While a corresponding paper may also be written for the final submittal, the bulk of the technical report will consist of this set of construction documents.

ENVIRONMENTAL IMPACT OF CROZET DEVELOPMENT

The worldwide trend of urbanization has also contributed to the worrisome trend of environmental degradation across the globe, due to the fact that urban locations "consume more than 66% of the world's energy and generate more than 70% of global greenhouse gas emissions" (Fragkias et al., 2013, p. 1). Developing countries and regions in particular are prone to rapid urbanization with little regard to sustainable growth, leading to future conditions of environmental pollution and economic downturn. These urban areas need to consider how and where they achieve "several needs such as educational facilities, transportation facilities, job, clean air, healthy potable water etc." (Kahlor & Mahdisoltani, 2015, p. 1). With proper planning,

these needs can be met in the present while also ensuring the requisite infrastructure will continue to be sustainable in the future as populations continue to rise.

While not on the scale of a major metropolis, the Crozet area in Albemarle County, Virginia is experiencing rapid growth, being designated one of the county's five "Development/Growth Areas" (Imagine Crozet, 2021). This growth led Albemarle County to develop the Crozet Master Plan to provide "long-range policy direction for land use, transportation, and parks and green systems for the Crozet Development Area." (Imagine Crozet, 2021, p. 7). An example of these recommendations can be seen in Figure 3 below, in a land use plan which demonstrates the myriad applications of space in the Crozet area and thus the myriad competing priorities and interests.

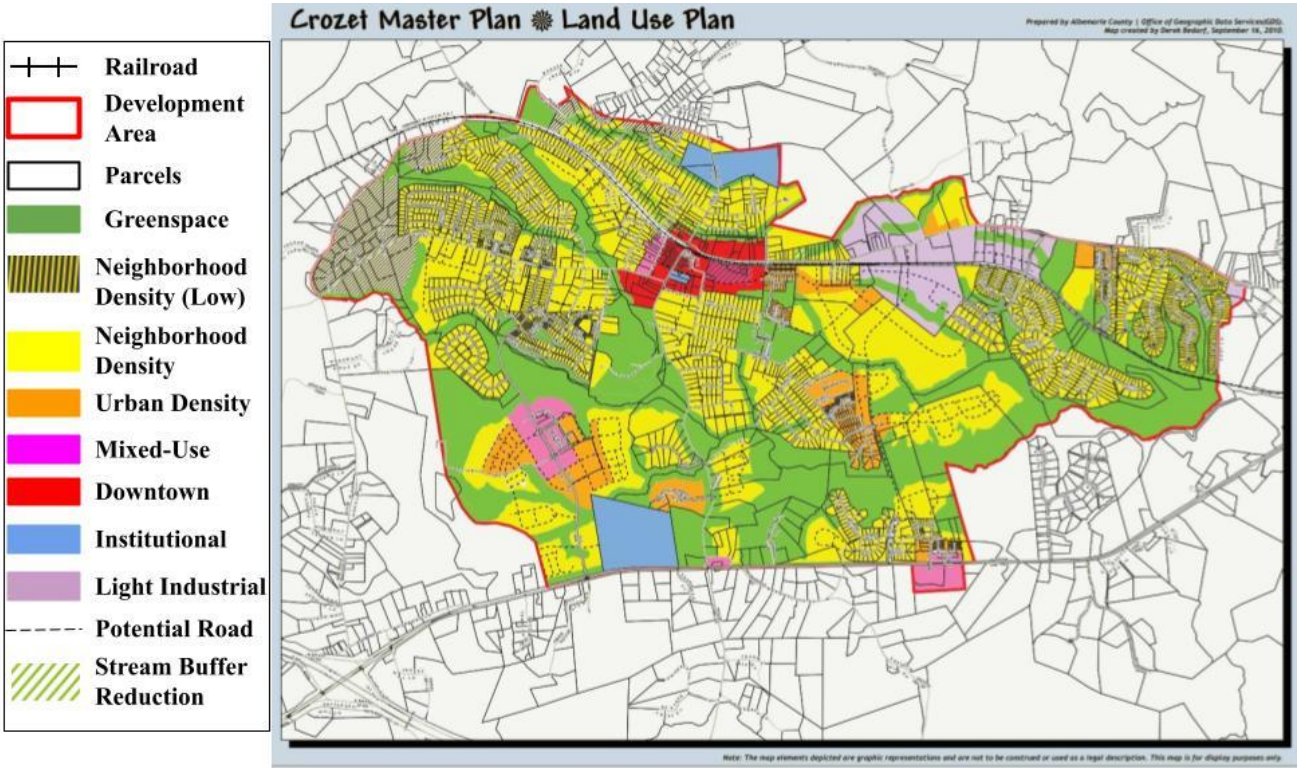

Figure 3: Crozet land use map. This map shows plans for land usage in the Crozet area in the 2010 iteration of the master plan including various housing densities and industries. (Adapted by Coppi (2022) from Bedarf, 2010)

This document was first developed in 2004, but has undergone several iterations due to changing conditions as well as community decisions with the most recent draft being finalized in 2021.

Crozet residents' input and feedback have helped shape these iterations of the Master Plan over the last two decades or so, and thus have also affected development of the Crozet area as a whole. Public opinion, support and research can be a vital tool in improving communities, and can be categorized as a form of citizen science, exemplified in citizen efforts to track and reduce industrial pollution in the locale of "Cancer Alley" (Dermansky, 2018). Carolyn T. Holter (2022), a researcher at the Responsible Technology Institute at Oxford, expresses the benefits of increased participation in the innovative process, in the forms of participatory design and responsible research and innovation, by which expanding the number of participants or "stakeholders" involved in innovation will lead to not only better outcomes but also a better process. In this context, the inclusion of Crozet residents with a variety of priorities and backgrounds in the drafting of the Master Plan should lead to better outcomes for all involved, by taking into consideration the wants and needs of all the involved parties. Determining whether or not this was the case will be a focus of STS research.

For the STS thesis, I plan to research public opinion and input on development plans for the Crozet area over the last fifteen to twenty years and how that feedback has affected the environmental impacts of the developments as it has been implemented, as well as how development has affected public opinion in turn. Probable sources include local newspapers such as *The Daily Progress* and *The Crozet Gazette*, public surveys, recorded town hall meetings, among others. This investigation will be viewed through the Social Construction of Technology (SCOT) framework developed by Trevor Pinch and Wiebe Bijker (1987). As seen in Figure 4 on page 8 below, the relevant social groups direct their concerns and priorities to the

engineer, who in this case would be those in charge of development design, and the engineer in turn should alter their design based on the relevant social groups. These social groups include any affected by development in the Crozet area, with an emphasis on the residents living there in a variety of housing types, local business and business owners, those who utilize transportation methods to travel within the Crozet area and to and from the area, and environmentalists focused on conserving the natural landscape.

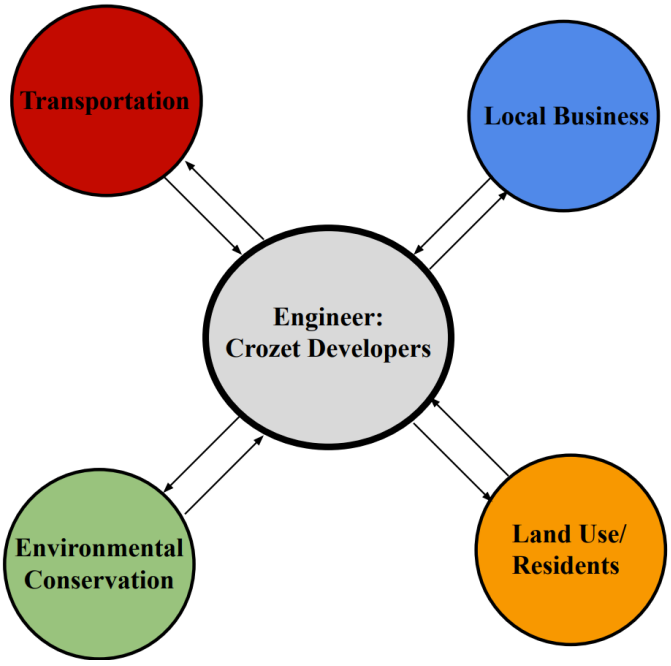

Figure 4: Crozet development SCOT model. The engineers must negotiate between the different social groups to protect each groups interests and ensure all concerns are heard and incorporated if possible. (Coppi, 2022)

This STS research project will take the form of a scholarly article focused on determining if public opinion had a beneficial or detrimental impact on the environmental effects of local development, as well any other effects, and whether or not those effects were significant to be noticeable after thorough analysis. The Crozet Master Plan claims to have incorporated residents throughout the decision-making process but it remains to be seen if planners were just paying lip service or actually altered and improved designs based on resident feedback. If public opinion did have a significant effect, positive or negative, Crozet could be used as a model for other locales experiencing rapid urbanization either to aspire or to avoid.

DEVELOPMENT AND DESIGN AND THE IMPACT OF PUBLIC OPINION

The example case of Crozet Elementary being expanded to meet capacity requirements for a growing student population is a microcosm of the Crozet area as a whole. A growing population needs additional infrastructure to meet a need and local residents push for what they feel is most important or pressing to them, which in this case would be educational infrastructure. By coupling the technical project of redesigning the Crozet Elementary parking system with research into the broader development in the area and the effects of local residents' opinions, the potential of utilizing public opinion for improving sustainability in urbanizing areas will be established.

REFERENCES

Albemarle County. (2015, April 27). Albemarle County design standards manual. https://www.albemarle.org/home/showpublisheddocument/270/637964079068470000

Albemarle County Public Schools. (2021, November 18). *Redistricting committee will recommend moving 219 students to Crozet Elementary School district.* https://www.k12albemarle.org/our-departments/communications/news-board/~board/newsroom/post/redistricting-committee-will-recommend-moving-219-students-to-crozet-elementary-school-district

Albemarle County Public Schools. (n.d.). *Additions and renovations.* https://cres.k12albemarle.org/about/additions-and-renovations

Bedarf, D. (2010, September). *Crozet master plan land use plan.* [Map]. [Figure 3]. Albemarle County. Retrieved from https://www.realcrozetva.com/2020/09/08/crozet-master-plan-serves-as-test-conversation-for-missing-middle-housing/

Coppi, D. (2022). *Crozet development SCOT model.* [Figure 4]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Coppi, D. (2022). *UVA civil capstone Gantt chart.* [Figure 1]. *Prospectus* (Unpublished undergraduate thesis). School of Engineering and Applied Science, University of Virginia. Charlottesville, VA.

Dermansky, J. (2018, January 11). *Citizens in Cancer Alley ramp up battle against industrial pollution.* Popular Resistance. https://popularresistance.org/citizens-in-cancer-alley-ramp-up-battle-against-industrial-pollution/

Fragkias, M., Lobo, J., Strumsky, D., & Seto, K. C. (2013). Does size matter? Scaling of CO_2 emissions and U.S. urban emissions. *PLOS One, 8*(6), 1-8. https://doi.org/10.1371/journal.pone.0064727

Holter, C. T. (2022). Participatory design: lessons and directions for responsible research and innovation. *Journal of Responsible Innovation*. https://doi.org/10.1080/23299460.2022.2041801

Imagine Crozet. (2021, June 14). *Phase 4: Crozet master plan review – public hearing draft.* PublicInput.com. https://publicinput.com/M8451

Kahlor, K., & Mahdisoltani, M. (2015, June). *Urbanization and its effects on the environment and society along with sustainable development.* ResearchGate. https://www.researchgate.net/publication/328732625_Urbanization_and_its_Effects_on_the_Environment_and_Society_Along_with_Sustainable_Development

Knott, K. (2020, May 28). Albemarle School Board gets first look at plans for Crozet Elementary expansion. *Daily Progress, The (Charlottesville, VA)*. Available from Newsbank: Access World News – Historical and Current: https://infoweb.newsbank.com/apps/news/document-view?p=WORLDNEWS&docref=news/17B44BE800B6C510

Medley, J. C. (2020, April). *Existing conditions topographic survey on the lands of County School Board of Albemarle County known as Crozet Elementary School.* [Map]. [Figure 2]. Timmons Group.

O'Neill, A. (2022, June). *Degree of urbanization in the United States from 1790 to 2020, and with projections until 2050*. Statista. https://www.statista.com/statistics/269967/urbanization-in-the-united-states/

Pinch, T. J., & Bijker, W. E. (1987). *The social construction of technological systems.* The MIT Press.

Price, R. (2021, September 16). *2020 census update: population up in urban and suburban areas but down in rural areas.* Virginia REALTORS. https://virginiarealtors.org/2021/09/16/2020-census-update-population-up-in-urban-and-suburban-areas-but-down-in-rural-areas/

Seto, K. C., Golden, J. S., Alberti, M., & Turner II, B. L. (2017). Sustainability in an urbanizing planet. *Proceedings of the National Academy of Sciences, 114*(34), 8935-8938. https://doi.org/10.1073/pnas.1606037114

U.S. Census Bureau. (n.d.). *QuickFacts: Crozet cdp, Virginia.* https://www.census.gov/quickfacts/crozetcdpvirginia

VMDO. (n.d.). *Albemarle County public schools: Crozet Elementary renovation + addition*. VMDO Architects. https://www.vmdo.com/crozet-elementary-school-renovation-addition.html