

Assignment 5: Multi-criteria analysis – Site Suitability Analysis for a Small Wind Farm Report

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Introduction

Growing concern over the environmental cost of fossil fuel generation has increased pressure to expand renewable energy sources. Ontario already operates one of the cleanest electricity grids in North America, and new wind capacity offers a means of extending that advantage. The Government of Ontario is looking for locations for small-scale wind farm projects across rural Southwestern Ontario

This report identifies two suitable sites in Bruce County, in the West region of Southwestern Ontario. The county was selected for its exposure to Lake Huron and Georgian Bay, its predominantly rural and agricultural character, and the availability of current municipal open spatial data (see Appendix A).

Methods

Data were drawn from Bruce County's open spatial data portal (roads, civic address points, forest tracts, municipal boundaries), Ontario GeoHub (built-up areas, airports), and the Canadian Wind Atlas (modelled mean wind speed at 30 m). All layers were projected to NAD 83 UTM Zone 17N and processed at a 30 m cell size ensuring every input was spatially coincident before overlay.

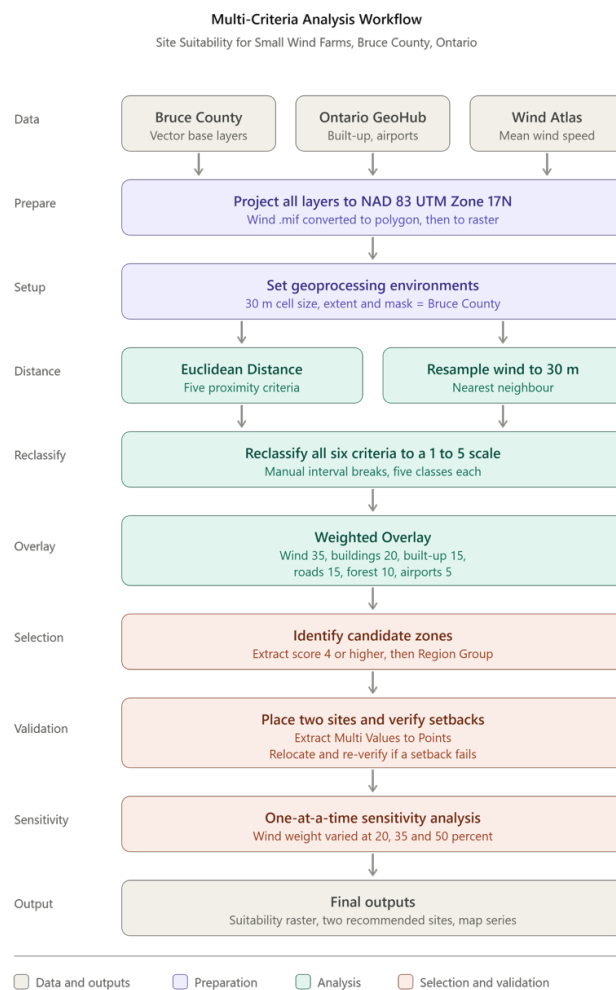


Figure 1. Overall multi-criteria analysis workflow.

Six criteria were assessed: wind speed potential, and distance from buildings, built-up land, roads, forest, and airports. Each criterion was scored on a 1 to 5 preference scale, as 1 means least preferable and 5 means most suitable conditions. Distance surfaces were generated for the five proximity criteria, and the wind layer was rasterised to the same grid, then all six were reclassified using the breaks in Figure 2. Roads is scored inversely to the other criteria, as proximity reduces construction and servicing cost (see Appendix B).

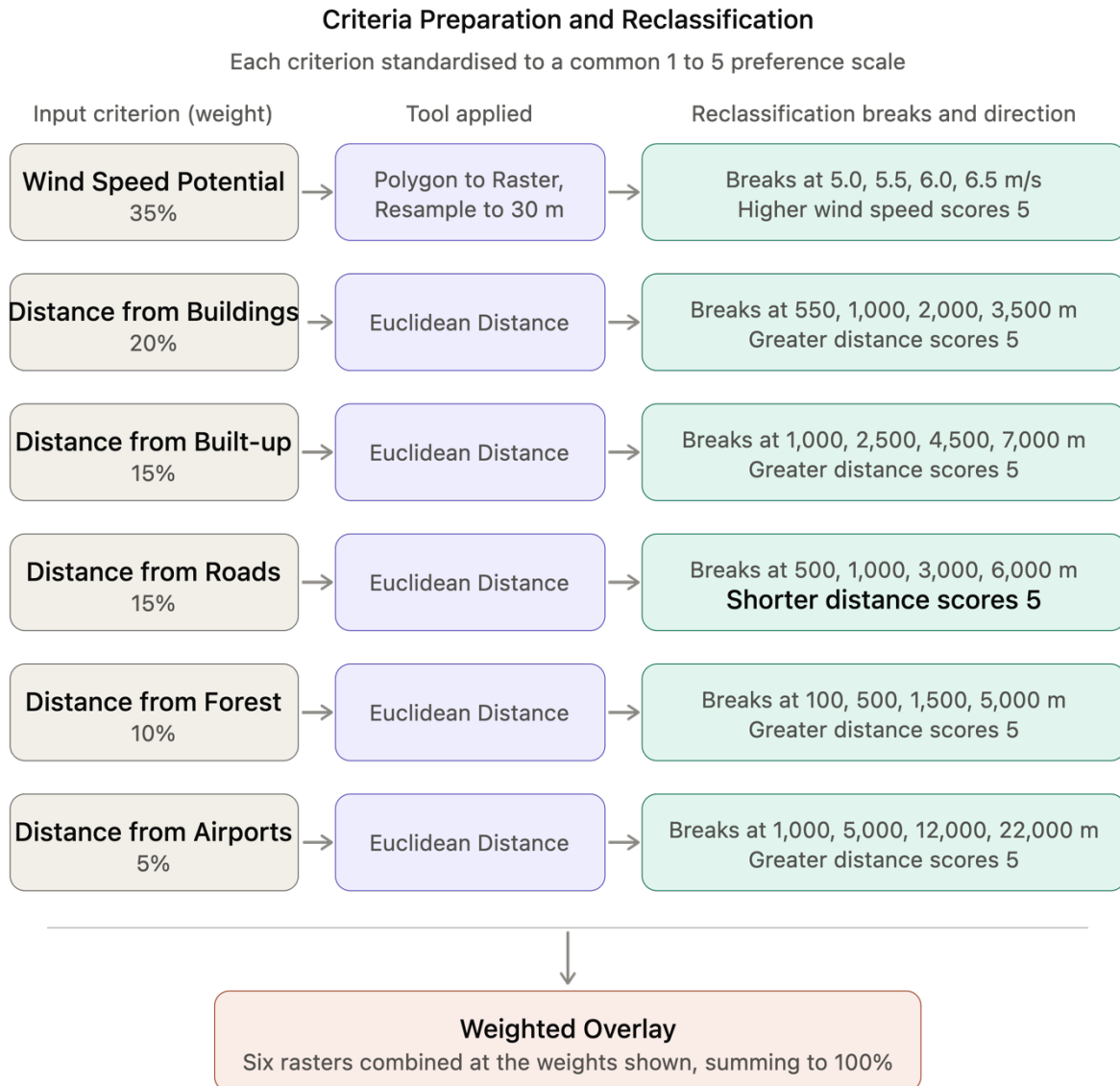


Figure 2. Reclassification breaks and scoring direction for each criterion.

Weights were derived from regulatory requirements and published GIS wind-siting literature. Published GIS wind-siting studies consistently rank wind resource as the highest-weighted criterion, reporting weights between 33% and 45% (Placide & Lollchund, 2024). Buildings received 20% as the only legally binding setback, with Ontario Regulation 359/09 requiring 550 m from the nearest noise receptor (O. Reg. 359/09). Airports received 5%, as the nearest recognised airport are up to 34 km from

most of the county, making the criterion effectively non-binding. An equal split across the five non-wind criteria was rejected, as it would weight a non-binding constraint identically to a mandated one.

Table 1. Criteria weights and justification.

Criterion	Weight	Justification
Wind speed potential	35%	Determines energy yield; ranked highest in published GIS wind-siting studies
Distance from buildings	20%	Only legally binding setback (O. Reg. 359/09, 550 m)
Distance from built-up land	15%	Concentrated receptors and planning conflict
Distance from roads	15%	Construction and servicing access, a direct cost driver
Avoid forest	10%	Land-use conflict and clearing cost
Distance from airports	5%	Non-binding across the study area
Total	100%	

Then, areas scoring 4 or higher were extracted and grouped into contiguous patches to assess by geometry as well as area, since elongated patches cannot accommodate the required footprint regardless of size. Each candidate site was verified independently against every setback rather than relying on its aggregate suitability score. In addition, varying the wind weight to 20% and 50% was tested, with the remaining criteria rescaled to total 100%.

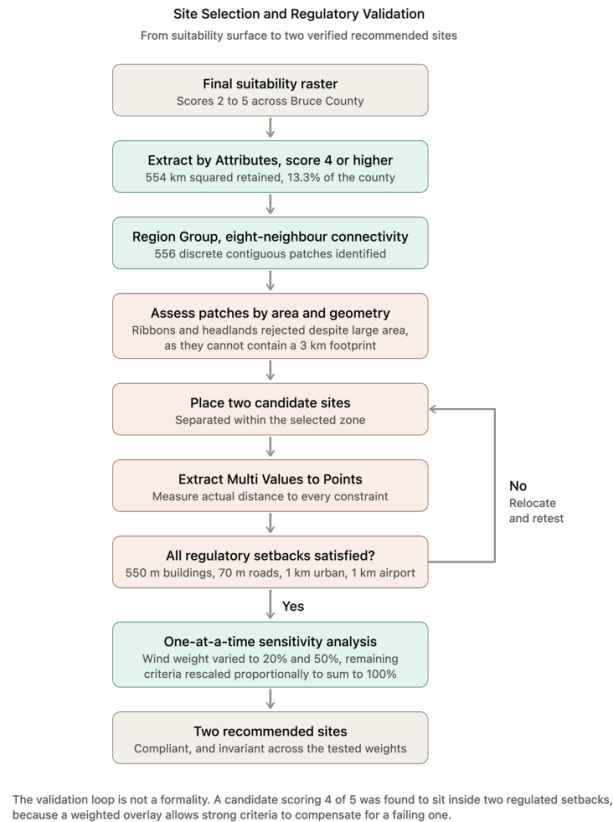


Figure 3. Site selection and validation sequence, including the relocation loop.

Results

The weighted overlay produced suitability scores ranging from 2 to 5 across Bruce County. High suitability (score 4) covers 554 km² (13.3% of the county), while 77.0% scored moderate (score 3) and 9.6% scored low (score 2). No land scored 1, indicating that the county contains no unsuitable area. Only 1.3 km² reached the highest class (score 5), an area smaller than a single wind farm footprint and too fragmented to host a project, so both recommended sites were selected from the high-suitability class.

Wind Farm Site Suitability, Bruce County

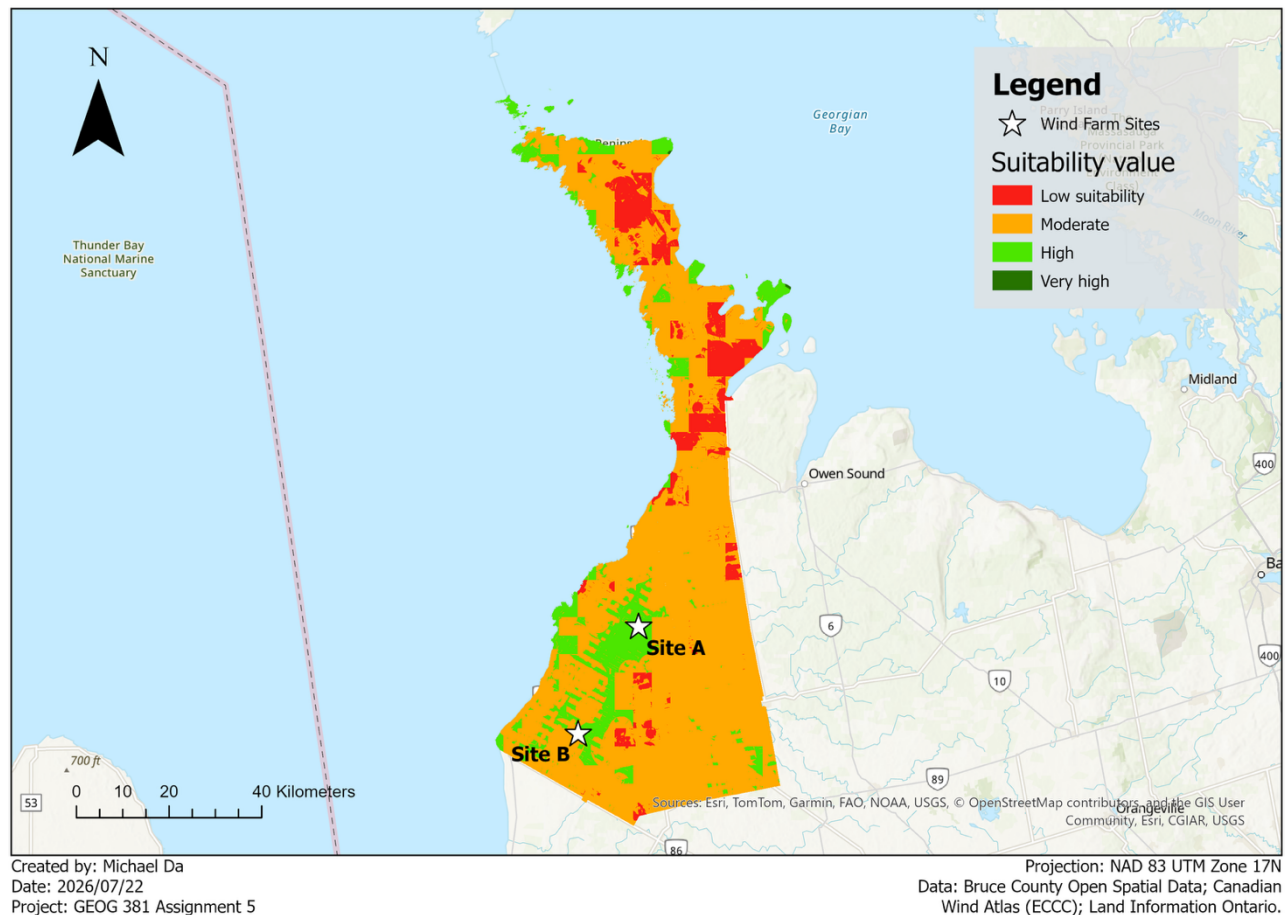


Figure 4. Final weighted overlay suitability raster with both recommended sites

Next, extracting land scoring 4 or above yielded 556 contiguous patches, of which one dominant zone of 240.5 km² in southern Bruce County contained a compact core suitable for development (see Appendix D). Two sites were placed within this zone, 28.07 km apart, giving two genuinely independent installations that share no noise receptors and would require separate access and grid connections. Measured clearances for both are given in Table 2 and the local context of each site is shown in Appendix E and F.

Table 2. Measured clearances at each recommended site against regulated minimums.

Constraint	Regulated minimum	Site A	Site B
Nearest dwelling	550 m	722 m	837 m
Nearest road	70 m	738 m	192 m
Nearest built-up boundary	1,000 m	7,347 m	3,505 m
Nearest forest tract	Not on forest	11,311 m	6,607 m
Nearest airport	1,000 m	23,324 m	12,649 m
Mean wind speed class	Above 4.17 m/s	4 of 5	4 of 5
Final suitability score	—	4 of 5	4 of 5

Turbine capacity was estimated using the assignment's 60 to 300 m inter-turbine spacing requirement. Both sites sit within Region 273, a contiguous high-suitability zone of 240.5 km², so available land is not the limiting factor at either location; the binding constraint is the definitional cap of fewer than five turbines within a 3 km area. Even at the maximum allowable spacing of 300 m, four turbines in a line require only 900 m, well inside the 3 km limit, so both sites can accommodate the full four-turbine complement without a layout conflict. At a typical onshore nameplate rating of 2 to 3 MW per turbine, this gives an indicative capacity of 8 to 12 MW at each site, or 16 to 24 MW combined across both projects.

Three factors determined the location of two recommended sites. First, wind resource differentiated between locations rather than eliminating any as the county-wide minimum mean wind speed of 4.452 m/s already exceeds the 4.17 m/s viability threshold, so wind identified the better sites rather than ruling areas out. Second, distance from buildings proved the binding constraint almost everywhere. Because settlement in Bruce County takes the form of dispersed farmsteads rather than concentrated rural buildings, most of the county lies within 550 m of an addressed structure, making those land suitable for wind farms. Clearances of 722 m (Site A) and 837 m (Site B) are therefore substantial rather than incidental. Third, patch geometry rather than patch area determined the final choice, as several large candidate zones proved to be narrow ribbons or headlands unable to contain a 3 km footprint despite their total size.

An initial placement for Site B illustrates why aggregate scores cannot be relied upon alone. That location scored 4 of 5 yet it is 212 m from the nearest dwelling and 42 m from the nearest road, inside two regulated minimums. Strong performance on wind, urban distance, forest, and airports had arithmetically offset a worst-case score on buildings. The site was relocated and re-verified. A weighted overlay therefore indicates relative preference; it does not certify regulatory compliance, and setbacks must be verified independently at any shortlisted location.

Discussion

To further test different weights, the overlay was re-run with the wind weight set to 20% and to 50%. County-wide suitability responded significantly across this range, with substantially more areas reaching the high class under the heavier wind weighting (see Appendix G). Both recommended sites nonetheless retained a score of 4 under all three weightings. Their stability is meaningful precisely

because so much else changed around them, indicating that neither site is an artifact of a particular weighting assumption.

Three limitations are presented for this project. First, the forest dataset covers only county-owned forest tracts and excludes private woodlots, so forested land is under-represented. Second, no protected-areas criterion was included, meaning the model scored parts of the Niagara Escarpment and Bruce Peninsula National Park as suitable; both recommended sites lie well south of these areas, but the omission would matter for any alternative site on the peninsula. Finally, no layer represented reserve lands or Indigenous interests, and Duty to Consult obligations under Ontario's Renewable Energy Approval process apply regardless of spatial suitability.

Subject to these investigations, both sites are recommended to advance to feasibility study. Each satisfies every regulated setback with margin, occupies land with confirmed wind resource, and retains its suitability across a realistic range of weighting assumptions.

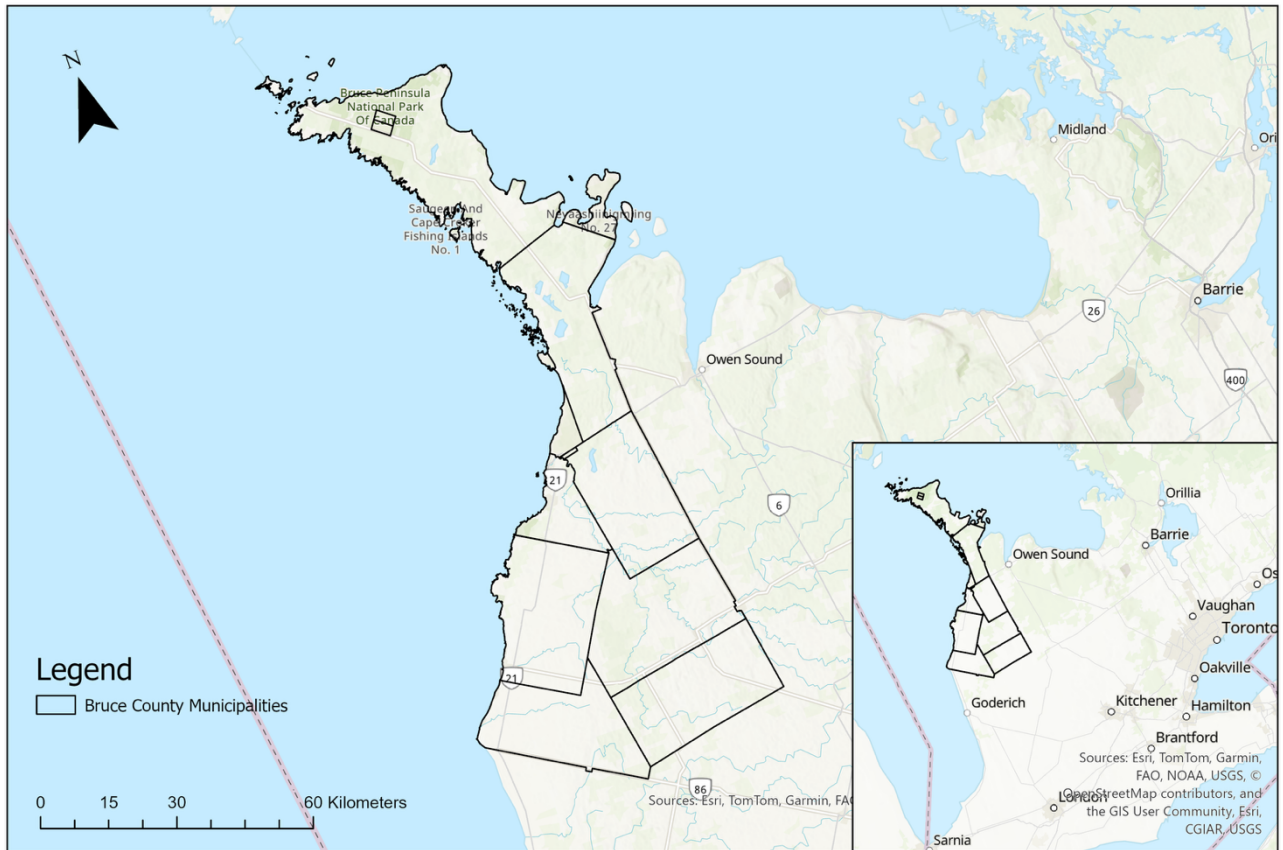
References

- Corporation of the County of Bruce. (n.d.). *Bruce County open spatial data* [Data set]. Retrieved July 22, 2026, from <https://gis.brucecounty.on.ca/pages/open-spatial-data>
- Environment and Climate Change Canada. (n.d.). *Canadian Wind Atlas* [Data set]. Retrieved July 22, 2026, from <https://windatlas.ca/maps-en.php>
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- Ontario Ministry of Natural Resources. (n.d.). *Built-up area* [Data set]. Ontario GeoHub. Retrieved July 22, 2026, from https://geohub.lio.gov.on.ca/datasets/56c19c8314b844adacdfb427c6e84b6b_35/explore?location=50.926000,-84.745000,4
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- Placide, G., & Lollchund, M. R. (2024). Wind farm site selection using GIS-based mathematical modeling and fuzzy logic tools: A case study of Burundi. *Frontiers in Energy Research*, 12, 1353388. <https://doi.org/10.3389/fenrg.2024.1353388>
- Renewable Energy Approvals under Part V.0.1 of the Act, O. Reg. 359/09. <https://www.ontario.ca/laws/regulation/090359>

Appendix

Appendix A. Study area: Bruce County in the West region of Southwestern Ontario.

Study Area: Bruce County, Southwestern Ontario



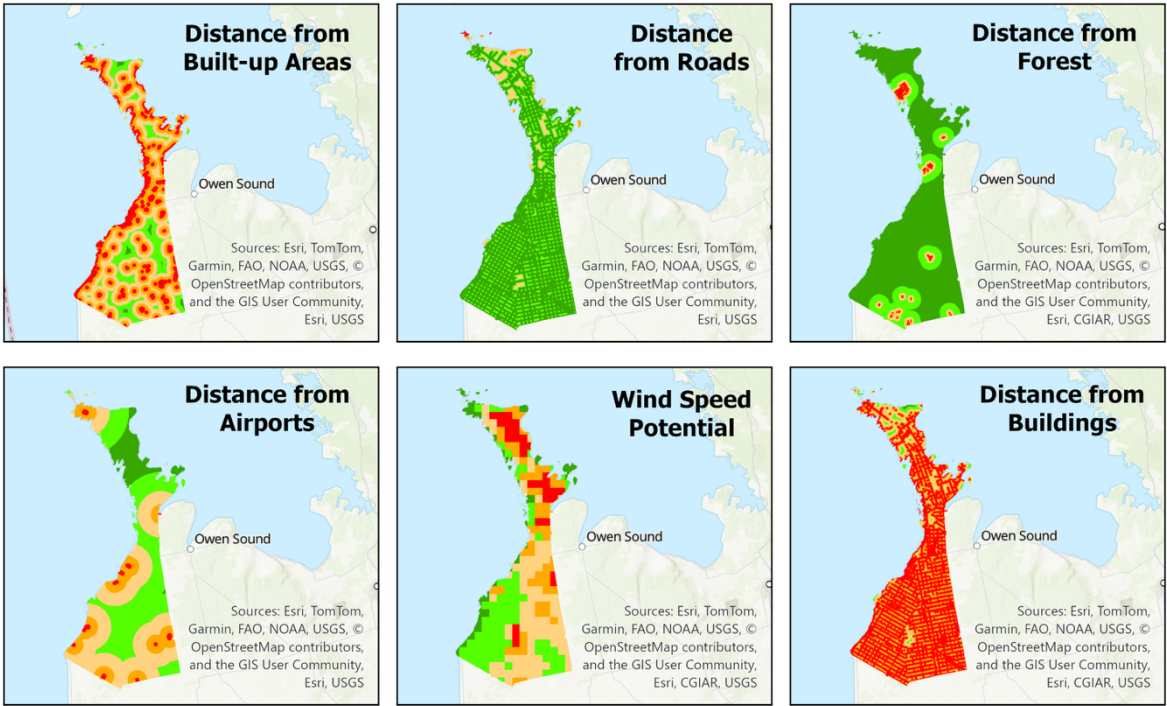
Created by: Michael Da
Date: 2026/07/22
Project: GEOG 381 Assignment 5

Projection: NAD 83 UTM Zone 17N
Data: Bruce County Open Spatial Data; Canadian
Wind Atlas (ECCC); Land Information Ontario.

Appendix B. Reclassified suitability criteria, each scored 1 (least suitable) to 5 (most suitable).

Reclassified Suitability Criteria

Each criterion scored 1 (least suitable) to 5 (most suitable)



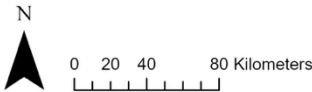
Suitability value

Least suitable Low

Moderate

High

Most suitable

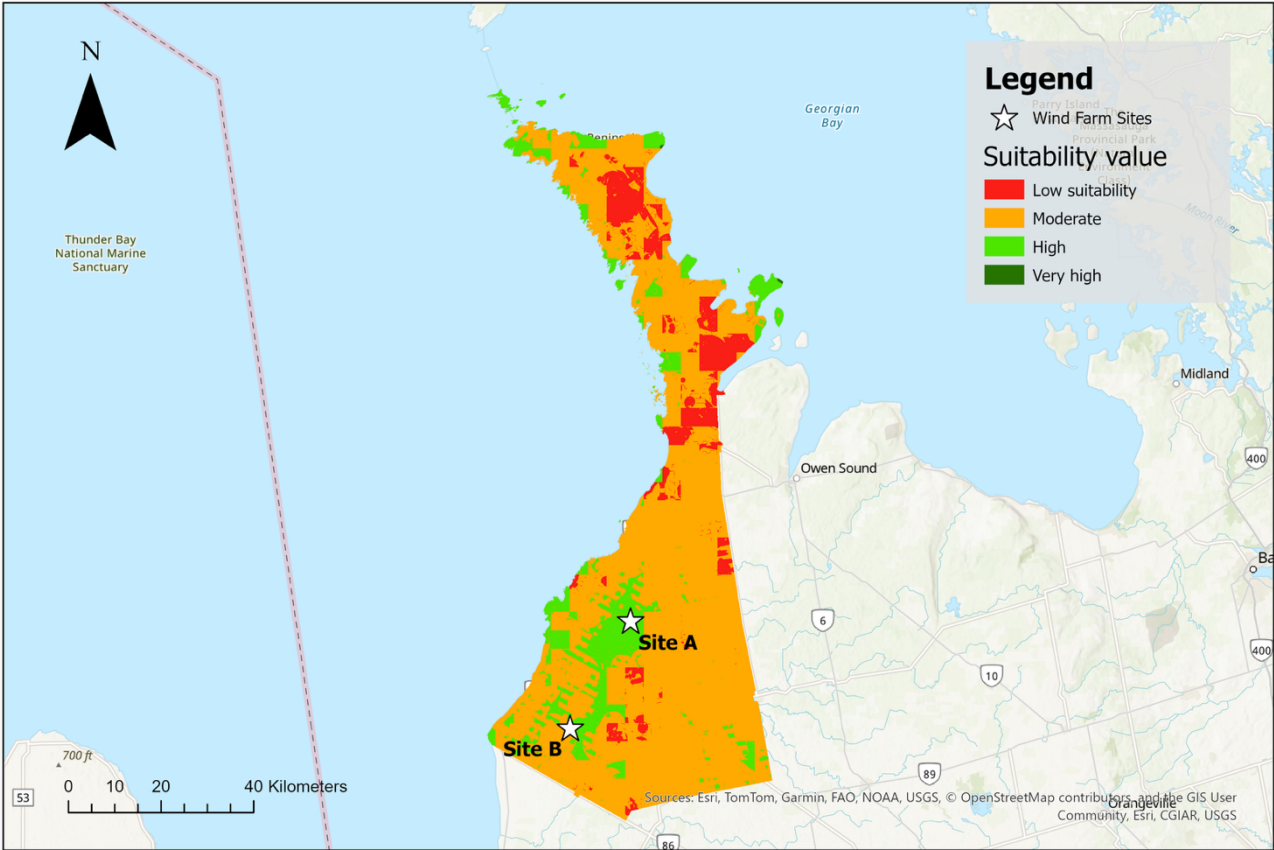


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Projection: NAD 83 UTM Zone 17N
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Appendix C. Final weighted overlay suitability raster with both recommended sites.

Wind Farm Site Suitability, Bruce County

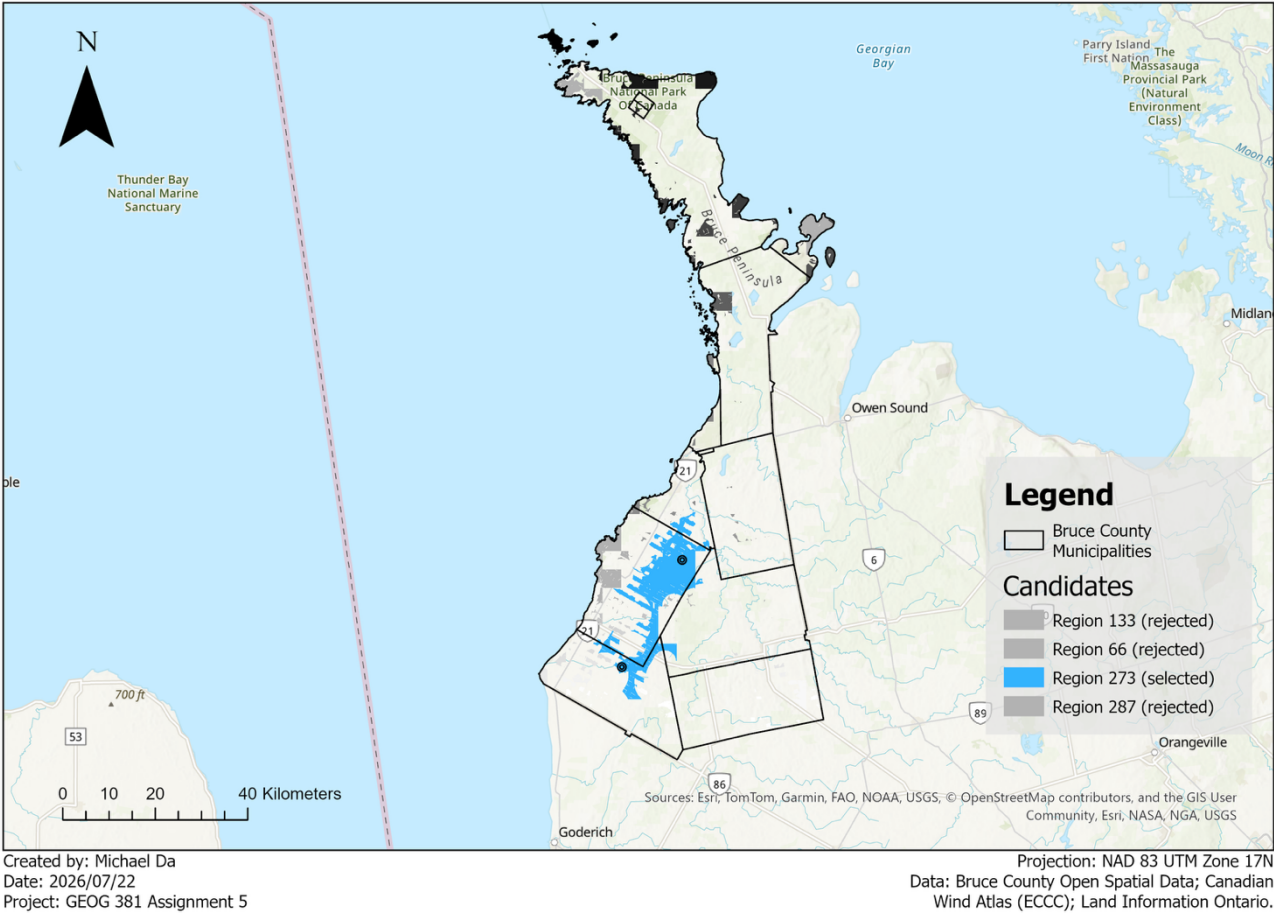


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Date: 2026/07/22
Project: GEOG 381 Assignment 5

Projection: NAD 83 UTM Zone 17N
Data: Bruce County Open Spatial Data; Canadian
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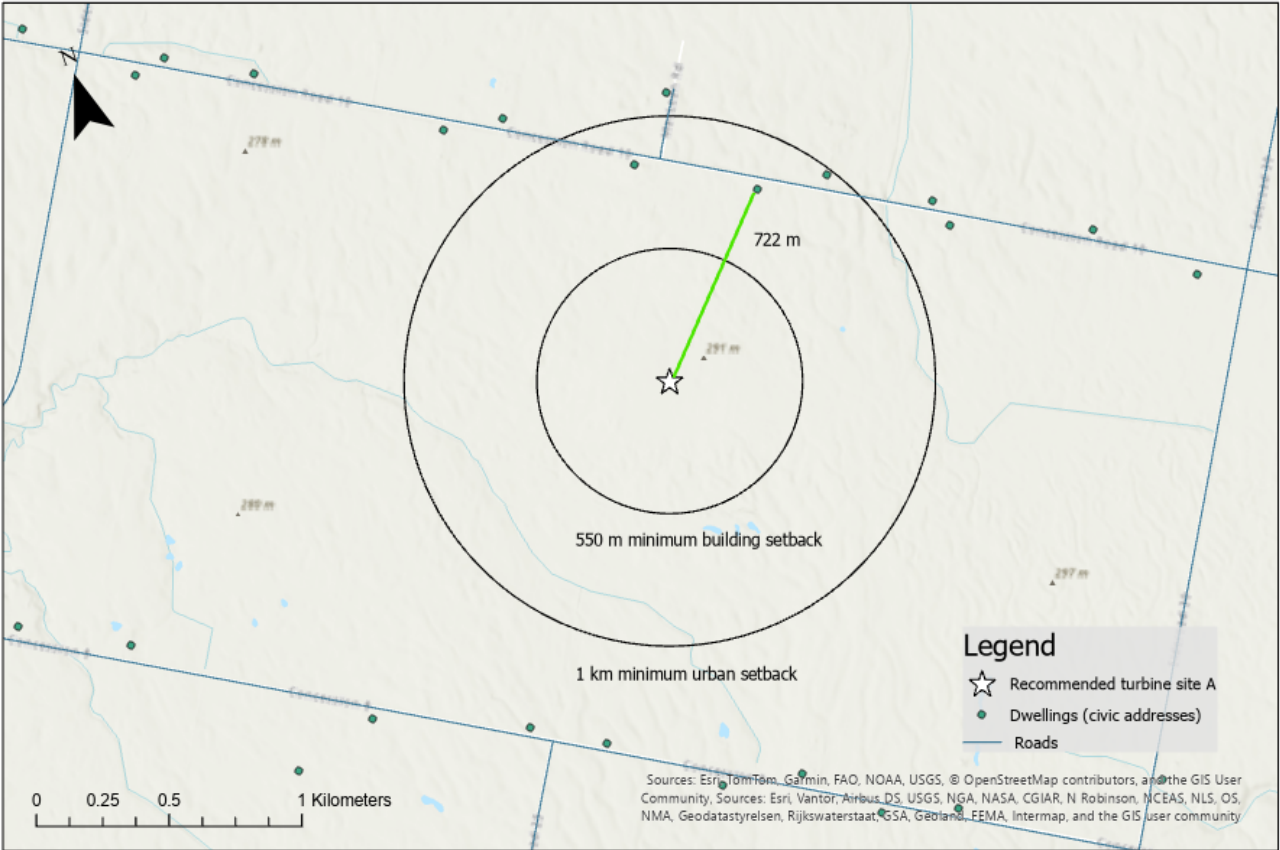
Appendix D. Contiguous high-suitability patches, with the selected zone and rejected candidates.

Candidate Suitability Zones



Appendix E. Site A: local context and clearance from dwellings, roads, and built-up areas.

Recommended Site A

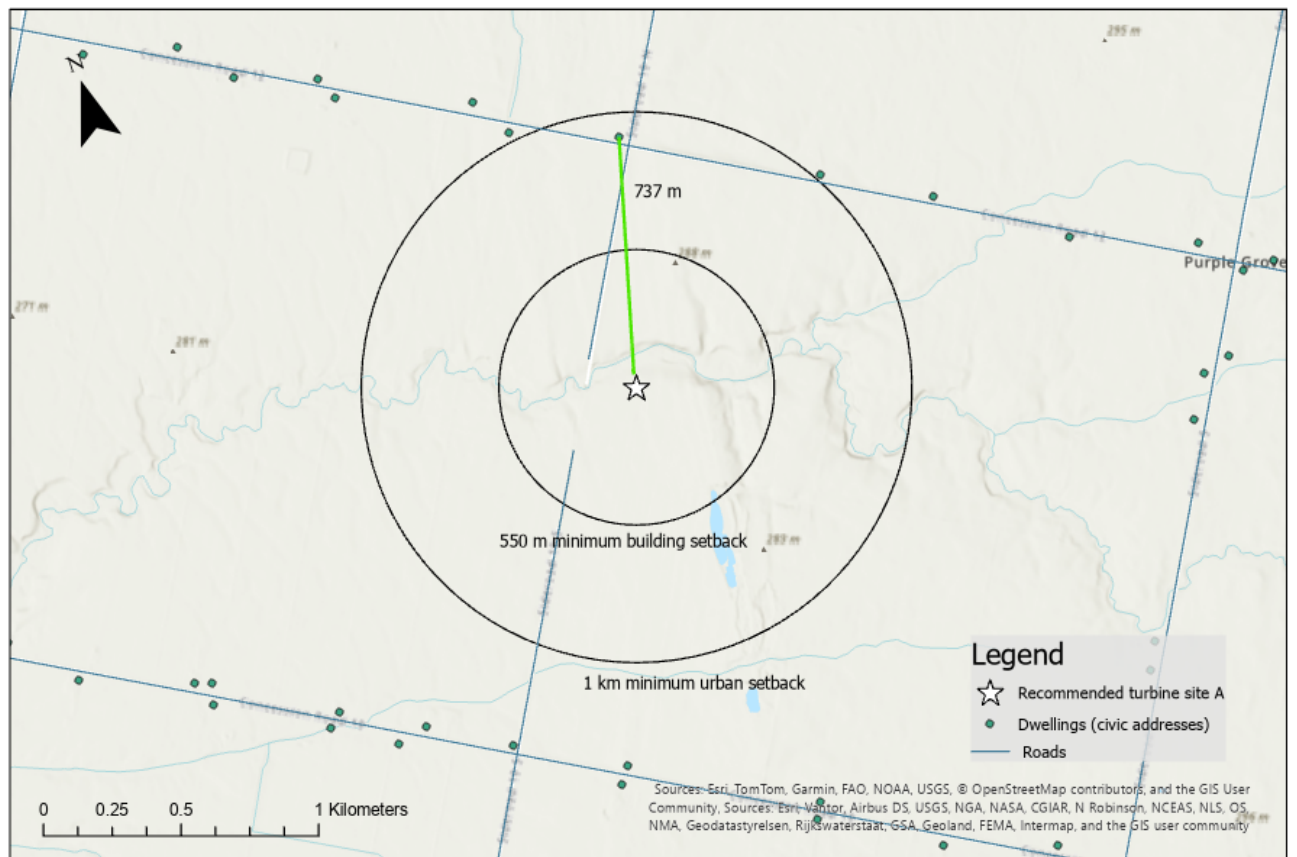


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Date: 2026/07/22
Project: GEOG 381 Assignment 5

Projection: NAD 83 UTM Zone 17N
Data: Bruce County Open Spatial Data; Canadian
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Appendix F. Site B: local context and clearance from dwellings, roads, and built-up areas.

Recommended Site B



Created by: Michael Da
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Project: GEOG 381 Assignment 5

Projection: NAD 83 UTM Zone 17N
Data: Bruce County Open Spatial Data; Canadian
Wind Atlas (ECCC); Land Information Ontario.

Appendix G. Suitability under wind weightings of 20%, 35%, and 50%, with both sites shown.

Sensitivity Analysis: Wind Speed Weighting

