Invasive Susceptibility

Design Solutions for Invasive Species Management in Response to Marcellus Drilling

Rick Hammond

NOT
WANTED

For Invading Sullivan County

Mile-a-Minute

Persicaria perfoliata

REWARD

NOT
WANTED

For Invading Sullivan County

Tree of Heaven

Ailanthus altissima

REWARD

NOT
WANTED

For Invading Sullivan County

Japanese Stiltgrass

Microstegium vimineum

REWARD

NOT
WANTED

For Invading Sullivan County

Japanese Honeysuckle

Lonicera japonica

REWARD

WHAT ARE INVASIVES?

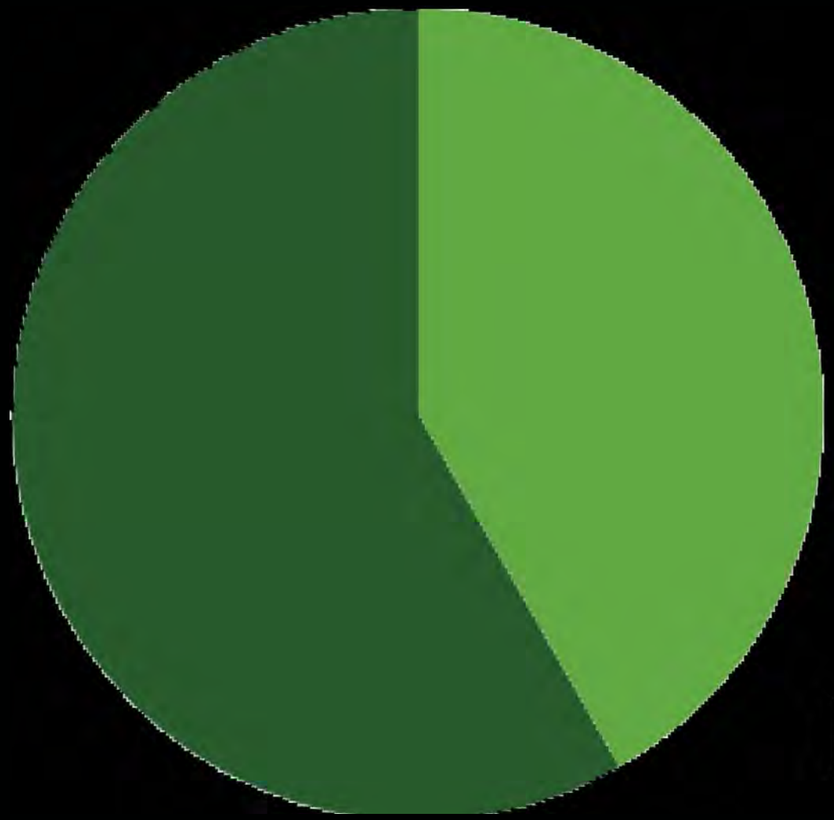
Invasive species are non-native species of plants, animals, or other organisms that are likely to cause economic, environmental, or human harm. For this project, I looked at the susceptibility of four highly aggressive invasive plants in the state of Pennsylvania: Mile-a-Minute, Tree of Heaven, Japanese Stiltgrass, and Japanese Honeysuckle. These four species cause extensive damage to environments in Pennsylvania and offer very few benefits. Currently none of these species have been reported in Sullivan County, however that does not mean that they are not already present. It’s also safe to assume to that as gas drilling increases in Sullivan County, the invasive species will also increase. This analysis explains what areas of Sullivan county are most susceptible and therefore most at risk.

WHY ARE THEY BAD?

Invasive species cause extensive damage in some way or another. They out-compete native species, which can cause damage to the ecosystem. They can invade farmland, causing huge economic losses and a reduction in the amount of food that can be produced. They also invade forests, affecting its health and the health of timber production. They also affect the aesthetics of the area, turning areas to be proud of into areas reminiscent of a vacant lot. People are not always aware that something is wrong, or they do not understand the dangers, but invasive species can be a real threat and right now Sullivan County has the opportunity to prepare for it.

ABOUT THE PROJECT

In this project I looked at the susceptibility of four inasive species: Mile-a-Minute, Tree of Heaven, Japanese Stiltgrass, and Japanese Honeysuckle. I mapped out the susceptibility of these four plants in four different scenarios. The first was a pre development scenario. This scenario looks at Sullivan County before any gas development started and it serves as a control. The second scenario was existing development. This looked at the existing gas development conditions in Sullivan County. The next scenario used the Nature Conservancy High Impact Gas Drilling data and market-based pipelines to show one of the two scenarios on a high impact level. The fourth and final scenario used the Nature Conservancy High Impact Gas Drilling data and conservation-based pipelines to show the second of two scenarios on a high impact level. The High Impact scenarios do not include Japanese Honeysuckle. The reasoning behind this is that I was not going to be able to replicate the quality of data for bird species in these scenarios and I would rather show the incomplete data then sacrifice the quality of it. After completing these susceptibility maps I came to a couple of conclusions. The first was that there was very little difference between the market-based and conservation-based pipelines in regards to invasive species. The second was that the four species seem to follow the same type of increase, with the area doubling as gas increases. The results of this project can be used to prepare for managing invasives in Sullivan County.



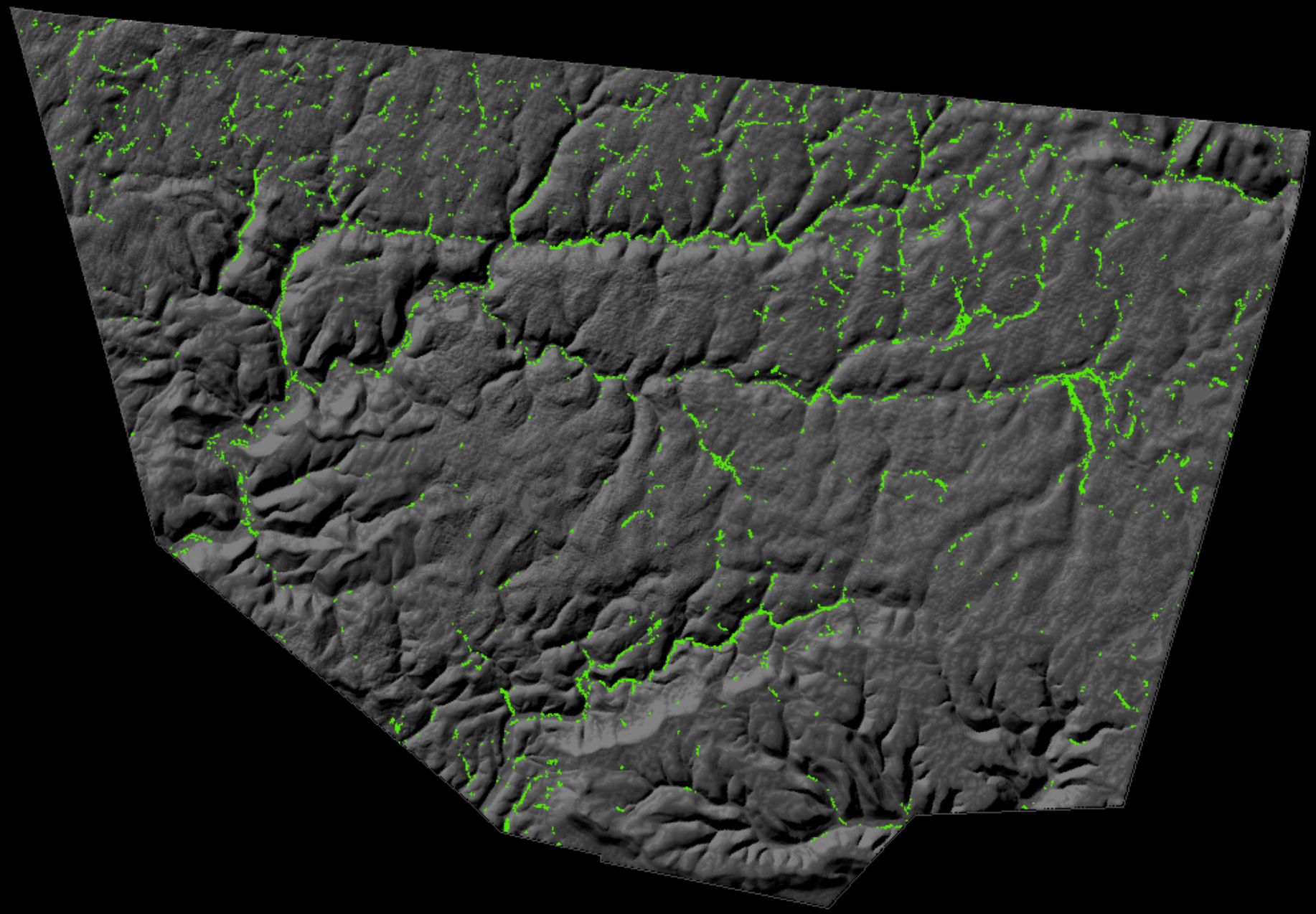
42%

OF ENDANGERED SPECIES ARE AT RISK BECAUSE OF INVASIVE SPECIES

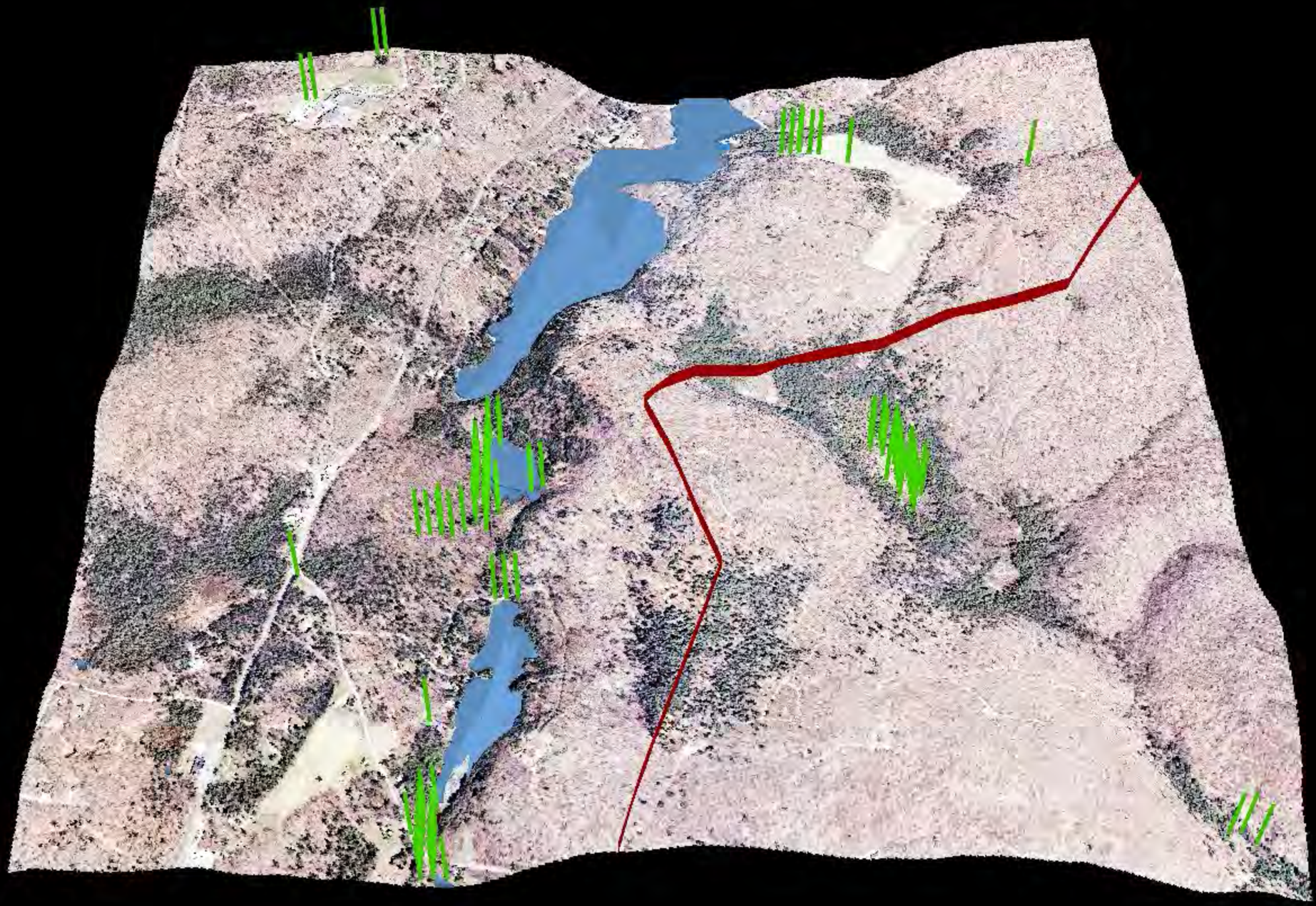
Mile-a-Minute

Persicaria perfoliata

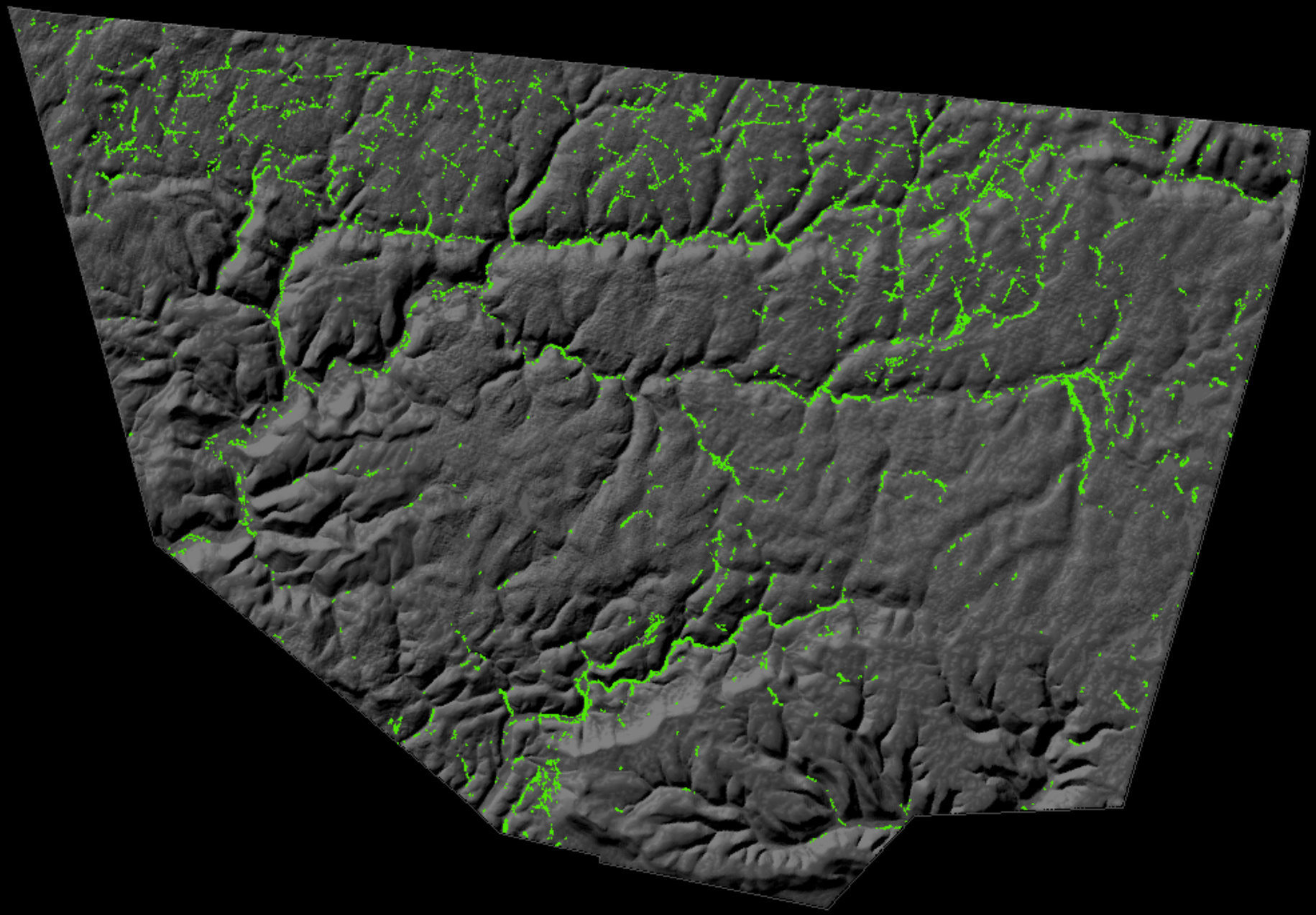
1) Roads (30ft Buffer and 0.6 Mile Buffer)
2) Existing Vegetation
3) Disturbance
4) Ownership
5) Aspect (Any)
6) Soil Type (Shallow, Well Drained Channery Loam)
7) Soil pH (5.5-6.4)
8) Soil Moisture (Moist to Wet Soil, No Standing Water; Tolerates dry)
9) Floodplains
10) Streams (100ft Buffer)
11) Existing Drill Pads (30ft Buffer and 0.6 Mile Buffer)
12) Marc 1 Pipeline (30ft Buffer and 0.6 Mile Buffer)
13) Existing Gathering Lines (30ft Buffer and 0.6 Mile Buffer)
14) High Impact Drill Pads (30ft Buffer and 0.6 Mile Buffer)
15) High Impact Market Based Gathering Lines (30ft Buffer and 0.6 Mile Buffer)
16) High Impact Conservation Based Gathering Lines (30ft Buffer and 0.6 Mile Buffer)



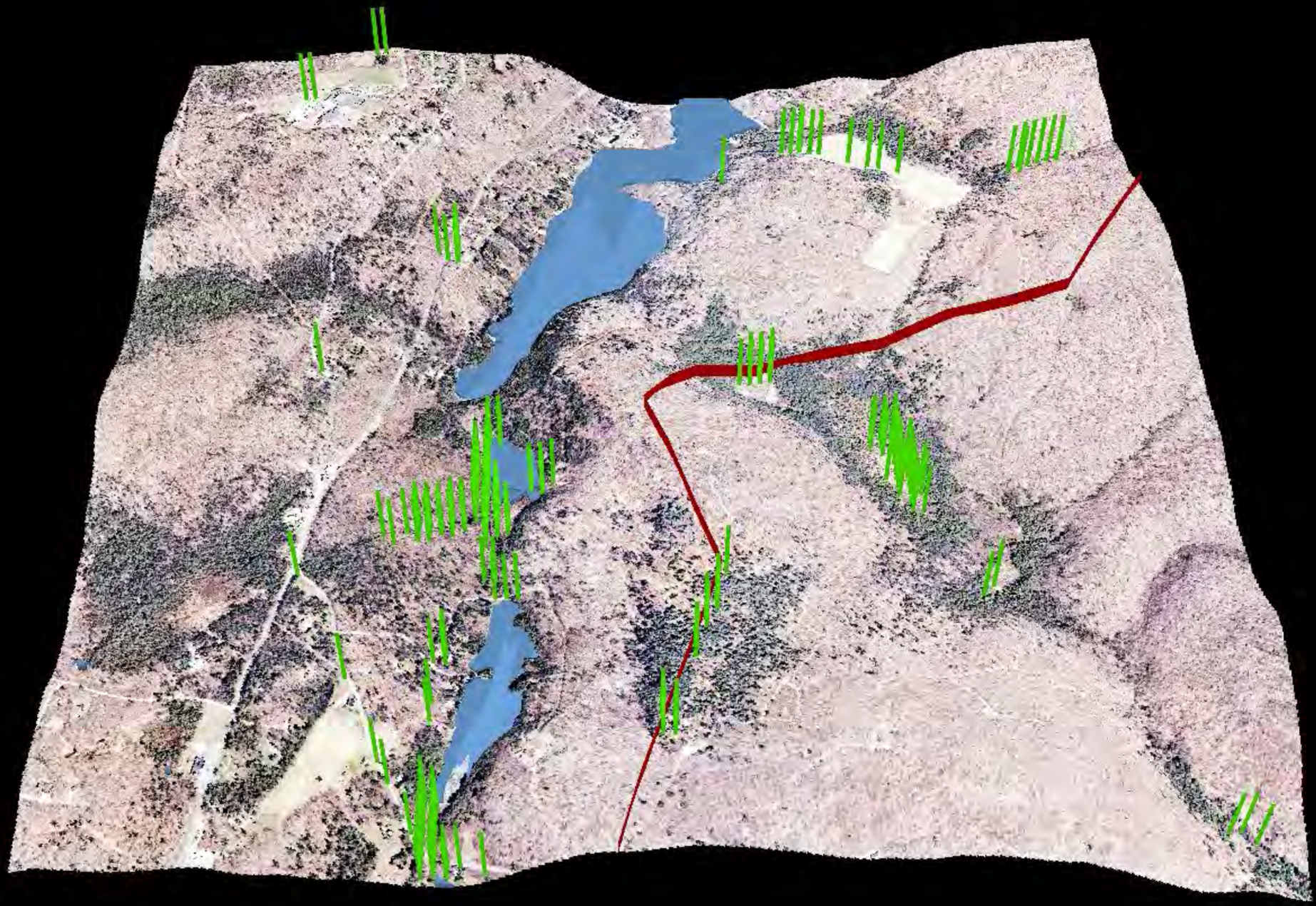
Pre Development - County Scale



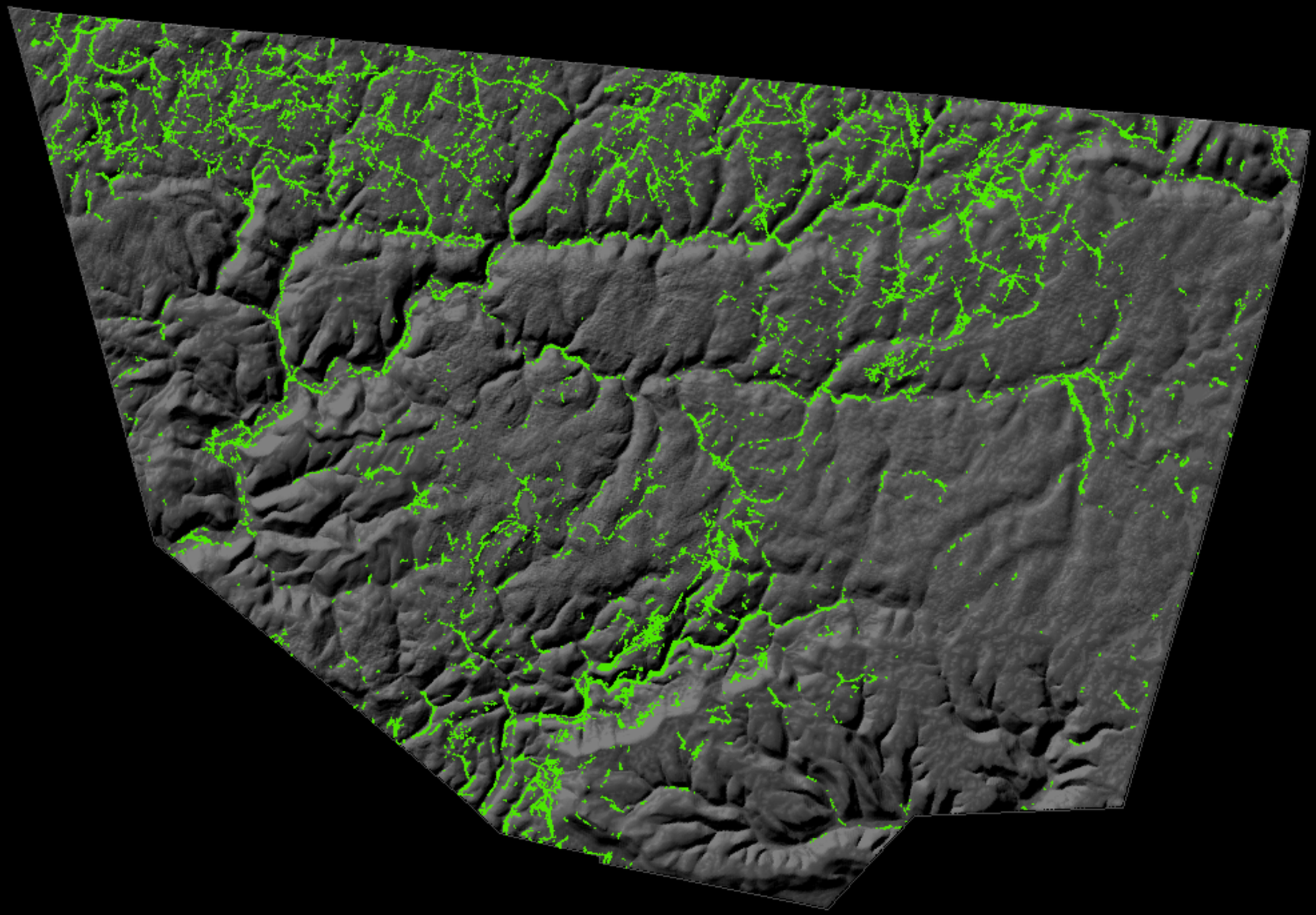
Pre Development - Lake Mokoma Scale



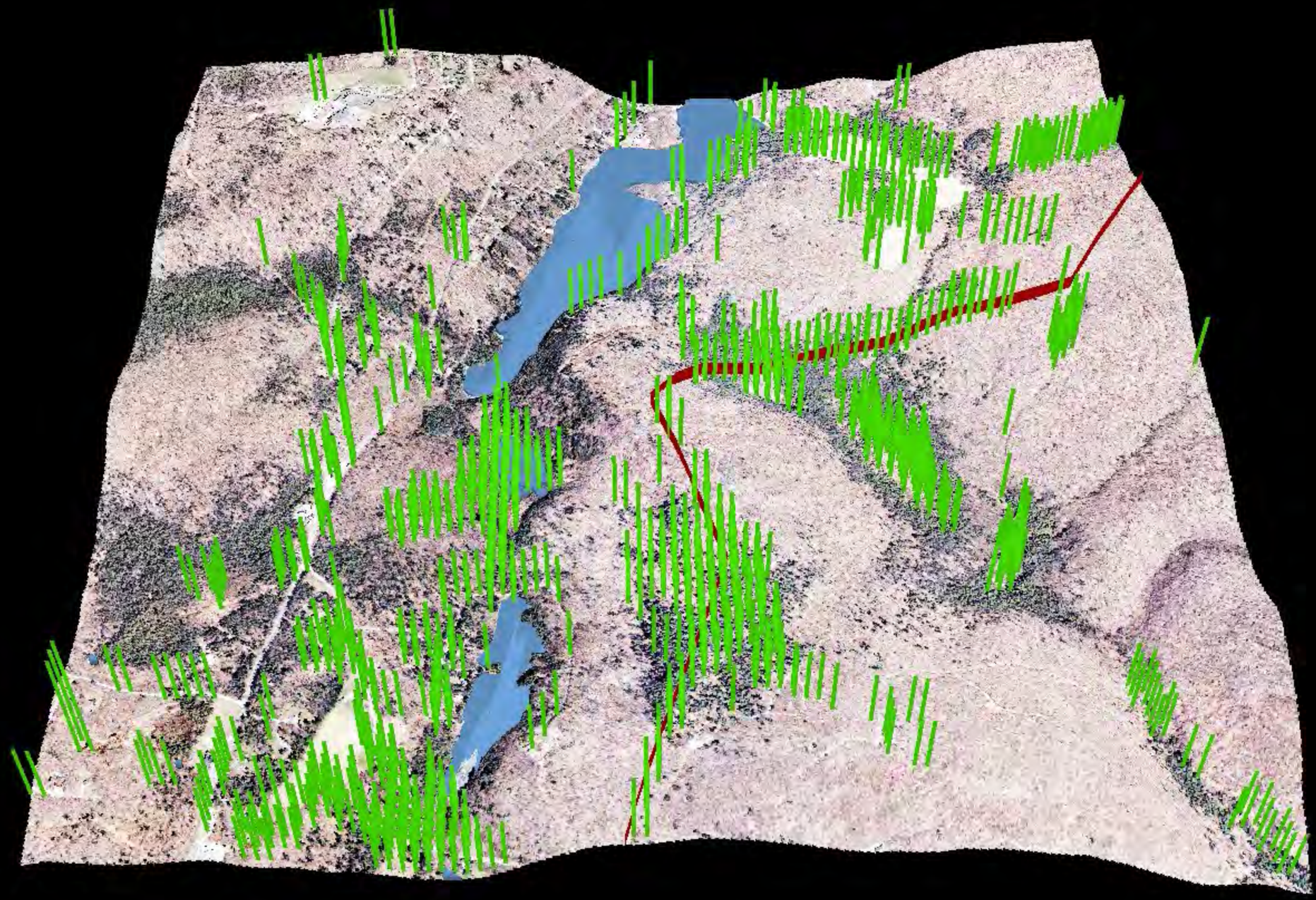
Existing Development - County Scale



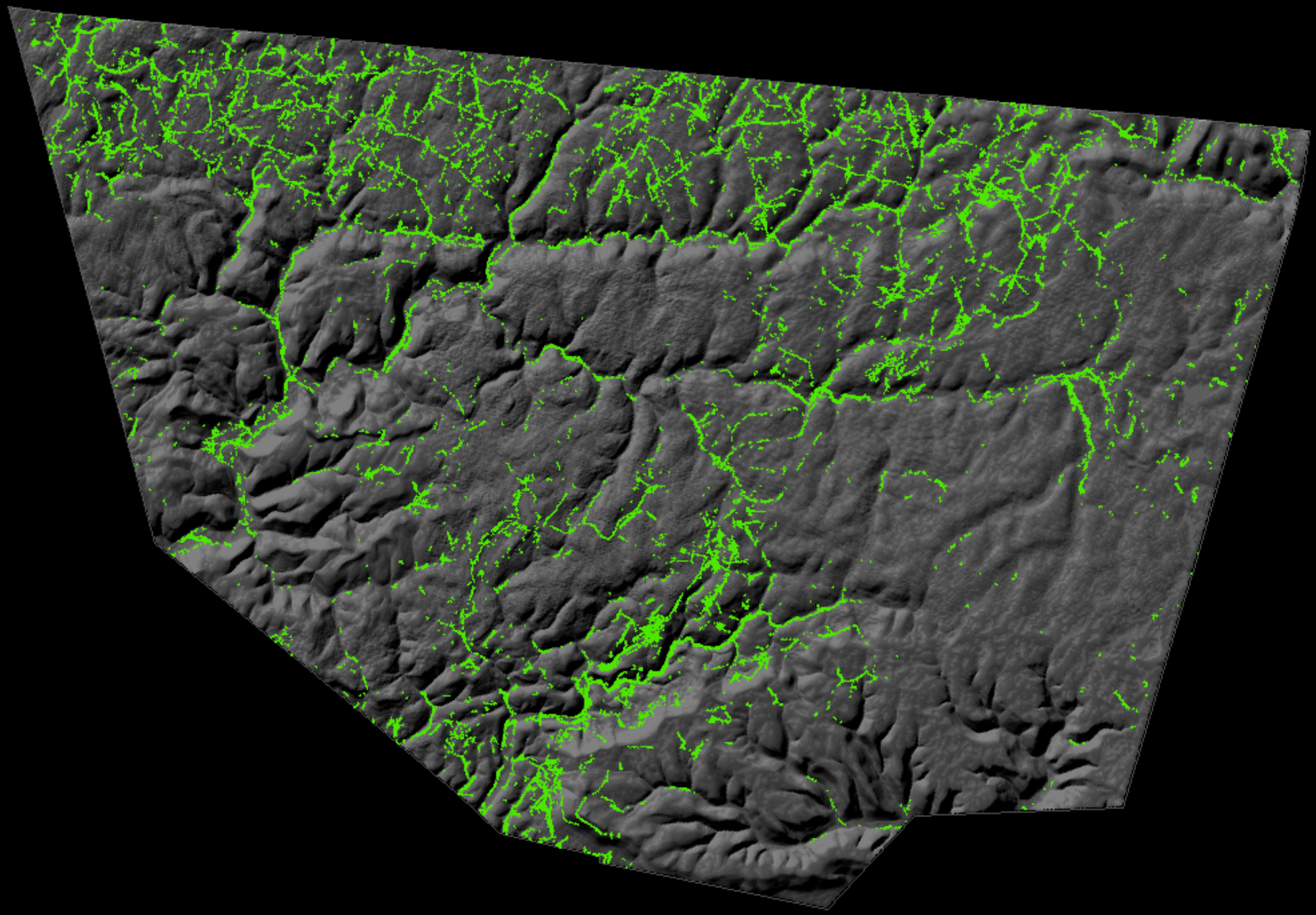
Existing Development - Lake Mokoma Scale



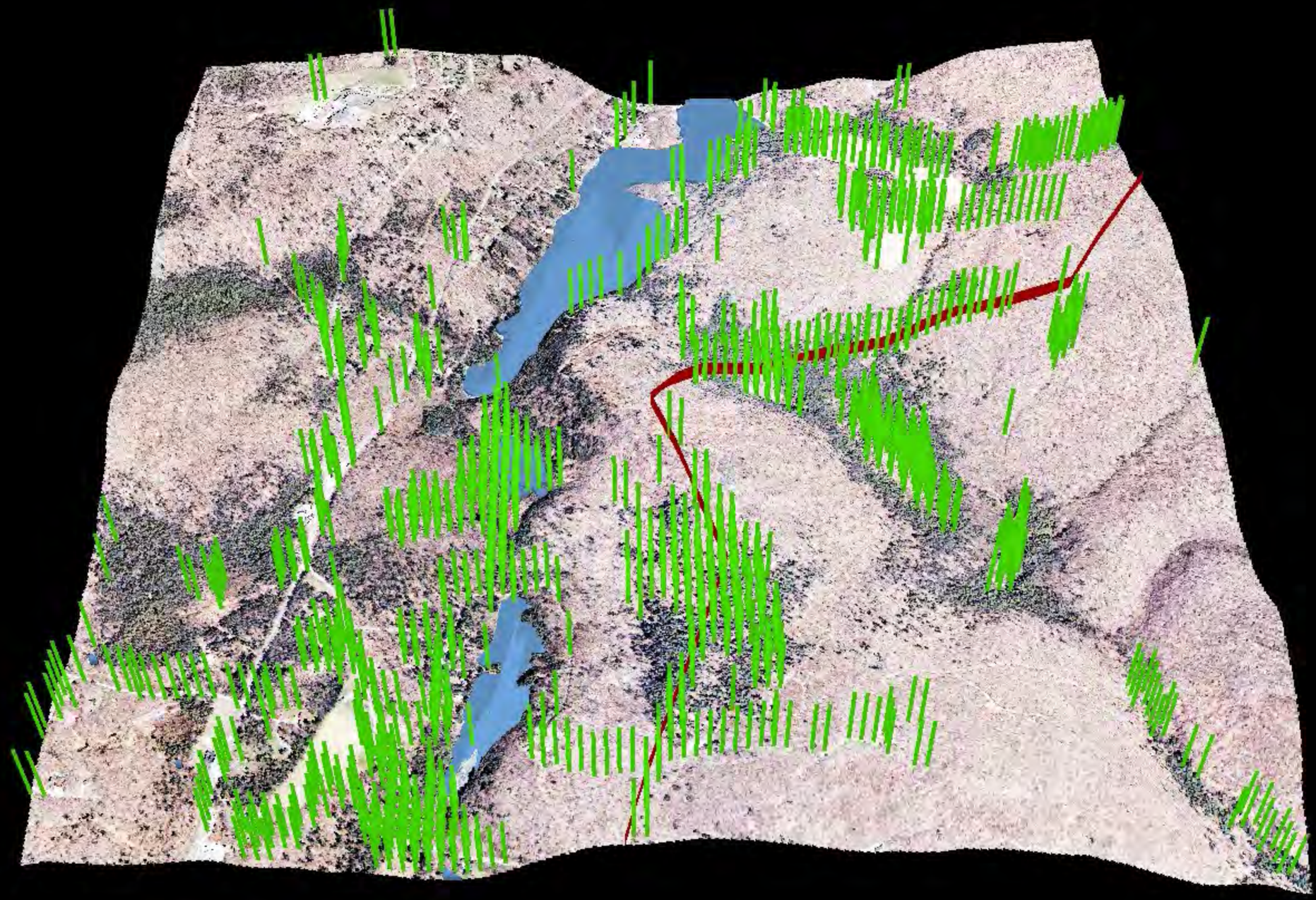
High Impact Development - Market Based Lines- County Scale



High Impact Development - Market Based Lines- Lake Mokoma Scale

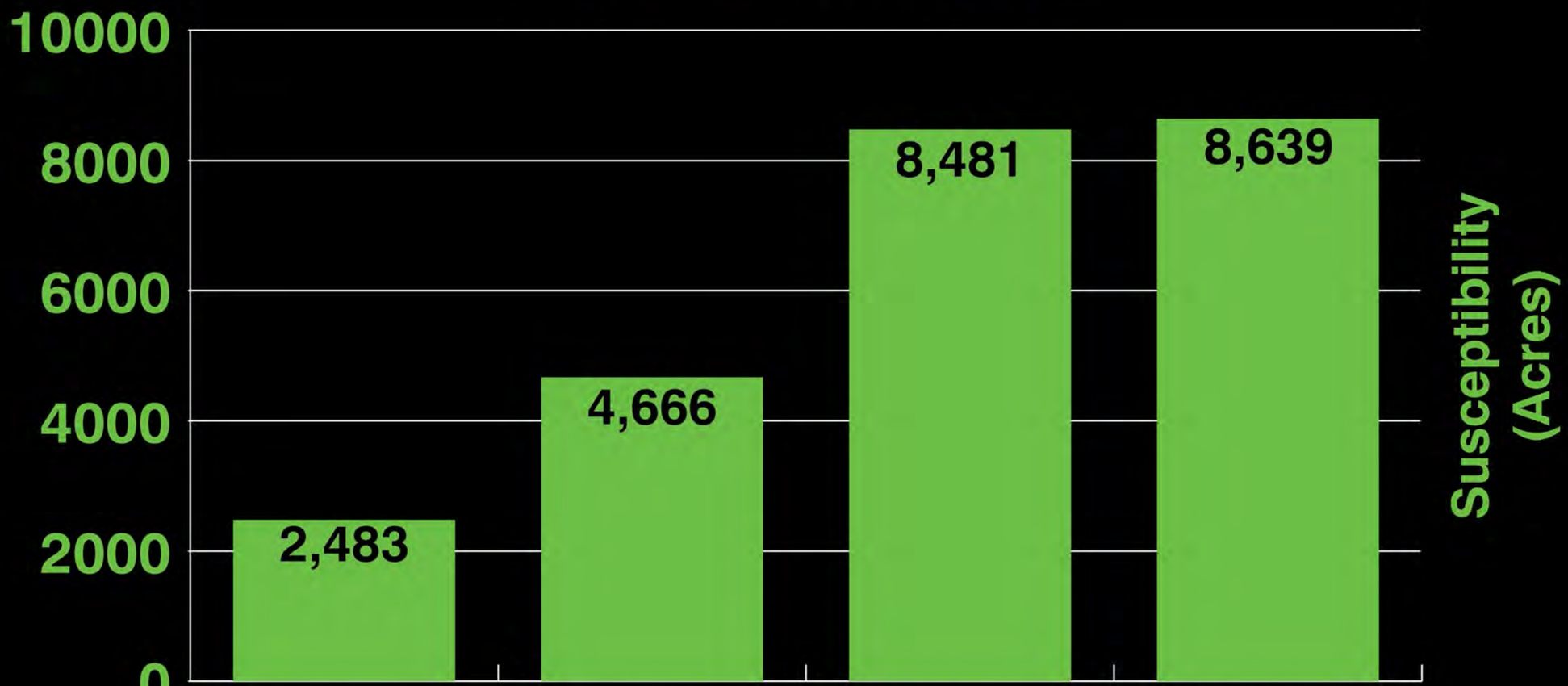


High Impact Development - Conservation Based Lines- County Scale

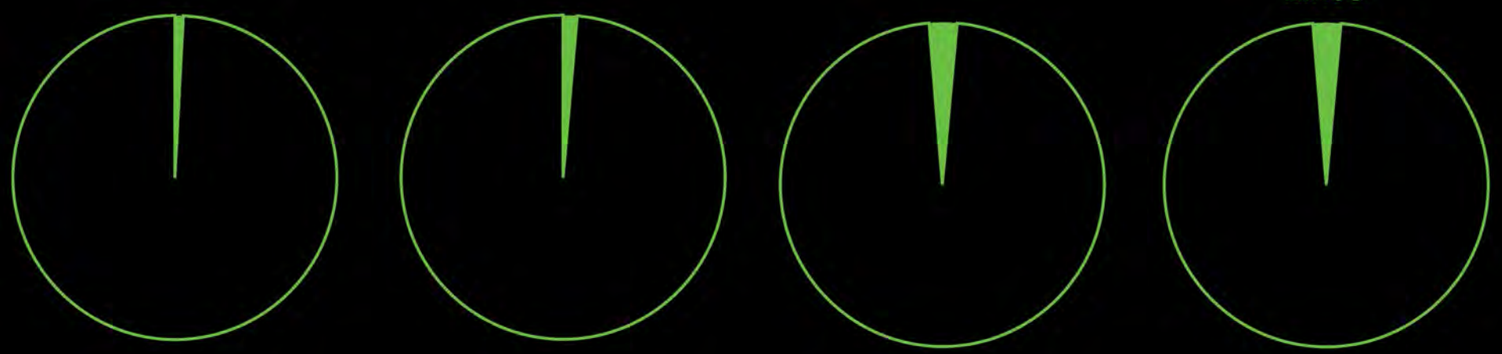


High Impact Development - Conservation Based Lines- Lake Mokoma Scale

Mile-a-Minute



Percent of Sullivan County Susceptible



Site Characteristics:

Soil Moisture: Moist to wet soil, no standing water; tolerates dry soils
Soil pH: 5.5-6.4
Soil Type: Shallow, Well Drained Channery Loam
Aspect: Any
Land Cover: Floodplains, Roadsides, Streams, Disturbed Sites, Open Woodlands, Logging Areas
Other Info: Full Sun

Mile-a-Minute, also known as Devil's Tail or Tearthumb, is a highly aggressive invasive vine. It is known for its triangle shaped leaves, thorny stem, and small blue berries. Mile-a-Minute is native to East Asia, but spread over to America through nursery stock, with "ground zero" being York, Pennsylvania in the 1930s. Mile-a-Minute is very fast growing; an individual vine can spread up to 30 feet in a season. The vine is very water tolerant and is commonly found in wet areas. Mile-a-Minute is a popular food among insects and birds, and they help spread the vine to new areas. As it grows so fast and so aggressively, it out competes native plants by shading them out and topples fully grown trees by climbing up them. The plant is very difficult to control and requires a variety of methods.

INVASIVE SPECIES INVADE 700,000 HECTARES A YEAR

THAT EQUALS = 6 SULLIVAN COUNTIES

WITH NO MANAGEMENT IT
WOULD TAKE

17 YEARS

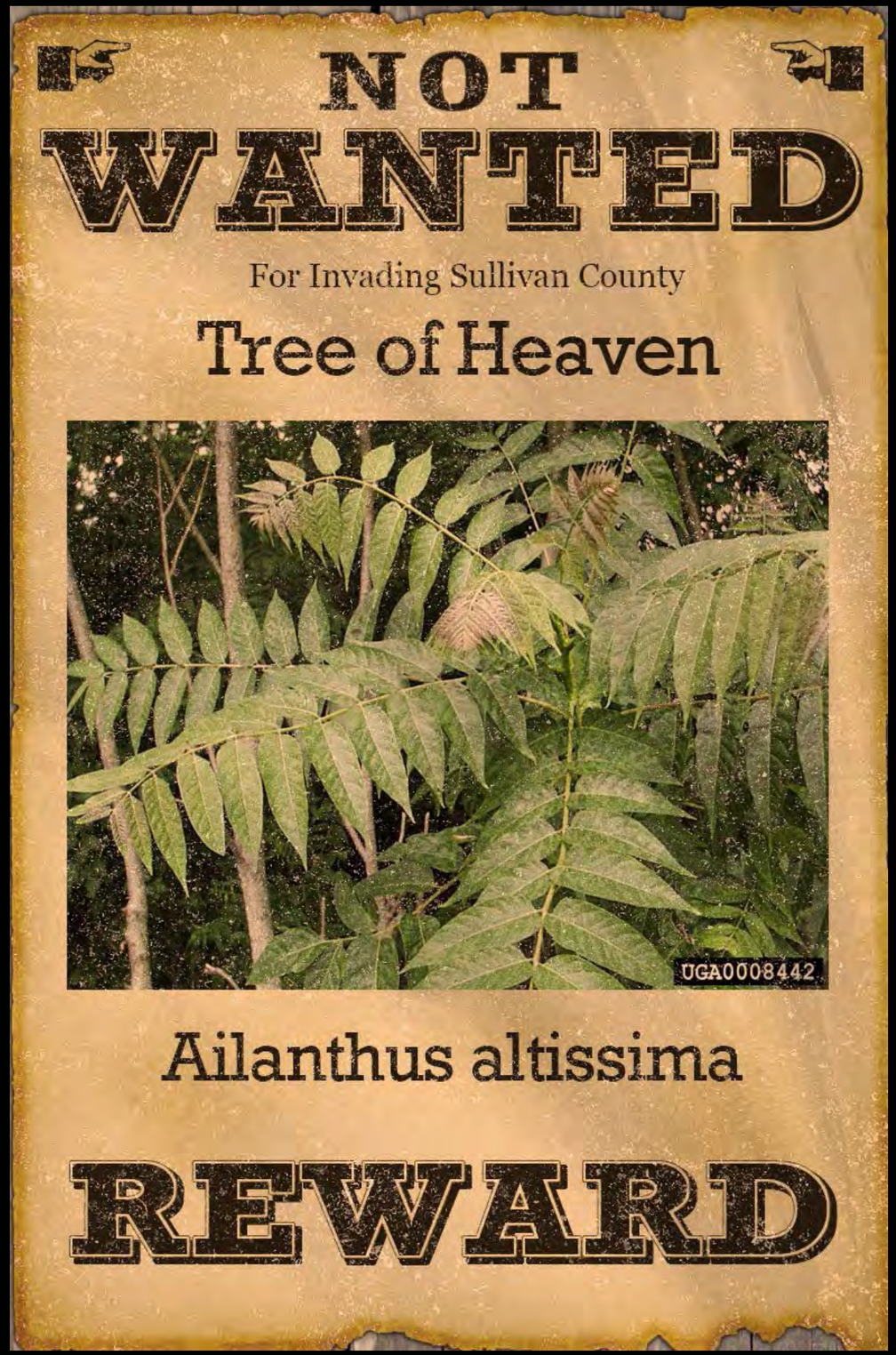
FOR INVASIVES TO TAKE OVER

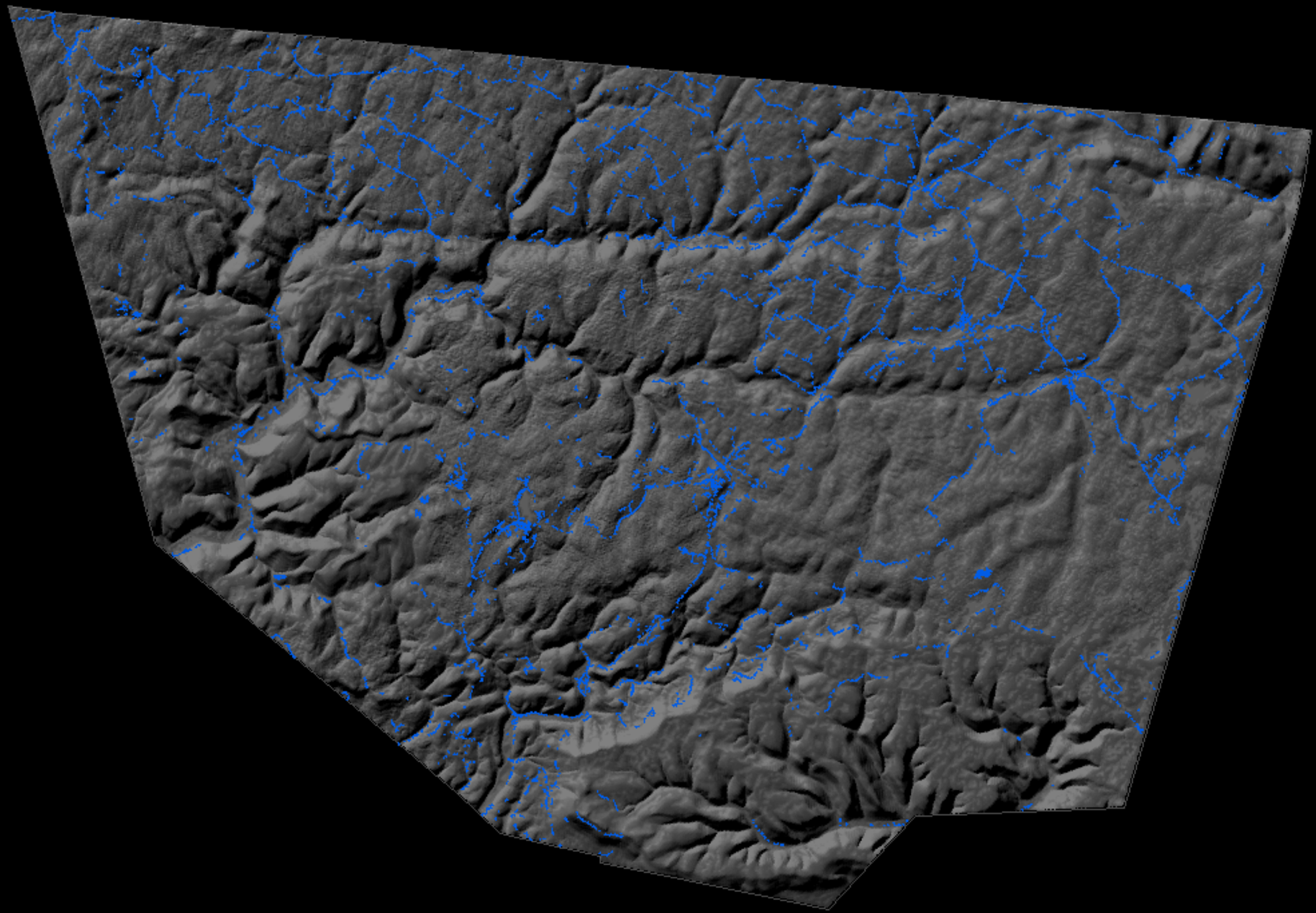
PENNSYLVANIA

Tree of Heaven

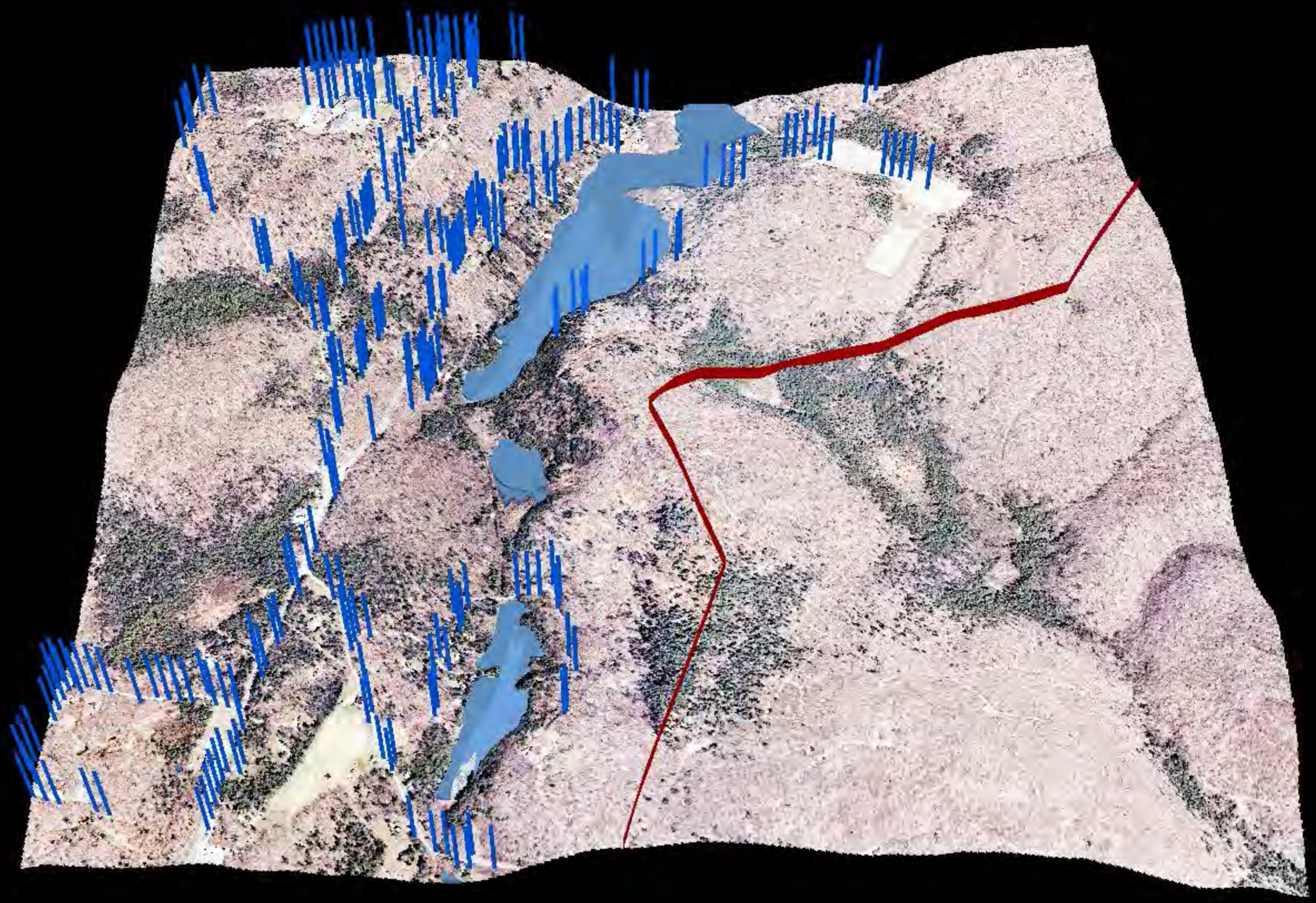
Ailanthus altissima

1) Roads (30ft Buffer and 0.6 Mile Buffer)
2) Existing Vegetation
3) Disturbance
4) Elevation (Any)
5) Ownership
7) Aspect (Any)
8) Soil Type (Preference for Loamy Soils, but will grow on any)
9) Soil pH (5.1>)
10) Soil Moisture (Any Soil Moisture Type)
11) Existing Drill Pads (30ft Buffer and 0.6 Mile Buffer)
12) Marc 1 Pipeline (30ft Buffer and 0.6 Mile Buffer)
13) Existing Gathering Lines (30ft Buffer and 0.6 Mile Buffer)
14) High Impact Drill Pads (30ft Buffer and 0.6 Mile Buffer)
15) High Impact Market Based Gathering Lines (30ft Buffer and 0.6 Mile Buffer)
16) High Impact Conservation Based Gathering Lines (30ft Buffer and 0.6 Mile Buffer)

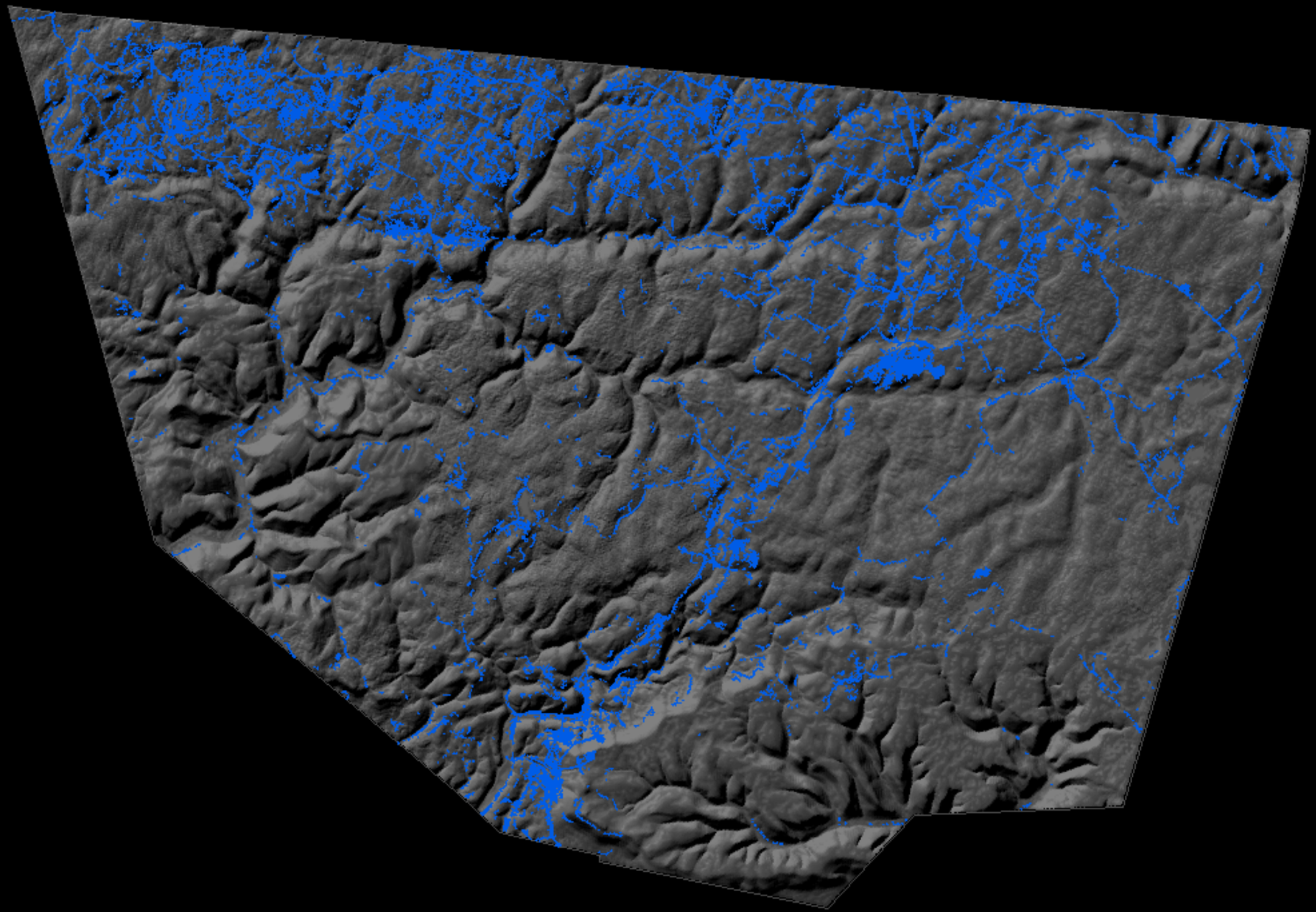




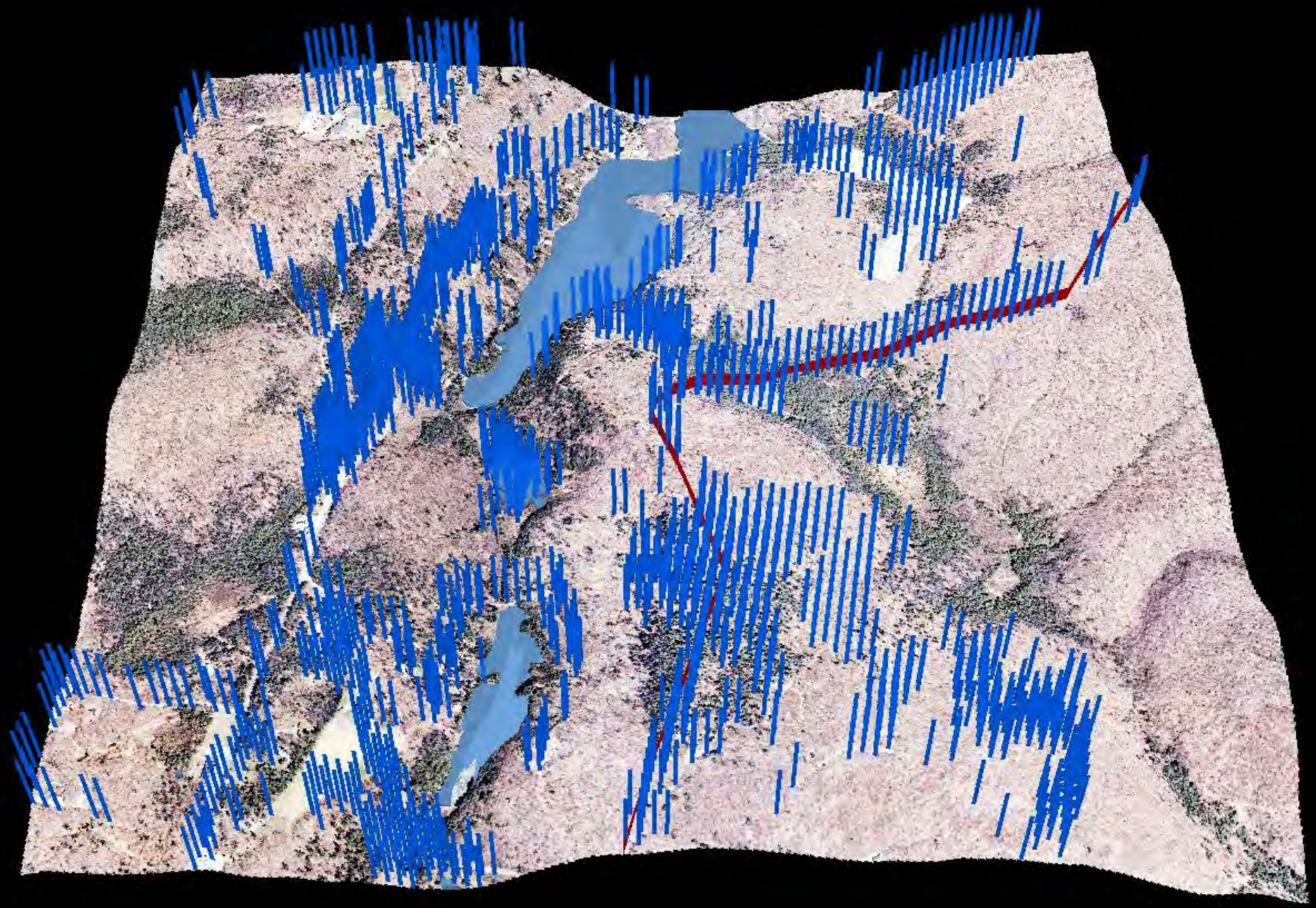
Pre Development - County Scale



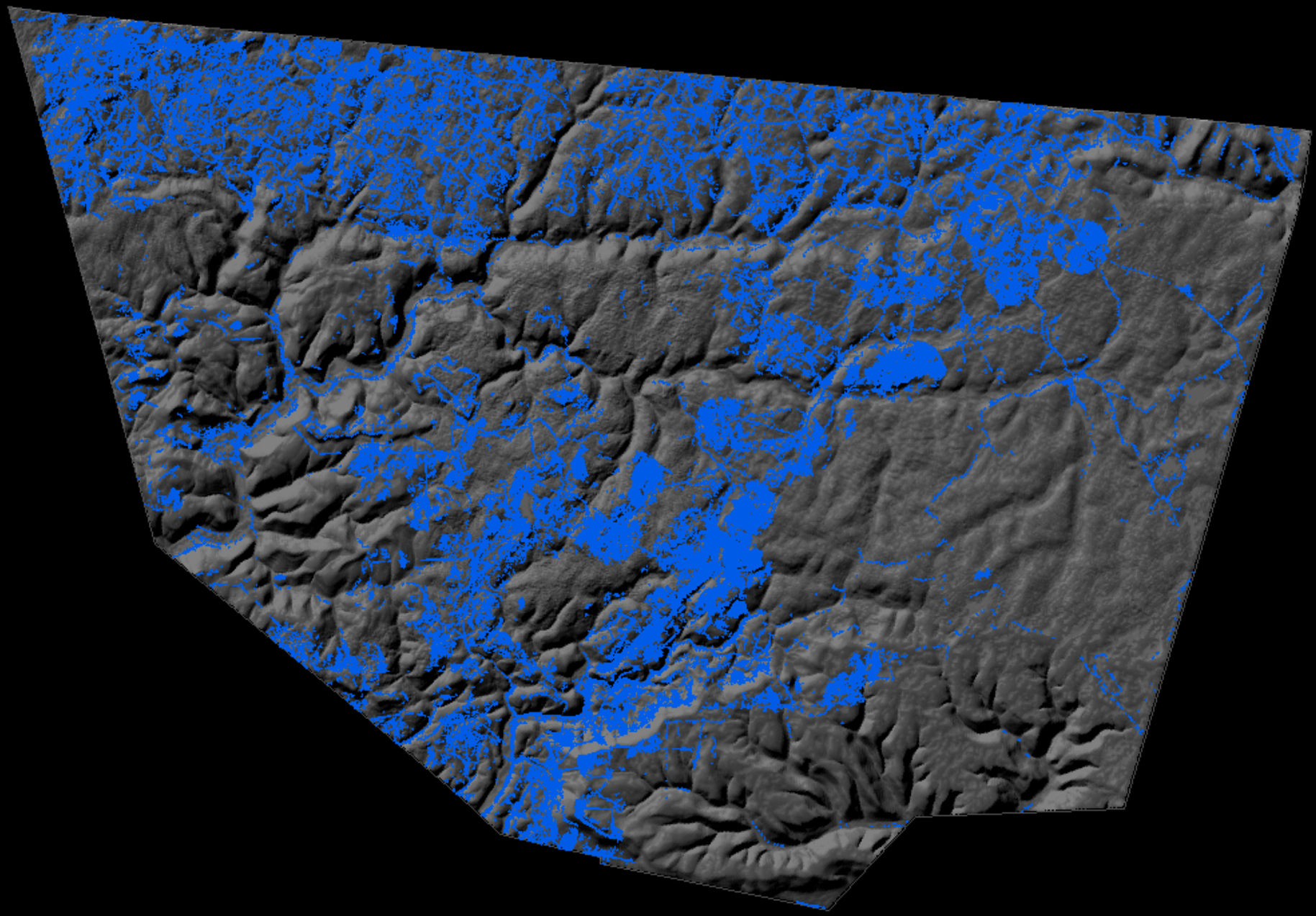
Pre Development - Lake Mokoma Scale



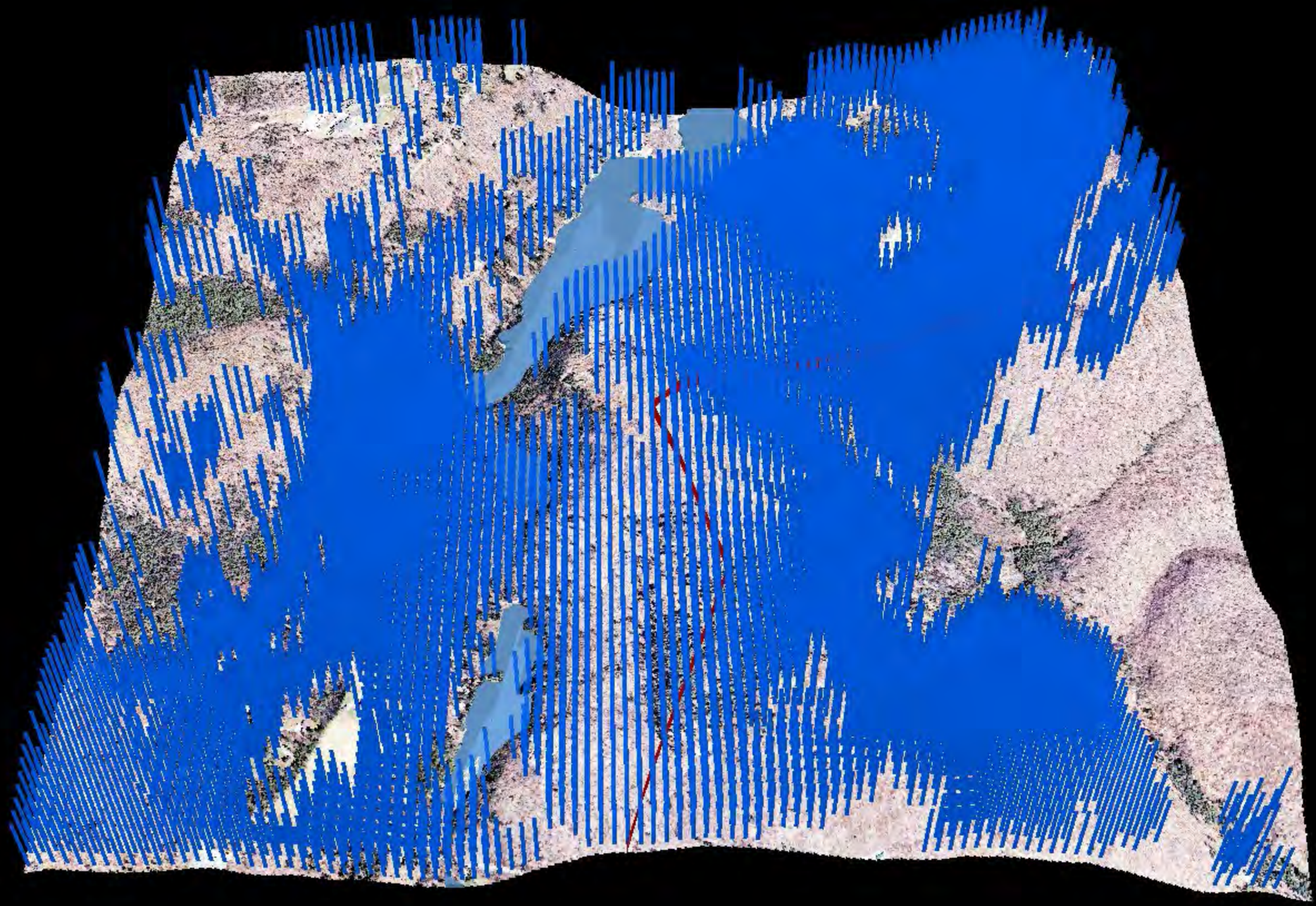
Existing Development - County Scale



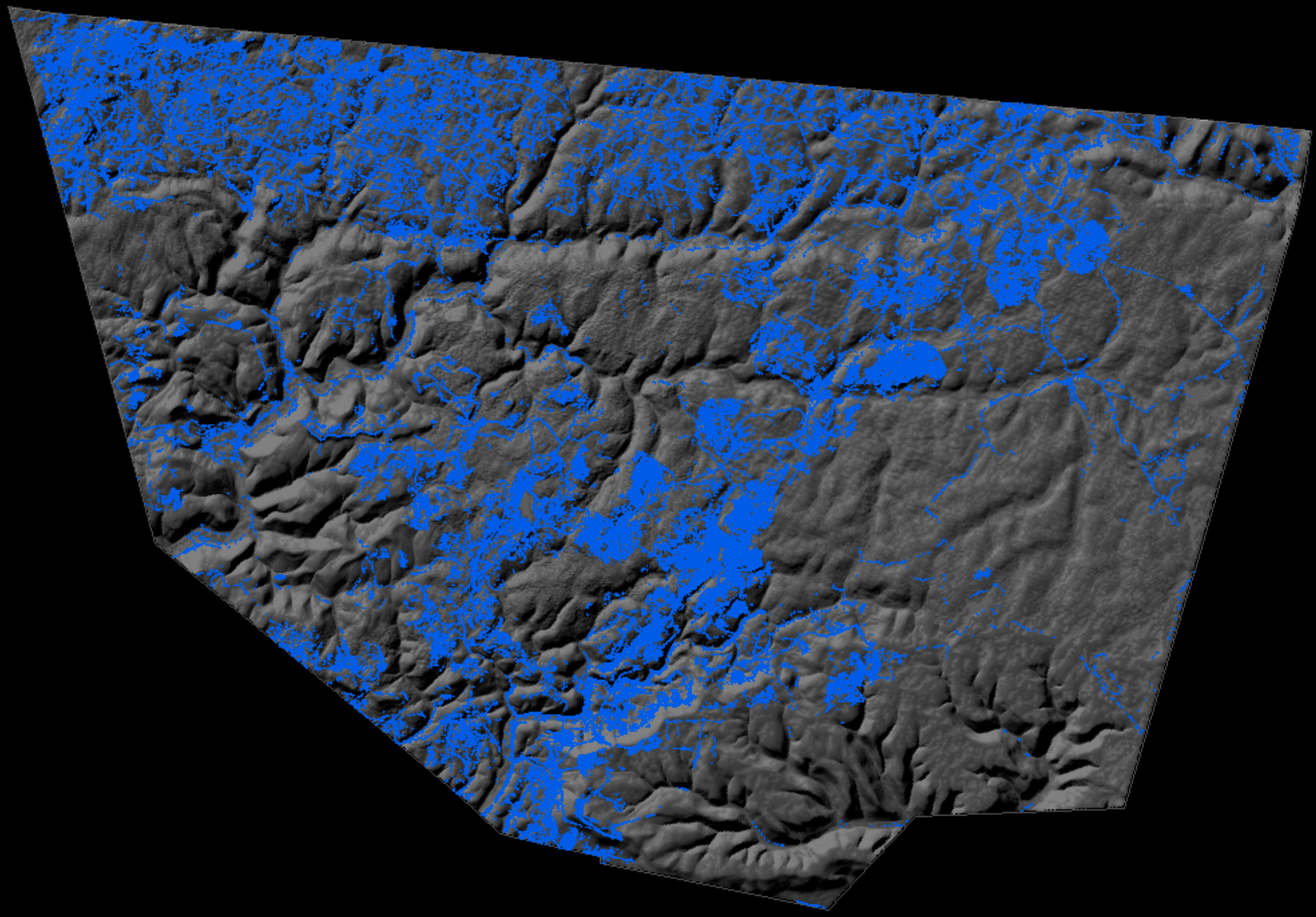
Existing Development - Lake Mokoma Scale



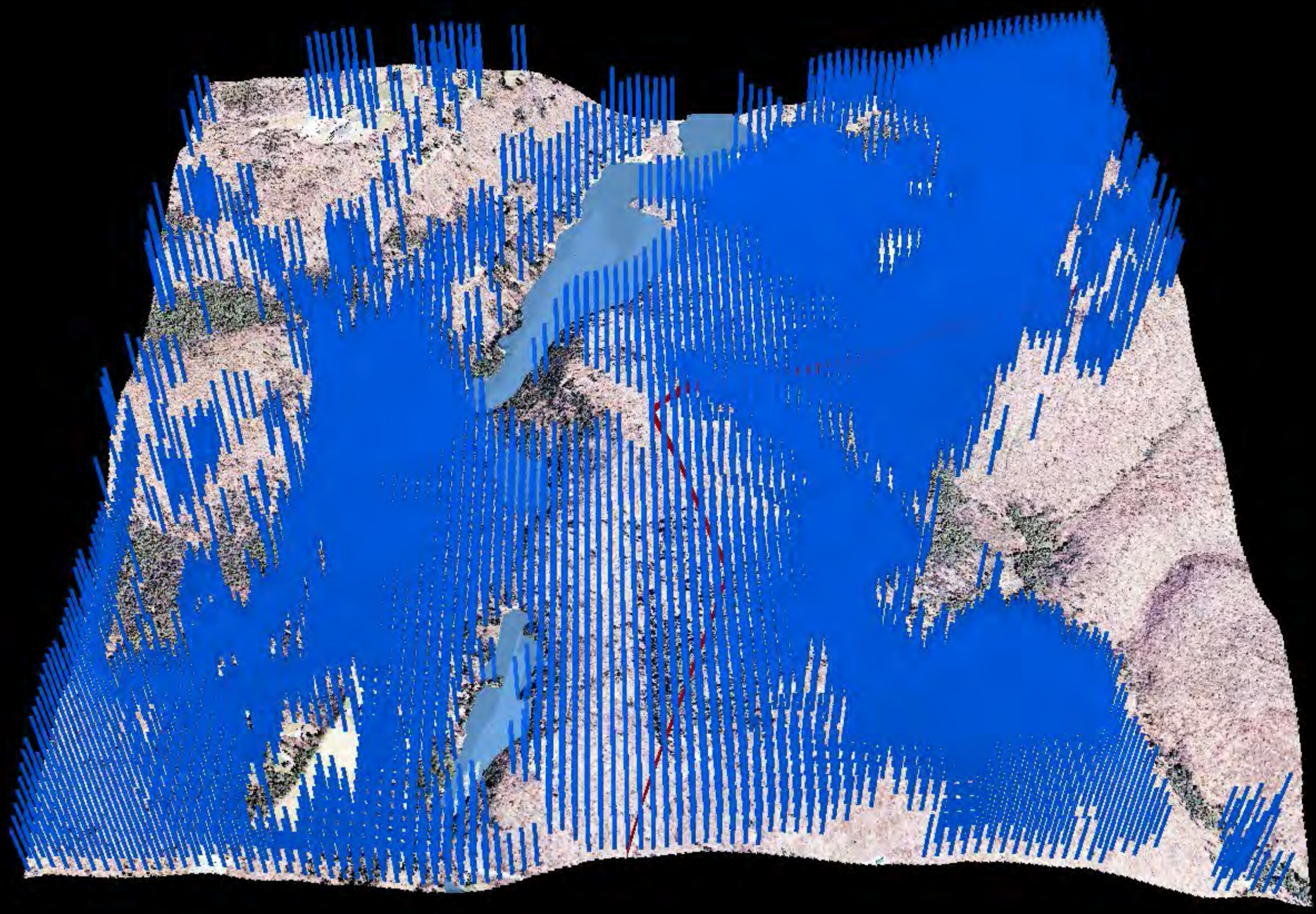
High Impact Development - Market Based Lines- County Scale



High Impact Development - Market Based Lines- Lake Mokoma Scale

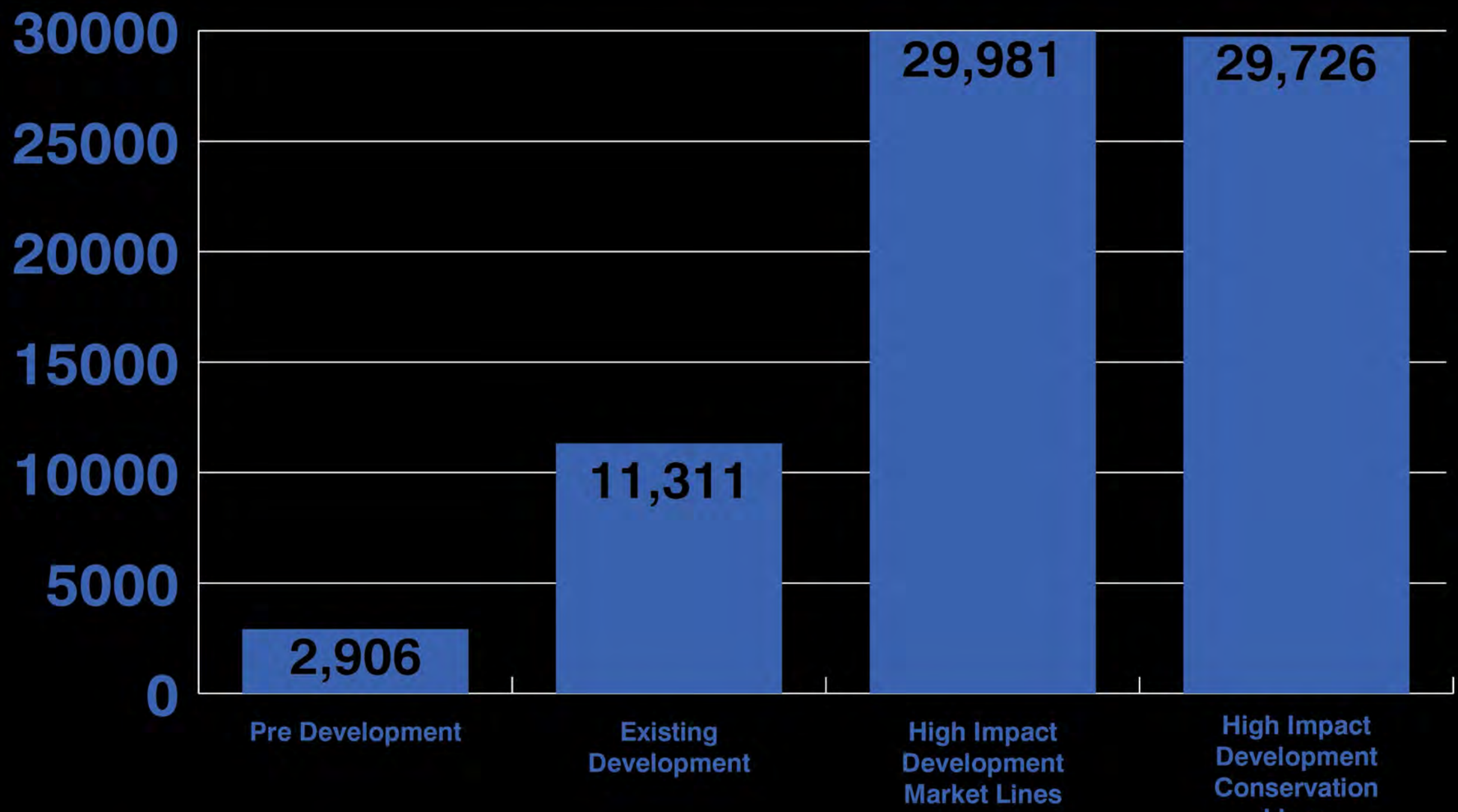


High Impact Development - Conservation Based Lines- County Scale

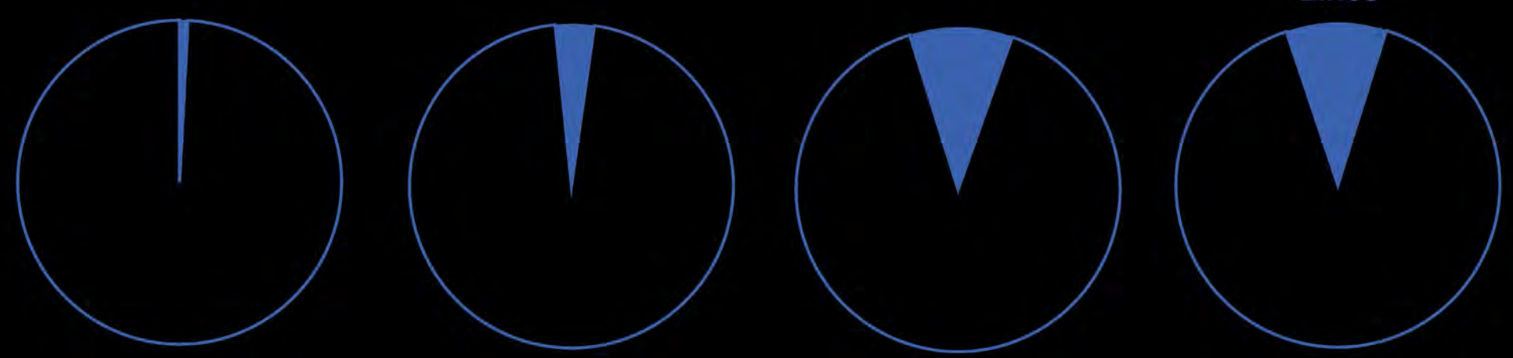


High Impact Development - Conservation Based Lines- Lake Mokoma Scale

Tree of Heaven



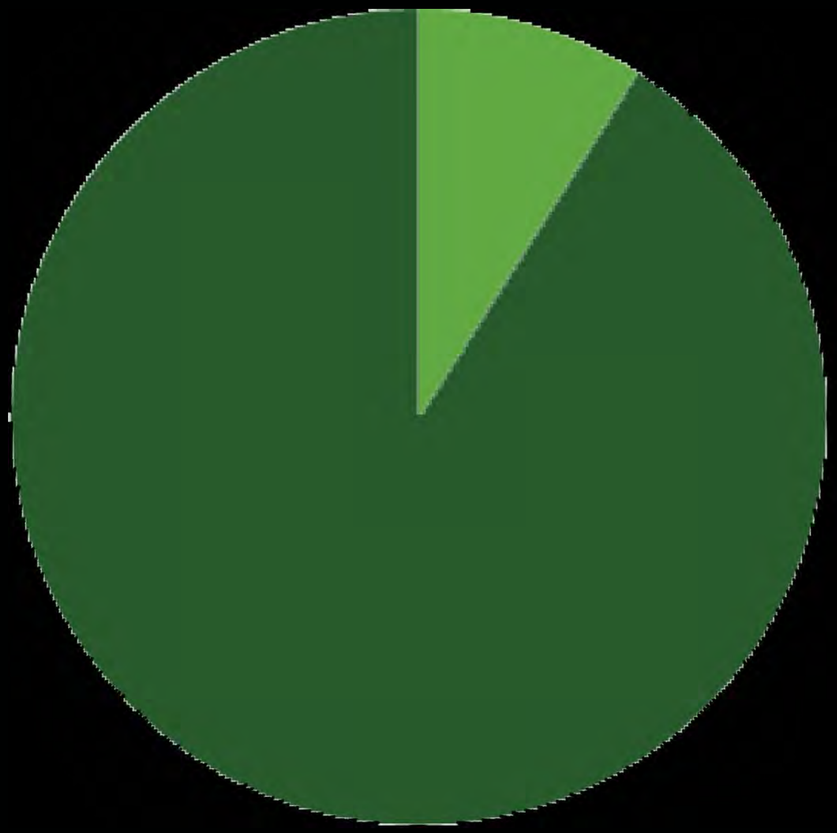
Percent of Sullivan County Susceptible



Site Characteristics:

Soil pH: 5.1>
Soil Type: Preference for Loamy Soil, but will grow in any type
Aspect: Any
Elevation: Any
Land Cover: Roads, Streams, Forests, Open Woodlands
Other Info: Really will grow anywhere

Tree of Heaven is a rapid growing, highly aggressive invasive tree species. Native to China, it was originally brought to the U.S. in 1784. It was planted for ornamental purposes, but became a nuicense in gardens for its tendency to spread and its terrible smell. As Tree of Heaven can grow in basically any condition, it became a commonly used urban tree. From these urban environents it began spreading out along roadways, and then gradually moving into disturbed areas farther out. The tree has a noxious smell, no benefits for wildlife, and will out-compete native species. Tree of Heaven will crowd out native species and will grow rapidly resulting in a dense canopy. However, the tree does have a short life of about 50 years.



INVASIVES CAUSE A 9% REDUCTION IN PA CROP YIELDS, THIS IS ABOUT

$278 MILLION A YEAR IN LOSSES

INVASIVE SPECIES CAUSE

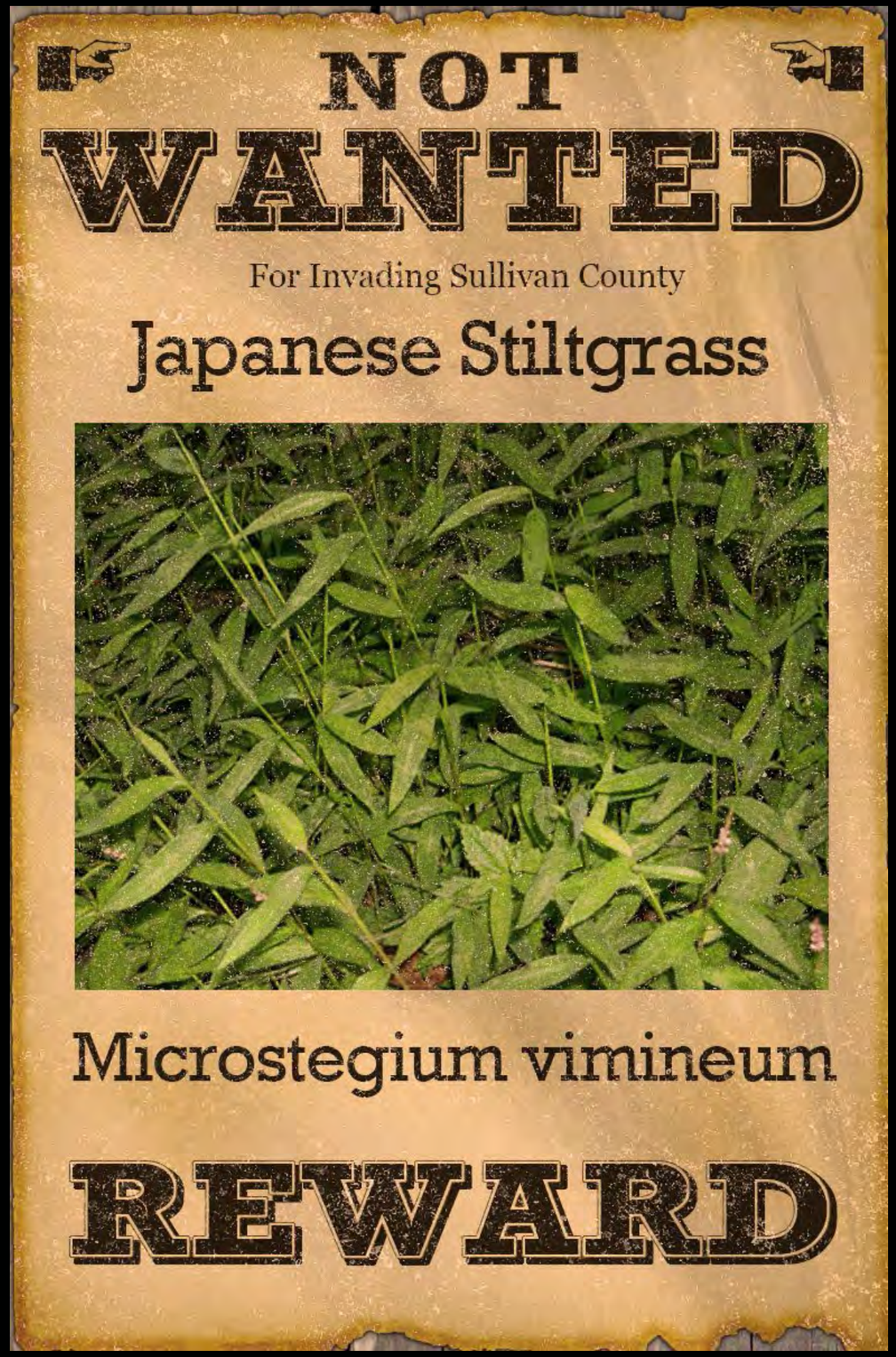
$96 MILLION

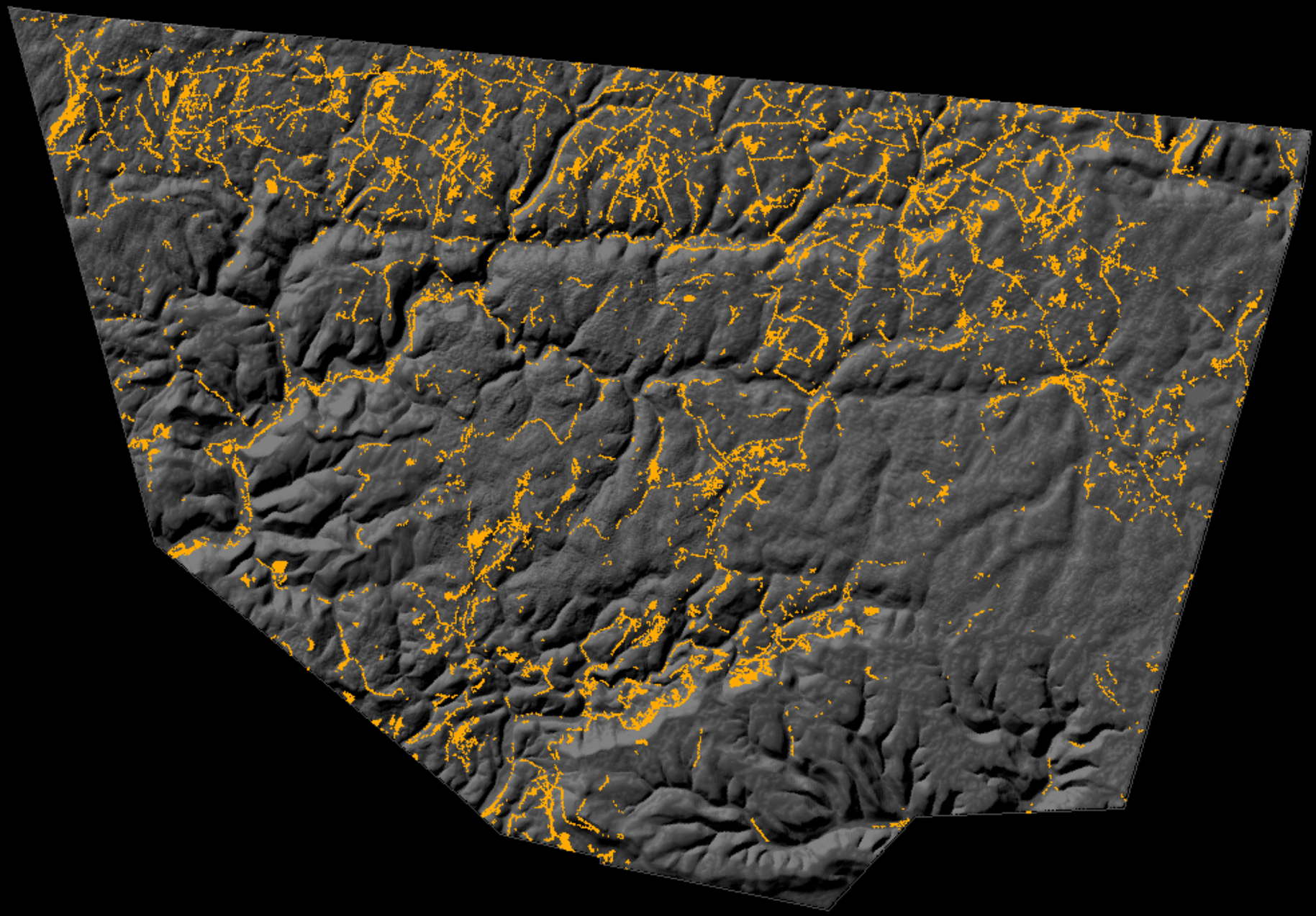
IN ECONOMIC DAMAGE TO TIMBER PRODUCTION IN PENNSYLVANIA

Japanese Stiltgrass

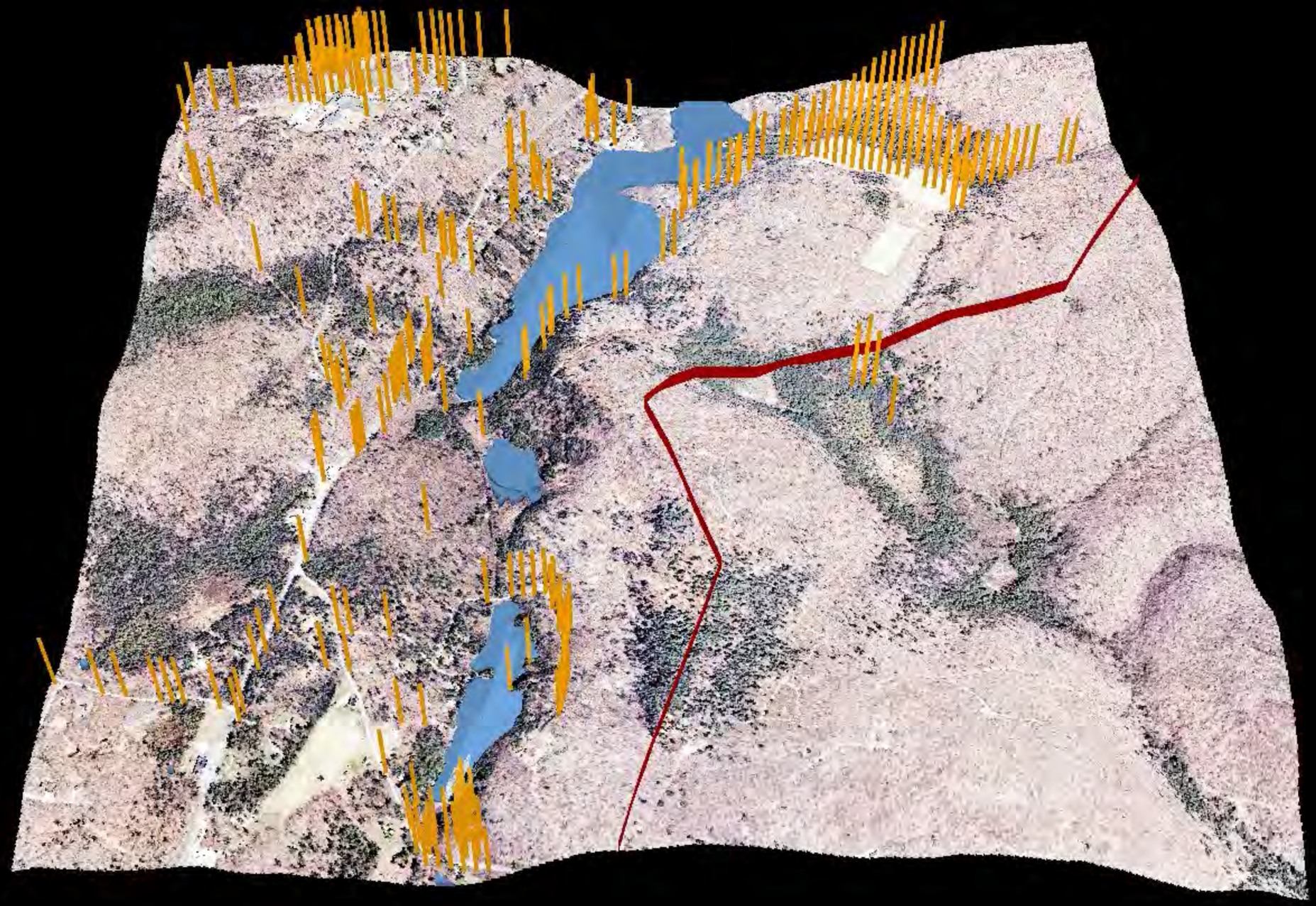
Microstegium vimineum

1) Roads (30ft Buffer and 0.6 Mile Buffer)
2) Existing Vegetation
3) Disturbance
4) Elevation (Any)
5) Ownership
7) Aspect (Southwest and Northwest)
8) Soil Type (Silty to Sandy Loams)
9) Soil pH (4.4-6.5)
10) Soil Moisture (Moist to Wet Soil, No Standing Water; Tolerates Dry Soils)
11) Floodplains
12) Existing Drill Pads (30ft Buffer and 0.6 Mile Buffer)
13) Marc 1 Pipeline (30ft Buffer and 0.6 Mile Buffer)
14) Existing Gathering Lines (30ft Buffer and 0.6 Mile Buffer)
15) High Impact Drill Pads (30ft Buffer and 0.6 Mile Buffer)
16) High Impact Market Based Gathering Lines (30ft Buffer and 0.6 Mile Buffer)
17) High Impact Conservation Based Gathering Lines (30ft Buffer and 0.6 Mile Buffer)

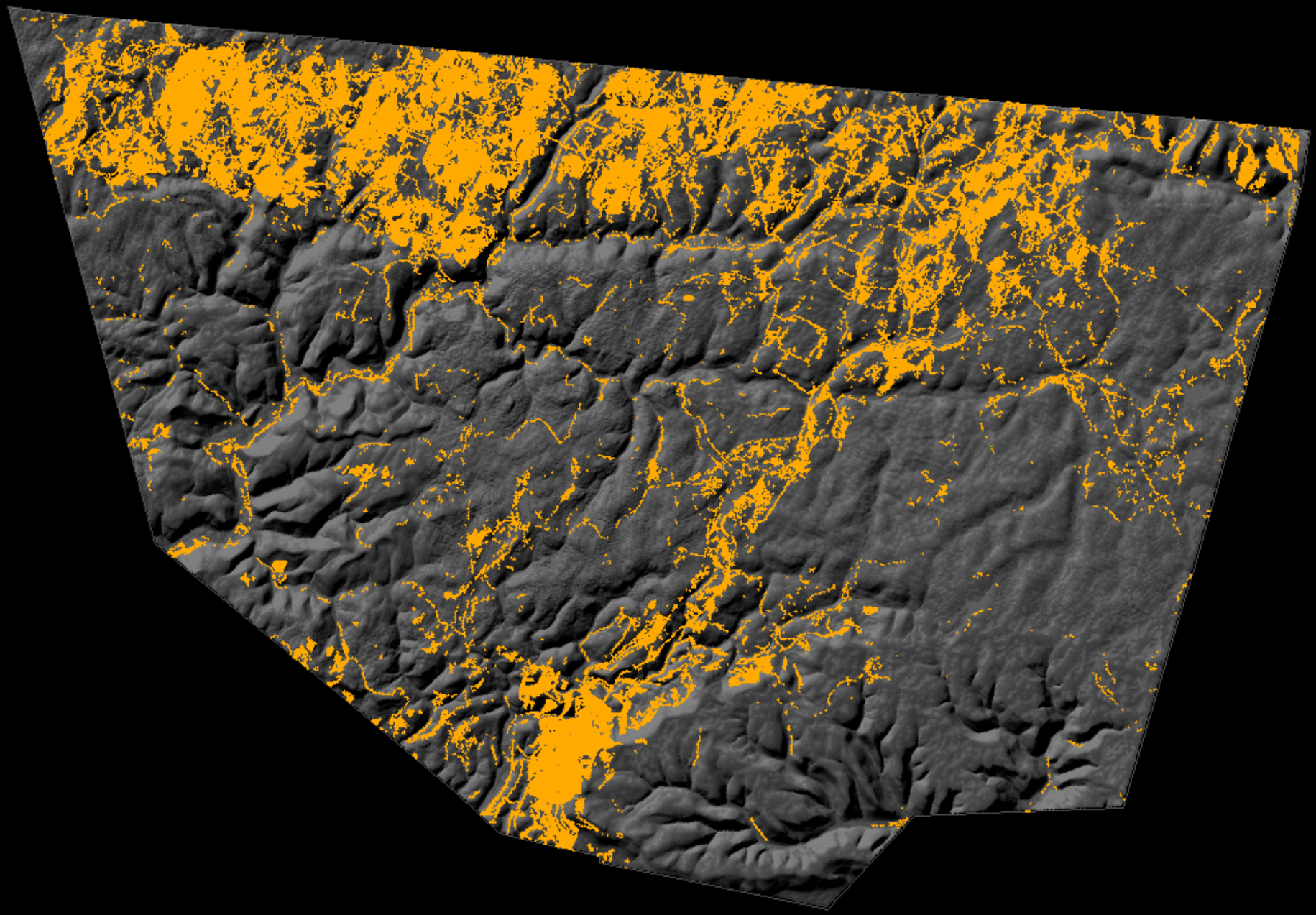




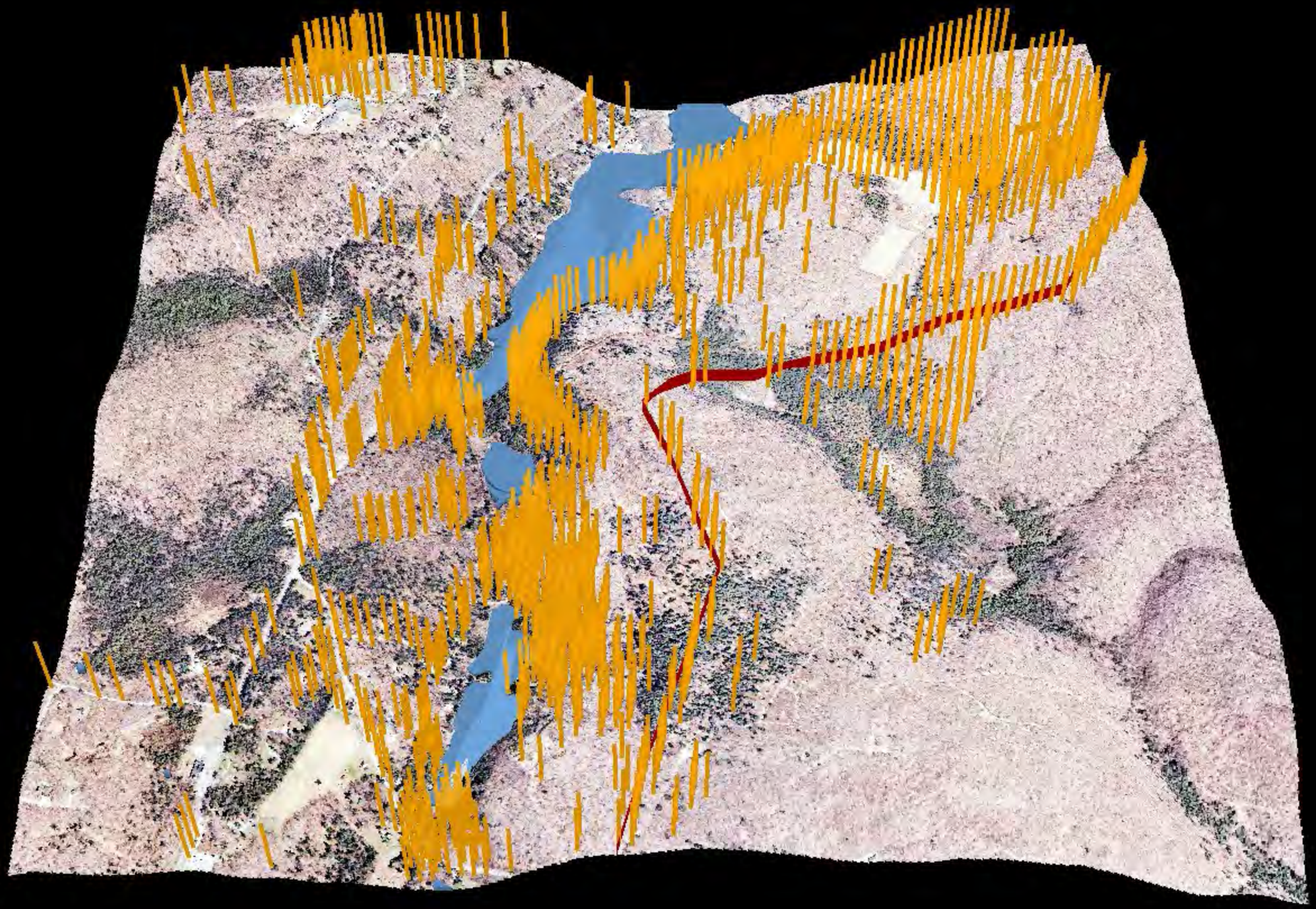
Pre Development - County Scale



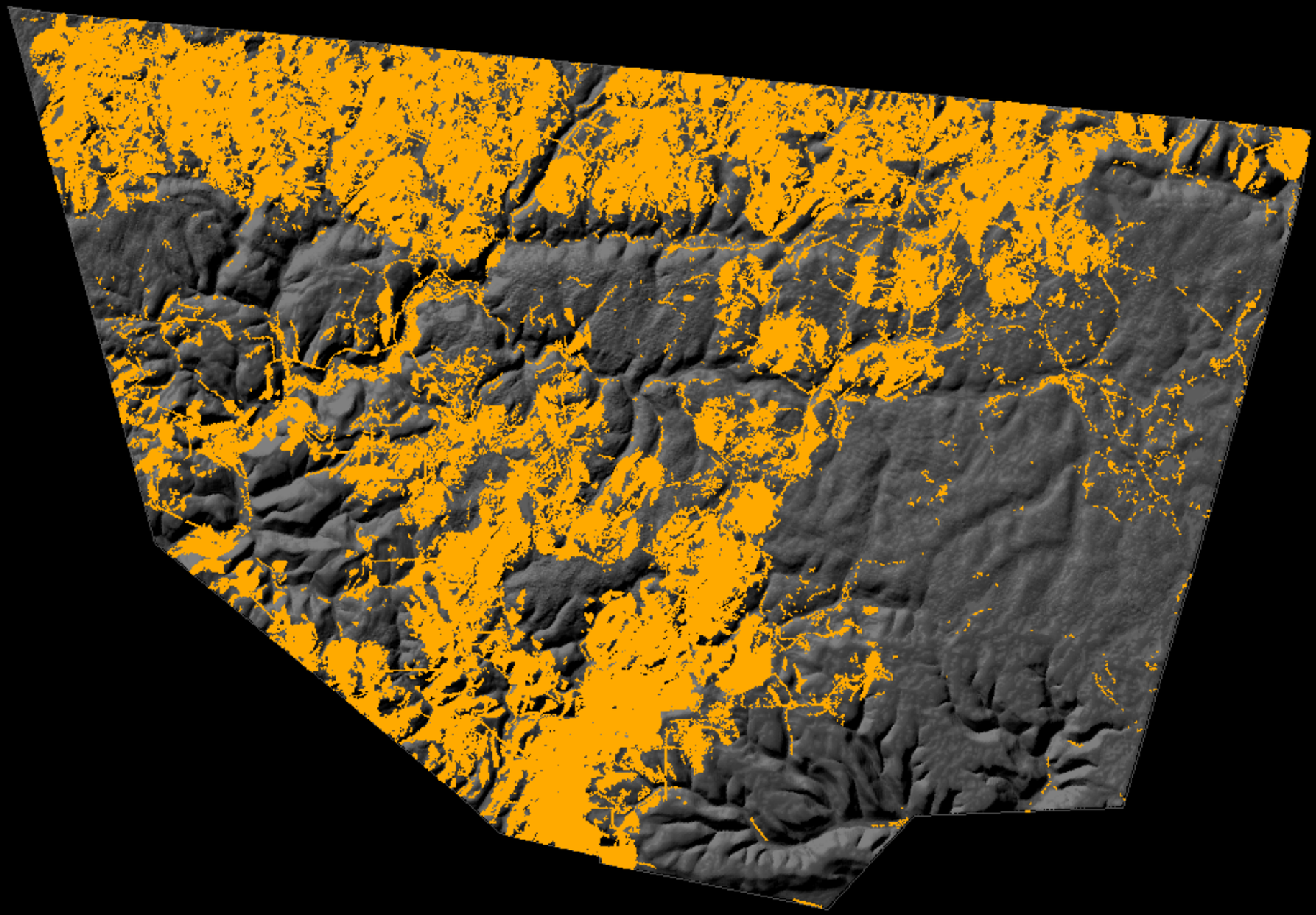
Pre Development - Lake Mokoma Scale



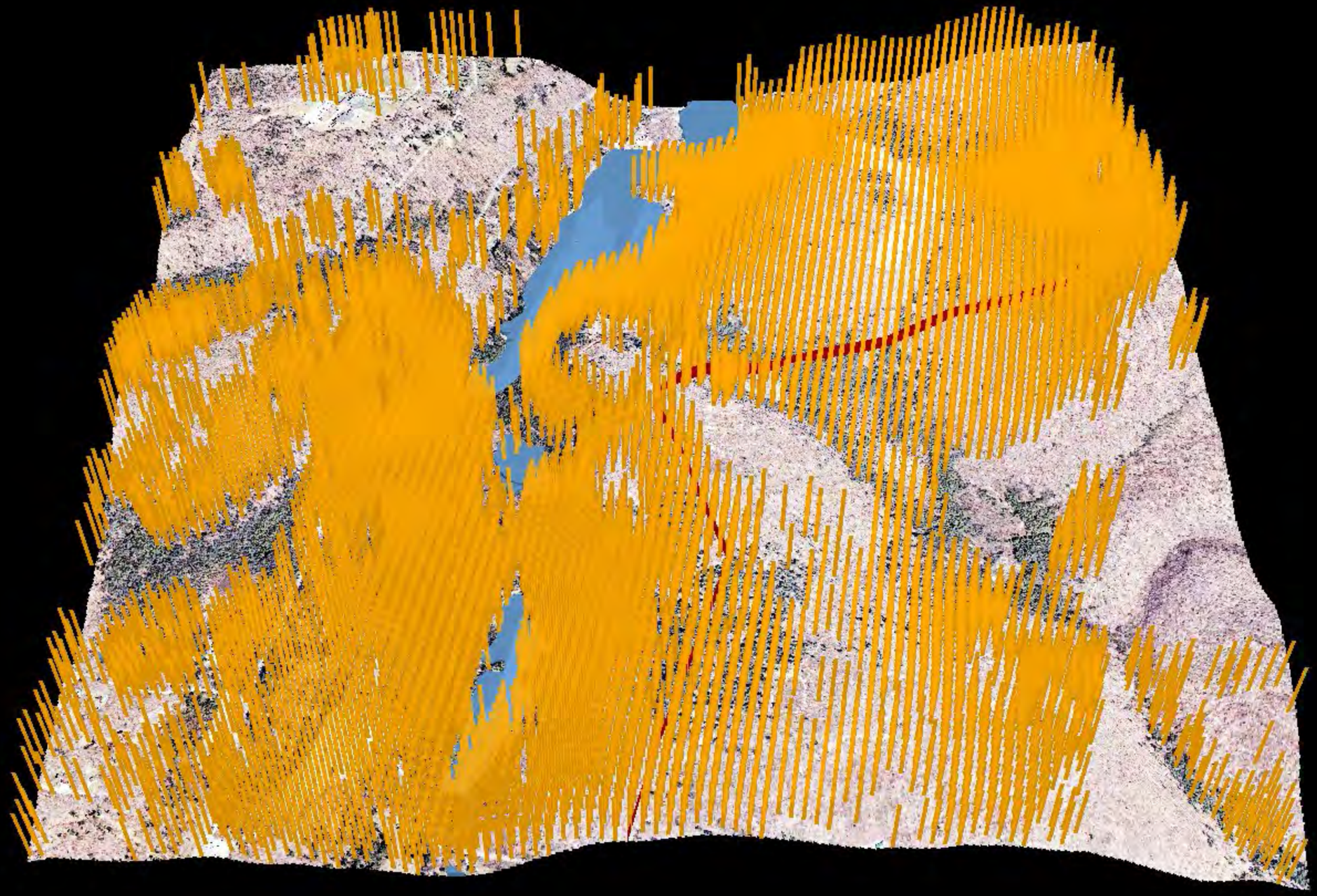
Existing Development - County Scale



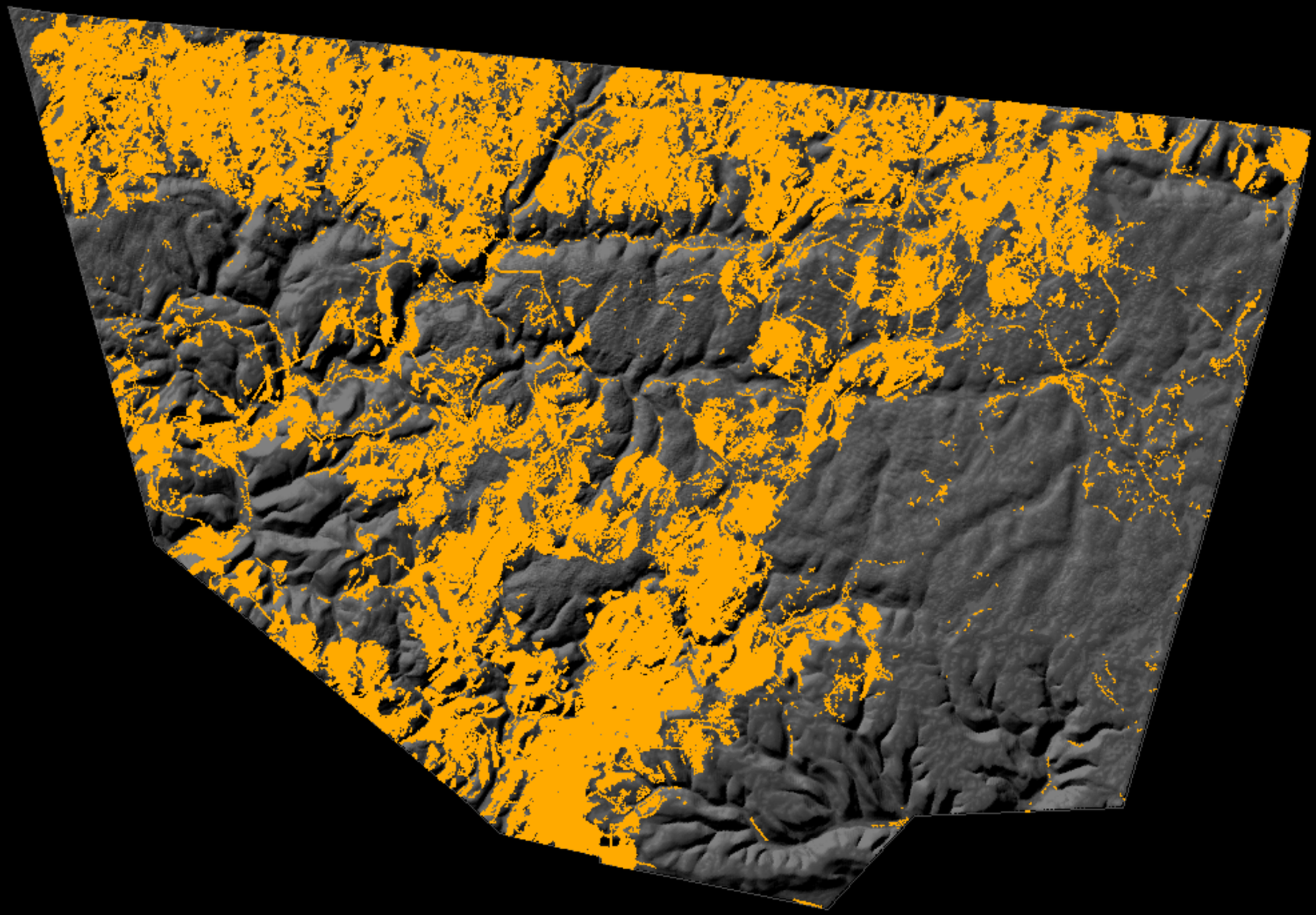
Existing Development - Lake Mokoma Scale



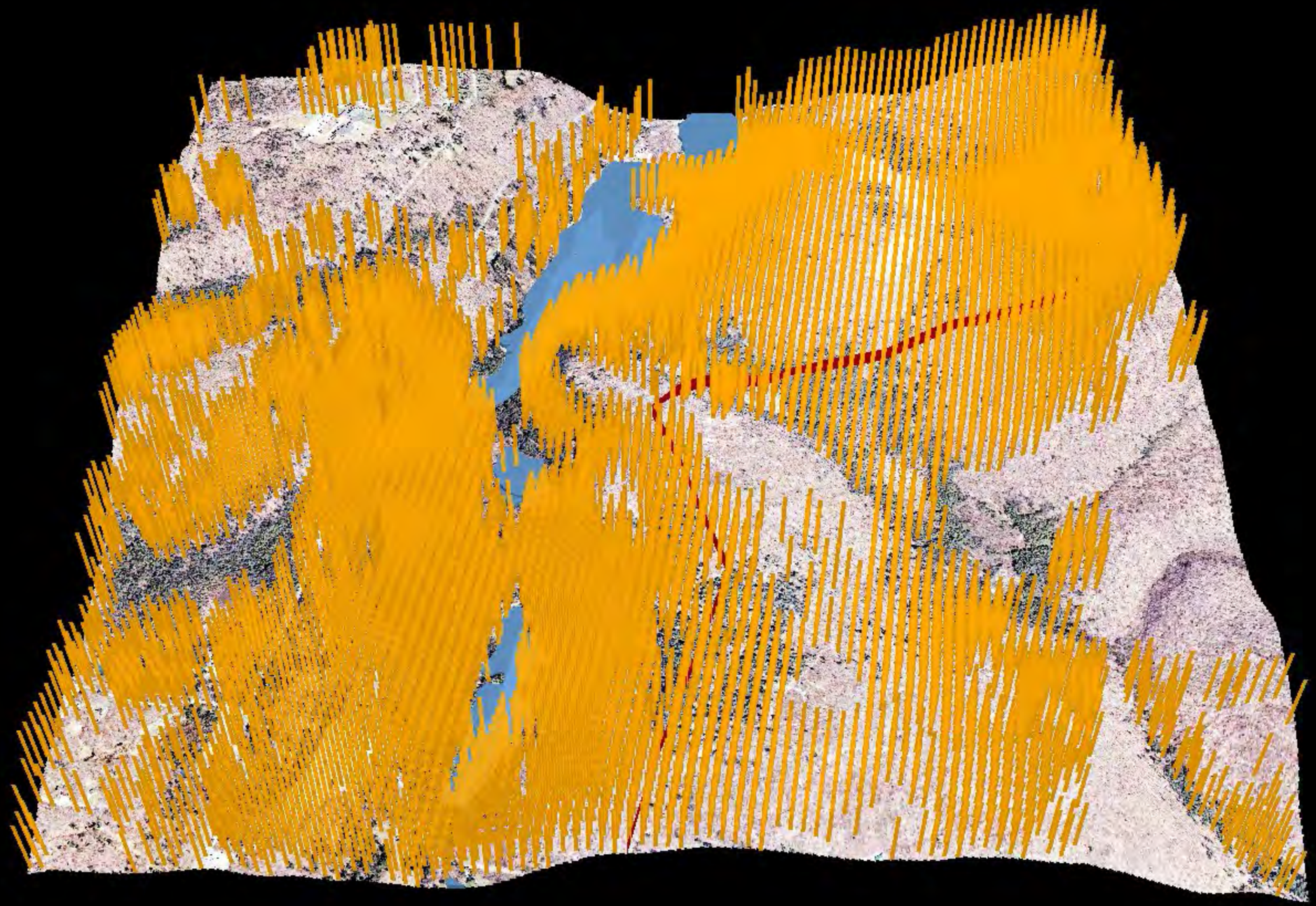
High Impact Development - Market Based Lines- County Scale



High Impact Development - Market Based Lines- Lake Mokoma Scale

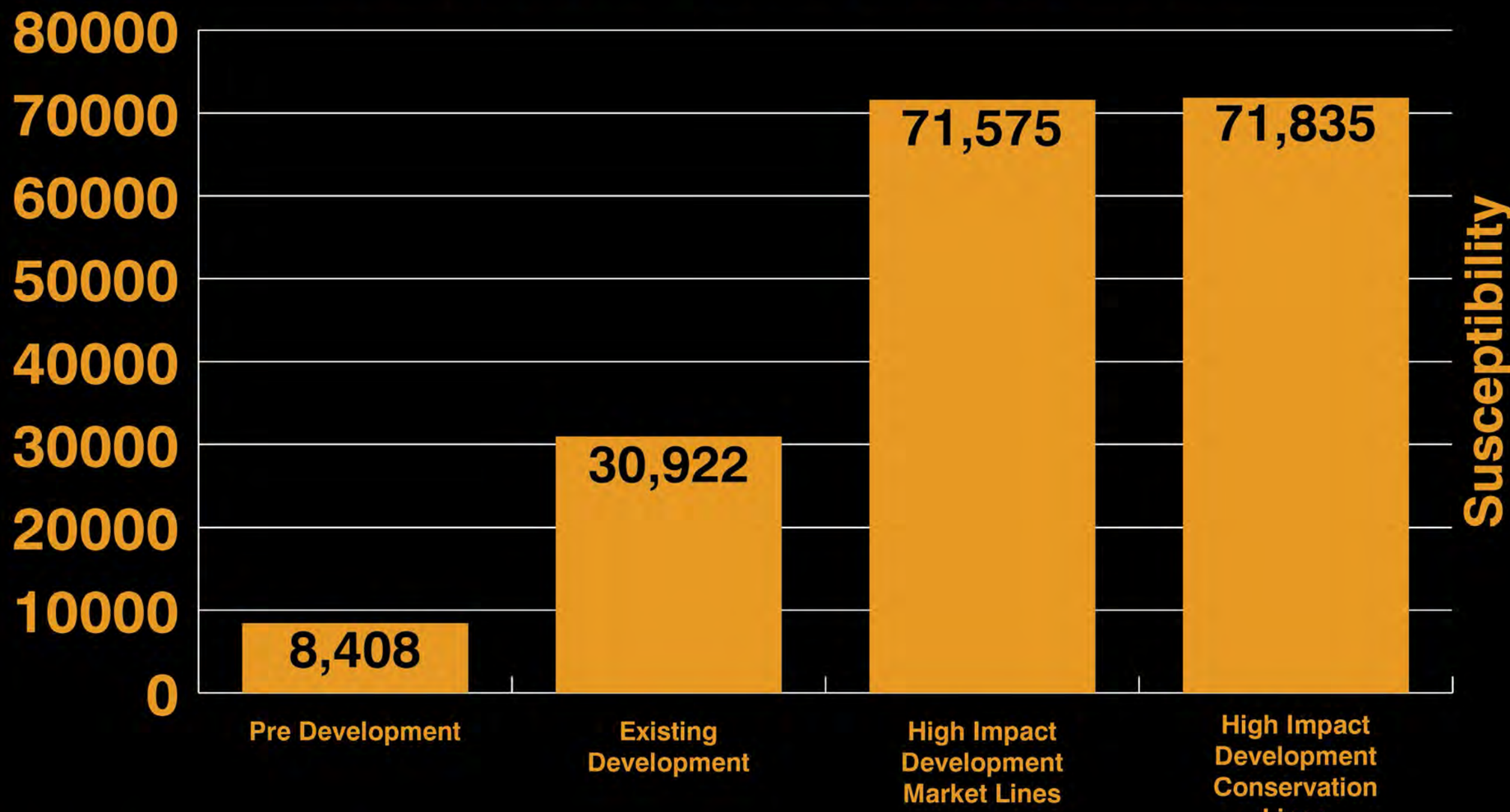


High Impact Development - Conservation Based Lines- County Scale

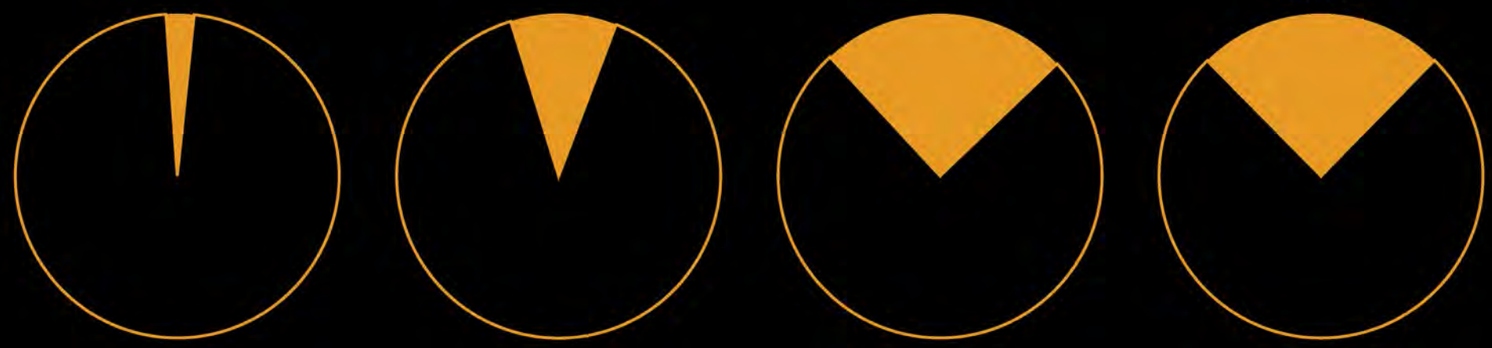


High Impact Development - Conservation Based Lines- Lake Mokoma Scale

Japanese Stiltgrass



Percent of Sullivan County Susceptible



Site Characteristics:

Soil Moisture: Moist to Wet Soil, no standing water; tolerates dry soils
Soil pH: 4.4-6.5
Soil Type: Silty to Sandy Loams
Aspect: Southwest and Northwest
Elevation: Prefers low elevations
Land Cover: Stream Banks, River Bluffs, Floodplains, Emergent Wetlands, Moist Wetlands, Successional Fields, Uplands, Thickets, Gas and Power Line Corridors, Homes and Lawns, Mowed Areas, Roadsides, Disturbed Sites
Other Info: Prefers shady areas, but can tolerate sunny conditions

Japanese Stiltgrass is a highly aggressive invasive grass that is native to tropical Asia. It was first introduced to the U.S in around 1919. The grass will basically grow anywhere; it has showed that it prefers shady areas, but has no problem out-competing natives in full sun. The grass prefers acidic soil, but it will raise the pH to compete better. It will also grow in a variety of soil moistures. Japanese Stiltgrass will form a dense carpet, filling up the entire ground layer, and preventing anything else from growing. The grass is deer resistant and very difficult to control;l if left to its own devices, it could wipe out an entire forest.

$35 MILLION

WORTH OF HERBICIDES ARE APPLIED TO INVASIVE SPECIES ON CROPLAND IN PENNSYLVANIA

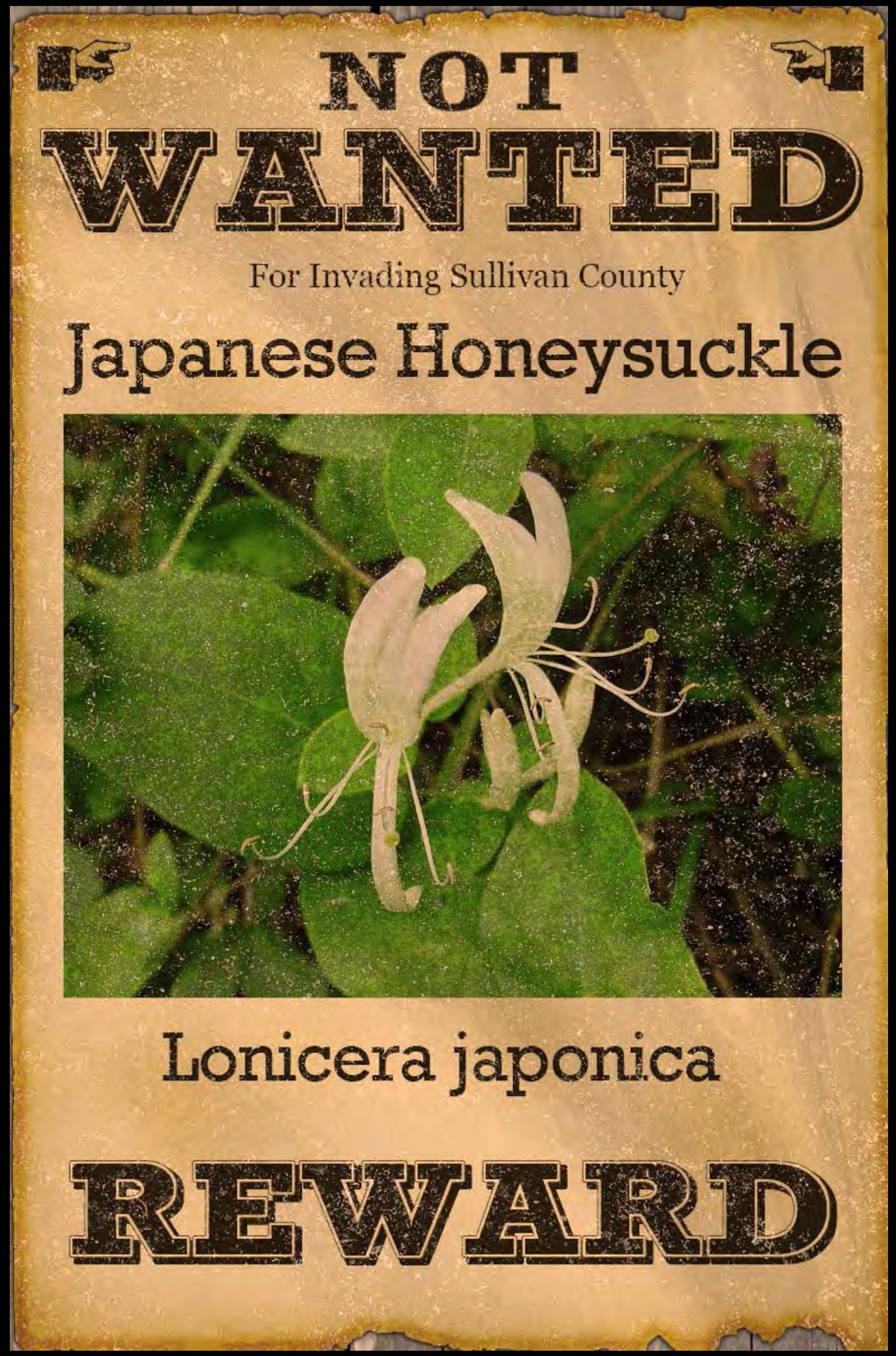
$20,000

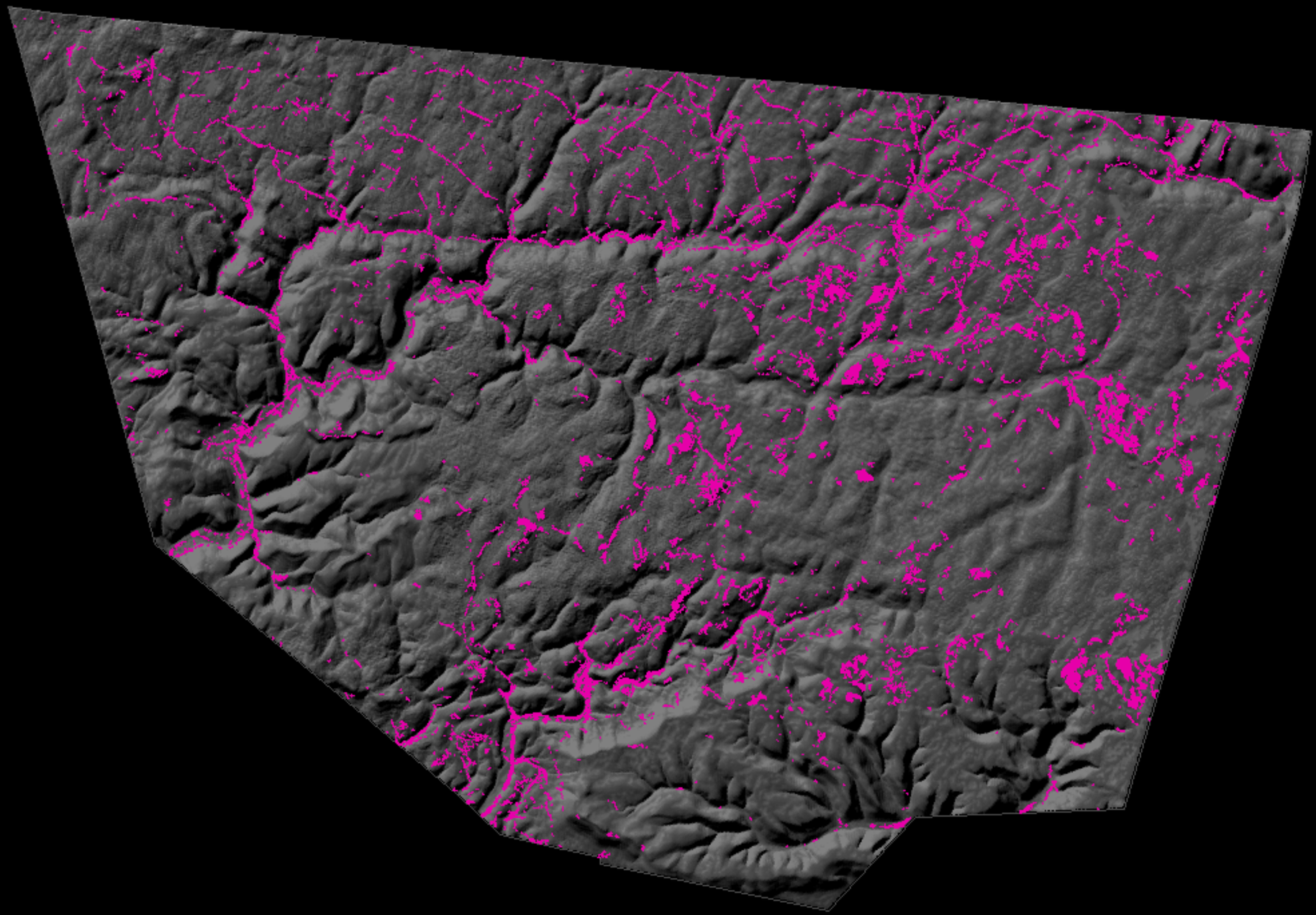
IS SPENT PER YEAR ON RESIDENTIAL INVASIVE PLANT CONTROL IN PENNSYLVANIA

Japanese Honeysuckle

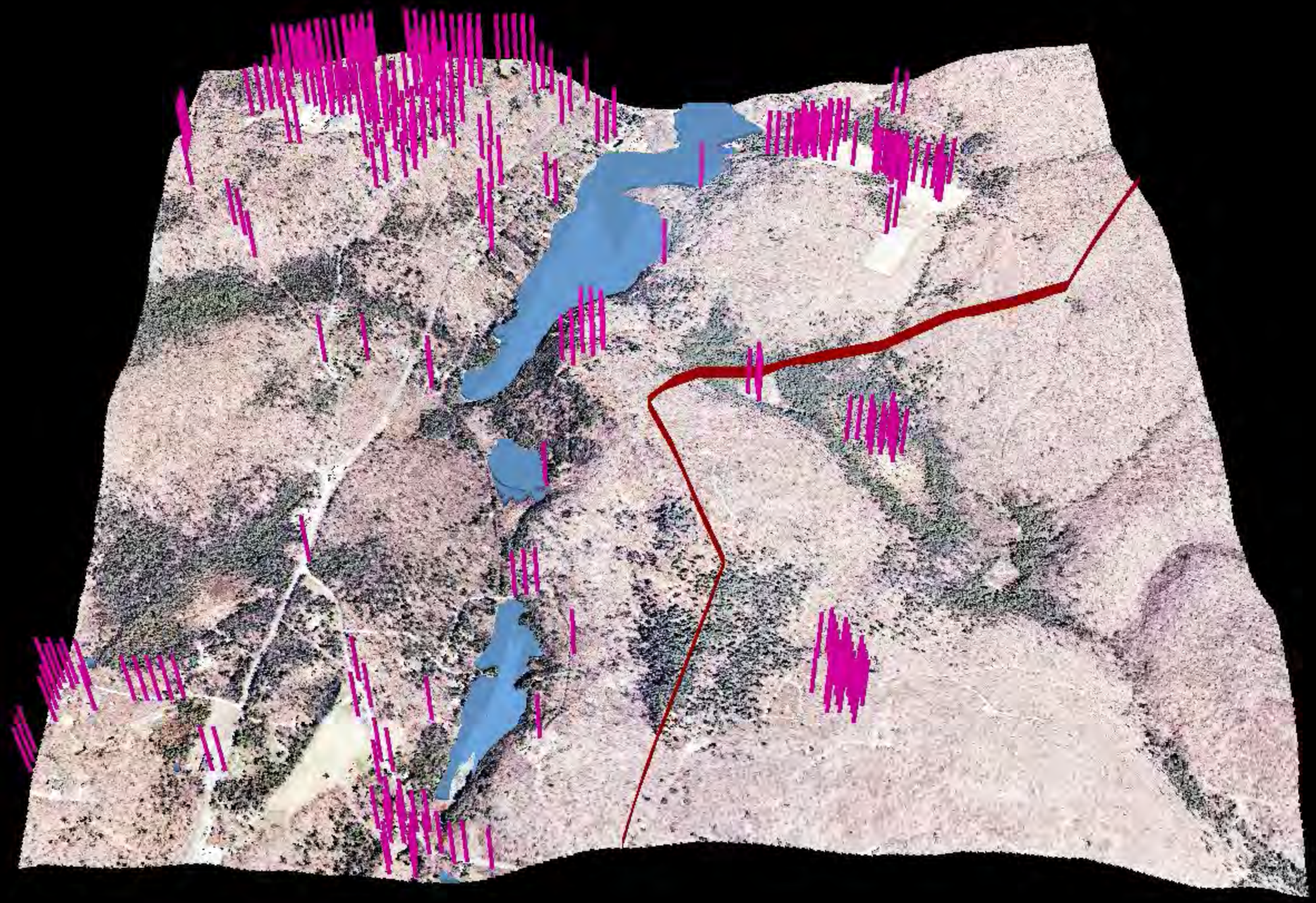
Lonicera japonica

1) Roads (30ft Buffer and 0.6 Mile Buffer)
2) Existing Vegetation
3) Disturbance
4) Elevation (<1200ft)
5) Ownership
6) Aspect (Any)
7) Soil Type (Mostly Sand to Mostly Clay)
8) Soil pH (4.5-8)
9) Soil Moisture (Coarse Well-Drained Soils; Not Poorly Drained)
10) Bird Habitat (Ruby-Throated Hummingbird, Eastern Bluebird, Northern Bobwhite, Northern Mockingbird, American Goldfinch)
11) Deer Habitat
12) Existing Building Location (30ft Buffer)
13) Existing Drill Pads (30ft Buffer and 0.6 Mile Buffer)
14) Marc 1 Pipeline (30ft Buffer and 0.6 Mile Buffer)
15) Existing Gathering Lines (30ft Buffer and 0.6 Mile Buffer)

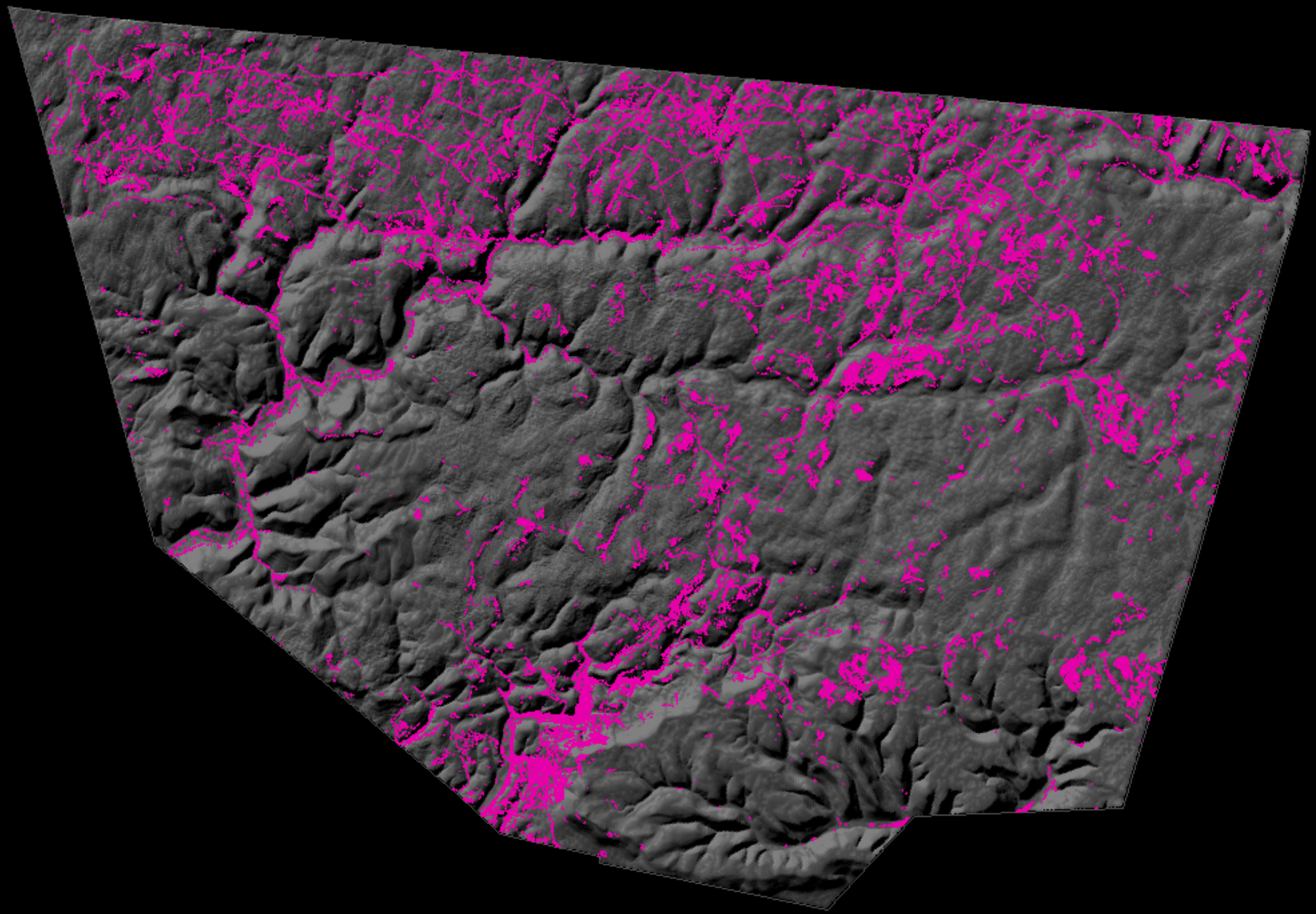




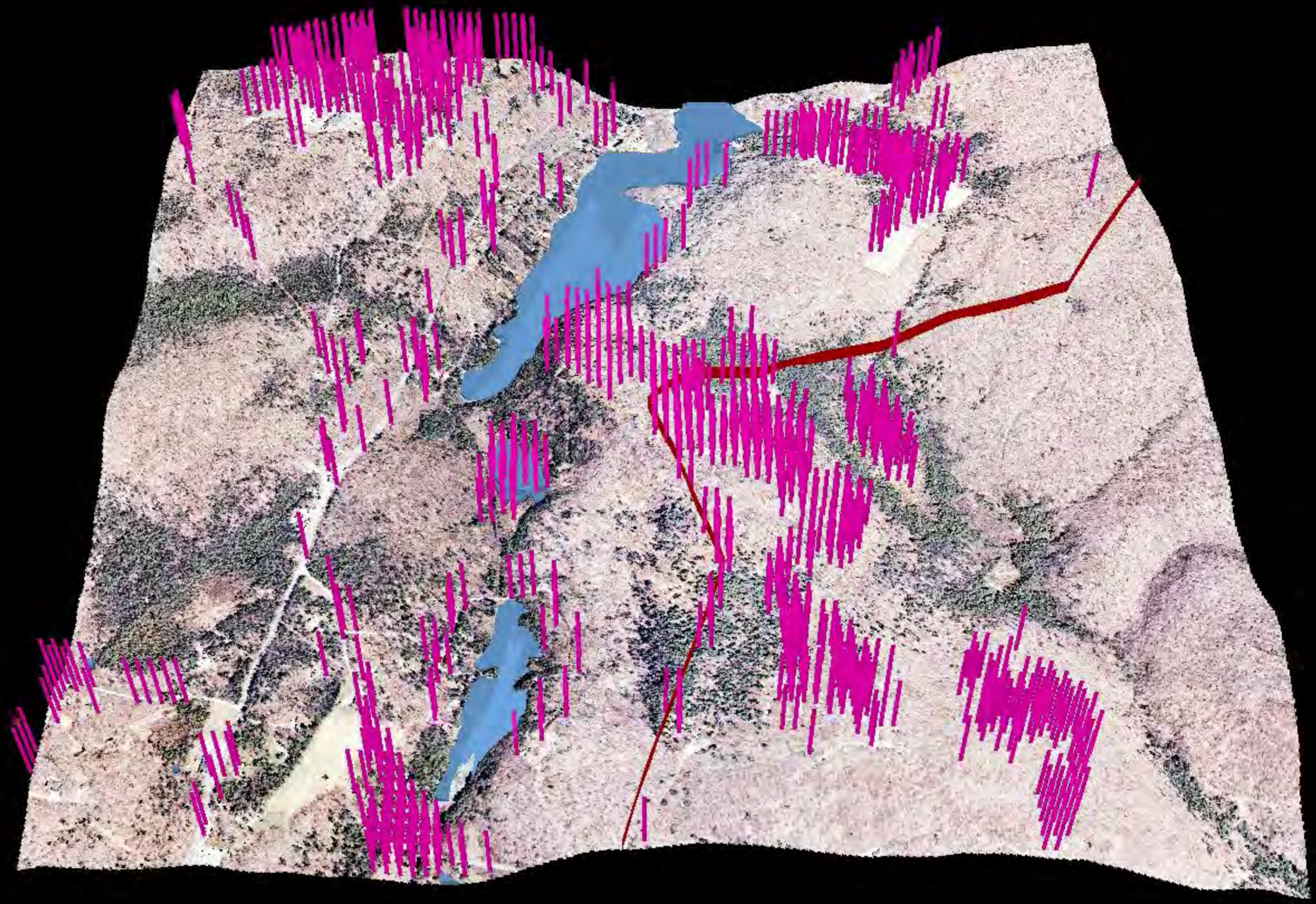
Pre Development - County Scale



Pre Development - Lake Mokoma Scale

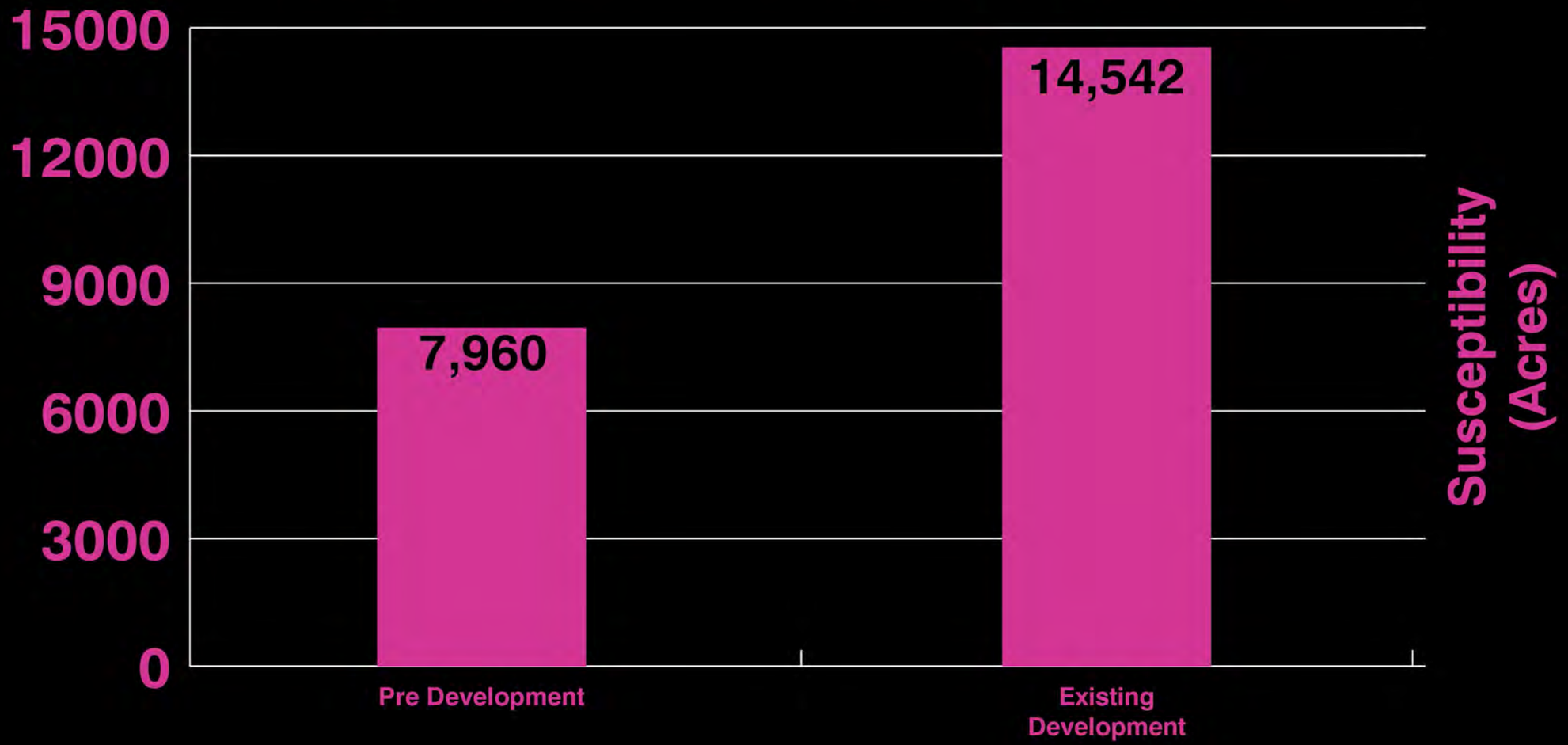


Existing Development - County Scale

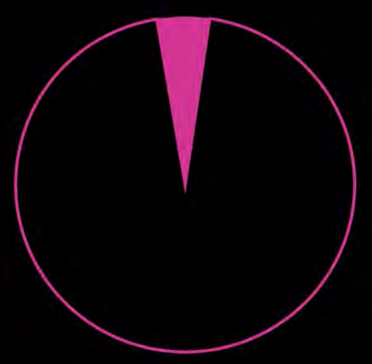


Existing Development - Lake Mokoma Scale

Japanese Honeysuckle



Percent of Sullivan County Susceptible



Site Characteristics:

Soil Moisture: Coarse Well-Drained Soils; Not Poorly Drained; No Coarse Sandy Soils or Peat
Soil pH: 4.5-8
Soil Type: Mostly Sand to Mostly Clay
Aspect: Any
Elevation: Rarely Found above 1200 ft.
Land Cover: Woods, Fileds, Disturbed Areas, Roadsides, Bottomlands, Fencerows
Other Info: Full Sun, Doesn't tolerate extreme dry conditions

Japanese Honeysuckle is a highly aggressive invasive vine. It is native to East Asia, but was introduced into the U.S in the 1800s for erosion control and ornamental plantings. Honeysuckle is a popular food for deer; and many bird species will feed on it as well as use it for habitat. Unlike the other species in this report, Japanese Honeysuckle does offer some benefits to native wildlife. It will however out-compete native species as well as take down trees. The plant can also take the form of a shrub, depending on the environment it is in. It can be commonly confused with the native honeysuckle, Lonicera sempervirens.

Comparing the Four

NOT
WANTED
For Invading Sullivan County
Mile-a-Minute

Persicaria perfoliata
REWARD

NOT
WANTED
For Invading Sullivan County
Tree of Heaven

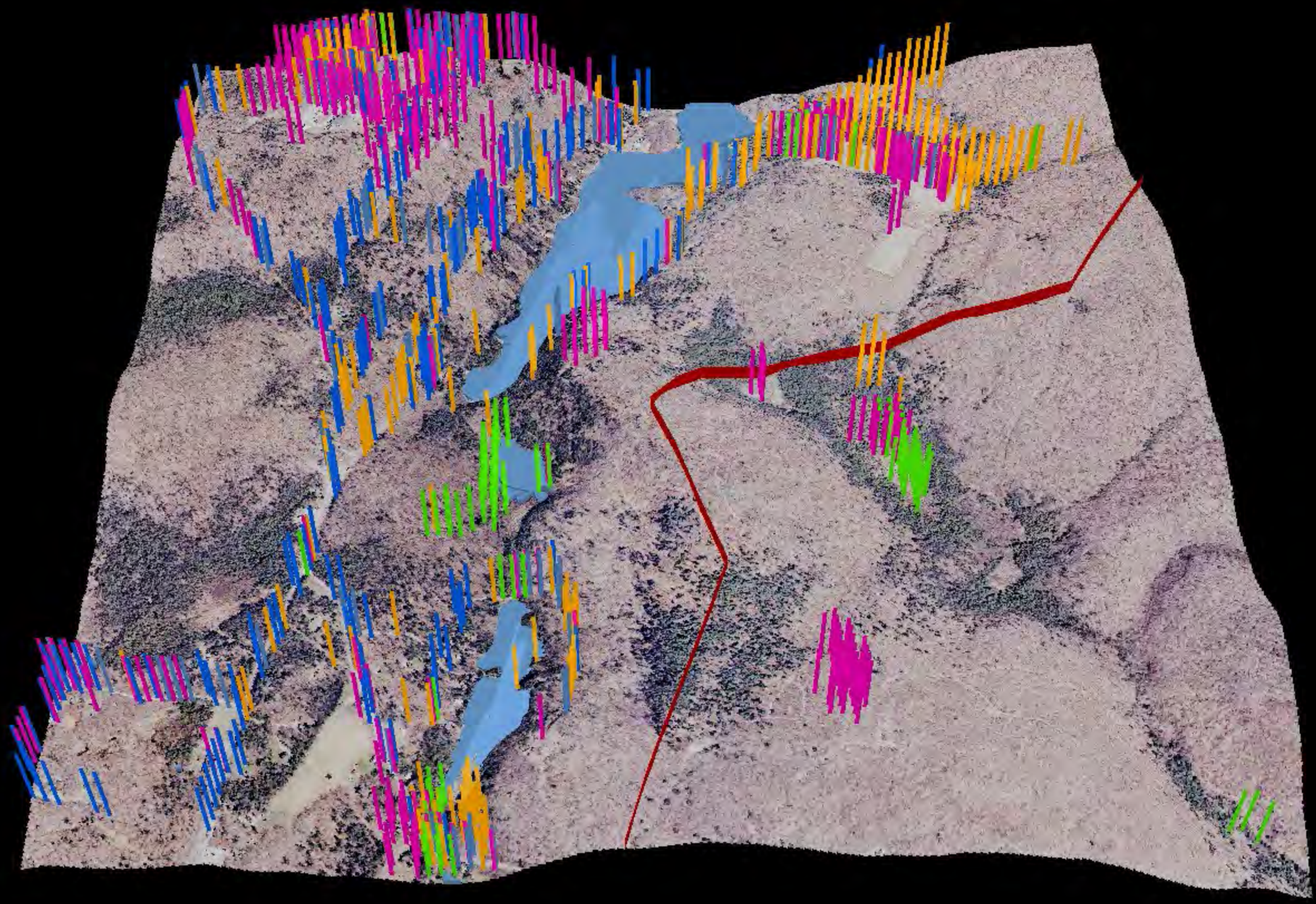
Ailanthus altissima
REWARD

NOT
WANTED
For Invading Sullivan County
Japanese Stiltgrass

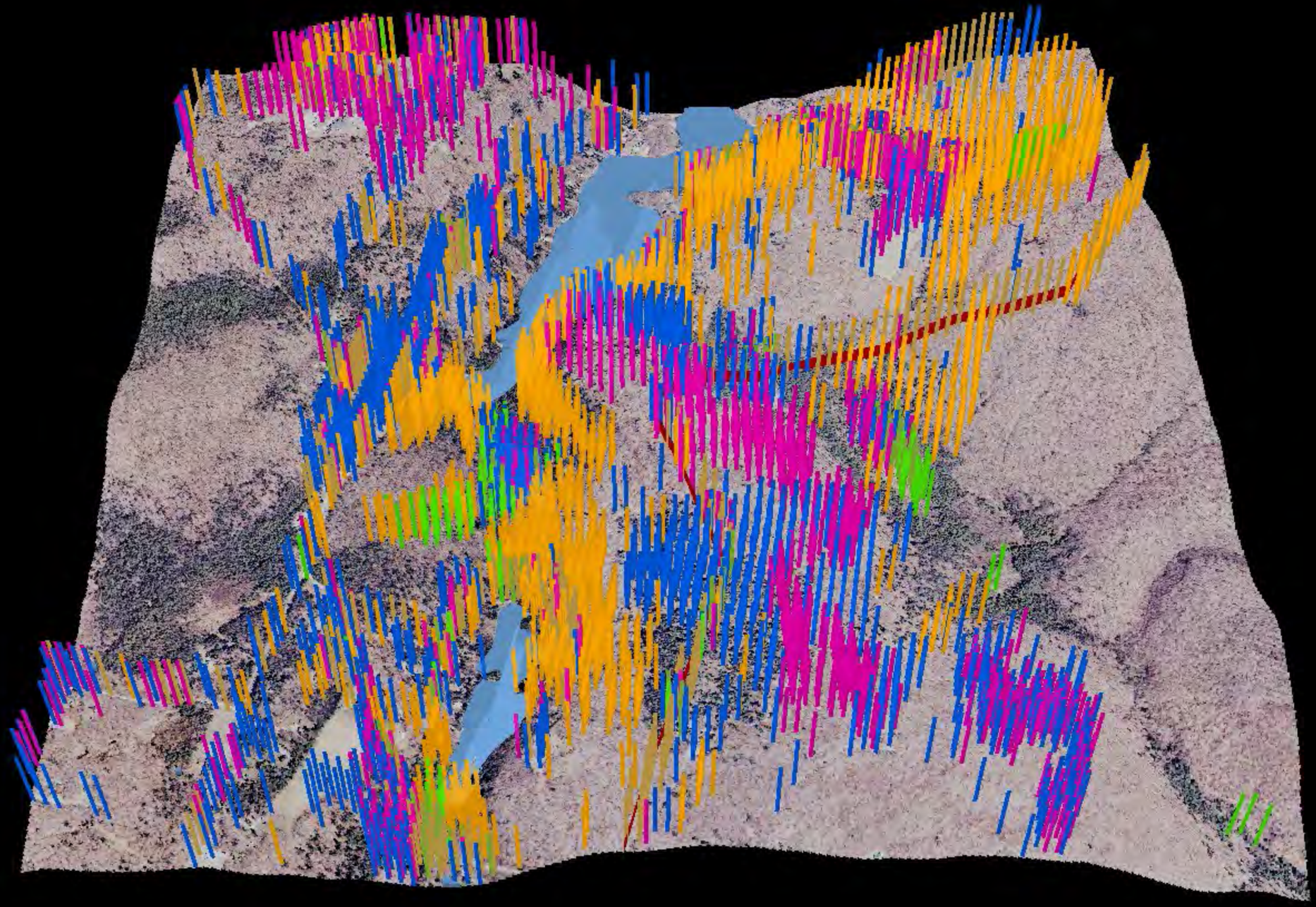
Microstegium vimineum
REWARD

NOT
WANTED
For Invading Sullivan County
Japanese Honeysuckle

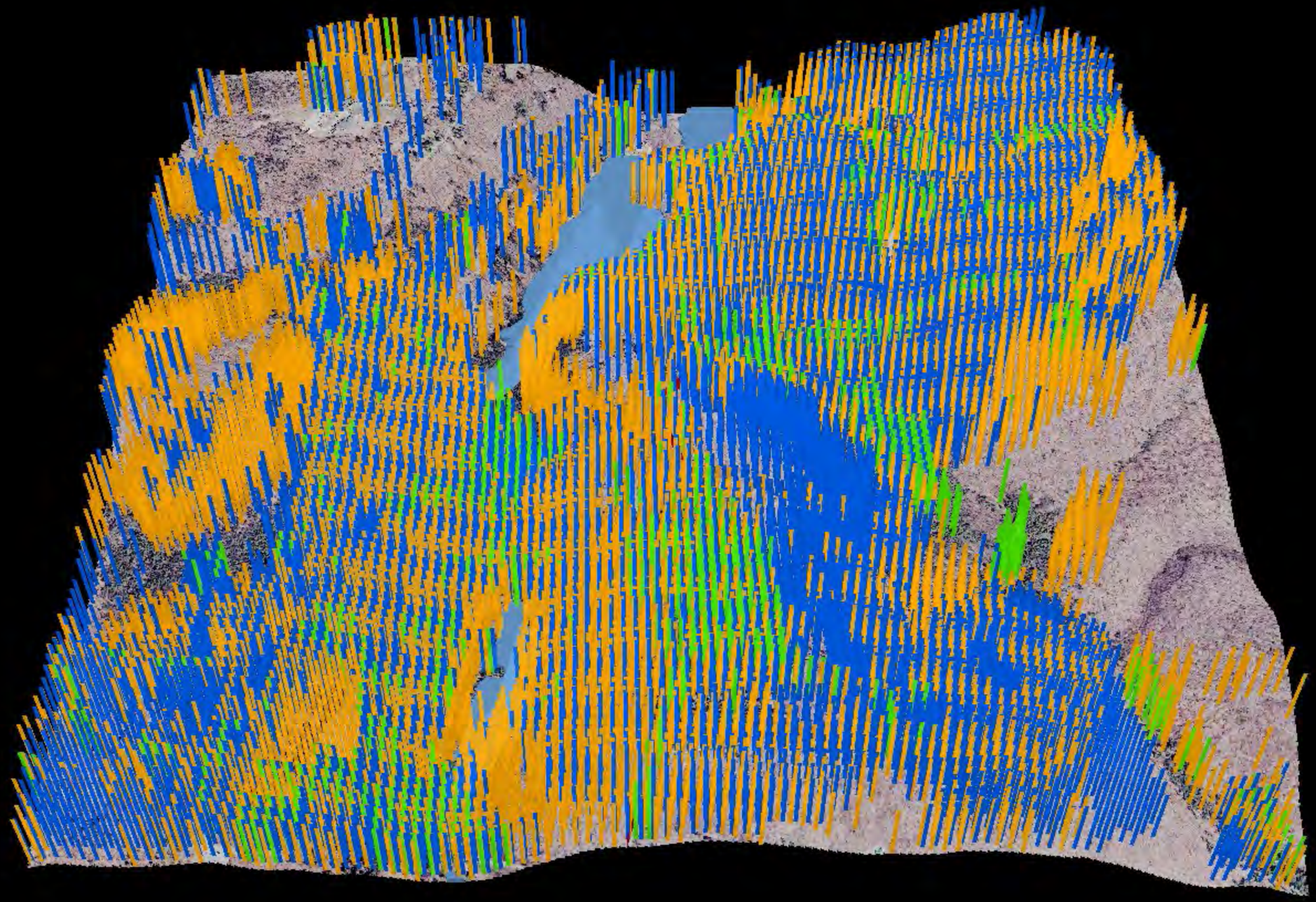
Lonicera japonica
REWARD



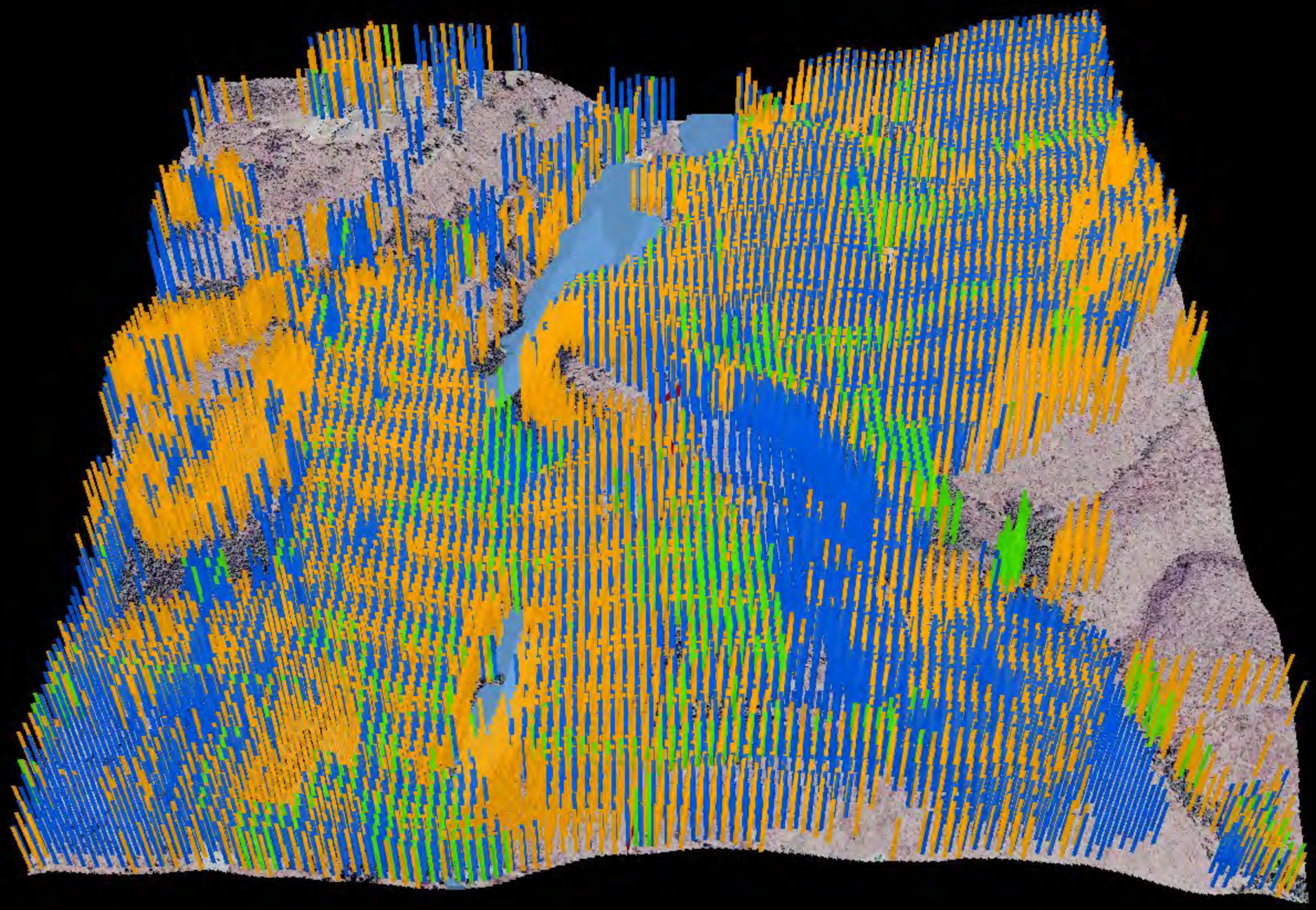
Pre Development - Lake Mokoma Scale



Existing Development - Lake Mokoma Scale

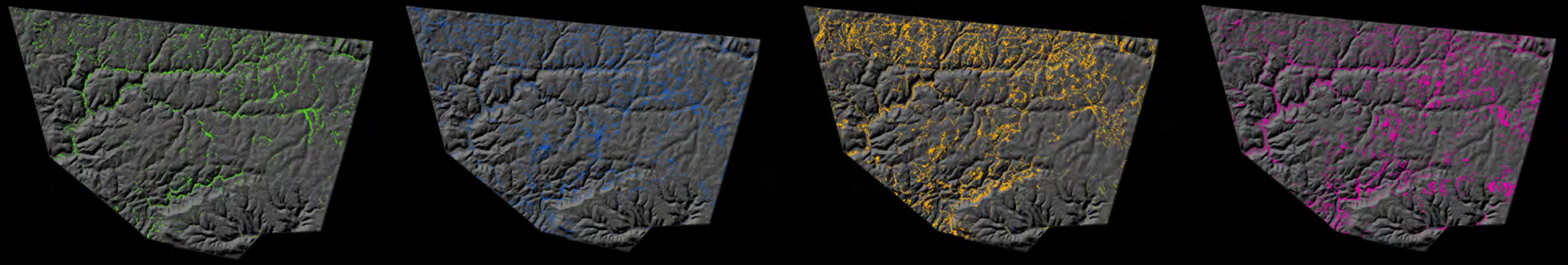


High Impact Development - Market Based Lines - Lake Mokoma Scale

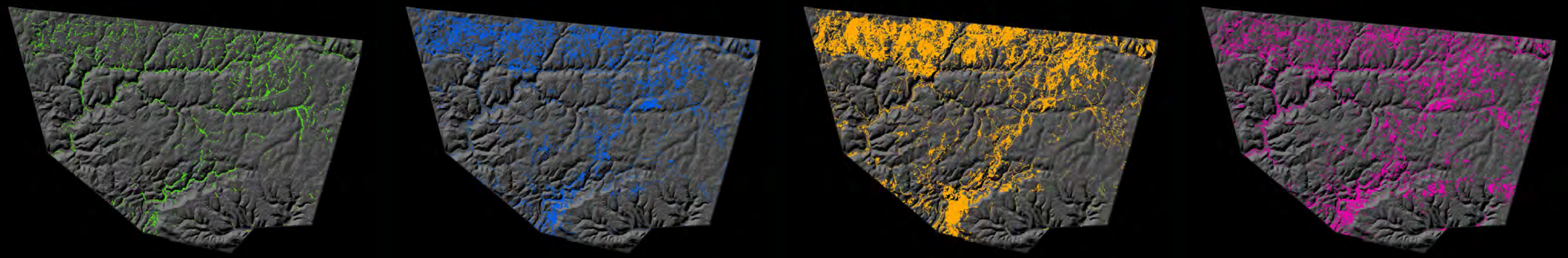


High Impact Development - Conservation Based Lines- Lake Mokoma Scale

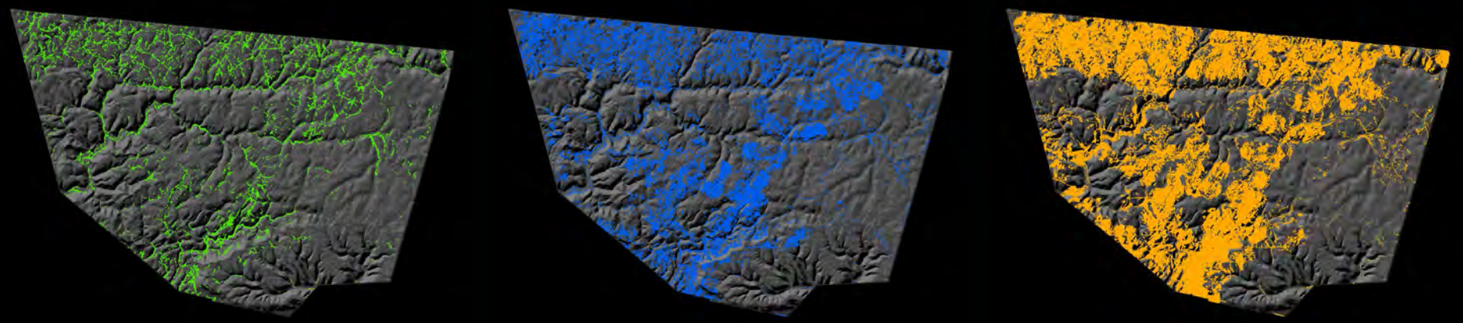
Pre Development



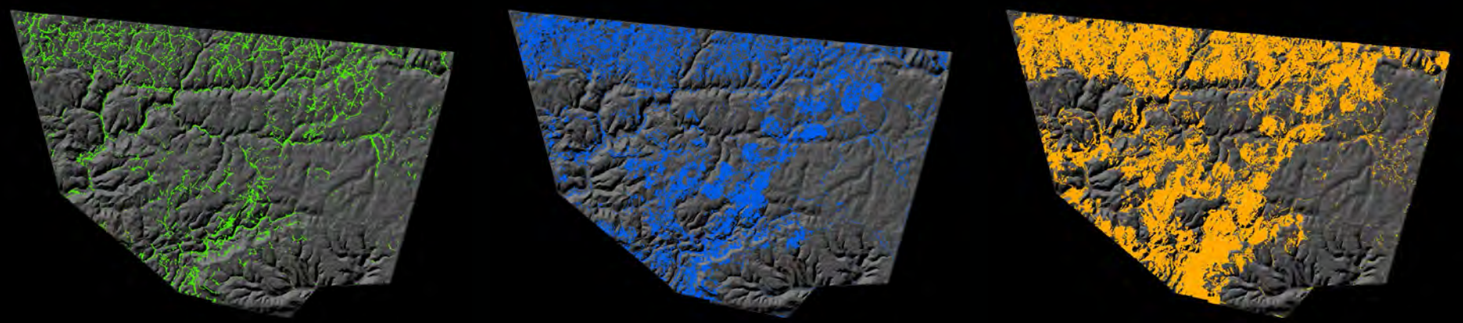
Existing Development



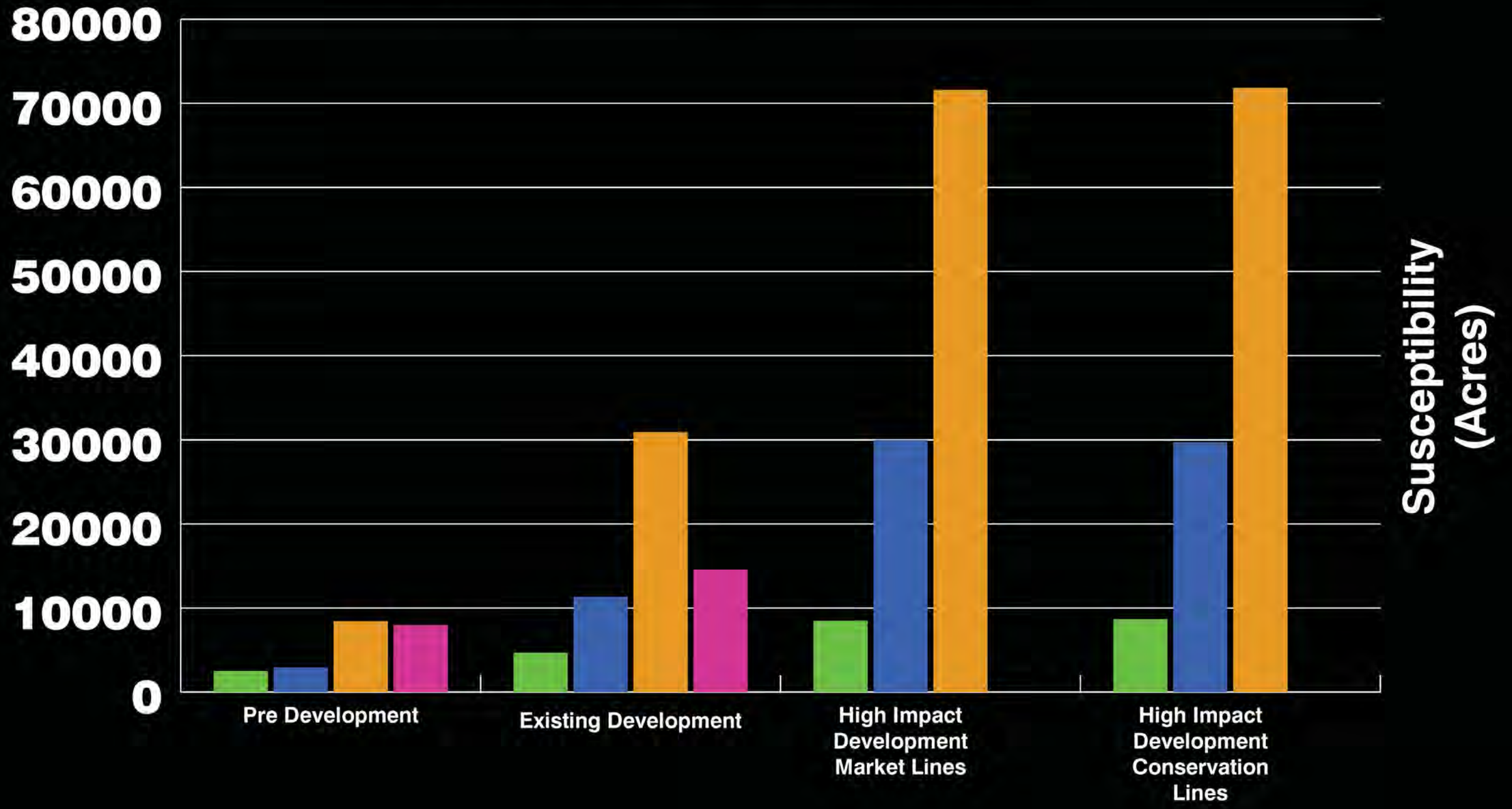
High Impact Development Market Based Lines



High Impact Development Conservation Based Lines



Comparing the Four



Controlling Invasives

1) Prevention
2) Early Detection and Rapid Response
3) Control and Management
4) Rehabilitation and Restoration

1) Prevention

A) Conduct Risk Assessments
B) Raise Awareness of Invasive Species
C) Create Educational Materials and Educate the Public
D) Develop Strategies to Prevent

A) Conduct Risk Assessments

The susceptibility mapping done in this study, is an early step to conducting risk assessments. By determining four species that could potentially be a threat to Sullivan County and mapping the areas that they would most likely invade, the residents can begin to prepare for them before they become a problem. Sullivan County is at a point where prevention is still a viable option.

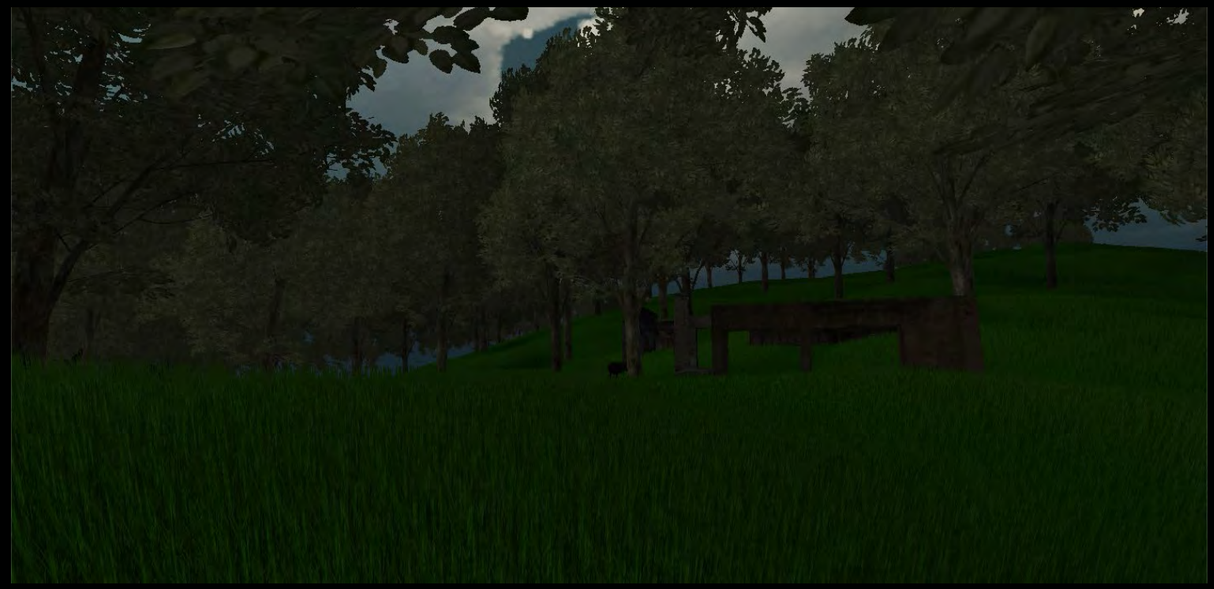
B) Raise Awareness of Invasive Species and

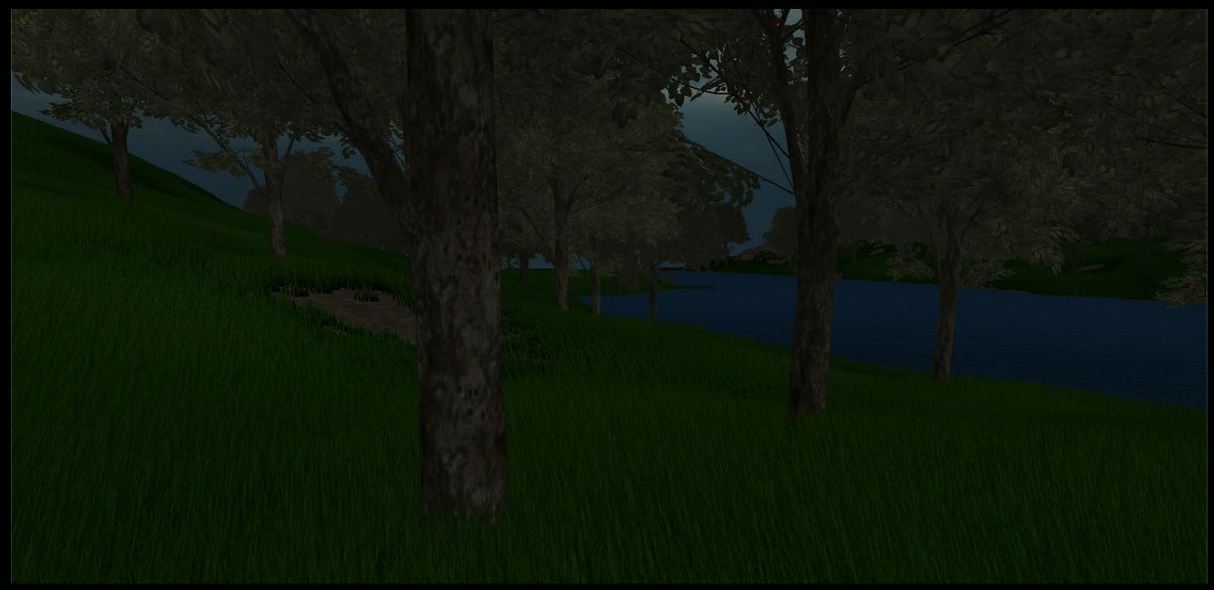
C) Create Educational Materials and Educate the Public

Pamphlets and Signage are alright ways to help educate, but a lot of times they go unnoticed. My solution is to create an interactive video game to show exaggerated effects of invasive species. The game would import the terrain of a relatable area, in this case Lake Mokoma, and would show the invasive species on a High Impact Level. The game would then have the player combat the invasive species and reclaim the landscape. The concept came from Kudzu, an invasive vine in the Southeastern United States, as well as B- Movies and Post Apocalyptic Video Games.

Concept:

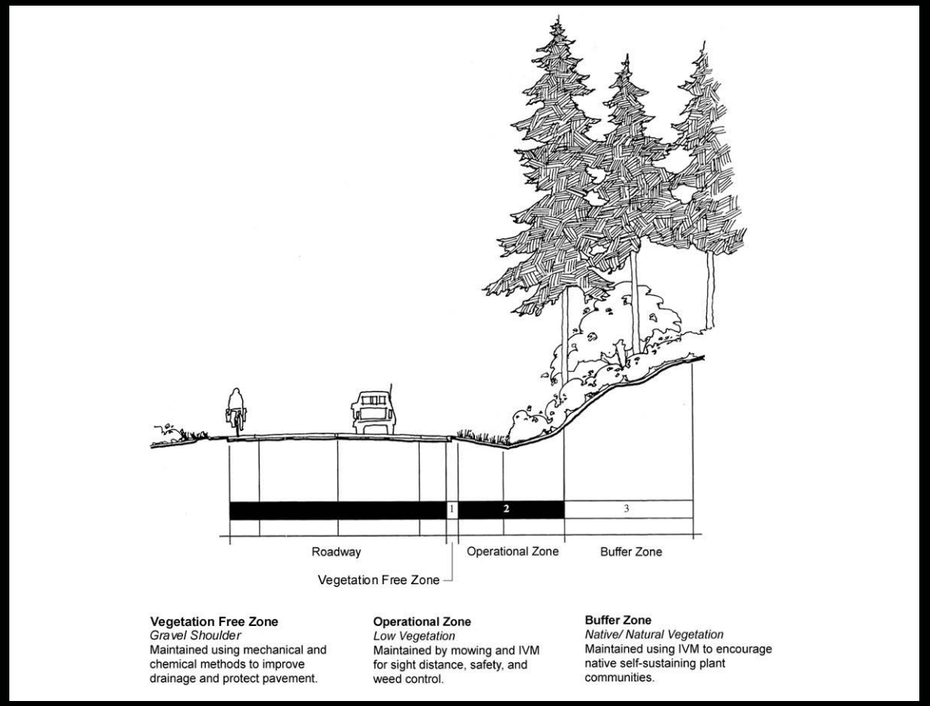
THEY DIDN'T THINK THEY WOULD SPREAD
THEY COULDN'T HAVE BEEN MORE WRONG
ATTACK OF THE
INVASIVES!





D) Develop Strategies to Prevent

1) Native Grasses and Herbs
    i) Helps Prevent Weeds
    ii) Controls Erosion
    iii) Aesthetically Pleasing
    iv) Less Maintenance
2) Salt Tolerant
    i) Only within 50ft of Road/Well Pad
    ii) Not for Pipeline Corridors
3) Staging Planting
4) Controlling Erosion
    i) Incorporate Stormwater Management
5) Selecting Appropriate Shrubs and Trees
    i) Zone Planting
        a) Zone 1: Shoulder, shorter turf
        b) Zone 2: Clear zone, herbs and shrubs
        c) Zone 3: Woodland, herbs, or shrubs



Zones of Vegetation

Roadside Buffers:

The type of plants for roadside buffers should be native, salt-tolerant, and attractive it would also be a plus for them to provide habitat for different types of species in the area. A full range of plants for roadside buffers is available in a separate excel file, But some common ones might include Sumac and Oak Species, Golden Rods and Milkweeds, and grasses such as Deer Tongue and Little Bluestem. Another option would also be to incorporate Mycofiltration techniques to help filter out pollutants, but this might be overkill for Roadsides.

White Oak

Goldenrod

Milkweed

Little Bluestem

Pipeline Corridors:

Pipeline Corridors are important arenas in the battle against invasive species. These areas become very disturbed and it becomes extremely important to make good decisions so that the invasives do not spread. It is also important to make up for the loss of habitat by creating new habitats for other species. Pipeline plant selections are composed of mainly herbaceous plants, grasses, vines, and small shrubs. There are no trees of large shrubs in pipeline corridors. A detailed list of plants can be found in the separate excel document

Lowbush Blueberry

Woodlily

Partridge Pea

Oxeye Sunflower

Drill Pad Buffers:

Drill Pad buffers are areas to be concerned about. They are tough soil conditions with lots of heavy activity around them. Buffering these areas requires strong, adaptable plants. They types of plants for these areas are salt tolerant, deer resistant, and pretty much native weeds. These plants are commonly found in very harsh environments and are selected for urban conditions. They also are deer resistant so that animals do not eat the potentially polluted plants. Mycofiltration is also recommended for Drill Pad buffers.

Eastern Red Cedar

Black Eyed Susan

Arrowwood Viburnum

Mycofiltration:

Mycofiltration is a approach to filtering pathogens, silt, and chemical toxins from the environment using mushroom mycelia. Mycofiltration systems can be installed around roads, farms, suburban and urban environments, watersheds, factories, and much more. The filters can be set up by inoculating materials such as brush, wood chips, yard waste, straw, corncobs, and other organic waste materials. The mushrooms will remove the pollutants from the soil and reduce the disturbance done by the pollution. The mushrooms will then thrive off of the contaminants.

Lentinula ododes (Shitake) is very effective at filtering hydrocarbons from the soil.

2) Early Detection and Rapid Response

A) Form Partnerships
B) Determine Priority Sites and Species
C) Respond Quickly

Early Detection and Rapid Response is the step following prevention. At this point, there are already invasive species in the area, but they have not gotten out of hand. In this stage one acts fast to control the threat. One also need to build up a strong communication and reporting network by relying on partners and local people. This is where educational materials help.

3) Control and Management

A) Inventory and Map Areas of Infestation
B) Develop Management Strategies

Control and Management means that the area probably has a problem. One needs to develop management strategies. These could mean washing vehicles so as not to spread more seed. Or it could go as far as using intergrated pest management to combat infestations. In most cases, there will be lots of mowing, tilling, pulling, and spraying.

4) Rehabilitation and Restoration

Rehabilitation and Restoration is very similar to the strategies employed in Prevention. The environments are recovering from invasive species and it is very important to rehabilitate them so that the invasives do not re-invade. Restoration strategies can involve planting native species. Restoring riparian buffers. Planting vegetative buffers along roadways. It also entails implementing management strategies like regular mowing or burning and continuing to educate the public on invasive species.

This...

..to This

Conclusion

As seen in this report, an increase in gas drilling will result in an increase in invasive plant susceptibility. This does not mean that the invasive plants will move in, but instead means that the chances of them moving in are higher. By understanding what areas are at more risk than others, communities can begin to plan and prepare for dealing with the invasive plants that could arrive. The control methods mentioned in this project are some of the ways that communities can use to mitigate the situations and much more information about them can be found in the references in the bibliography. While the analylis done in this project applies only to Sullivan County, the same approach can be applied anywhere and the control methods can be used throughout the entire Marcellus Shale area. Its important to communicate the threats that invasive species pose to the environment as well as the amount of money that is lost because of them. If the public can understand these dangers, then they can be more vigilant in combating them.

Bibliography

1) A national early detection and rapid response system for invasive plants in the United States: conceptual design. Washington, D.C.: Federal Interagency Committee for the Management of Noxious and Exotic Weeds, 2003. Print.

2) Byers, James. “Impact of Non-Indigenous Species on Natives Enhanced by Anthropogenic Alteration ofSelection Regimes.” Oikos 97.3 (2002): 449-458. Print.

3) Cook, David C.. “Predicting the Economic Impact of an Invasive Species on an Ecosystem Service.” Ecological Applications 17.6 (2007): 1832-1840. Print.

4) Davis, Anthony , Julie Lundgren, Barbara Barton, Jill Belfonti, Jenni Farber, John Kunsman, and Anthony Wilkinson. A Natural Areas Inventory of Sullivan County, Pennsylvania. Laporte, PA: The Nature Conservancy, 2001. Print.

5) Ferguson, Leslie, and Celestine Lacey Duncan. Backcountry road maintenance and weed management. Missoula, MT: U.S. Dept. of Agriculture, Forest Service, Technology & Development Program, 2003. Print.

6) Gillham, John. Weed Spread Modeling– Building a New GIS-based Model Based on Known Growth Requirements. Salt Lake City, UT: U.S. Dept. of Agriculture, Forest Service, 0. Print.

7) Gillham, John. Weed Susceptibility Modeling– Building a New GIS-based Model. Salt Lake City, UT: U.S. Dept. of Agriculture, Forest Service, 0. Print.

8) Grubb, Robert G.. Soil survey of Bradford and Sullivan Counties, Pennsylvania. Washington, D.C.?: The Service, 1986. Print.

9) Guide to noxious weed prevention practices. Version 1.0. ed. Washington, D.C.: U.S. Dept. of Agriculture, Forest Service, 2001. Print.

10) Gurevitch, Jessica, and Dianna Padilla. “Are invasive species a major cause of extinctions?.” Trends in Ecology and Evolution 19.9 (2004): 613-620. Print.

11) Holmes, Thomas P.. “Economic Impacts of Invasive Species in Forests.” The Year in Ecology and Conservation Biology 1162 (2009): 18-38. Print.

12) Huebner, Cynthia D., Cassandra Olson, and Heather C. Smith. Invasive plants field and reference guide: an ecological perspective of plant invaders of forests and woodlands. United States: USDA Forest Service, Northeastern Research Station :, 2005. Print.

13) Invasive Species Team, DCNR. Invasive Species Management Plan. Harrisburg: Pennsylvania Department of Conservation and Natural Resources, 2011. Print.

14) Johnson, Ann M., and John D. Krenz. Best practices handbook for roadside vegetation management. St. Paul, Minn.: Minnesota Department of Transportation, Office of Research Services] ;, 2008. Print.

15) MacDougall, Andrew, and Roy Turkington. “Are Invasive Species the Drivers or Passengers of Change in Degraded Ecosystems?.” Ecology 86.1 (2005): 42-55. Print.

16) Mortensen, David A. . “Forest Roads Facilitate the Spread of Invasive Plants.” Invasive Plant Science and Mangement 2 (2009): 191-199. Print.

17) National strategy and implementation plan for invasive species management. Washington, D.C.: U.S. Dept. of Agriculture, Forest Service, 2004. Print

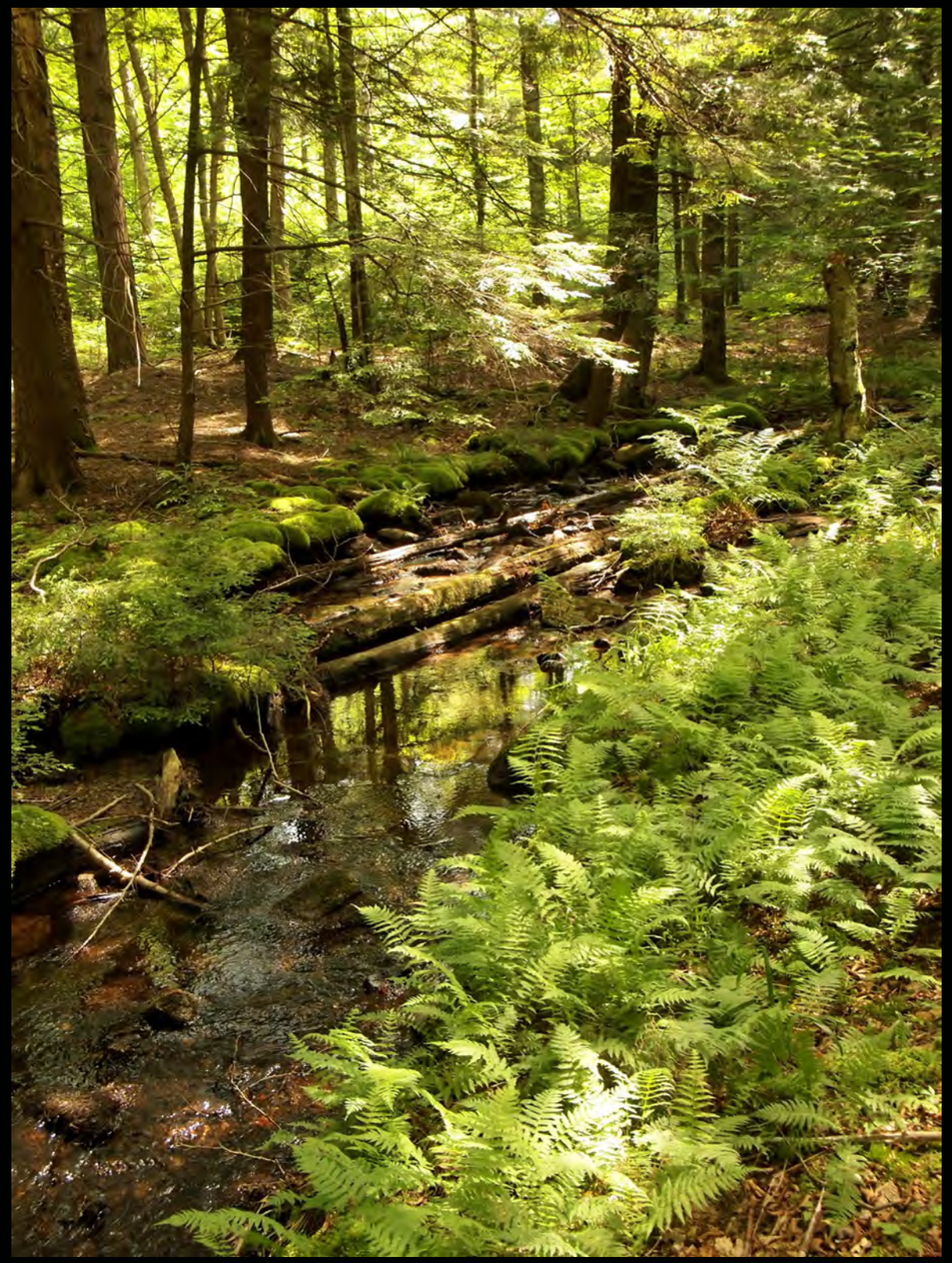
18) Native Plant Framework. Washignton, DC: U.S. Dept. of Agriculture, Forest Service, 2004. Print.

19) Pimentel, David, Rodolfo Zuniga, and Doug Morrison. “Update on the environmental and economic costs associated with alien-invasive species in the United States.” Ecological Economics 52 (2004): 273-288. Print.

20) Romanello, Genevieve Allen. Microstegium vimineum invasion in central Pennsylvanian slope, seep wetlands site comparisons, seed bank investigation and water as a vector for dispersal. State College, Pa: The Pennsylvania State University, 2009. Print.

22) Siegel, Steven, and Susan Donaldson. Measures to Prevent the Spread of Noxious and Invasive Weeds During Construction Activities. Reno, NV: University of Nevada, 2004. Print.

23) Slattery, Britt, Kathryn Reshetiloff, and Susan M. Zwicker. Native plants for wildlife habitat and conservation landscaping: Chesapeake Bay Watershed. Annapolis, MD: U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, 2005. Print.

24) Stamets, Paul. Mycelium running: how mushrooms can help save the world. Berkeley, Calif.: Ten Speed Press, 2005. Print.

25) Trent, Andy, and Dick Karsky. MTDC portable vehicle washer: interim report. Missoula, Mont.: USDA Forest Service, Missoula Technology & Development Center, 2002. Print.