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# Designing Variable-Width Filter Strips on Vermont Fields Using the AgBufferBuilder ArcGIS Tool

AgBufferBuilder 1.0 is a geographic information systems (GIS) tool that uses a satellite image and a digital elevation model (DEM) of a given field to design a grass filter strip that maximizes trapping efficiency of sediment or sediment-bound pollutants in field runoff. A free download of the tool and other supporting information is available at <https://www.fs.usda.gov/nac/tools/AgBufferBuilder.shtml>

Currently, the tool is only compatible with ArcGIS versions 10.0 and 10.1. Information regarding compatibility with newer versions of ArcGIS will be posted on the AgBufferBuilder website as it becomes available. While mastery of ArcMap is not necessary to use the tool successfully, a basic understanding of the software is recommended, and access to ArcGIS 10.0 or 10.1 is required. This document should be used in addition to the valuable resources available at the AgBufferBuilder [website](#).

Agriculture and conservation technical assistance providers in Vermont may find this document helpful when working with farmers to mitigate water quality impacts from field runoff. Our purpose is to provide examples of how the tool can be used to design grass filter strips and evaluate existing filter strips on agricultural fields in Vermont.



Photo: Michelle Graziosi

## Variable width buffers and filter strips

A vegetated filter strip is a best management practice that removes sediment or sediment-bound pollutants, such as phosphorous, from agricultural runoff before it leaves the field or enters a waterway. Typically, vegetation within a filter strip is composed of dense planting of mixed grasses (assumed within AgBufferBuilder). Regardless of whether or not a particular field is located nearby or adjacent to a waterway, such grassed filter strips are a simple and low-cost way to reduce sediment loss from a field and mitigate water quality impacts (Dosskey et al. 2015).

Given the evolving policies surrounding agricultural impacts on water quality in Vermont, there may be a unique opportunity for implementation of variable-width filter strips. Many factors impact the effectiveness of a filter strip or buffer, and considering a width that adjusts according to the terrain may provide better water quality benefits than a fixed width buffer (Dosskey et al. 2015). Contrary to the conventional practice of implementing a fixed-width buffer strip only along the edge of a field adjacent to a waterway, AgBufferBuilder indicates any areas in a field that would result in the greatest trapping efficiency of sediment or sediment-bound pollutant if left as unmanaged vegetation. Even when the general slope of a field indicates that runoff will be directed toward a specific field border, it is possible, even likely, that in-field topography results in runoff being concentrated and flowing through one or more distinct locations along the field border.

The AgBufferBuilder tool can help to identify those locations in the field. In addition to indicating where the best location for a filter strip might be, the results can also be used to determine where a buffer or filter strip should *not* be located. This can prevent inefficient expenditure of resources toward creating a filter strip with limited conservation benefit, and rather help to focus efforts on areas of the field where a filter strip would have the greatest impact. Such an approach is likely preferable to both the conservationist and the agricultural producer.

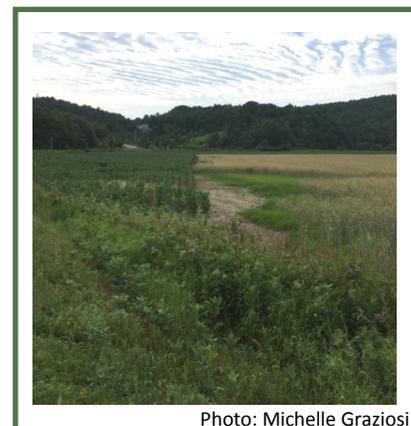


Photo: Michelle Graziosi

Though the output from the AgBufferBuilder tool is often irregularly shaped and pixelated, the designed buffer can serve as a starting point for a conservation professional or farmer who is exploring options for mitigating water quality impacts from field runoff. All results should be field-verified, confirming that identified areas do appear to be points of runoff based on field topography.

## Examples

Any field for which a satellite image and DEM can be acquired can be analyzed using the AgBufferBuilder tool. The data resources mentioned in the AgBufferBuilder user guide are reliable sources of 3-meter and 10-meter DEM data for most locations. For fields in Vermont, higher resolution data can be found at the Vermont Center for Geographic Information website: <http://vcgi.vermont.gov>.

In the following examples filter strips are designed on three different agricultural fields in Vermont under different tillage conditions, and using DEM data having different resolutions. These are just a few examples of the types of results and insights that can be provided through AgBufferBuilder. For all three fields, the soil is fine-textured (Class 0) and the filter strip is designed to trap 75% of sediment that enters it from the field during a large rainstorm (2.4 inches in 1 hour) (Dosskey et al. 2015). The tool inputs can also be adjusted to design for a smaller storm event using the procedure described in Dosskey et al. (2015). The trapping of sediment-bound pollutants such as phosphorous can be modelled in the same way that the trapping of sediment is modelled. In general, the filter strip design will be similar to the design for trapping sediment, but because pollutants attach to finer sediment particles that remain suspended for a longer period of time the

## Field 1

Field 1 was analyzed using DEMs with two different resolutions and the two different tillage practices in order to determine how DEM resolution and tillage practice selection impacts the filter strip needed to obtain the desired trapping efficiency of 75%.

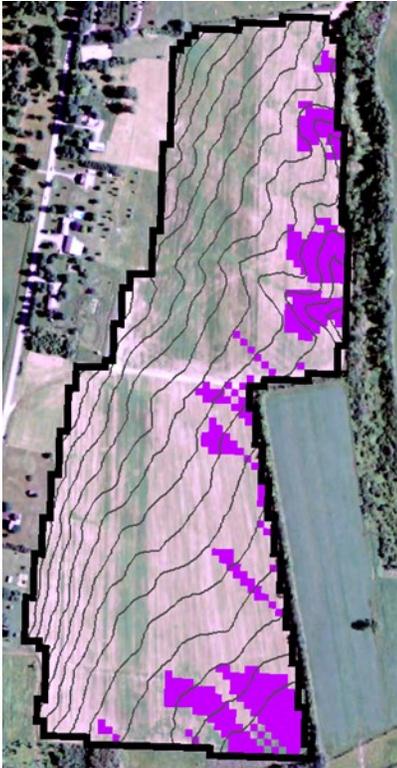


Figure 1a: Output for Field 1 under plow tillage, 1.6-meter DEM

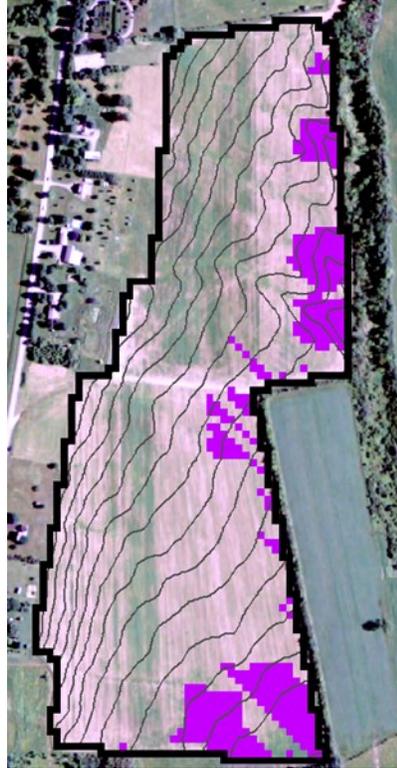


Figure 1b: Output for Field 1 under plow tillage, 10-meter DEM

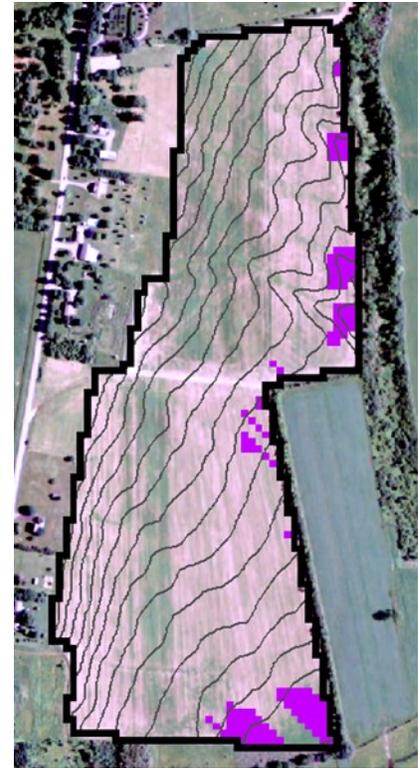


Figure 1c: Output for Field 1 under no-till, 10-meter DEM

Table 1. Summarized results for Field 1 examples

Figure	DEM Resolution	Tillage Practice	Total Field Area (ac)	Buffer Design Area (ac)	Percentage of Field
1a	1.6-meter	Plow tillage after corn or chisel after soybeans	61.8	7.8	12.6%
1b	10-meter	Plow tillage after corn or chisel after soybeans	61.8	8.0	13.0%
1c	10-meter	No-till or chisel after corn leaving good residue cover	61.8	3.2	5.2%

Figure 1a depicts the output after running the AgBufferBuilder tool on Field 1 using a high-resolution 1.6-meter DEM. This DEM was obtained through the Vermont Center for Geographic Information, but this resolution is not available for all fields in the state. The 10-meter DEM that was used to produce the output shown in Figure 1b was obtained from the USDA (U.S. Department of Agriculture)-NRCS (Natural Resources Conservation Service) Geospatial Data Gateway at <https://gdg.sc.egov.usda.gov>. Data with this resolution is widely available. In these two examples, the conditions under which the tool was run were exactly the same, the DEM resolution was the only difference. The images and data table show that using the 1.6-meter DEM vs. the 10 meter DEM does not have a significant impact on the output filter strip size or location. This may vary for other fields, but in this case, the difference in total filter strip area and percentage of field in Fig. 1a and Fig. 1b is negligible.

If planning a filter strip on this particular field, the shapes given in the AgBufferBuilder output may not be a feasible pattern to follow. However, the areas where the buffer is concentrated in large chunks might be a good place to create a vegetated filter strip or buffer. The small difference in shape and total buffer area observed between the two DEMs likely wouldn't have any implications in interpreting and applying the results on a field.

Tillage practice, however, does appear to have a significant impact on the buffer output. The output under no-till, shown in Figure 1c, had a total area of less than half of the size of the previously proposed filter strip area under conventional tillage. This trend was observed in all three sets of examples, and demonstrated the significant impact that tillage practice and field management can have on managing agricultural runoff. This is because as the magnitude of the pollutant load in runoff from the field decreases, the efficiency of the filter strip for trapping sediments (i.e., percent of load trapped) increases – a double benefit for reducing sediment and associated pollutants in waterways.



Grass filter strip along the edge of a grain crop field in Richmond, Vermont. Photo: Michelle Graziosi

## Field 2

Field 2 is significantly smaller in total area than Field 1, but is located adjacent to a much larger waterway. Conventionally, a filter strip would be placed in the area of the field bordering the waterway, indicated by the orange polygon in Figures 2a and 2b and referred to as “Buffer Assessment” in Table 2 and within the Ag-BufferBuilder attribute table. A fixed-width filter strip adjacent to a waterway, or a riparian buffer, is meant to trap sediment and sediment-bound pollutants before they get to the waterway. However, there may be other ditches or drainages on a given field where much of the runoff leaves the field, and if vegetated, could yield additional sediment retention. A particular strength of the AgBufferBuilder tool is its ability to find areas such as these on a given field that may otherwise be overlooked when planning the location of a vegetated filter strip.



Figure 2a: Output for Field 2 under plow tillage



Figure 2b: Output for Field 2 under no-till

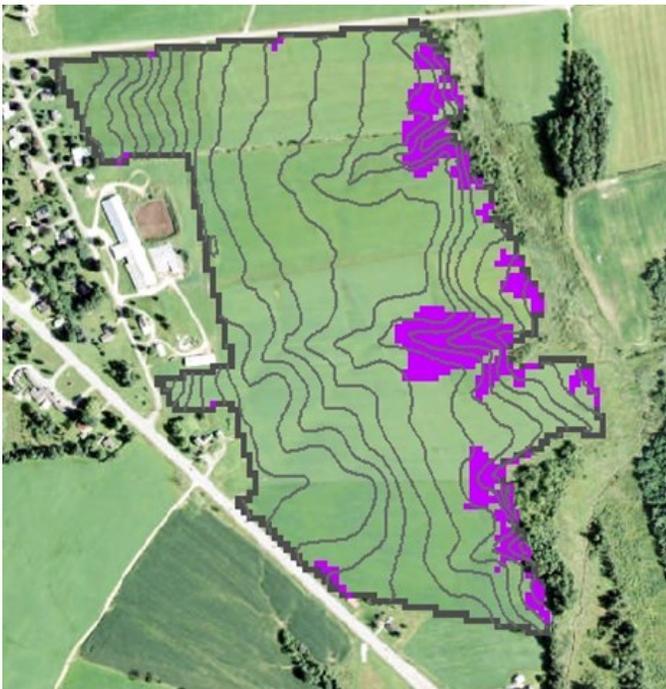
Table 2. Summarized results for Field 2 examples

Figure	DEM Resolution	Management Practice	Total Field Area	Buffer Assessment Area (ac) (Orange)	Buffer Design Area (ac) (Pink)	Percentage of Field
2a	10-meter	Plow tillage after corn or chisel after soybeans	13.2	1.7	0.7	5.2%
2b	10-meter	No-till or chisel after corn leaving good residue cover	13.2	1.7	0.2	1.5%

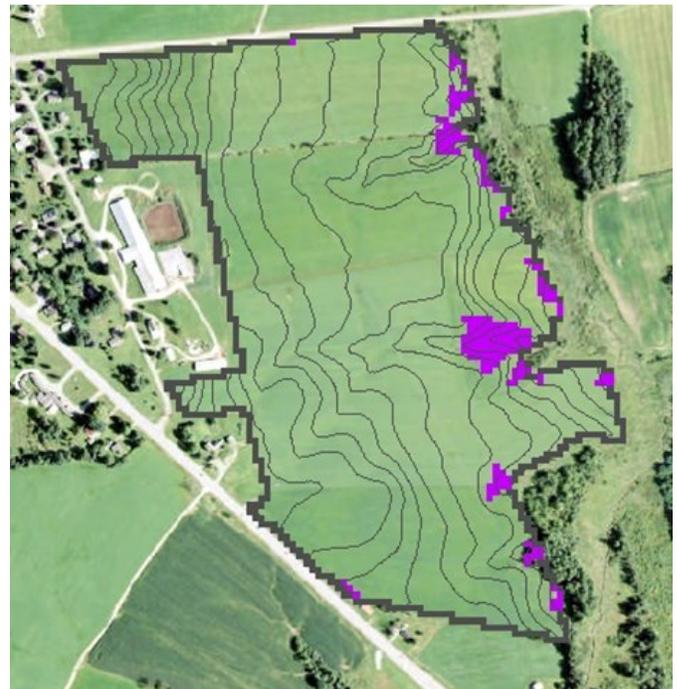
In addition to demonstrating that filter strips can be beneficial beyond the riparian area of a field, this example also highlights the difference that field management practices make on the area of filter strip needed to achieve maximum sediment retention. Changing from plow tillage to no-till decreased the percentage of field area needed to retain the same percentage of sediment load from 5.2% to 1.5% by reducing the water and sediment runoff load from the field, which increases the efficiency by which filter strips trap the sediment. While the buffer assessment area (orange) only slightly intersects with the buffer design area and may not have significant sediment trapping potential, unmanaged vegetation or a woody riparian buffer in this area would provide other conservation benefits, such as streambank stabilization and wildlife habitat.

### **Field 3**

The smaller buffer area required under no-till (as compared to plow tillage) is seen even more clearly in Field 3, which has a much larger area. Under this practice, the area of the filter strip needed to achieve 75% sediment retention decreases from 9.8 acres to 3.5 acres, a reduction of 6.3 acres. This is a significant area which can remain in crop production. If the goal is to designate the smallest possible area of the field as a filter strip, then focusing on tillage and other soil management practices can make a big difference.



**Figure 3a: Output for Field 3 under plow tillage**



**Figure 3b: Output for Field 3 under no-till**

**Table 3. Summarized results for Field 3 examples**

<b>Figure</b>	<b>DEM Resolution</b>	<b>Management Practice</b>	<b>Total Field Area (ac)</b>	<b>Buffer Design Area (ac)</b>	<b>Percentage of Field</b>
3a	10-meter	Plow tillage after corn or chisel after soybeans	94.4	9.8	10.3%
3b	10-meter	No-till or chisel after corn leaving good residue cover	94.4	3.5	3.7%

## Summary

Each of these examples show how the AgBufferBuilder tool can provide important insight into creating filter strips in areas of the field where they would provide the greatest water quality benefit. Sediment- and pollutant-containing runoff leaves a field whether it is adjacent to a waterway or not, and vegetated filter strips can help to minimize its impact. Each field has his own unique management, terrain and soil conditions, and all of this should be considered when designing filter strips. The AgBufferBuilder tool suggests a new and innovative way for farms and conservationists to think about and manage runoff, and provides an exciting opportunity to maximize the benefits of filter strips.

## Acknowledgements

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## References

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