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January 4, 2019

Piedmont Regional Office
RE: Buckingham Compressor Station
4949-A Cox Rd
Glen Allen, VA 23060

Re: Proposed Dominion Energy Buckingham Compressor Station; 5297 S. James River Hwy, Wingina, VA 24599

Dear Air Pollution Control Board Members:

Thank you for the opportunity to present my findings and comment statement regarding the proposed Dominion Energy Buckingham Compressor Station (BCS).

My name is Stephen Metts; I am writing to you as adjunct faculty with The New School in New York City specializing in GIS analysis for policy issues related to energy infrastructure development. I am offering to you my independent spatial analyses of the proposed action upon an Environmental Justice (EJ) eligible community in close proximity to the proposed BCS.

To establish a baseline and context for my analysis, I have reviewed 4 primary documents:

- The FERC DEIS and FEIS EJ findings pertaining to the proposed action.
- The subsequent EJSCREEN documentation for the proposed action dated 12/3/2018.
- The Dominion ESRI Profile and EJ Review document dated 11/28/2018.
- The Dominion Air Quality Modeling Report dated July 2018.

I have further been granted, under a confidentiality agreement with Dr. Lakshmi Fjord, access to the raw data supplied by the Union Hill Community Household Study Site and Methods Report.

My analysis consists of 4 main components:

First, I establish a baseline of census-derived cartographic products and summarizations to reinstate the Federal Energy Regulatory Commission (FERC) finding that indeed the geography intersecting with the proposed action is EJ eligible. There should be no question regarding this issue, in spite of Dominion's misleading statements in the ESRI Profile and Environmental Justice Review, dated 12/3/2018, to suggest otherwise.

Second, I detail the deficiencies of utilizing strictly census-derived aggregated products to typify large scale, local populations - exactly the populations at issue regarding the proposed action.

Third, I offer several disaggregation techniques that are much more accurate approaches to determining population density in a large scale geography. These methods use more precise data inputs and result in more accuracy than a strict adherence to census-only products.

Finally, I overlay the refined spatial results of the Union Hill Community Household Study to qualify the EJ eligible community at the intersection of the proposed action as indeed minority-majority by a significant margin.

While my findings are detailed and at times iterative - particularly in establishing the EJ eligibility criteria already accomplished by FERC - the critical points of my work presented to you in the findings statement are three-fold:

1. There should be no question that the immediate geography and local populations in close proximity to the proposed action (< 2 miles) are indeed EJ eligible. This fact is proven and underscored by two methods - the establishment of the census variables for EJ eligibility and the mapping overlay of the Union Hill Community Household Study data.

2. Based on disaggregated spatial methods detailed in the findings statement to follow, a significant population density 'hotspot' is ascertained. This 'hotspot' can be summarized as follows:

*There exists a significant 'hotspot' of largely residential density within 1 mile of the proposed action. This 'hotspot' is statistically a **51% increase in density over that of the county at large**. Further, the disaggregated analysis method of the findings statement ascertains 55.8 persons per square mile within 1 mile of the proposed action whereas the ESRI community profile proffered by the Dominion ESRI Profile and EJ Review ascertains only 31.5 persons per square mile within the critical 1 mile radius of the proposed action.*

3. Not only is there a significant 'hotspot' of residential density in immediate proximity to the proposed action, but the population therein is decidedly a minority-majority population (83%) based on the door to door, disaggregated methodology utilized for the Union Hill Community Household Study dataset. This is diametrically opposed to the assertion found in the Dominion ESRI Profile and EJ Review that finds the study area to be majority White beyond 70%.

As the board deliberates on the issue of the proposed action relative to the EJ eligible populations detailed accurately and precisely in my findings statement, I would respectfully remind the board that once an EJ population is established - which clearly and forthrightly has been done in this case - it is incumbent on decision makers to not primarily rely on aggregated, census-only cartographic and statistic products. The local, large scale population must be assessed using precise and accurate methods. I do hope that my findings statements and methods will provide the board an opportunity for such an assessment, often referred to as a 'hard look', in consideration of the EJ population most immediately and adversely impacted by the proposed action.

Respectfully,

Stephen Metts

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An environmental justice and proximity review utilizing independent spatial analyses for the proposed Dominion Energy Buckingham Compressor Station, Virginia

The following methods, analysis and findings statement quantifies and qualifies the most impacted populations by the proposed action of siting the of the Dominion Buckingham Compressor Station (BCS). The analysis takes into consideration the methods and assertions of both The Federal Energy Regulatory Commission (FERC) Environmental Justice analysis; the Virginia Department of Environmental Quality (DEQ) Environmental Justice review; as well as the Dominion ESRI Profile and Environmental Justice review of the proposed BCS.

This finding statement utilizes disaggregated spatial methods to quantify and qualify local populations most impacted by the proposed action, whereas both the FERC, DEQ and Dominion methods utilized an aggregated methodology. It will be shown in the analysis that the methods deployed by FERC, DEQ and Dominion do not fully, precisely nor accurately represent impacts of the proposed action on localized populations. Documents utilized in the following analysis as source materials are listed in the **References** section at the end of this findings statement.

The methods, analysis and findings are conducted across three sections as follows:

- **Section 1 - Review and establishment of baseline aggregated census statistics for geographies intersecting with the proposed BCS.**
- **Section 2 - Discussion of the deficiency of an aggregated approach and development of the disaggregated spatial analysis. The analysis includes dasymetric mapping; density surfaces and an address-based sampling approach to quantify localized population densities relative to the county at large.**
- **Section 3 - Quantification of the local population study results conducted by Dr. Lakshmi Fjord. Resulting cartographic products are developed, resulting in the qualification of population densities most impacted by the proposed action.**

Section 1:

- **Preparatory data methods and baseline mapping to establish EJ eligibility:**
- US Census Tiger products were accessed (12/2018) for cartographic boundary files required for mapping state, county and census block group geographies within Virginia and surrounding the proposed BCS. Both tabular products and geographic features were then downloaded and incorporated into desktop GIS software (ArcGIS 10.6) for further analysis.
- As recommended by US Census: *For ACS data, use the TIGER products for the last year in the range for the ACS estimates*. As this analysis seeks not to question neither the vintage nor veracity of specific census products, but rather how the products have been deployed to typify vulnerable populations in close proximity to the proposed compressor site, the most recent **2013-2017 ACS 5-year estimates** and respective geographies are utilized here. As will be demonstrated in the analysis, the core Environmental Justice (EJ) findings are consistent across all recent census products dating to 2010 decennial Census, utilized by the Federal Energy Regulatory Commission (FERC) in their draft DEIS and final FEIS analysis products. By utilizing the most recent vintage for this analysis, both currency and precision are maintained over utilization of 2010 decennial census alone. As stated by the US Census in their guidance:

> Precision is more important than currency Analyzing very small populations Examining tracts and other smaller geographies because 1-year estimates are not available

- The FERC analysis, DEQ review and Dominion's own ESRI profile and review all utilize, in various degrees, State of Virginia benchmarks to ascertain EJ thresholds in proposed action Census block group geographies. The following mapping results update these findings, and reiterate that indeed the proposed action will incur intersecting census tracts that feature designated EJ populations. In effect, an aggregated baseline is first established, highlighting the need for a further disaggregated treatment to both quantify and qualify impacted EJ populations.

As stated in the FERC FEIS analysis and further utilized by DEQ and Dominion, both % poverty and % minority relative to state median values are utilized to determine EJ threshold criteria. In the case of % minority, a further threshold of at least 50% minority must be crossed for final EJ status. For the State of Virginia, the median values are as follows based on the 2014 census data tables as shown in the FEIS Appendix U:

- 11.5% Persons in Poverty
- 30.8% Minority (69.2% White alone, not Hispanic or Latino)

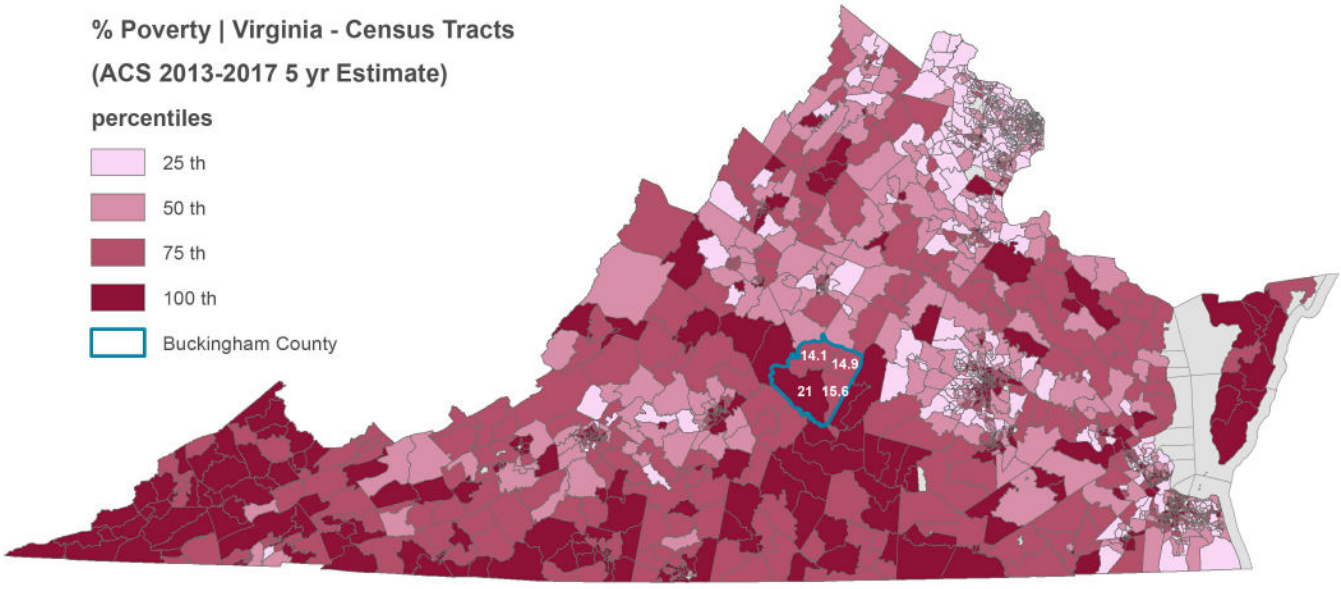
Based on **2013-2017 ACS 5-year estimates** these rates show differences as follows:

- 11.2% Persons in Poverty
- 38% Minority Population (62% White alone, not Hispanic or Latino)

When mapped to the census tract geographies utilizing a percentile classification method, it is clear that the 4 census tracts in Buckingham County - the county where the proposed action would occur - are decidedly above average on the EJ threshold pertaining to poverty:

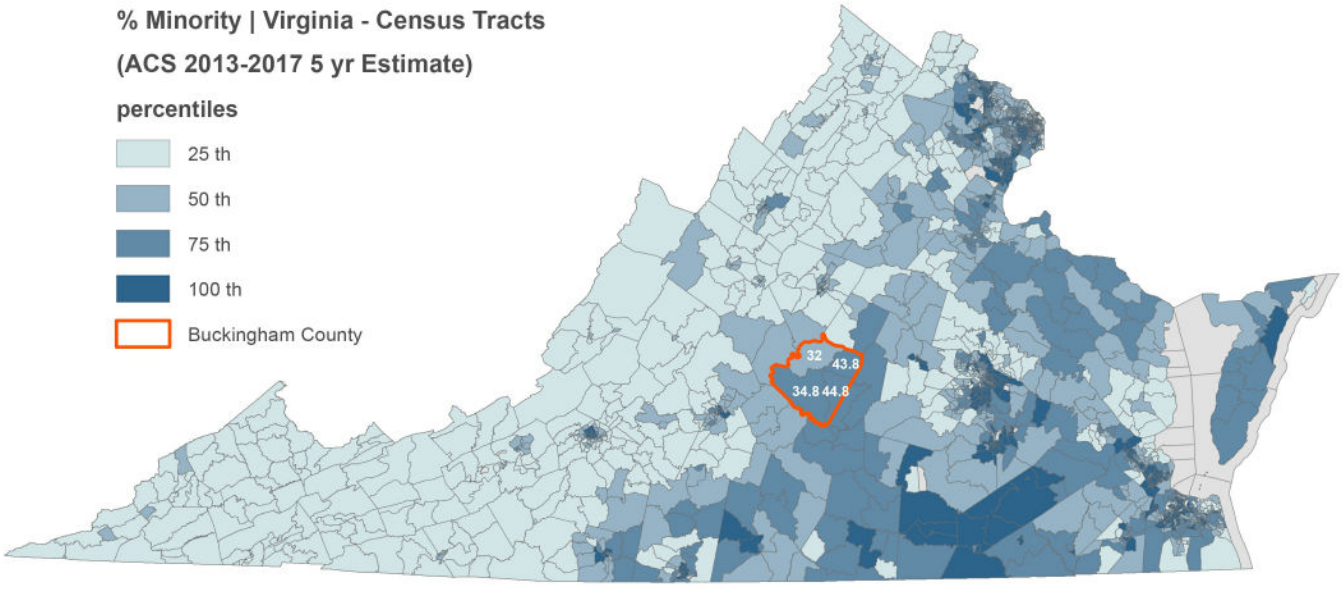
- Census Tract 9302.02 - 21% poverty
- Census Tract 9301.01 - 14.1% poverty
- Census Tract 9301.02 - 14.9% poverty
- Census Tract 9302.01 - 15.6% poverty

It should be noted **clearly and forthrightly** based on this variable alone, **EJ consideration is triggered and further study is warranted**.



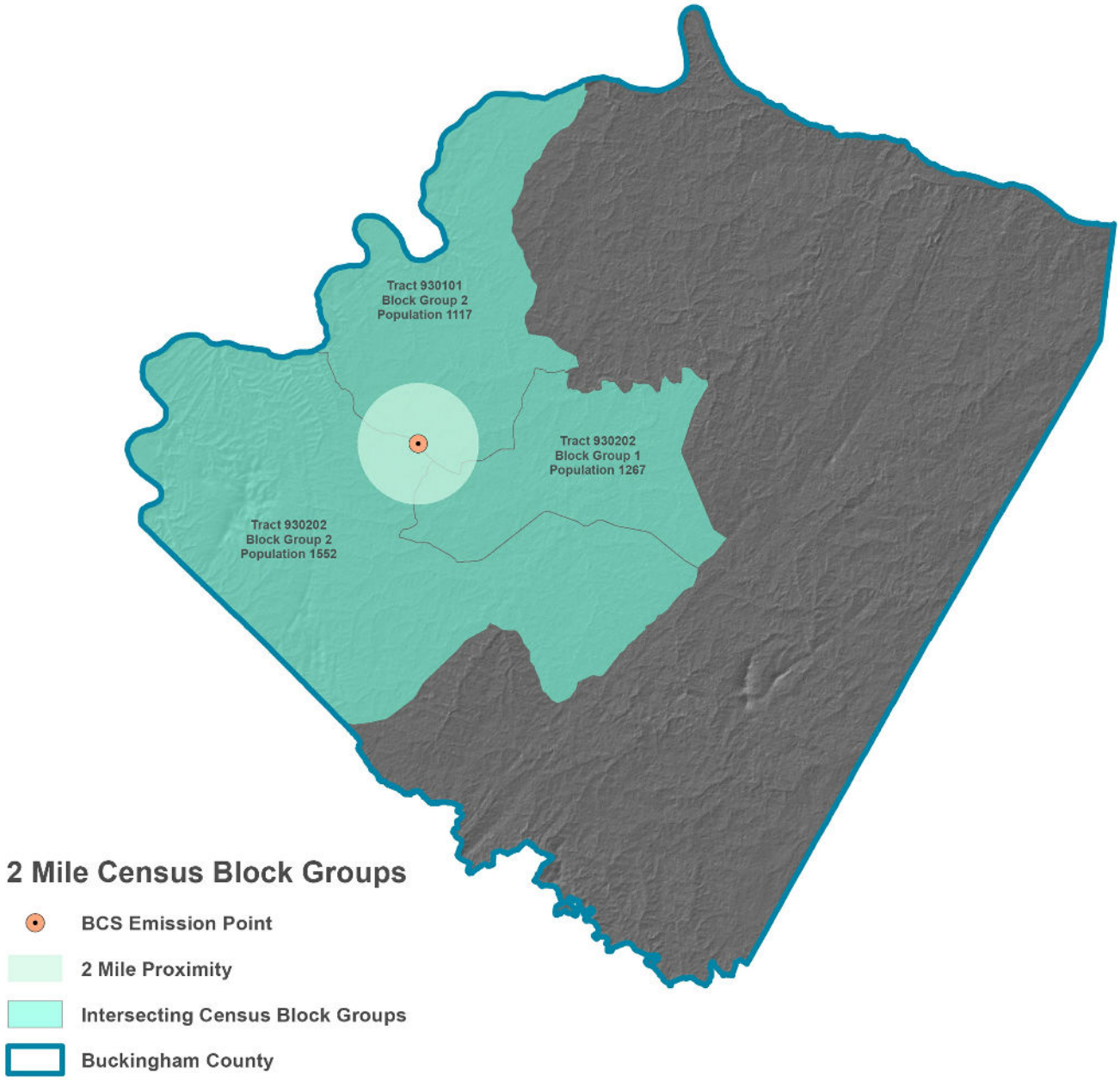
Regarding the second EJ criteria - % minority population - analysis and thematic mapping results based on **2013-2017 ACS 5-year estimates** show that the 4 census tracts in Buckingham County do not trigger further EJ consideration based on % minority population alone. While tract statistics cross at least two state median values, none of the 4 tracts cross the either the state median nor the further necessary 50% minority threshold:

- Census Tract 9302.02 - 34.8% minority
- Census Tract 9301.01 - 32% minority
- Census Tract 9301.02 - 43.8% minority
- Census Tract 9302.01 - 44.8% minority

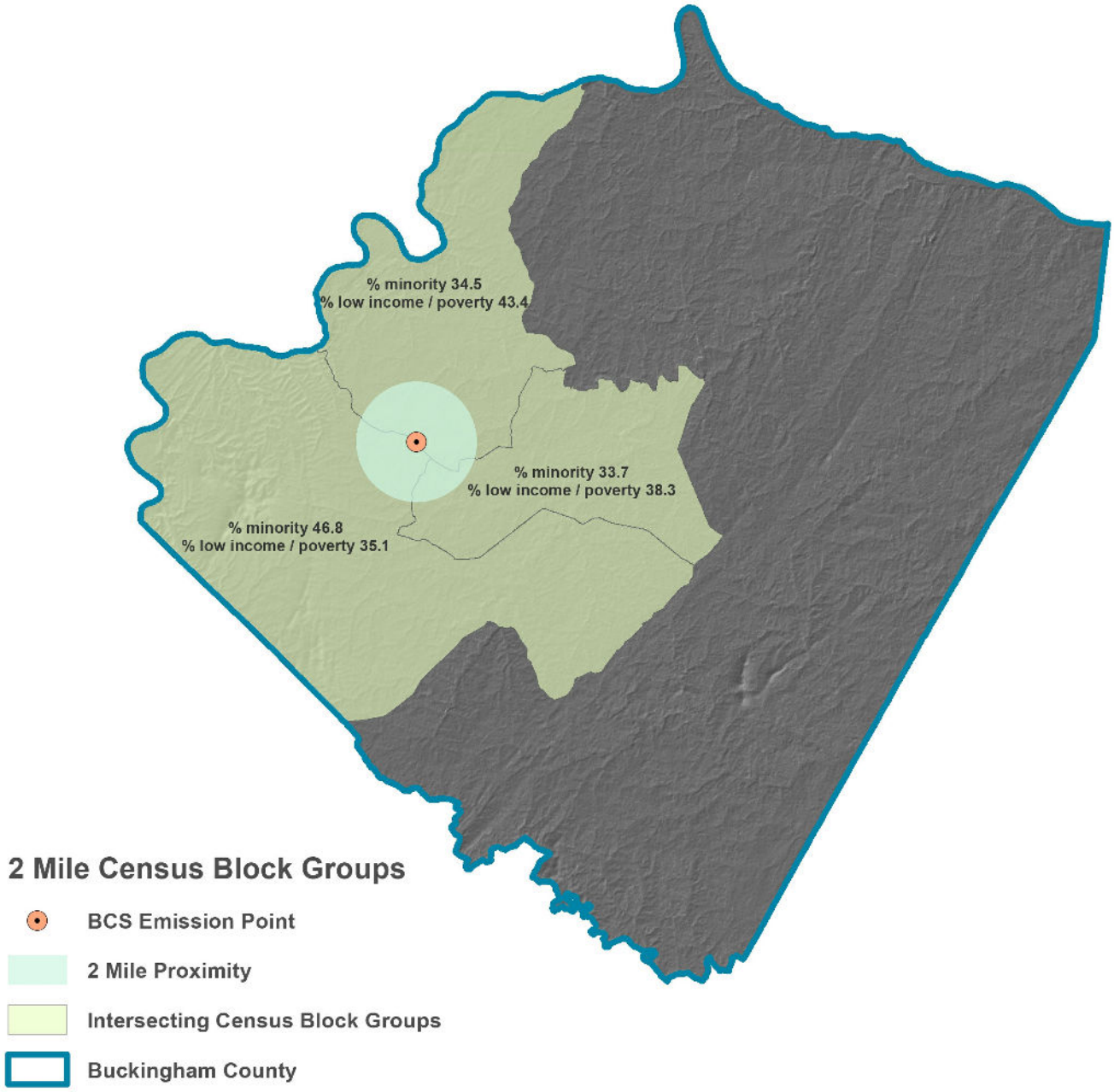


However, it should be noted at this juncture that the census tract boundaries within Buckingham County delimit substantial square area unlike those found in more urban geographies. As such, large scale, local populations (population centers, clusters and 'hotspots') are **not** denoted with precision utilizing census tract geographies in Buckingham County alone. In other words, concentrations of minority-majority, large scale populations cannot be ascertained with precision using the census tract unit of geography within Buckingham County.

This is also the case for larger scale census tract block group (CBG) geographies behind all EJSCREEN products - products that has been utilized by the DEQ in their consideration of the proposed action and its potential impacts on human populations in Buckingham county. The intersecting CBGs at the two-mile proximity are notated as follows; and their respective % minority and % poverty values as well as population counts are mapped accordingly:



Census Tract	Block Group	Population
Census Tract 9302.02	1	1267
Census Tract 9302.02	2	1552
Census Tract 9301.01	2	1117



Census Tract	Block Group	% Minority	% Low Income/Poverty
Census Tract 9302.02	1	33.7	38.3
Census Tract 9302.02	2	468	35.1
Census Tract 9301.01	2	34.5	43.4

Note 1: % minority and % poverty values are determined by ACS 2016 5-yr estimates as utilized by EJSCREEN, whereas the total population values are determined by ACS 2017 5-yr estimates in the map products shown above.

*Note 2: CBG data for ACS **2013-2017 ACS 5-year estimates** does not fully break out 'White Alone' as 'White alone, Not Hispanic or Latino', thus likely resulting in a slightly less final % minority population statistic per CBG. Further, Poverty Status is not collected at the CBG for ACS 2017 5-yr estimate products at the time of the mapping above.*

Note 3: both % minority and % poverty values have been derived from the following product: United States Environmental Protection Agency. 2017. EJSCREEN. Retrieved: 12/31/2018 https://www.epa.gov/ejscreen/download-ejscreen-data

It should be evident from the analysis thus far that there is no mechanism by which to locate, quantify or qualify impacted populations within the 2 mile proximity radius as denoted on the preceding maps. This is a known and documented limitation of any census geography, and is further a limitation of any environmental screening product that relies primarily on census data to typify large scale, local populations. Given these limitations, well known to geographers and demographic researchers, disaggregation methods are employed to typify large scale, local populations. This is the subject and goal of the following **Section 2**, specifically in regards to population density.

Section 2:

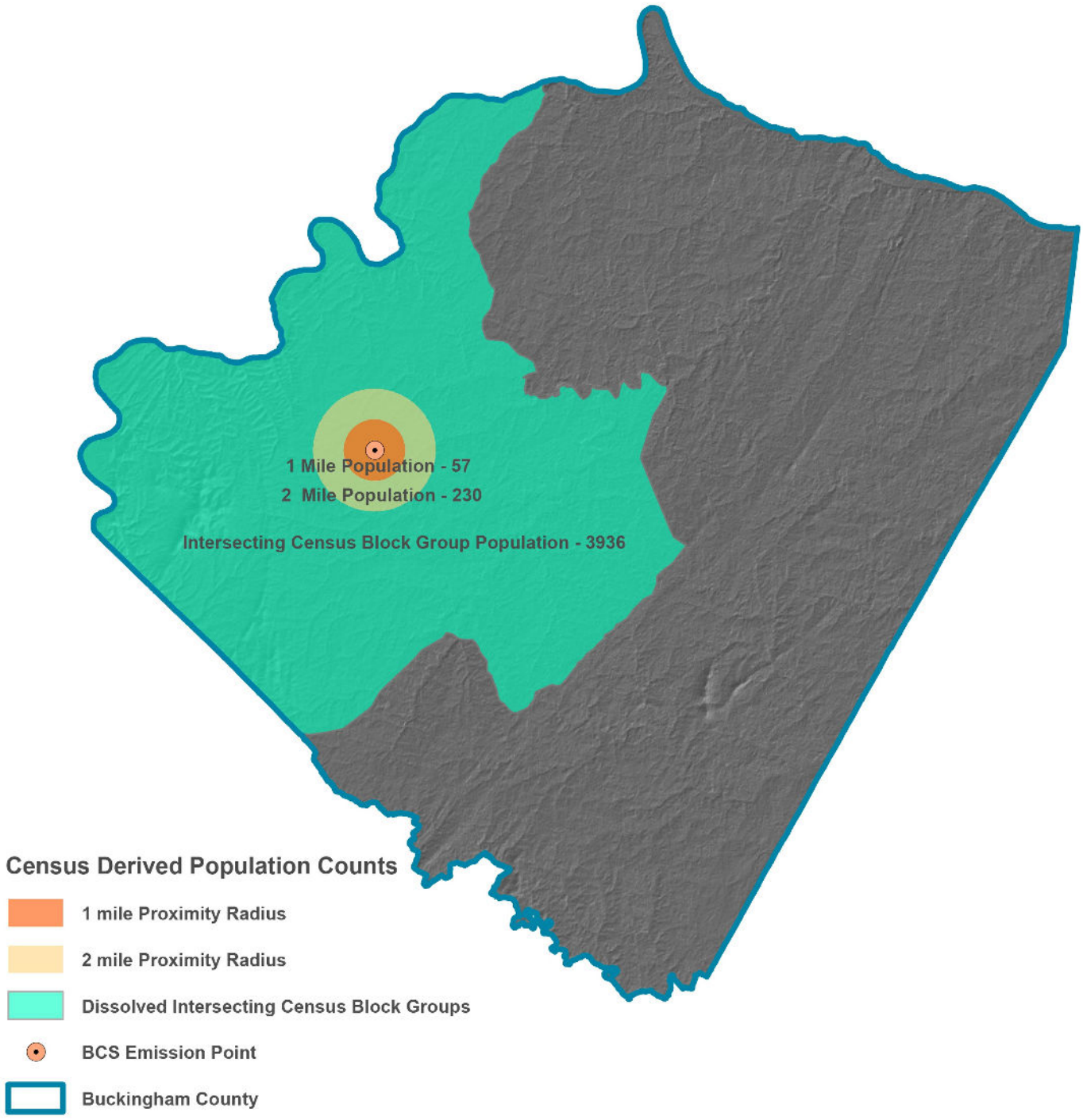
In this second section, population density is addressed. This section does not take into consideration qualitative dimensions of EJ analysis; this is simply an establishment of the differences that result from an aggregated vs disaggregated population density method across both county and proposed action proximity geographies.

Before proceeding to three disaggregation strategies to more accurately access risk to potential vulnerable populations located in close proximity to the proposed BCS, it is valuable to review the limitations of an exclusively census-based analysis method as described in **Section 1**.

The following logic will be applied generally to the population density results of this **Section 2**:

- If no significant population concentration exists in close proximity to the proposed action, adverse impacts are likely minimal or simply nonexistent as there is little or no human population at risk.
- By this logic, the converse is also true: if a significant population concentration exists in close proximity to the proposed action, then the subject population may indeed be at risk of adverse impacts.

To reinstate the population findings of **Section 1** and to establish a baseline, analysis findings for census counts (ACS 2017 5-yr estimates) first across the dissolved intersecting census geographies, and then across the two noted proposed action proximities:



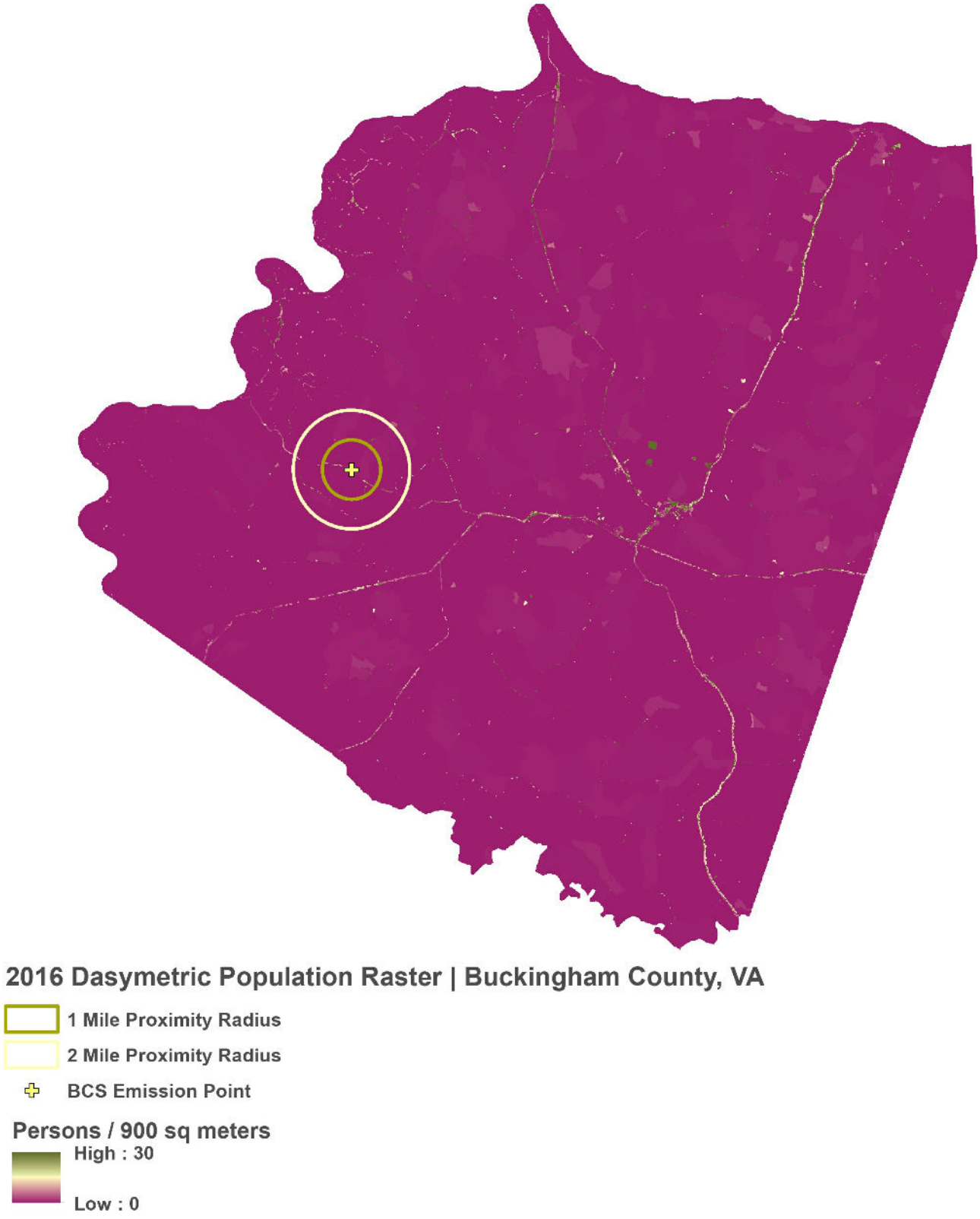
Geography	Square Area Miles	Persons per Square Mile	Approximate Population Count
Intersecting Analysis Census Block Groups Dissolved	215.19	18.28	3936
2 Mile Proximity Radius	12.56	18.28	230
1 Mile Proximity Radius	3.14	18.28	57

As shown, this aggregated analysis approach is only as accurate as the larger dissolved census geography at 215.19 square miles; and the population counts for the 1 and 2 mile proximity radii simply utilize the same population density of 18.28 persons per square mile and adjust according to 12.56 and 3.14 square miles, respectively. In other words, using this approach, population density in close proximity to the site is the same as it is at any other location throughout the census geography.

Given the deficiency noted, both EPA's EJSCREEN and EPA's EnviroAtlas both acknowledge this limitation and suggest - in the case of EJSCREEN - and actualize - in the case of EnviroAtlas - a Dasymetric approach to deriving more precision in the actual location of population densities. Here the logic is based on the fact that human populations almost exclusively inhabit certain land cover types and slope profiles. As noted by EnviroAtlas:

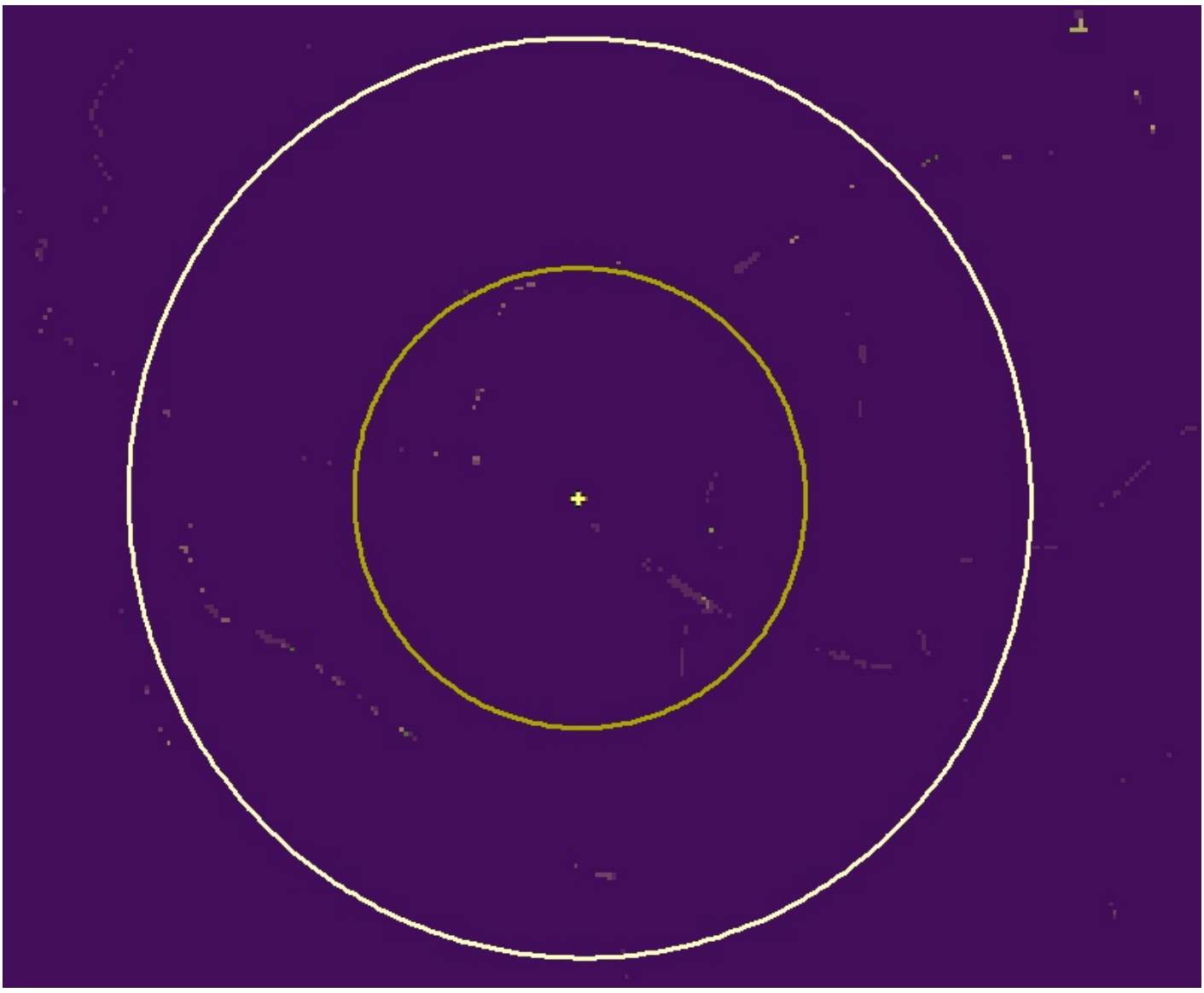
> By removing areas that are uninhabitable, such as open water and slopes greater than 25 percent, researchers can better estimate where people live.

Utilizing the same 30 meter dasymetric raster product as EPA's EnviroAtlas, the following population densities were mapped and derived at the county, 1 mile and 2 mile proposed action proximities:



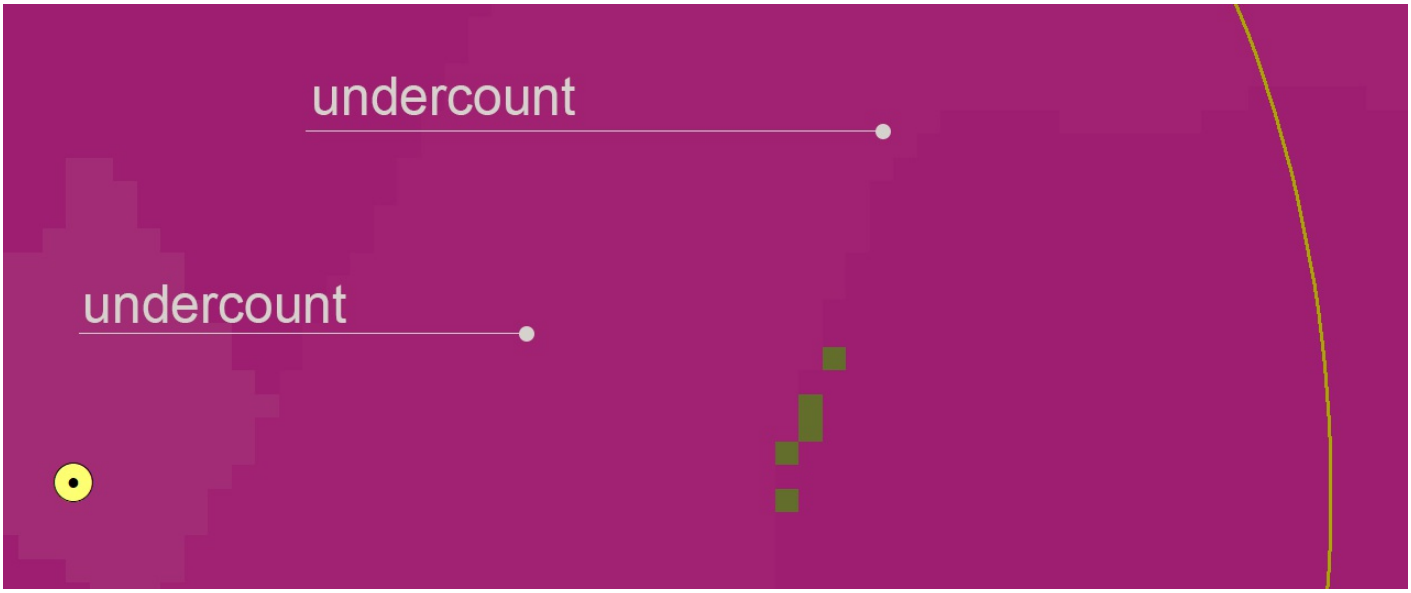
Geography	Square Area Miles	Population Count	2016 Dasymetric 30 meter Population Density (Persons Per Sq Mile)
Buckingham County, Virginia	583	17151	29.39
2 Mile Proximity Radius	12.56	95	30.30
1 Mile Proximity Radius	3.14	266	21.24

While this analysis approach for population density has advantages generally over a strict census geography method, it tends to undercount actual population due to the inability to distinguish population densities at finer resolutions than the 30 meter cell size that is determinant of the product. To illustrate this problem, the following image shows the distribution pattern throughout an area within 2 mile proximity radius. While it can determine major infrastructure features and larger structure complexes and collect population into those features accordingly, much of the immediate area pixels record inaccurate zero or very low population where population does indeed reside:



significant human habitation features in the 2 mile proximity radius register as zero population value (purple pixel color)

By comparing the product to an orthoimagery from Virginia Geographic Information Network with much finer resolution, the challenge becomes further evident. In the end, this is an enhanced analysis approach, but still possesses significant limitations for determining precise population density, especially in more rural locations outside the densest urban geographies:



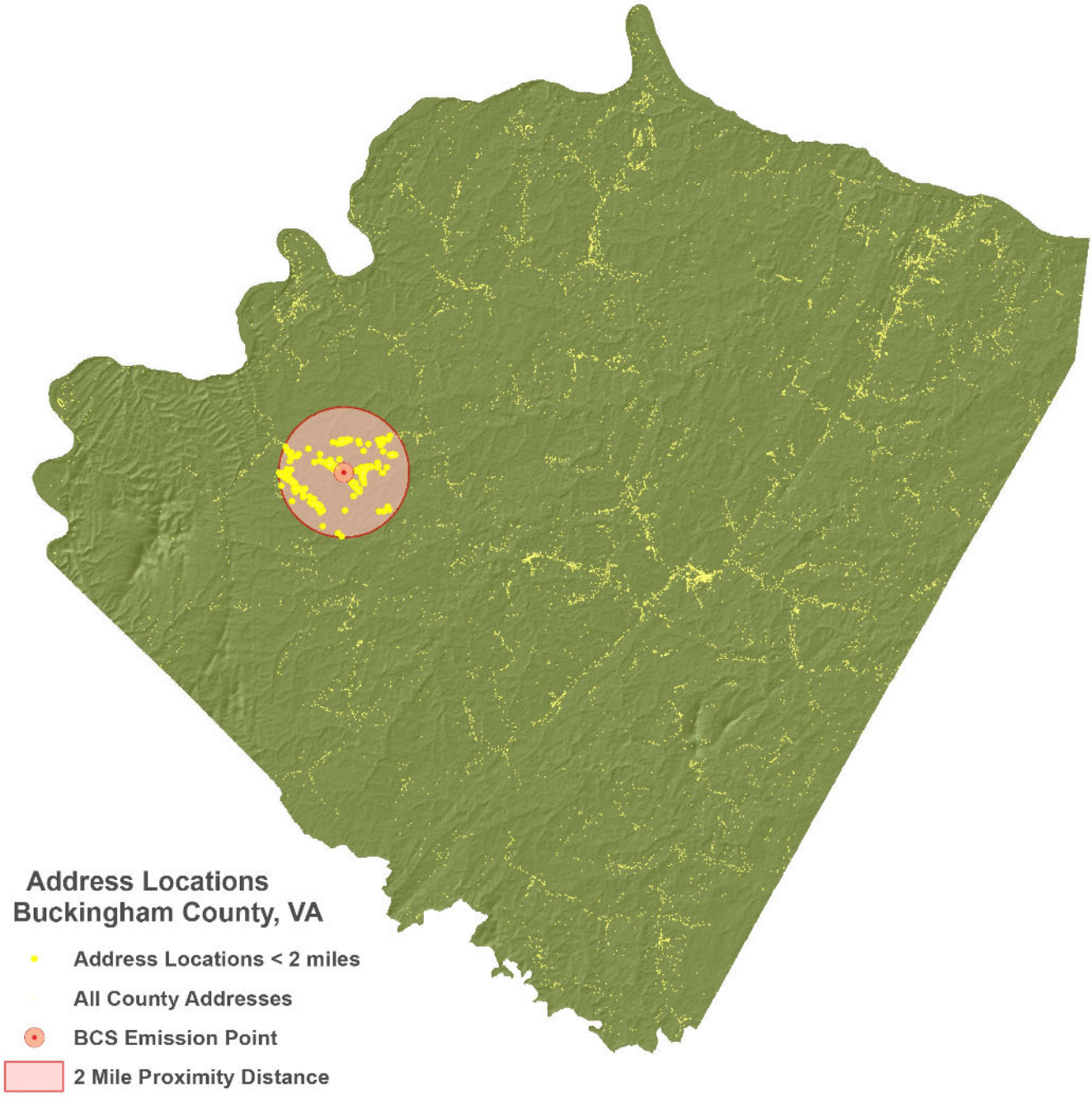
Pixel undercount at Dasymetric 30 meter resolution

Evidence of undercount in high resolution orthoimagery

With the deficiencies of both a census-only and dasymetric method based on a 30 meter cell resolution, the final, preferred analysis method of this findings statement is presented below. Based on the logic that human populations are largely defined by both household location and type, utilizing known residence locations can denote the location of population with high accuracy with one caveat: the data input must maintain significant accuracy.

Housed at the Virginia Geographic Information Network, 2018 Q3 Address points offers features with a very high degree of accuracy, in many cases 'rooftop' accuracy. By gaining a quantified count of household structures, both absolute counts can be compared across various geographies; further, interpolation methods can be run on the points features to create continuous density grids that can also be compared and analyzed across various geographies with relatively high accuracy.

The following map features highlighted address points within the 2 mile proposed action proximity. Based on summaries per analysis geography - county, 2 mile and 1 mile proximities - it is clearly demonstrated that there exists a significant 'hotspot' of largely residential density within 1 mile of the proposed action. This 'hotspot' is statistically a **51% increase in density as compared to the county at large**. Based on Virginia's Persons per Household, 2013 - 2017 ACS data the rate of household population is 2.62 on average in the state of Virginia. This translates into nearly a *doubling* of population density over the subsequent filings by Dominion dated November 21, 2018 - 55.8 persons per sq mile within 1 mile of the proposed action, versus 31.5 as found by the Dominion Filing utilizing an ESRI community profile forecast that extrapolates from a baseline established via US Census 2010 SF1 data.



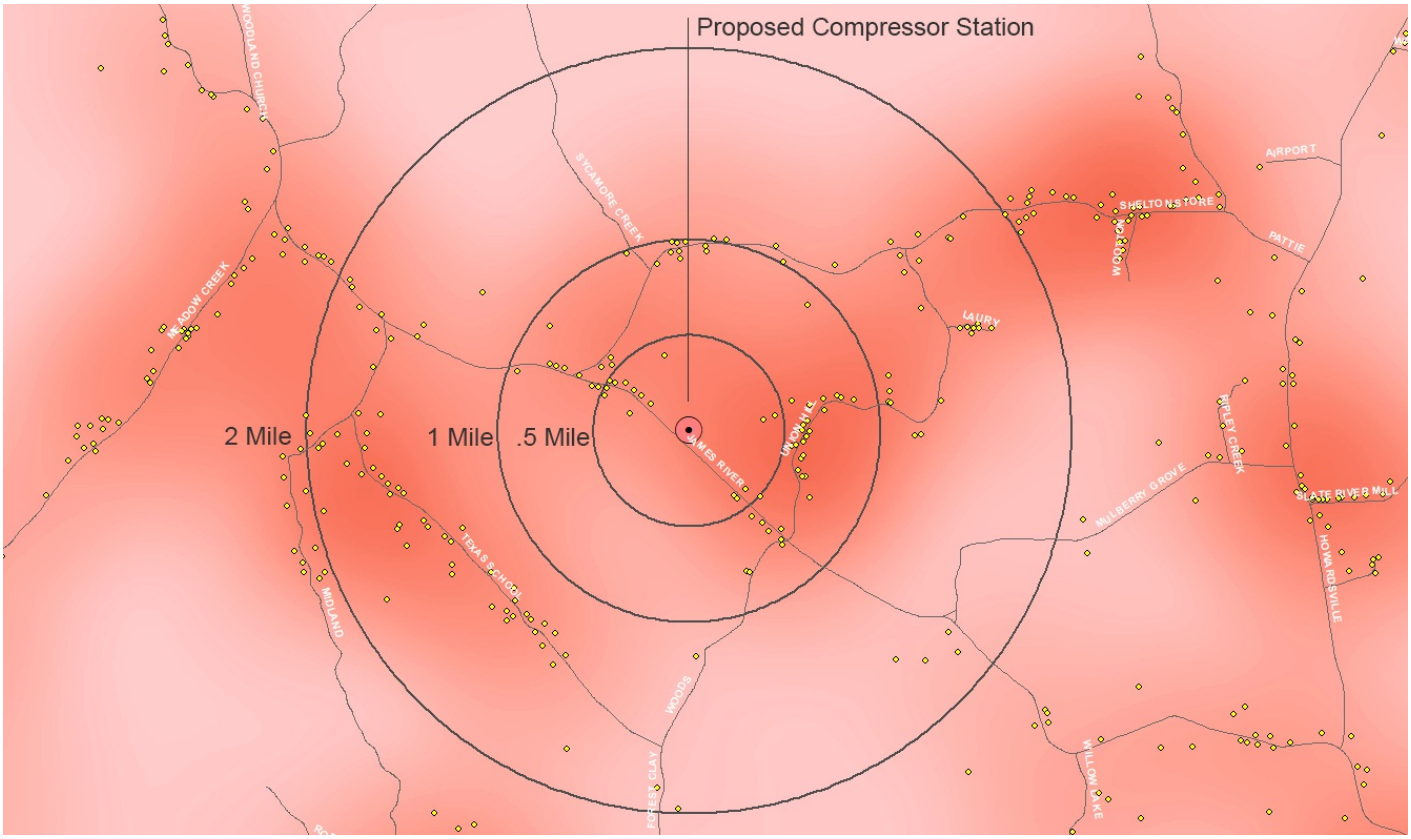
Geography	Square Area Miles	Address Points per Square Mile
Buckingham County, Virginia	583	14.1
2 Mile Proximity Radius	12.56	13
1 Mile Proximity Radius	3.14	21.3

The accuracy of the address points precision can also be tested visually within the 1 mile proximity of the proposed action. Here the address points are overlayed to Virginia Geographic Information Network orthoimagery. It is readily apparent that they are generally 'rooftop' accuracy throughout at least the 1 mile proximity geography:

Further, the prevalence of residential density in the immediate proximity geographies surrounding the proposed action can be tested, analyzed and compared outwards to other geographies using standard interpolation techniques. In this process, the address points featured in the preceding map and summarization become the input to a Kernal Density Interpolation technique that determines a rate of density per resulting raster cell. In this analysis the following criteria have been established for the interpolation run:

- Input : VGIN address points
- Search Distance Radius: 1 mile
- Return Area Units: Square Miles
- Return Cell Size: 20 meters

Given these parameters, a consistent but slightly different finding compared to address point summarization per county at .5, 1 and 2 mile proximities is determined:



Geography	Square Area Miles	Address Structures Per Mile
Buckingham County, Virginia	583	13.92
2 Mile Proximity Radius	12.56	12.51
1 Mile Proximity Radius	3.14	18.55
.5 Mile Proximity Radius	0.78	21.21

The 'hotspot' determined in the address point summarization alone is again returned with the addition of the .5 mile proximity. The three proposed action proximities except at the 2 mile proximity are **increases** above the county median, and most significantly at the nearest .5 mile proximity:

- 2 mile proximity: **10% - decrease in density as compared to the county at large**
- 1 mile proximity: **33% + increase in density as compared to the county at large**
- .5 mile proximity: **52% + increase in density as compared to the county at large**

Section 3:

As **Section 2** above clearly demonstrates significant residential density - a population 'hotspot' - in close proximity to the proposed action, this is only a quantification of the number and rate of household locations. The analysis thus far is unable to account for the critical qualitative variables that describe populations, most notably for the purpose of this statement, racial composition.

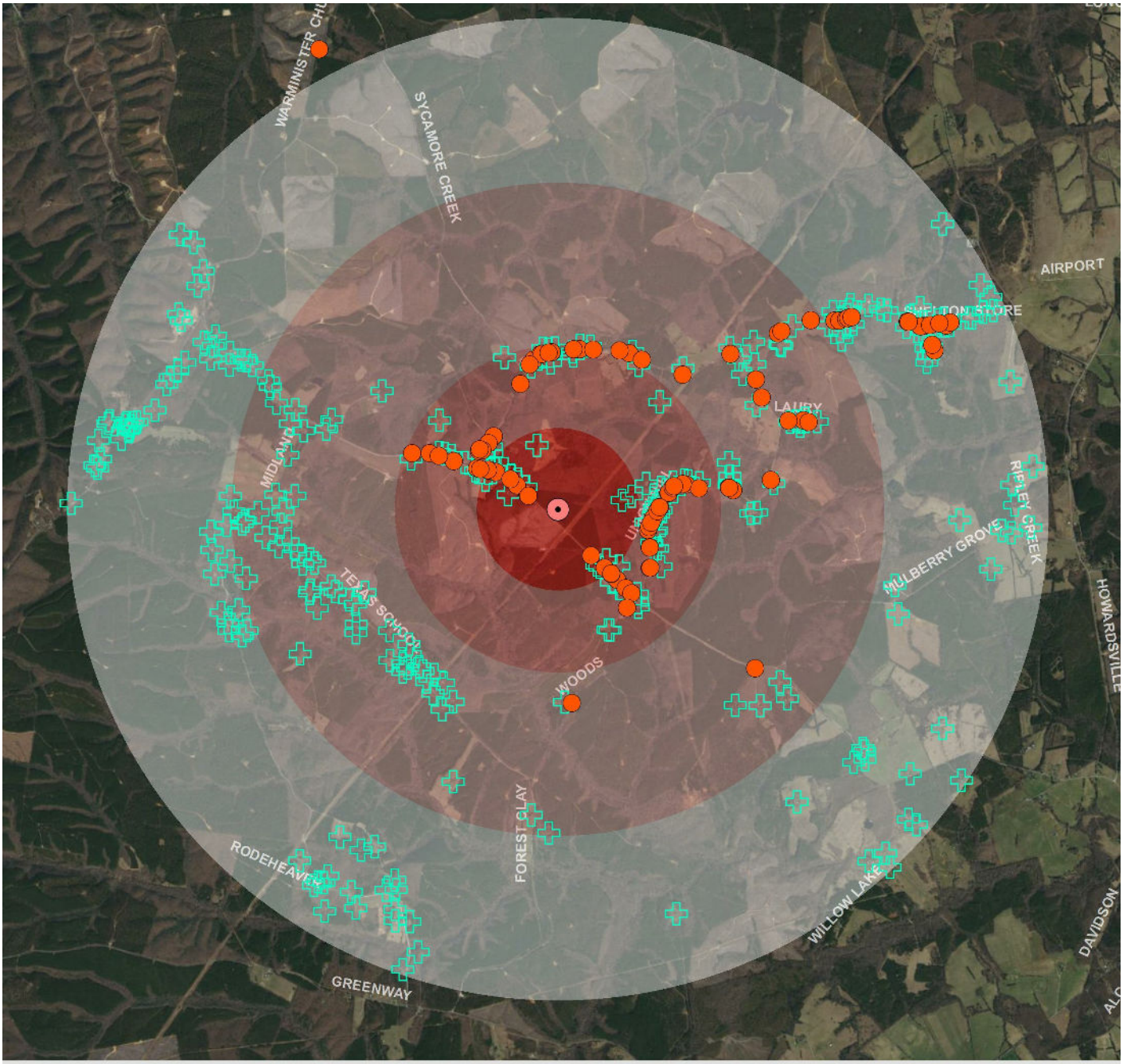
In order to assess and map population characteristics including racial composition, a census taking must be accomplished. While this is the purpose and task of the US Census across various products, scales and vintages, it important to acknowledge that these are aggregated products; and while critical to demography generally, that are not designed to fully assess large scale, local populations. This is especially an issue in larger census geographies such as those of Buckingham county, largely outside of urban centers.

To address this inherent limitation of US Census data, the Union Hill community has taken steps to conduct a robust and transparent local population study of which the findings are known as the Union Hill Community Household Study Site and Methods Report. This detailed, disaggregated study consists of door-to-

door household surveys that have resulted in a rich, validated and comprehensive demographic and statistical summary of many population variables including racial composition.

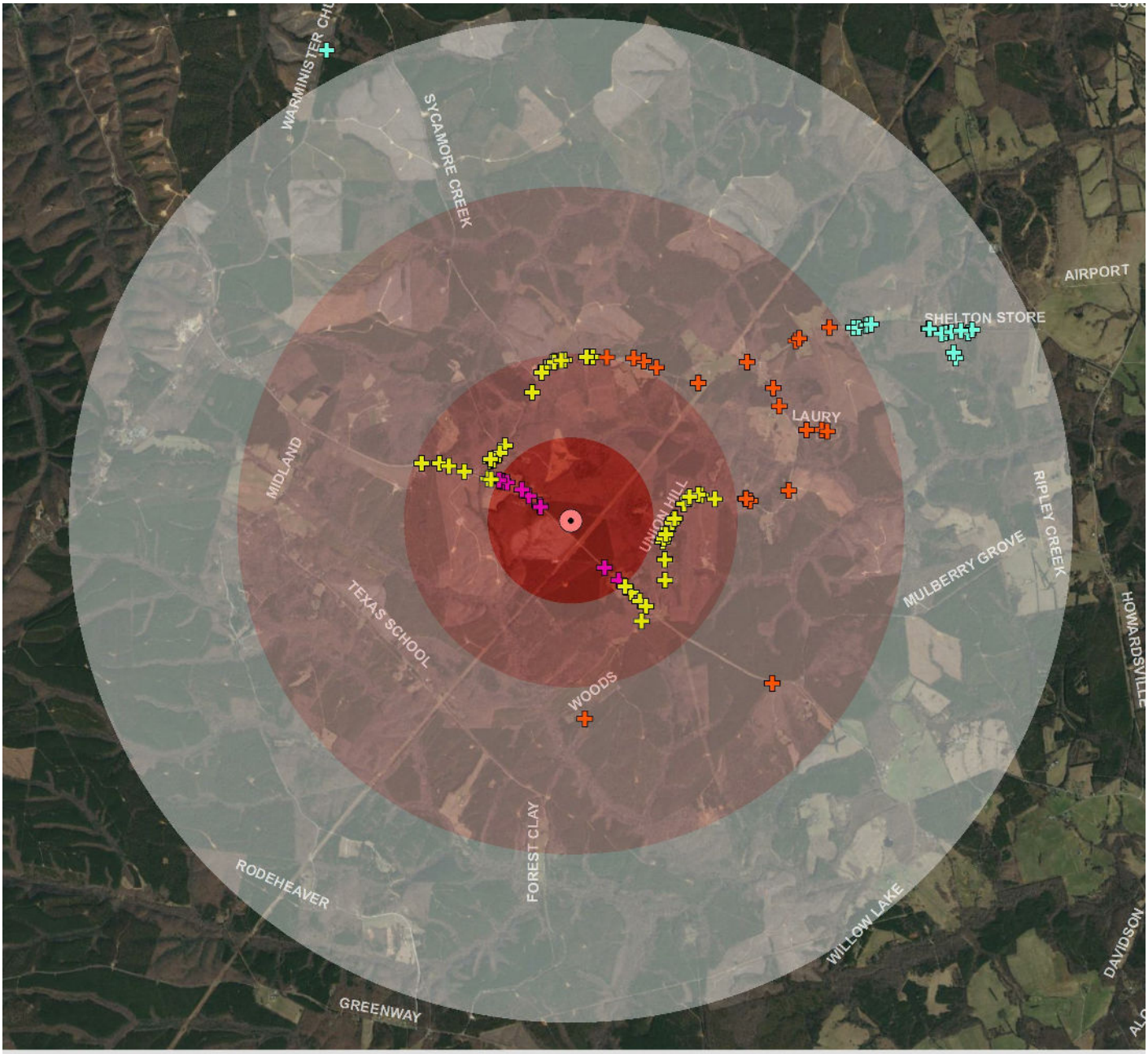
As the spatial analyst for this findings statement, I was provided full access to the dataset based on a confidentiality agreement with Dr. Lakshmi Fjord, the primary researcher and author of the study. With full access, we collectively verified each survey location with a full new geocode process via the batch US Geocoder platform. For the few addresses that were not exact matches with high spatial accuracy, the Google Maps Geocode API was utilized. In the end, every address within the 100 feature dataset has been fully documented and locational accuracy either maintained or increased over previous mappings of the dataset.

To gauge the accuracy of the survey dataset and compare its coverage relative to the Virginia Geographic Information Network address points dataset used for the population density analysis of **Section 2**, the following map allows visual comparison of the two dataset coverages, and the summary table denotes counts of each dataset within the study proximities as noted in the map and table:



Dataset	Proximity Distance - Miles	Count Features
VA Address Points	.5	15
VA Address Points	.5 - 1	52
VA Address Points	1- 2	89
VA Address Points	2 - 3	126
UH Survey Points	.5	11
UH Survey Points	.5 - 1	50
UH Survey Points	1- 2	20
UH Survey Points	2 - 3	18

As is clear from the aforementioned cartographic output and summary table - especially at the critical 1 mile proximity - there is nearly a one-to-one match in coverage. While its necessary and valuable to ascertain consistency with a known, validated address dataset, the performance value of the Union Hill Survey Points is by far the demographic attributes which they hold. The following map shows each intake survey location thematically mapped to its respective proximity distance, and the following summary tables denote both population and racial composition per proximity distance:



Union Hill Community Household Study | Resident Survey Map

Resident Study Locations & Proximities

- < .5 Miles
- .5 - 1 Miles
- 1 - 2 Miles
- > 2 Miles

Miles

0 0.5 1 2 3

Proposed Buckingham Compressor Station

Proximity Distances - Miles

- 0 - . 5
- .5 - 1
- 1 - 2
- 2 - 3

N

Data Sources: Virginia Geographic Information Network
Union Hill Community Survey Data
DETI Air Modeling Report, July 2018

Resident Count	Proximity				
Proximity Distances	.5 mile	.5 - 1 mile	1 - 2 mile	>2 mile	Total
Resident Count	15	112	43	30	200
Percentage	7.50	56.00	21.50	15.00	100.00

Race								
Proximity Distances	African American	White	Native-American	Native-American-White	Native American-African American	Hispanic	Asian	Total Race
.5 mile	4	4	3	4	0	0	0	15
.5 - 1 mile	66	14	0	5	27	0	0	112
1 - 2 mile	29	13	0	0	0	0	1	43
>2 mile	25	2	0	0	0	3	0	30
Total All Distances	124	33	3	9	27	3	1	200
Percentage	62.0	16.5	1.5	4.5	13.5	1.5	0.5	100.0

The Union Hill Community Household Study demographic summarization above clearly demonstrates households nearest the proposed action as decidedly minority-majority at 83.5%.

This third and final section of the findings statement has accomplished two critical thresholds in the characterization of this EJ eligible community in close proximity to the proposed action:

- Population densities in the immediate proximity of the proposed action are dense 'hotspots' of residential human occupation. This 'hotspot' is 51% more dense when compared to the county at large.

- While the population densities are indeed dense in close proximity to the proposed action, it is also a clear they are minority-majority populations at 83.5%.

Based on these two thresholds alone, not only is EJ eligibility criteria triggered, but disproportionate impacts are inescapable due to the combination of density and racial composition of those living nearest to the proposed action.

References:

- ESRI Demographic and Income Profile for proximities from the proposed action
- EJSCREEN runs utilized by DEQ for analysis of proposed action
- FERC FEIS Volume 1, Socioeconomics chapter #4, section 4.9.9, pp 35-39
- DETI ACP Air Quality Modeling Report - July 2018
- Recording of DEQ presentation of EJSCREEN results - *Union Hill DEQ 12-19-2018*
- FERC statistics tables - census tracts within 1 mile of ACP & SHP proposed actions
- Union Hill Community Household Study Site and Methods Report