Appendix 1.
GIS Farmland Prioritization Methods

SECTION I: DATA PREPARATION

Before beginning analysis, we projected all the data not already in the NAD 1983 State Plane North Carolina FIPS 3200 Feet into that coordinate system, and applied datum transformations as needed within the projection tool. We clipped any feature data above the county-level to the extent of the study region. We also created a polygon layer of the study region buffered on all sides by five miles. We created this expanded study area region to use in analyses where we looked at proximity for a five-mile neighborhood. We merged the individual county parcels with each other to form a study region-wide parcels layer. Similarly, we merged all the soils data for the different sub-basins. We extracted all raster data to the extent of study area. We also projected the raster data to NAD 1983 State Plane North Carolina FIPS 3200 Feet.

To focus the land cover data on farmland, we reclassified the croplands raster such that any type of cropland was given a value of "1" and all non-cropland defined as NoData. Similarly, we reclassified the NLCD data such that only the agricultural land classes (grassland, pasture, cultivated crops) were given a value of 1, and all other land cover types were defined as NoData.

Identifying Farmland. To create a baseline layer of farmland for parcel selection and prioritization, we added the binary croplands raster and the binary agricultural land cover raster together using map algebra. The intersection of these two layers theoretically represents a greater confidence in the true location of farmland than either layer would individually. We reclassified this farmland raster from values of NoData and 1 to 0 for non-farmland and 2 to 1 for farmland. To identify farmland parcels, we calculated the percentage of farmland for each tract. We did this by calculating zonal statistics with the parcels as zones, and the statistic as the average value of the binary 0/1 raster. Based on ground-truthing with aerial imagery, we established a conservative threshold for farmland classification at about 1% farmland. Although there are parcels with estimates of greater than 1% farmland that do not contain actual farmland, there are also parcels at just 5% that do contain some farmland. This conservative threshold minimizes the number of false negatives (parcels identified as non-farmland despite actually containing farmland) and ensures most of the true positives (parcels identified as farmland that do contain farmland) are included in the analysis.

We also removed all parcels less than five acres in size, because the land cover classifications would not be able to detect any farming activities at such a small scale. This greatly reduced the number of parcels in the base layer because there are a large number of very small tracts, especially in highly developed areas. We manually added in small farming enterprises based on confirmed locations to make up for some of this loss (see Accounting for Small Farms, below). The sources for small farms and their locations came from Carolina Farm Stewardship Association (CFSA).

Because the parcel attributes vary by county, we were able to narrow down the baseline data further in some counties. For Durham County, in addition to keeping all parcels with greater than 1% calculated farmland, we kept any parcels with land use coded as agriculture, present use agriculture or horticulture, residential, or vacant. For Johnston County, we removed all parcels with use codes other than auxiliary improvements, manufactured home, mobile home, single

family residential, or vacant from the baseline layer. We also removed all parcels with the following exempt statuses: charitable, county, municipal, private educational, religious, state, and utilities/railroads. For Wake County, we removed all parcels with land classes other than acreage with building on property that is not a main structure, over 10 acres with one or more houses, commercial, manufactured home, residential 10 acre, and vacant. Based on reviewing owner names, we were also able to remove all parcels with billing codes 3 (exempt) and 6 (home associations). We were unable to conduct further refining of Orange and Chatham counties due to attribute limitations.

Accounting for Small Farms. The creation of the baseline layer included the removal of all parcels under 5 acres, so we manually added back in known farms smaller than five acres. We used a list of farms that have been involved in some capacity with CFSA, and imported their coordinates as point features. We looked at each point and recorded the corresponding parcel information that matched the farm location if the farm was not already included in the base layer. We used this information to select parcels, export them to new layers, and then merged the layers from each county to form one layer. Finally, we merged this countywide layer with excluded farm parcels back with the baseline layer we created based on acreage and a minimum of one percent farmland.

After reviewing this baseline layer, we found that some parcels with under one percent farmland were still being included. To remove these parcels, but not the farms manually added in, we created a layer with all parcels under one percent from the baseline layer. We erased the small farms we added in to create an output layer with just the extraneous parcels we wished to remove. We took this layer back to the baseline layer and erased all the extraneous parcels, leaving the final baseline layer containing parcels with over one percent farmland and over five acres, unless we manually added the farm.

SECTION II: MODEL CRITERIA

Acres of farmland. We calculated the estimated acres of farmland on each parcel using the same data layer we created while developing the baseline layer. This is a remotely sensed estimation of farmland, so you should keep in mind that this criterion merely *estimates* the amount of acres of a parcel in farmland, but does not precisely represent acreage in production. We calculated this estimate by multiplying the parcel's acreage by the percent of the parcel estimated as farmland according to the agricultural land cover data layer created earlier. For our traditional farmland protection model, we gave higher priority to parcels with more acres of farmland, and for our urban fringe model, we have higher priority to parcels with fewer acres of farmland (Table 1).

Table 1. Point values awarded for various size classes for the two models.

	Point Values in Farmland Protection Model		Point Values in Urban Fringe Model
Less than 5 acres	2	Less than 5 acres	10
5 to 25 acres	6	5 to 10 acres	9
25 to 50 acres	8	10 to 25 acres	8
50 to 100 acres	9	More than 25 acres	6
More than 100 acres	10		

Distance to urban areas/clusters. We used distance to urban areas/clusters as a proxy for development pressure. The urban areas and urban clusters data came from the NC OneMap database, and the data itself came from the U.S. Census Bureau. According to the U.S. Census Bureau, urban areas/clusters are defined as "a densely settled core of census tracts and/or census blocks that meet minimum population density requirements". Urban areas must have at least 50,000 people, and urban clusters must have at least 2,500 people. We calculated distance to urban areas/clusters using the Euclidean distance tool, and then reclassifying the resulting rasters into specific distance classes assigned different point values. We included urban areas/clusters falling outside the study area boundary but within five miles, so parcels near the boundary could be scored accordingly. For the urban fringe model, we prioritized parcels closer to urban areas and clusters, and for the farmland protection model, we prioritized parcels farther away from urban areas and clusters (Table 2).

Table 2. Point values awarded for various distance classes for the two models.

	Point Values in Farmland Protection Model	Point Values in Urban Fringe Model
Within urban area/cluster	2	10
Less than 0.5 miles	4	8
Less than 1 mile	6	6
Less than 5 miles	8	4
More than 5 miles	10	2

Surrounding population. To calculate population density, we used the highest resolution of population data, which are U.S. Census blocks. Census blocks and their related population data were downloaded from the U.S. Census Bureau as TIGER shapefiles. First, we calculated population density by dividing the total population in a block by its area. We then multiplied this value by the anticipated cell size of the raster (30m) to estimate the number of people for each cell. We converted the census blocks data into a raster, using the value we just calculated, and then ran focal statistics using a circle with a radius of 1 mile to sum up the number of people per each cell. We reclassified the raster twice, once for each model, each time awarding point values for each distance class. For the urban fringe model, parcels received more points for a larger surrounding population, and for the farmland protection model, parcels received more points for a smaller surrounding population (Table 3). For this analysis, we used input layers clipped to the one mile buffer around the study area so that the surrounding population for farms on county borders were accurately represented.

Table 3. Point values awarded for different size classes for the two models.

	Point Values in Farmland Protection Model	Point Values in Urban Fringe Model
Less than 250 people	10	2
250 to 500 people	8	4
500 to 1,000 people	6	6
1,000 to 2,000 people	4	8
More than 2,000 people	2	10

Proximity to agricultural protected areas. For agricultural protected areas, we merged three separate datasets: voluntary agricultural districts, agricultural easements, and century farms. While century farms are not under protection, we considered farms that went through the certification process as likely committed to remaining in agriculture. We attained data on century farms from North Carolina Department of Agriculture and Consumer Services' Public Affairs Division and digitized it into a spatial format. We calculated Euclidean distance from the merged agricultural protected areas layer, and then a reclassified the raster into the desired distance classes and assigned point values (Table 4).

Table 4. Point values awarded for different distance classes for the two models.

	Point Values in Farmland Protection & Urban Fringe Models
Within/adjacent	10
Less than 0.5 miles	8
Less than 1 mile	6
Less than 2 miles	4
More than 2 miles	0

Soils. For our soils data, we used ESRI's web service SSURGO downloader, which provides already processed soils data containing only the most commonly used attributes of SSURGO data at a watershed level. One such attribute is the non-irrigated capability class, an indicator of the soil's suitability for growing most field crops. There are several other indicators of agricultural quality, but we chose non-irrigated capability class because it provided a higher level of distinction among soil quality than prime soil classification. We scored the parcels based on their majority capability class, calculated using zonal statistics, with each parcel as the zone and using the majority statistic. We assigned point values the same way for both models, with the rapid decline in point values reflecting the strongly decreasing capability of the higher classes (Table 5).

Table 5. Point values awarded for non-irrigated agricultural capability classes for the two models.

Capability Class	Point Values in Farmland Protection & Urban Fringe Models
1	10
2	8
3	4
4	2
5 - 8	0

Proximity to low access/low income tracts. The USDA Food Access Research Atlas has census tract level data defining whether the tract is low access according to a few different definitions and whether a tract is defined as low income. Because we only included proximity to low access/low income tracts in our urban fringe model, we were only interested in the distance metrics for urban low access tracts. The USDA defines low access for urban census tracts as either no supermarket or grocery store within either one half or one mile. We decided to

designate tracts as low access using the one mile metric. We calculated Euclidean distance from the census tracts and reclassified them into distance classes to prioritize parcels within one mile of low access/low income tracts. We assigned higher point values for parcels within a low income and low access tract, with decreasing point values as distance from low income and low access tracts increases (Table 6).

Table 6. Point values awarded for different distance classes for the urban fringe model.

	Point Values in Urban Fringe Model
Within a low income/low access tract	10
Less than 0.25 miles from a low income/low access tract	8
Less than 0.50 miles from a low income/low access tract	6
Less than 1 mile from a low income/low access tract	4
More than 1 mile from a low income/low access tract	0

Present Use Value Taxation. As an additional bonus point for the farmland protection model, we included information on present use value (PUV) taxation. We wanted to give parcels in PUV a bonus because of the confidence that these parcels were indeed farms. We obtained PUV information from county tax offices. We awarded a bonus point only to parcels in horticulture or agriculture PUV, and not those in forestry. We added the bonus point after creating the weighted model (see Section III), by converting the PUV parcels to a raster consisting of ones (parcels in PUV) and zeroes (parcels not in PUV) which was then added to the final weighted overlay raster.

SECTION III: WEIGHTED OVERLAY

First, we converted all the criteria from polygon to raster, using the points we allocated earlier as the raster values. We combined all the criteria rasters in the weighted overlay tool, keeping the scale values the same as the raster values, and therefore the same as the values we assigned earlier. We ran the weighted overlay tool using weights determined based on consultation with local resource professionals (Table 7).… The output consisted of a raster with values ranging from 2 – 9 for the urban model, and 1 – 11 for the farmland protection model. We used zonal statistics to calculate the mean value for each parcel and determine the prioritization scores for the parcels.

Table 7. Final weights used in the weighted overlay analysis for both models.

Model Criteria	**Farmland Protection Model**	**Urban Fringe Model**
Soils	29	29
Acres of Farmland	25	19
Distance to Urban Areas	18	18
Proximity to Agricultural Protected Areas	16	11
Surrounding Population	12	14
Proximity to Low Access and Low Income Census Tracts	N/A	9
Present Use Value Taxation	1 bonus point	N/A