GRAND RIVER WATERSHED

Water Management Plan

Nutrient Source Area Mapping

Firella Creek Pilot Area
Reference Atlas

Report from the Nutrient Source Area Mapping Working Group

March 2014

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Pilot Project Context:

Non-point sources of nutrients and sediment remain the most challenging to manage for water quality improvement. Funding for best management practices is limited; to maximize the benefits of limited funding to yield the greatest improvements in water quality, nutrient and sediment source areas need to be identified.

Pilot Project Goals:

The goal of the project was to develop tools and approaches using a high resolution digital elevation model (DEM) and advanced GIS techniques to identify nutrient/sediment source areas at the farm/field scale.

Maps created from the tools and approaches, were envisioned to be the tool that Conservation Specialists could use to start the discussion with local farmers about nutrient and soil loss at the farm/field scale so that funding, through the Rural Water Quality Program, could be offered to implement best management practices in priority local source areas.

Reference Atlas:

This reference atlas illustrates the spatial datasets created and used to identify and map nutrient/sediment source areas at the farm/field scale.

Located within the Grand River watershed (**Figure 1**), the upper Nith River basin (**Figure 2**) was identified as a priority catchment for this pilot study, based on a study that identified priority subwatersheds for nutrient and sediment management in the Grand River watershed[1]. Large scale, three dimensional (3-D) vector hydrology (**Figure 8**) was digitized for the upper Nith basin. The 3-D vector hydrology layer provided the foundation for creating a high resolution DEM (**Figure 9**). These spatial data layers were essential for developing the approach used to identify nutrient and sediment priority areas for targeting best management practices.

Firella Creek (**Figure 3**), a small subwatershed within the upper Nith basin, was identified to pilot the use of terrain analysis tools and soil erosion models that were developed using the high resolution DEM (**Figure 10**). The terrain analysis tools and soil erosion models were used to determine nutrient and sediment source areas.

The Revised Universal Soil Loss Equation for the Application in Canada (RUSLEFAC) was used to identify areas with a potential risk of sheet erosion (**Figure 17**). Four raster factors were combined to calculate RUSLEFAC: Rainfall (**Figure 4** and **Figure 5**), Soil Erodibility (**Figure 6** and **Figure 7**), Slope Length and

[1] Sources of Nutrients and Sediments in the Grand River Watershed, Report from the Water Quality Working Group, 2013 (http://www.grandriver.ca/waterplan/Nutrientsources_Dec2013.pdf)

Steepness (**Figure 14**), Cropping Management (**Figure 15** and **Figure 16**). Although the equation usually takes support practices (P Factor) into account, for this project, adequate data related to these practices were not available and, as such, a value of 1 was used across the entire pilot area.

The terrain analysis approach was used to identify areas of concentrated overland flow that were hydrologically connected to digitized surface hydrology features. Slope (**Figure 13**) and flow accumulation (**Figure 12**) were combined to determine a 'stream power index' (SPI) (**Figure 18**). This approach was used to identify areas with a high potential for gully erosion (**Figure 19**).

Combining the analytical approaches identified those areas that had the highest likelihood of contributing nutrients and sediment to streams (**Figure 20** and **Figure 21**).

Pilot Results:

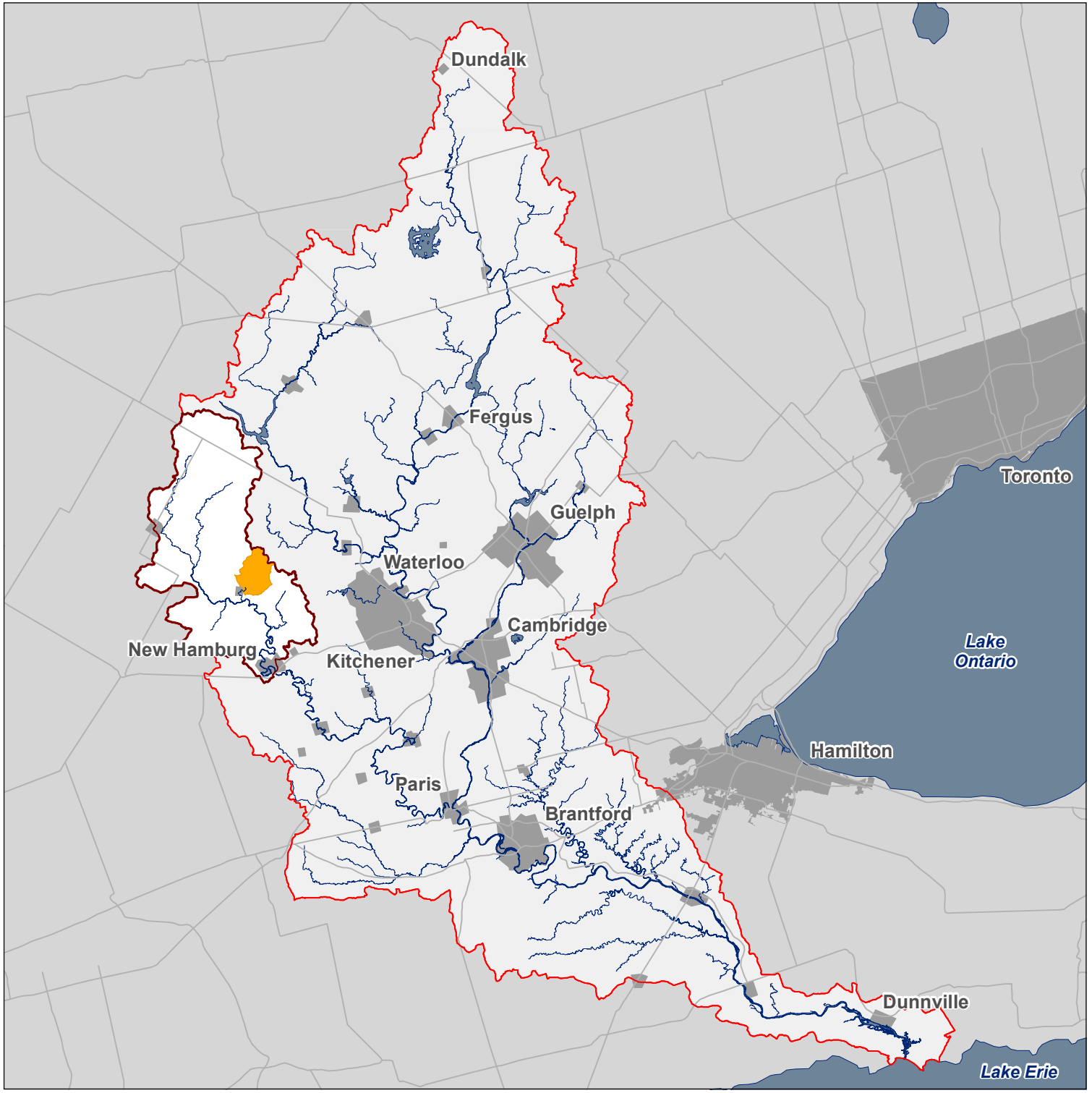
The series of maps generated from this pilot project have proven to be a catalyst among soil, agronomy, and water experts to discuss and conceptualize nutrient and erosion processes at the subwatershed and farm/field scale.

Farm/field scale maps, derived from this study, were motivation for starting the discussion about sediment and nutrient source areas on the farm. Three farmers consulted through this process confirmed the accuracy of the source area maps, and one requested assistance in designing an erosion control project to mitigate soil loss.

The high resolution DEM is expected to aid staff in the process of designing erosion control structures, such as water and sediment control basins or grassed waterways, since it will eliminate the need for a detailed field survey.

Mapping created for this study will also be valuable in identifying potential water quality monitoring sites for subwatershed scale monitoring purposes.

The mapping products and information developed by this pilot and its continued development will continue to be used by Conservation Specialists to advocate for the adoption of best management practices in priority areas, as identified in the Water Management Plan.



Grand River Conservation Authority

SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 1: Grand River Watershed

Legend

- Firella Creek Pilot Area
- Upper Nith Subwatershed
- Grand River Watershed
- Road
- Lake/River
- Stream
- Built-Up Area

N

Scale 1:800 000

Kilometres

0 5 10 15 20

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SWI - Nutrient Source Area Mapping
Firella Creek Pilot Area

Figure 2:
Upper Nith River Basin

Legend

- Firella Creek Pilot Area
- Upper Nith Subwatershed
- Subcatchment Boundary
- Road
- Lake/River
- Stream

N

Scale 1:210 000

Kilometres

0 1 2 3 4 5

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 3: Firella Creek Subwatershed

Legend

- Road
- Stream
- Firella Creek Pilot Area

N

Scale 1:37 500

Kilometres

0 0.5 1

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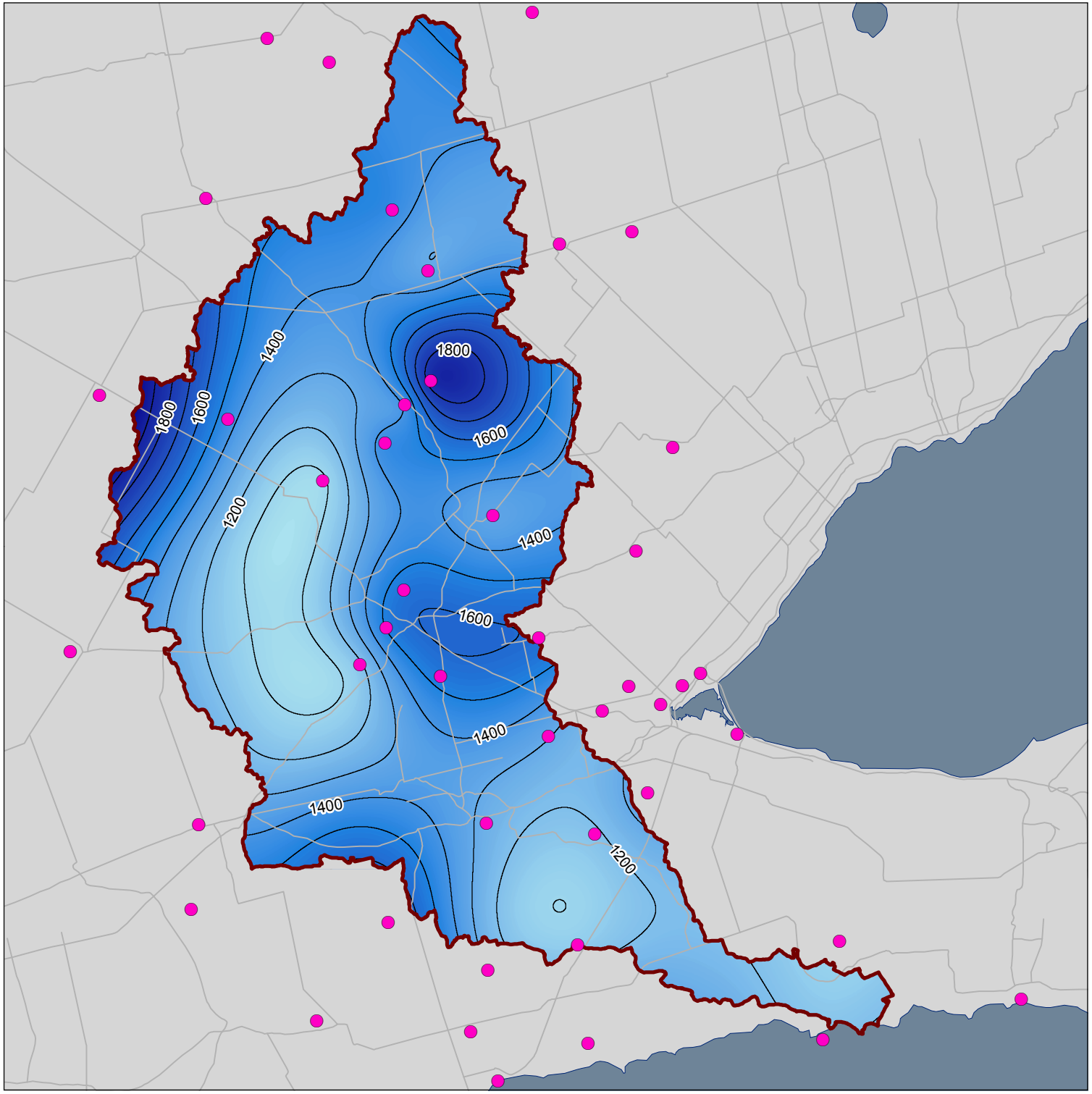

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 4: R Factor Creation

Legend

- Climate Station Used to Create R Factor Layer
- Contour (Interval = 100 MJ mm ha^{-1} h^{-1})
- Interpolated R Factor (MJ mm ha^{-1} h^{-1})
  - High : 2000
  - Low : 1000

N

Scale 1:37 500

Kilometres

0 10 20

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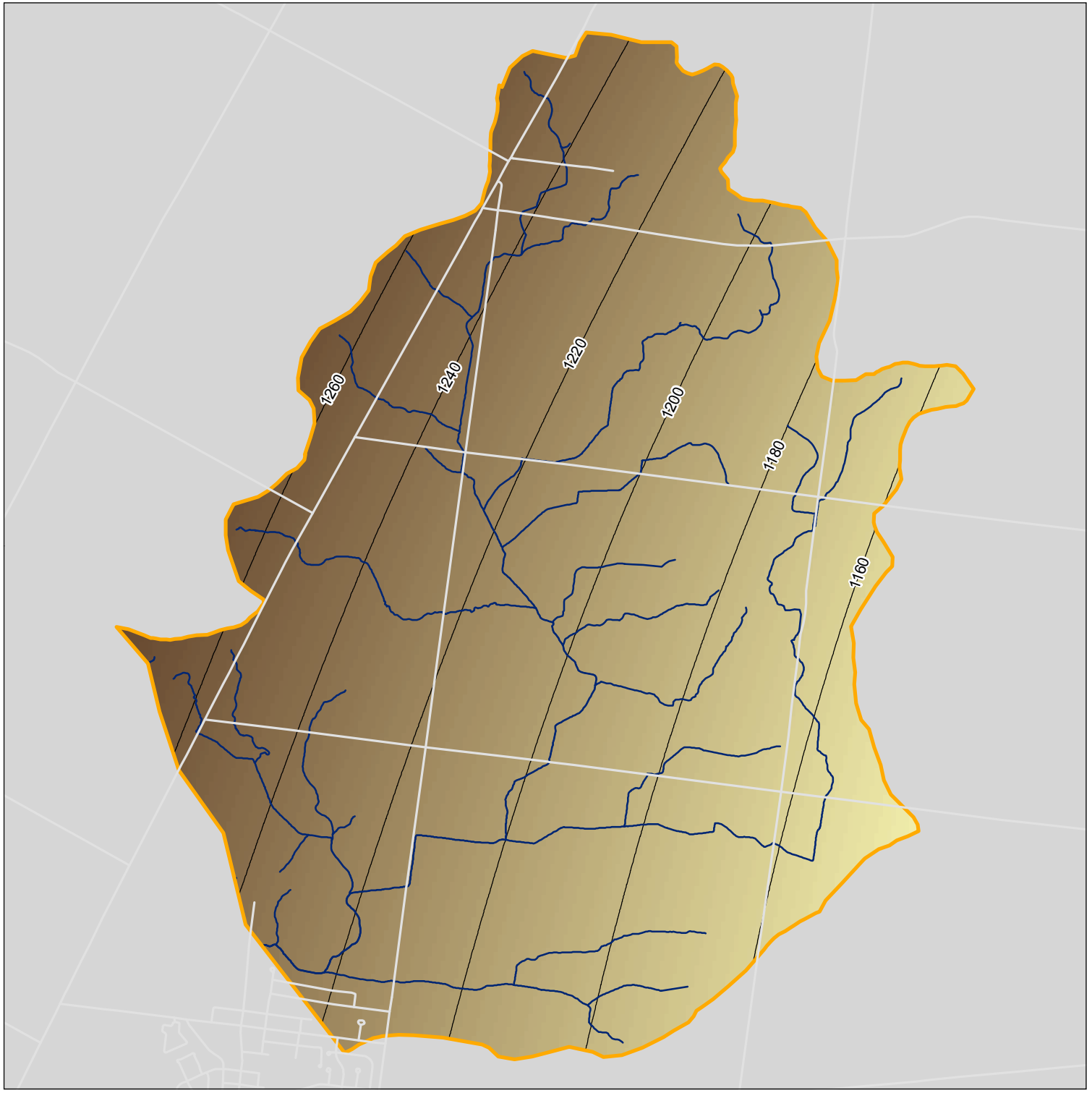

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 5: R Factor (Rainfall & Runoff)

Legend

Contour
(Interval = 100 MJ mm ha^{-1} h^{-1})

Interpolated R Factor (MJ mm ha^{-1} h^{-1})
High : 1280
Low : 1140

N

Scale 1:37 500

Kilometres
0 0.5 1

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 6: Soil Type

Legend

Soil Type

- Bennington loam
- Berrien sandy loam
- Bookton sandy loam
- Brady sandy loam
- Brant loam
- Brisbane sandy loam
- Brooke loam
- Brookston clay loam
- Brookston loam
- Brookston sandy loam
- Burford cobbly loam
- Burford gravelly loam
- Caledon sandy loam
- Colwood loam
- Fox sandy loam
- Freeport sandy loam
- Granby sandy loam
- Grand loam
- Gravel pits
- Heidelberg fine sandy loam
- Hespeler sandy loam
- Huron clay loam
- Huron loam
- Huron sandy loam
- Kirkland sandy loam
- Lisbon sandy loam
- Macton loam
- Maplewood loam
- Martin sand and gravel
- Organic soils
- Perth clay loam
- Perth loam
- Perth sandy loam
- Pothole
- Scarp
- St. Clements sandy loam
- St. Clements silty clay loam
- Tavistock loam
- Tuscola loam
- Water
- Waterloo fine sandy loam
- Wauseon sandy loam
- Wellesley sandy loam
- Wellesley silty clay loam
- Wellesley silty loam
- Wilmot sandy loam
- Wilmot silty clay loam

N

Scale 1:37 500

Kilometres

0 0.5 1

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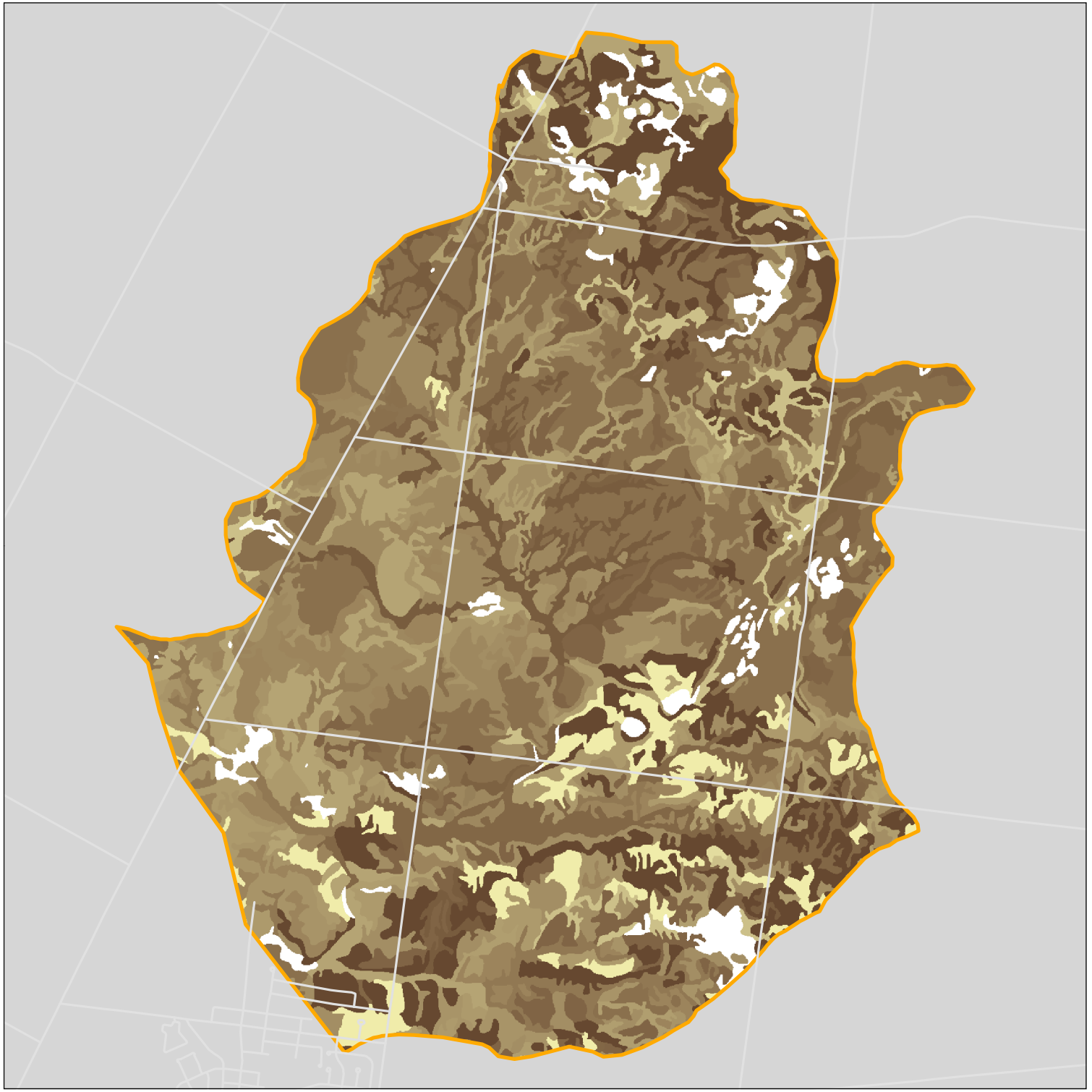

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 7: K Factor (Soil Erodibility)

Legend

K Factor (t·h·hr/h·mj·mm)

High : 0.067

Low : 0.013

N

Scale 1:37 500

Kilometres

0 0.5 1

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SWI - Nutrient Source Area Mapping
Firella Creek Pilot Area

Figure 8:
Upper Nith Hydrology

Legend

Large Scale Hydrology

N

Scale 1:210 000

Kilometres

0 1 2 3 4 5

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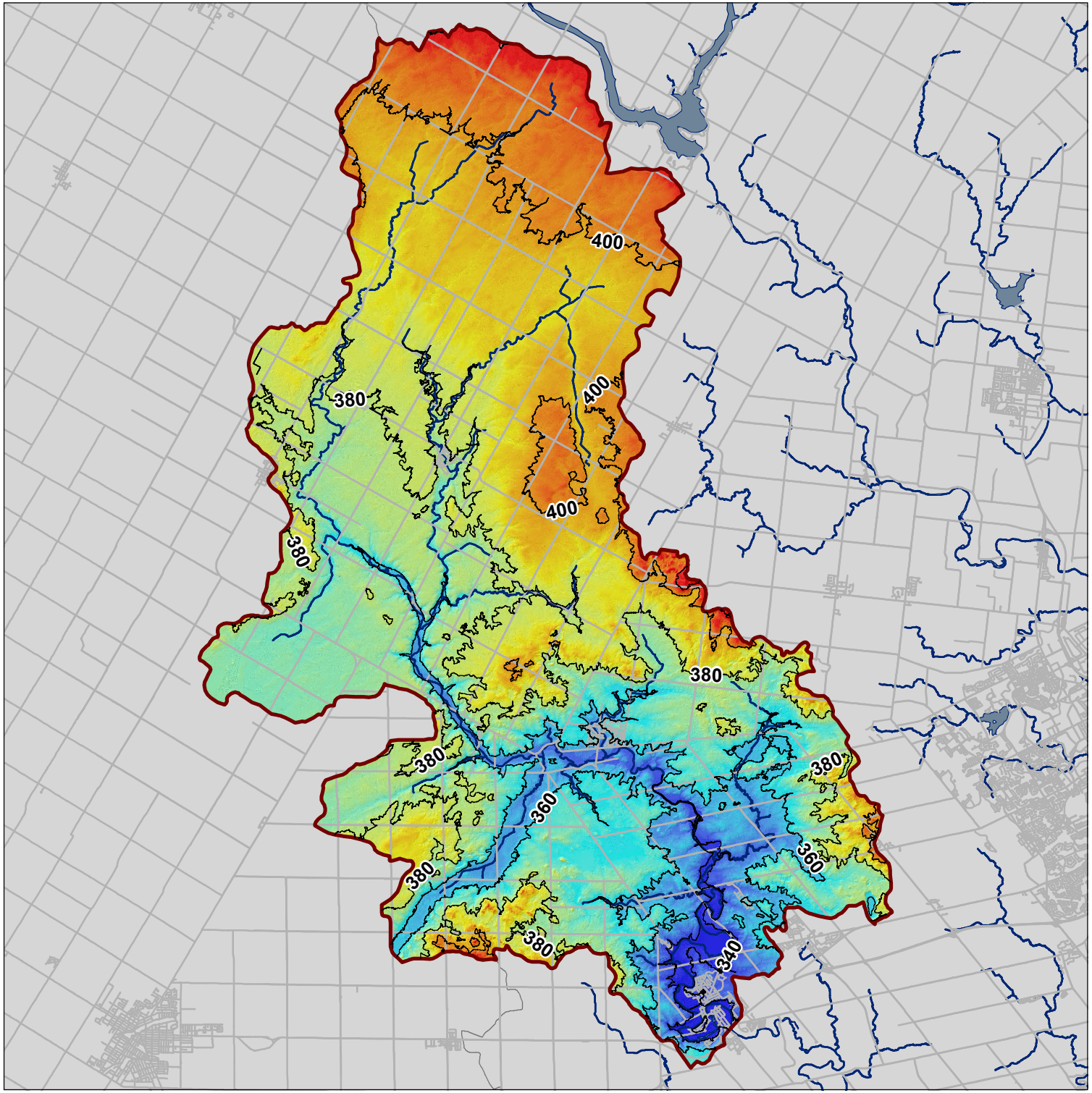

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SWI - Nutrient Source Area Mapping
Firella Creek Pilot Area

Figure 9:
Upper Nith DEM

Legend

Contour (Interval = 20m)

Ground Surface Elevation

High : 441 masl

Low : 295 masl

N

Scale 1:210 000

Kilometres

0 1 2 3 4 5

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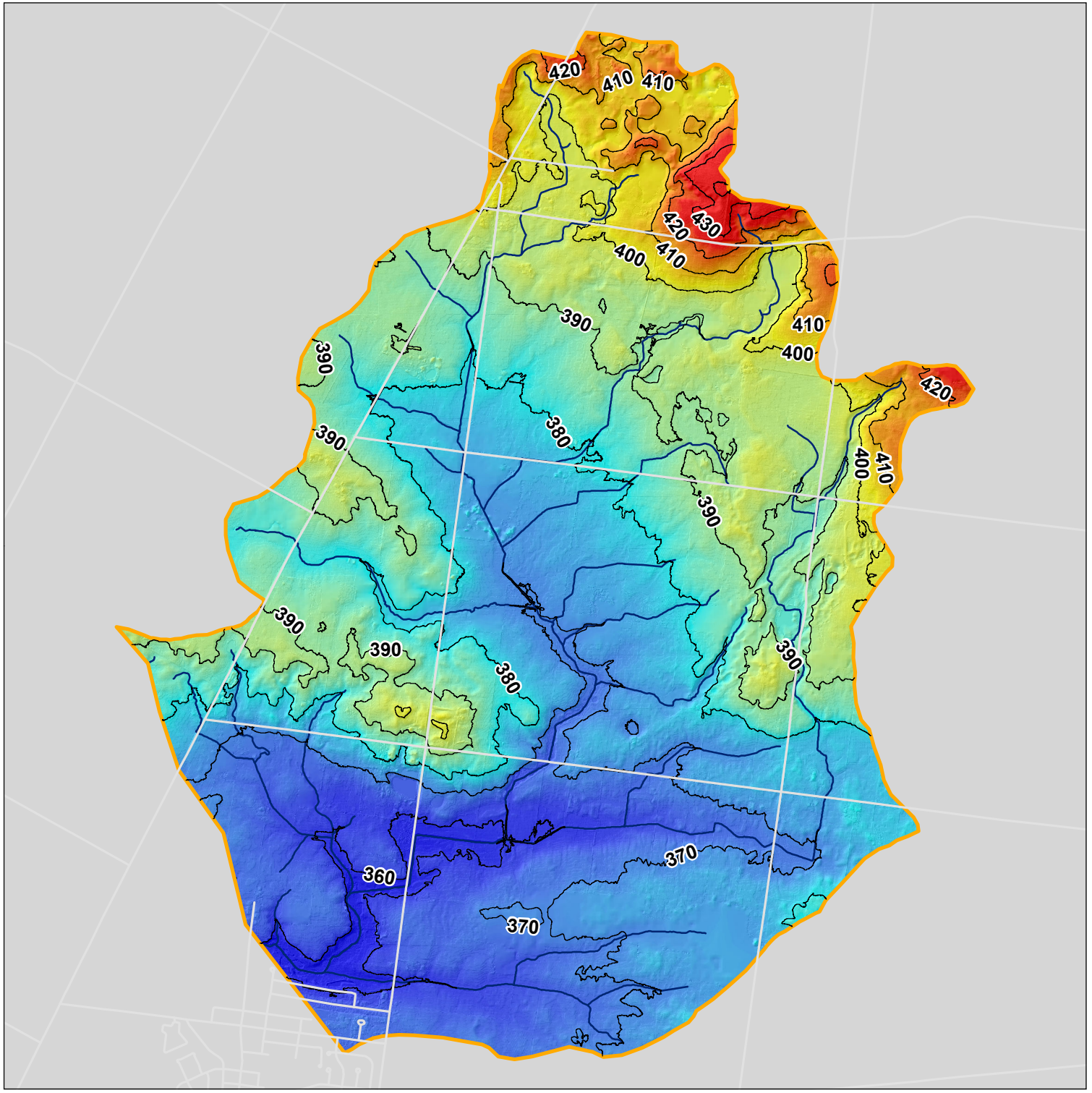

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SWI - Nutrient Source Area Mapping
Firella Creek Pilot Area

Figure 10: Firella DEM

Legend

Contour (Interval = 10m)

Ground Surface Elevation

High : 441 masl

Low : 351 masl

N

Scale 1:37 500

Kilometres

0 0.5 1

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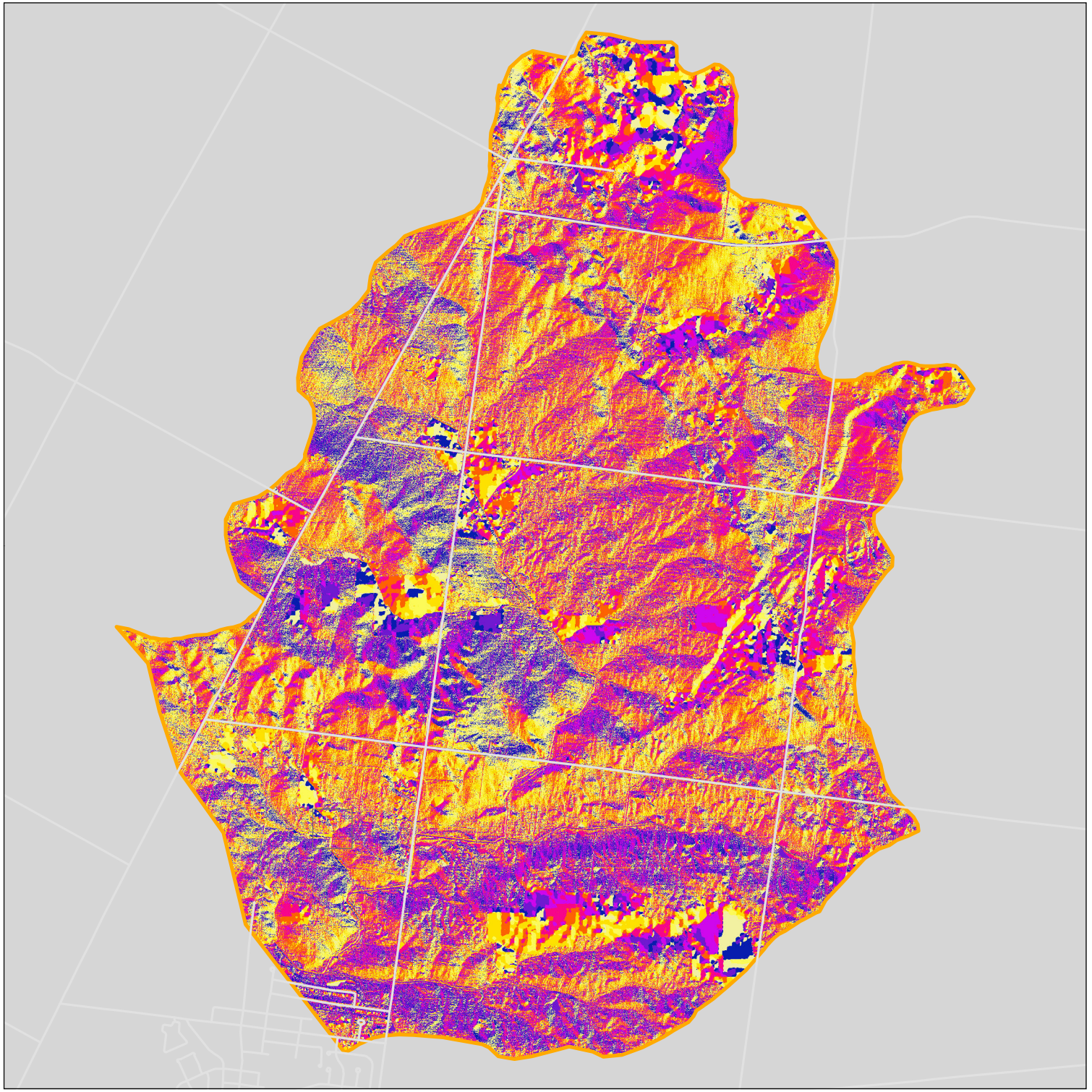

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 11: Flow Direction

Legend

Flow Direction

NW	N	NE
W		E
SW	S	SE

N

Scale 1:37 500

Kilometres

0 0.5 1

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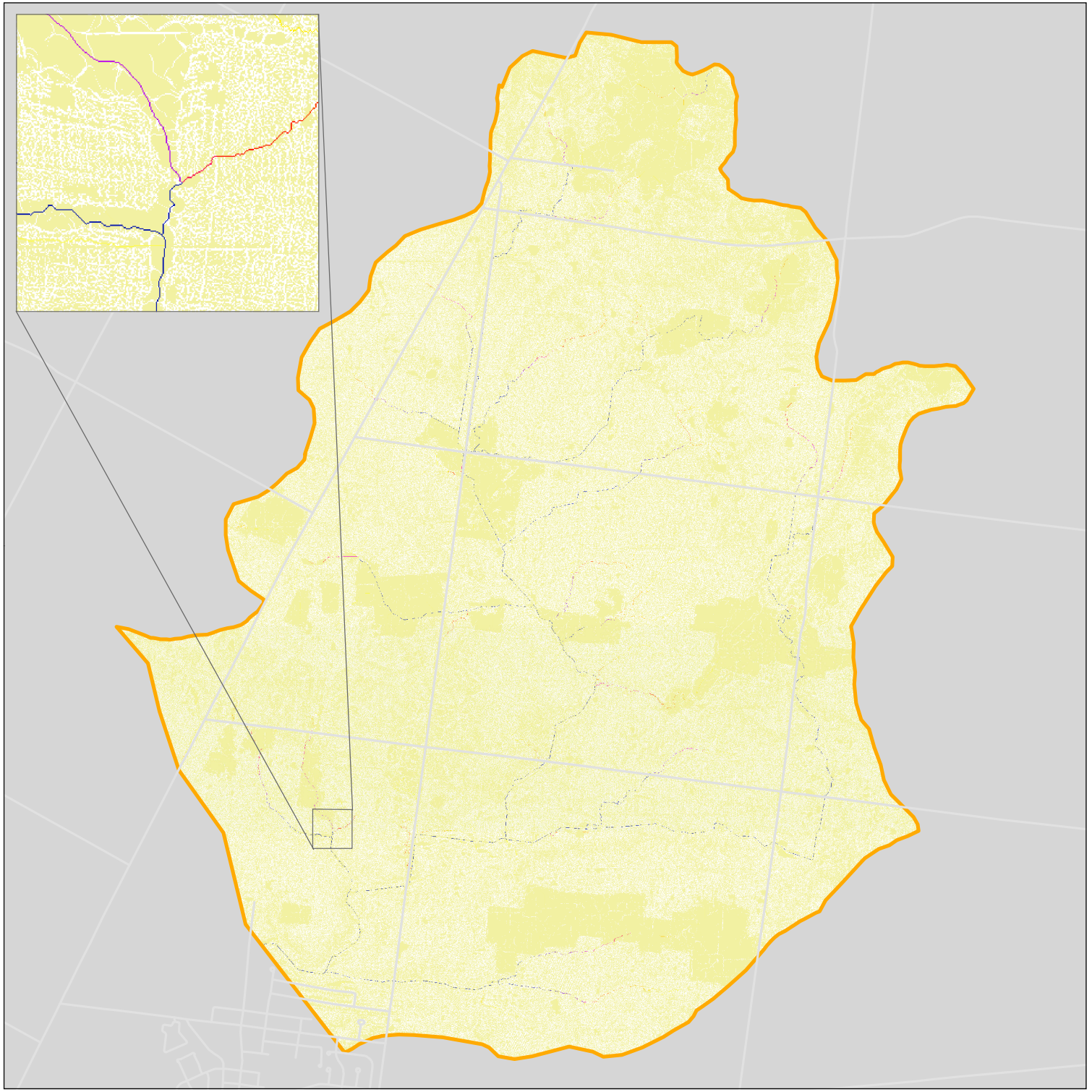

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SWI - Nutrient Source Area Mapping
Firella Creek Pilot Area

Figure 12:
Flow Accumulation

Legend

Flow Accumulation

High

Low

N

Scale 1:37 500

Kilometres

0 0.5 1

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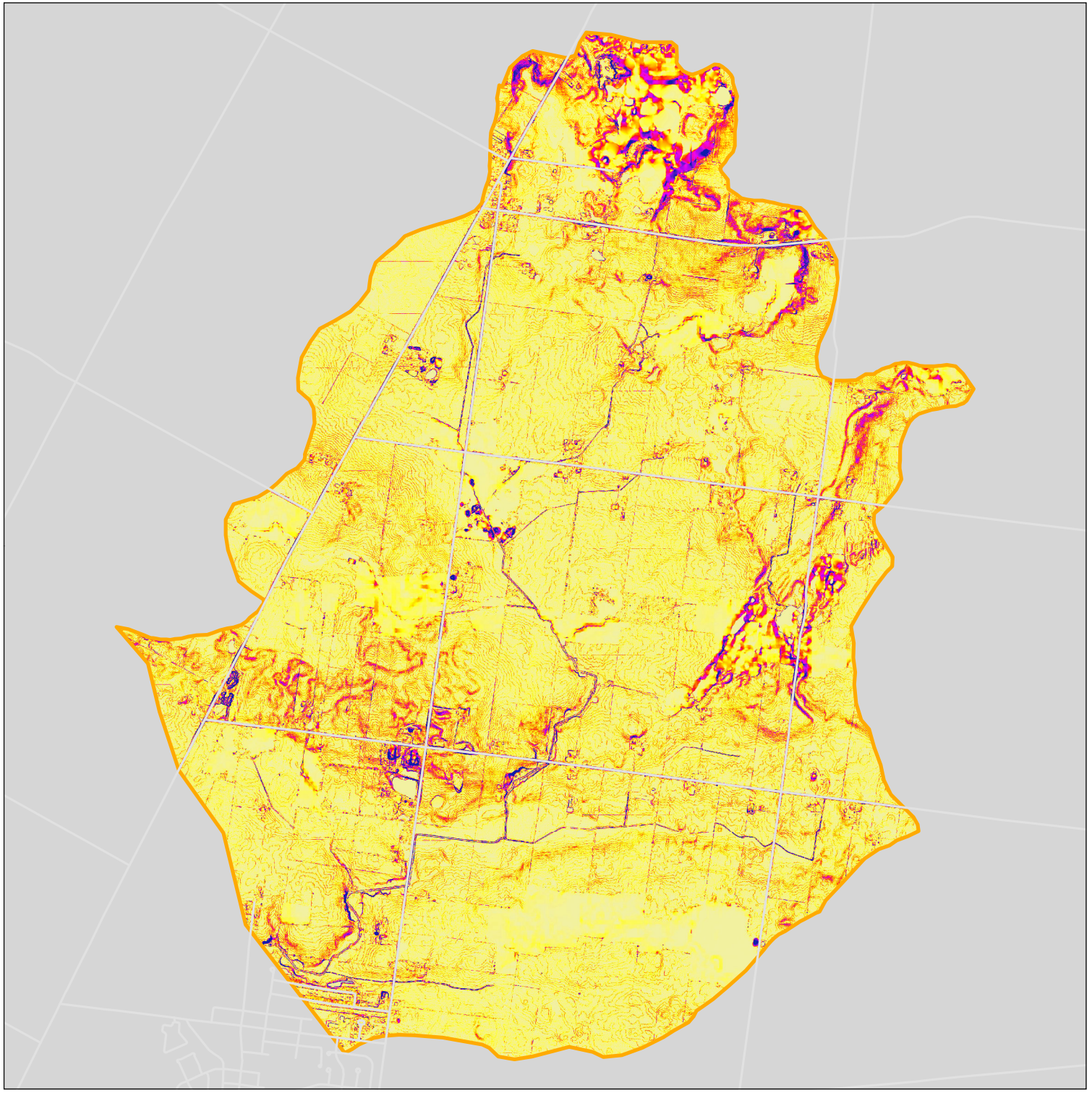

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 13: Slope (in Degrees)

Legend

Slope (degrees)

High : 65

Low : 0

N

Scale 1:37 500

Kilometres

0 0.5 1

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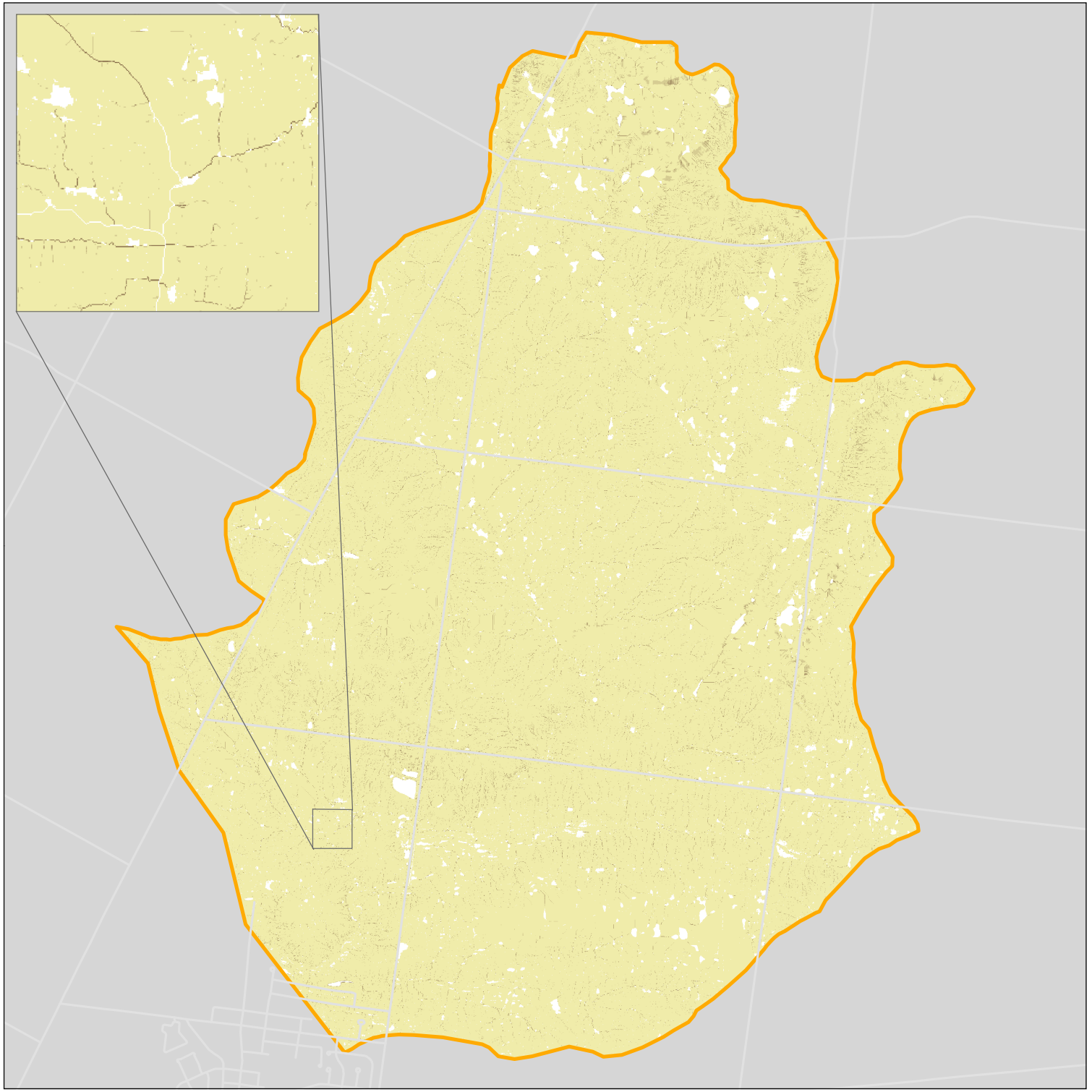

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 14: LS Factor (Slope)

Legend

LS Factor

- > 1500
- 1,000 - 1,500
- 500 - 1,000
- 100 - 500
- 20 - 100
- 15 - 20
- 10 - 15
- 5 - 10
- 1 - 5
- 0

N

Scale 1:37 500

0 0.5 1 Kilometres

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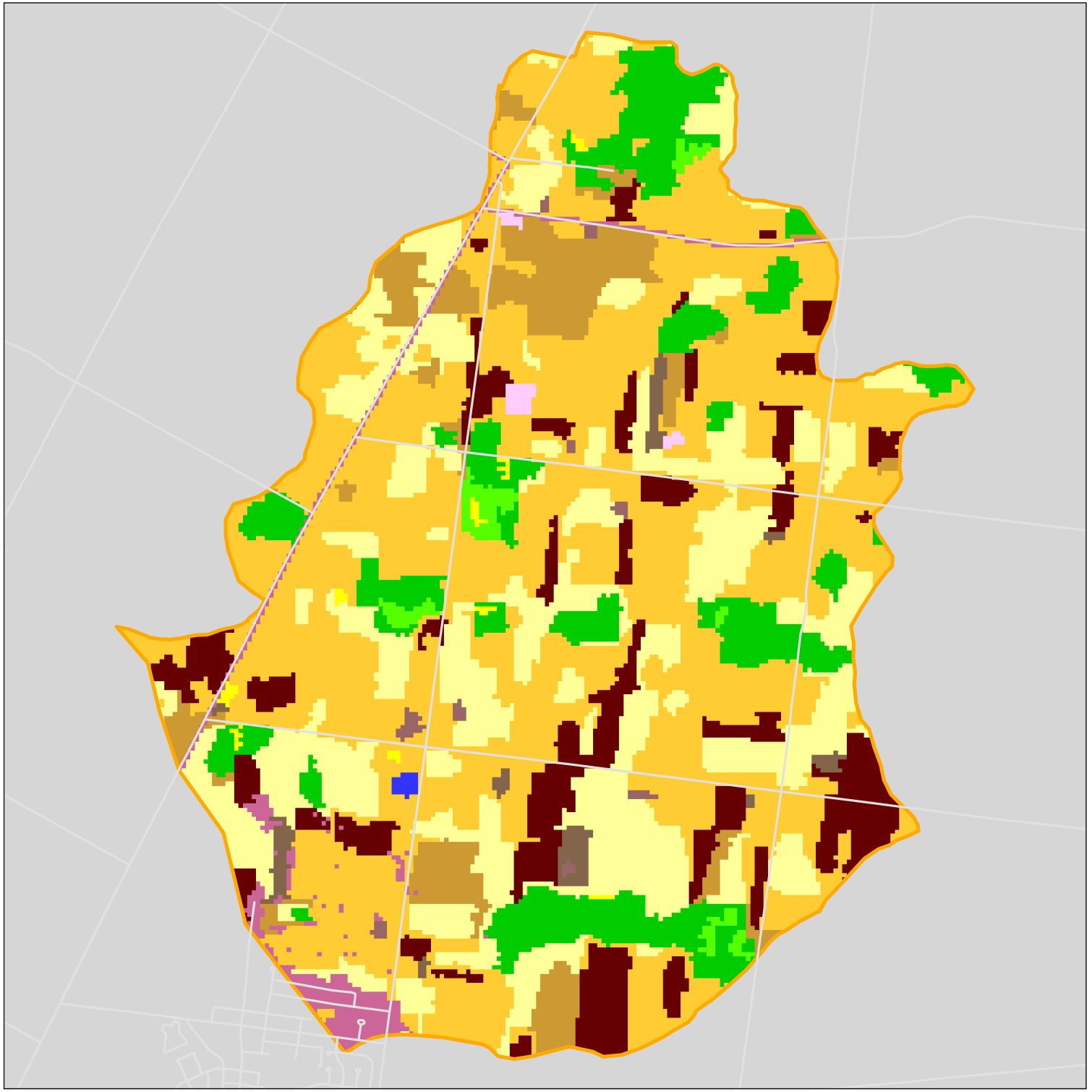

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 15: AAFC Crop Inventory

Legend

- Water
- Barren
- Urban
- Shrubland
- Forage Crops
- Cereals
- Corn
- Soybeans
- Beans
- Other Vegetables
- Broadleaf
- Mixedwood

N

Scale 1:37 500

Kilometres

0 0.5 1

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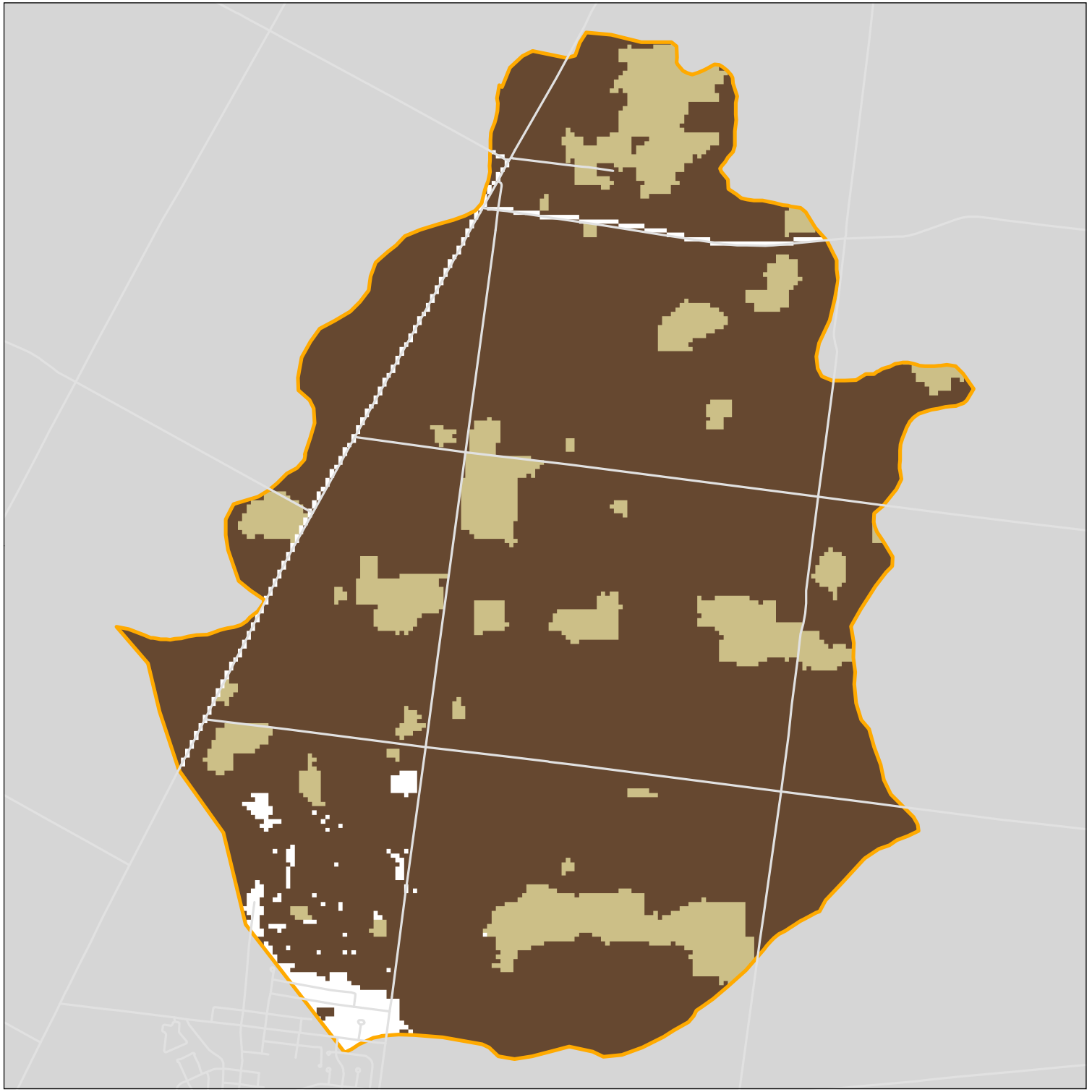

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 16: C Factor (Crop/Vegetation & Management)

Legend

C Factor

- 1
- 0.03
- 0

N

Scale 1:37 500

0 0.5 1 Kilometres

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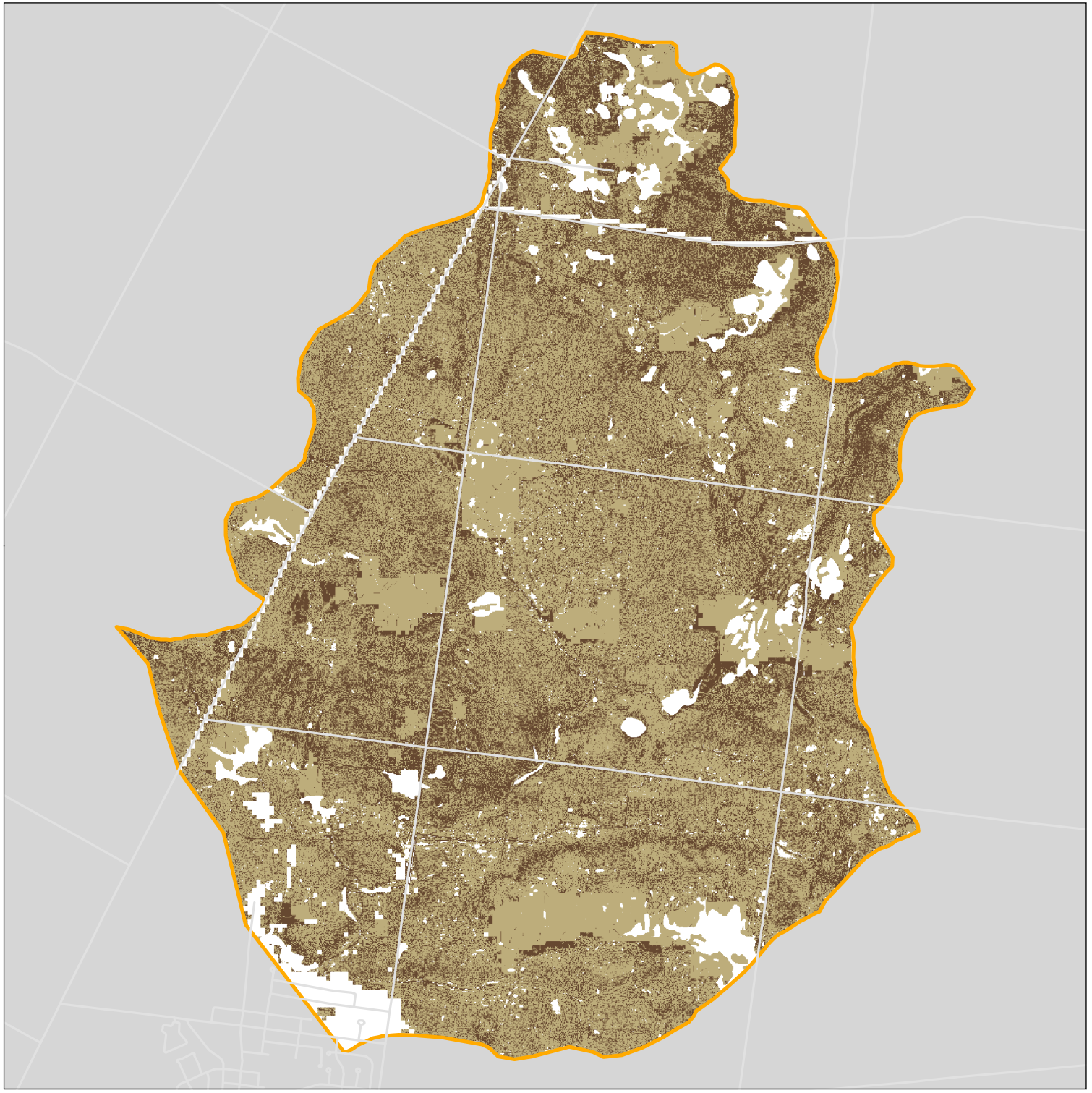

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 17: RUSLEFAC Potential Soil Loss

Legend

Potential Soil Loss (tonnes/ha/year)

- 0 - 0.001
- 0.001 - 11
- 11 - 22
- > 22

N

Scale 1:37 500

Kilometres

0 0.5 1

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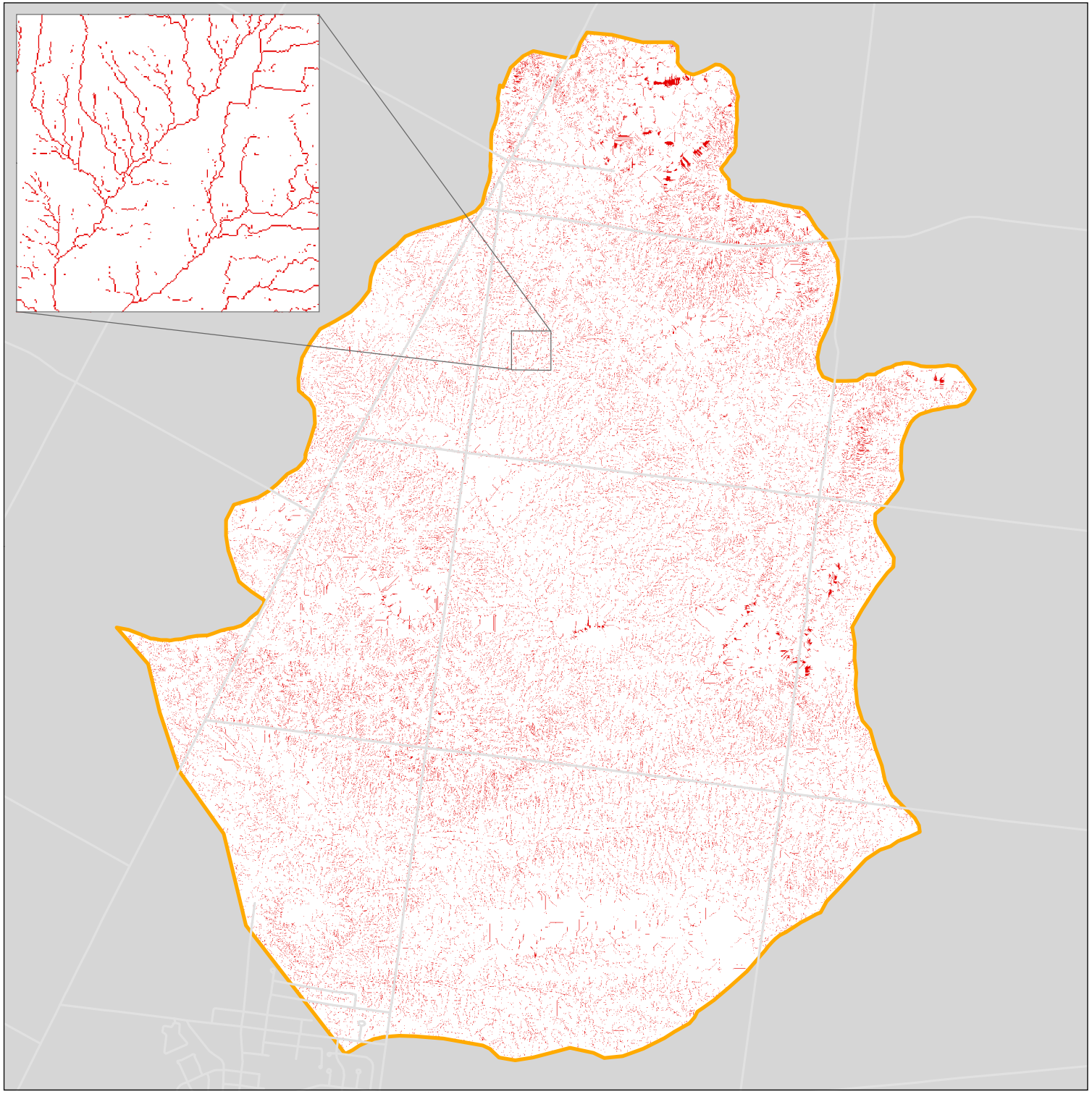

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SWI - Nutrient Source Area Mapping
Firella Creek Pilot Area

Figure 18:
Stream Power Index (SPI) 95th Percentile

Legend

95th percentile of SPI

N

Scale 1:37 500

Kilometres

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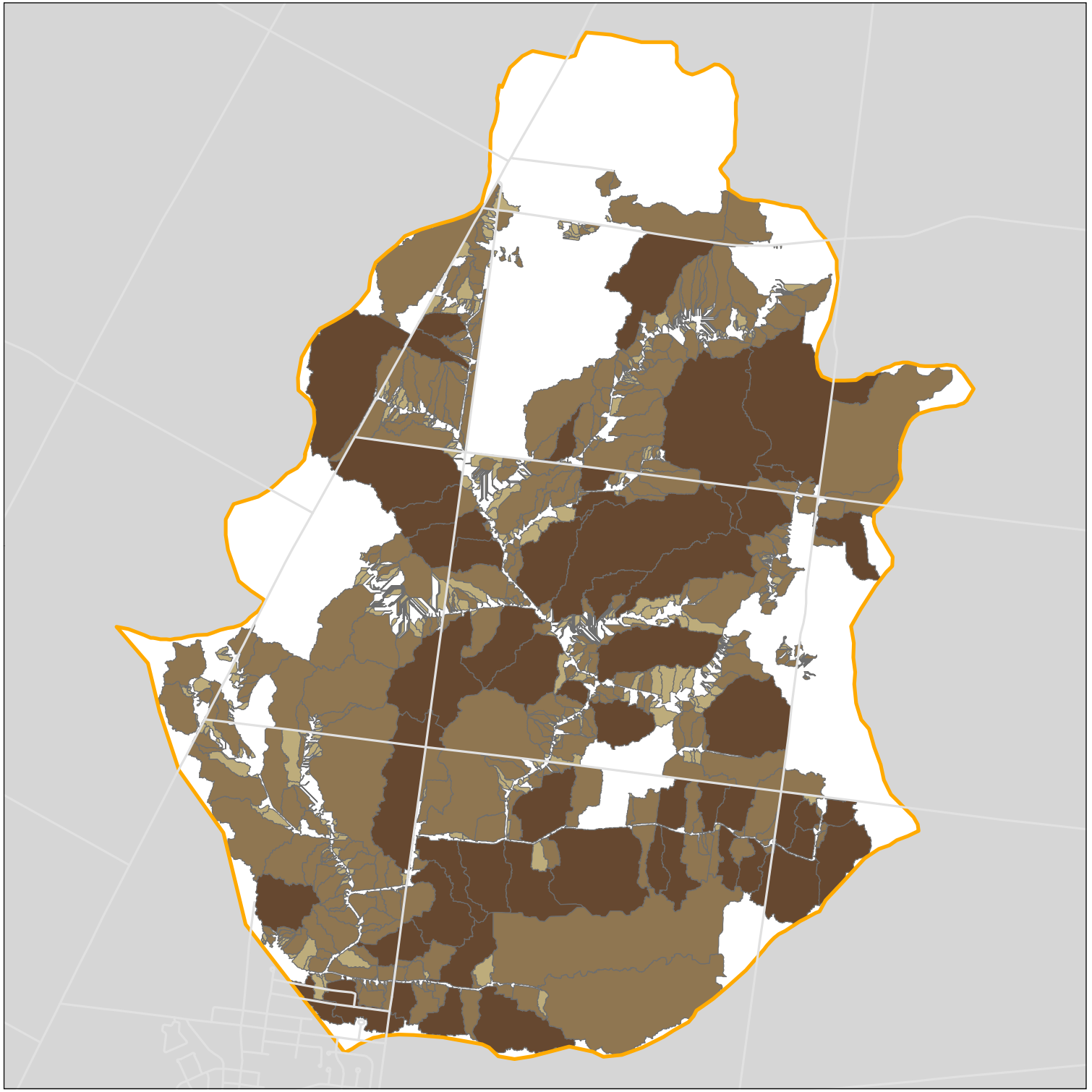

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Figure 19: Stream Power Index Priority Areas

Legend

SPI Priority Areas

- 9.0 - 12.3 (High)
- 5.6 - 9.0 (Medium)
- 2.2 - 5.6 (Low)

N

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Kilometres

0 0.5 1

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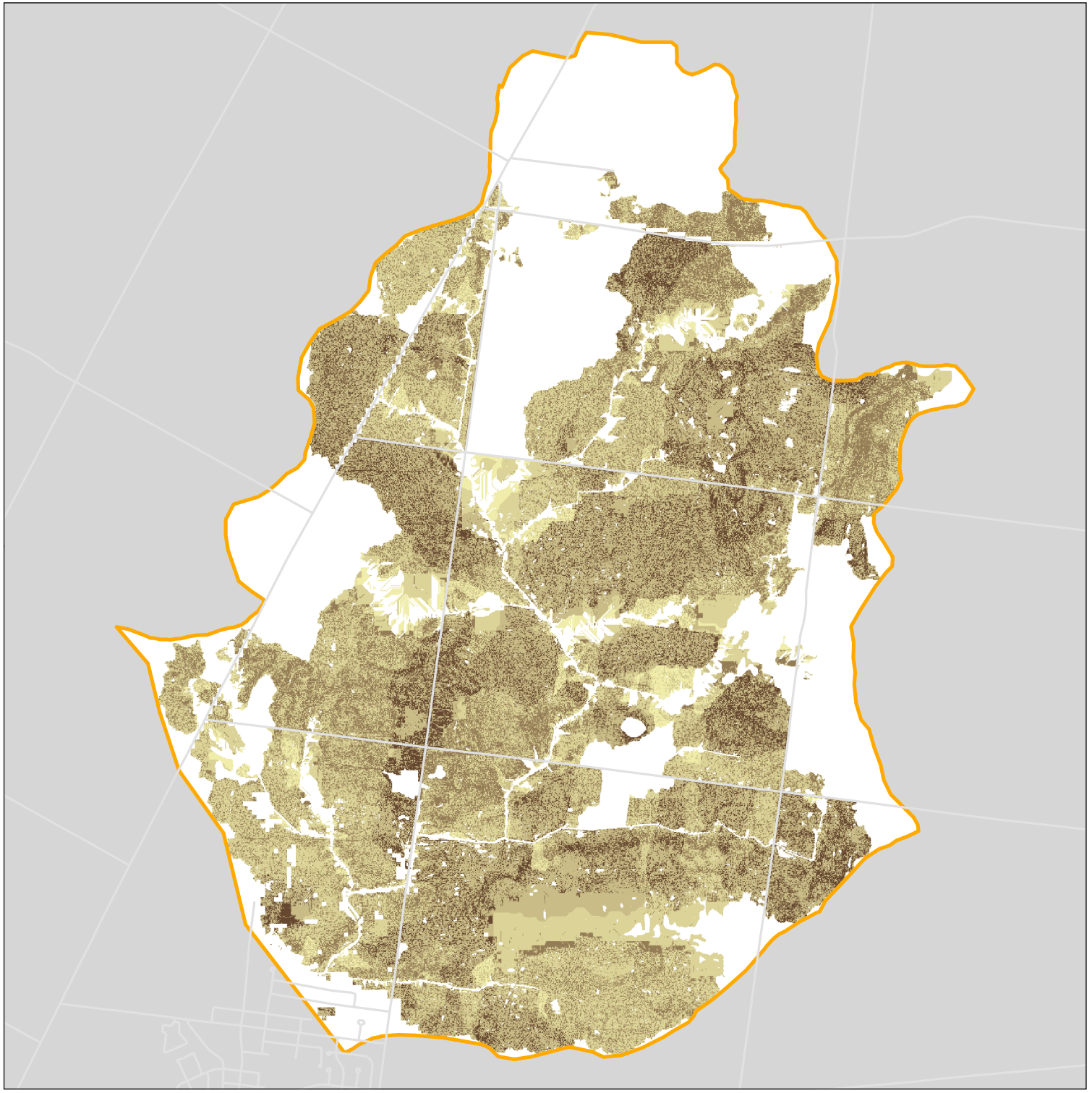

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 20: Combined RUSLEFAC & SPI Priority Area Soil Loss Potential

Legend

Combined RUSLEFAC & SPI Soil Loss Potential

High

Low

N

Scale 1:37 500

Kilometres

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SWI - Nutrient Source Area Mapping Firella Creek Pilot Area

Figure 21: High RUSLEFAC Values located within High SPI Priority Areas

Legend

- High RUSLEFAC within High SPI Priority Area
- High SPI Priority Area

N

Scale 1:37 500

Kilometres

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