

Memo

To:	Stephen Chiles	Job No:	1014982
From:	John Carter	Date:	3 May 2021
cc:	Greg Haldane, Jovanna Leonardo		
Subject:	GIS advice on smoothing of noise contours around the state highway network		

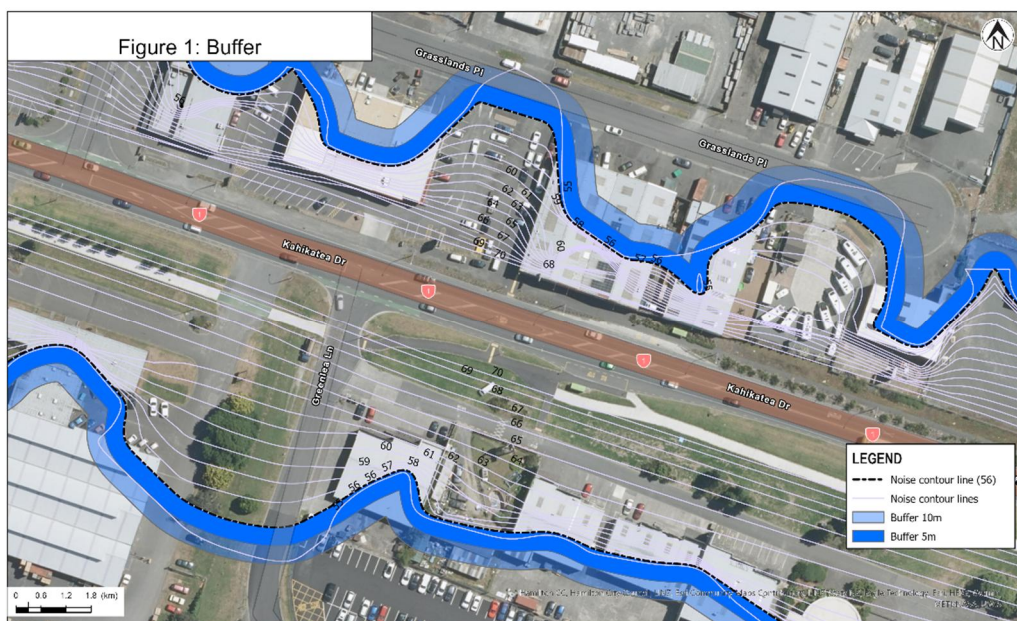
I am writing this memo to provide GIS advice on smoothing of noise contours around the state highway network, as you requested in our meeting on the 15th of April.

There are three main smoothing techniques that could be used to assist your work with Waka Kotahi, in refining rules for acoustic treatment of additions to existing houses or new houses being built near existing state highways. The three most relevant techniques are.

1. Buffer;
2. Simplify; and
3. Smooth.

Buffer

Buffering allows you to set the distance and the side of the line you want to create the buffer around. This is demonstrated in Figure 1 below. The buffer distance in metres can easily be modified based and depending on the distance used, the Figure shows how some of the smaller bends in the noise contour line (the dotted black line) are smoothed by the 5 metre (dark blue) and more so by the 10 metre (light blue) buffers.



Pros:

With buffering you will still keep the general shape of the line and have a consistent distance along the entire contour. This can be easily built into models and automated for the entire country.

Cons:

The negatives of this techniques are you still get some unwanted bends/curves, despite an overall more consistent line. The result of a buffer is an area (polygon), so there are two small steps to convert the polygon into a line, then erase the original line to give one new contour line. The other downside is you push the line out (i.e. needlessly increasing the extent of the contour) in a large proportion of areas where it is already smooth, unlike the smoothing and simplifying methods detailed later in this memo. This can be negated relatively simply by offsetting the line back by buffering the results by the same amount as the original buffer but back towards the original line.

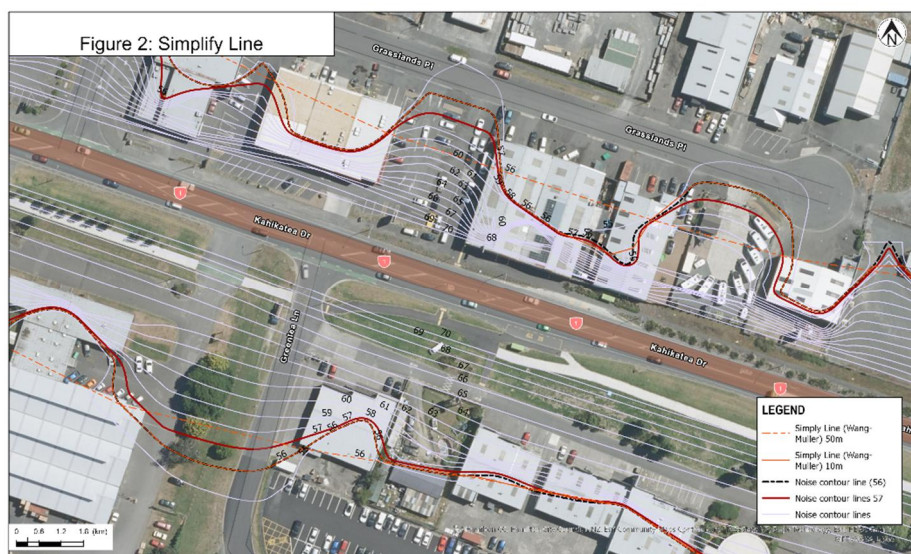
Overall, this is a viable option for your needs, but the main issue would be deciding on the appropriate distance to buffer. Buffering could be used in conjunction with the other methods to provide both a smooth and conservative contour line from the raw modelling results.

As discussed in our meeting, this can be done in ArcGIS, FME and QGIS, but I would only recommend ArcGIS or FME for this task and to allow for integration with automation/existing models. More detail is available from ArcGIS provider ESRI: <https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/buffer.htm>.

Simplify Line

Simplify Line simplifies a line by removing points along the line and therefore unwanted bends/curves, while preserving its shape (depending on the degree of simplification set known as *the tolerance*).

There are four available methods, when using ArcGIS Pro, the two most viable for this task are 'Wang-Muller' which retains critical bends and 'Zhou-Jones' which retains the weighted-effective areas. I have included the 'Wang-Muller' method on the 56 dB contour in Figure 2 below, with tolerance set at 10 metres and 50 metres.



The Zhou-Jones method needs lower tolerance set in general, as the results of the simplify tool can vary quite a lot from the original line.

Simplify Line with a Barrier

Simplify Line includes an option of having a barrier, which is another layer or feature can be used to prevent the main simplify line touching or crossing the barrier.

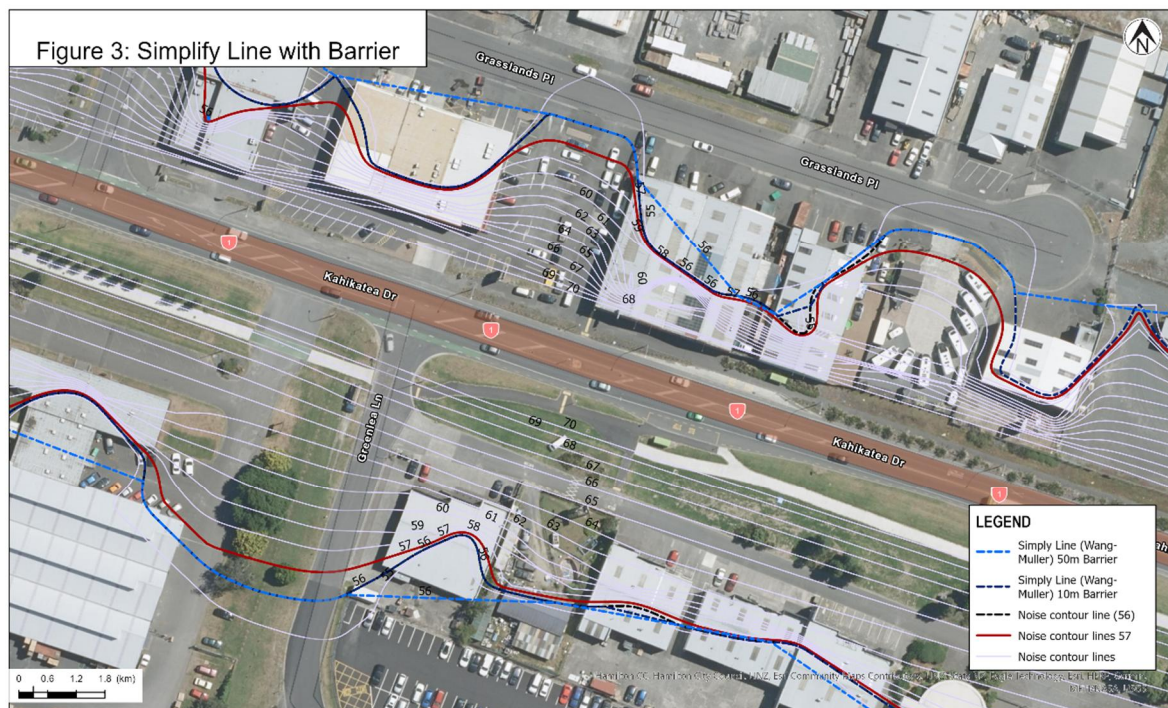


Figure 3 shows how this can be used. The Red line is the decibel (dB) 57 contour, it is included in the method as a barrier, to prevent the simplify line from the 56 dB contour line going across the 57 dB contour. The light Blue line has a tolerance of 50 metres and the dark blue line only has 10 metres tolerance. This should prove very useful when it comes to proving a planning line from noise contours.

Pros:

With simplifying you can set a tolerance to keep very true to the original contour line or really simplify it by setting a higher tolerance to cut out unwanted bends. The barrier should enable more sensible results by preventing modelled results of higher noise to be cut off by smoothing. You will keep the general shape of the line and where the line is already smooth or at least simply the line will match the modelled raw output. This can be easily built into models and automated for the entire country.

Cons

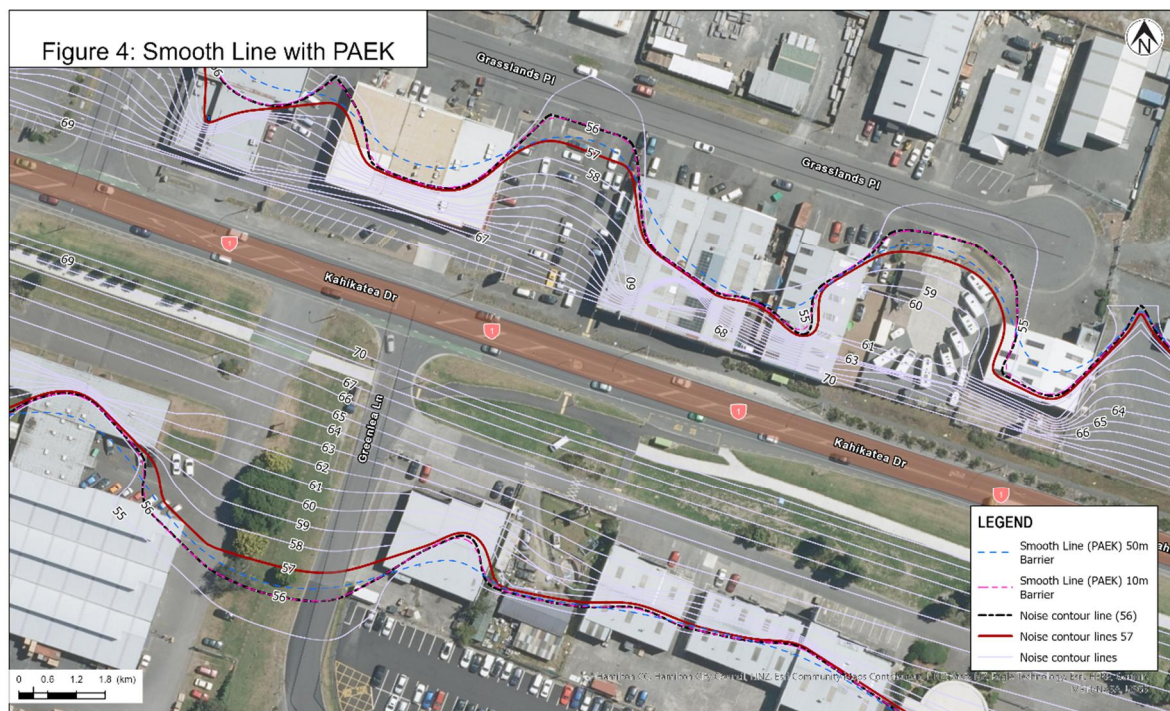
The negatives of this techniques are you still get some unwanted bends, but this can be overcome by adjusting tolerance to suit your wanted outcomes.

Overall, again this is a viable option for your needs, but the main issue would be deciding on the appropriate tolerance distance and barrier location.

More detail is available from ArcGIS provider ESRI: <https://pro.arcgis.com/en/pro-app/latest/tool-reference/cartography/simplify-line.htm>

Smooth Line

Smoothing lines removes the sharper angles with two main methods or algorithms. The Bezier interpolation method and the Polynomial Approximation with Exponential Kernel (PAEK) method. The Bezier method smooths the lines without using a tolerance, so it is not as viable for this task. The PAEK method, which like the simplify line tool allows you to set the tolerance, although the line may actually be more complicated, or have more points along it, which is something to think about for a national dataset. I have demonstrated the results of the PAEK method in Figure 4 below. The tolerance distance in metres can easily be modified based and barriers are also an option.



The Figure shows how the difference in the two tolerance values of 10 metres and 50 meters can vary greatly, where the 50 metre tolerance varies a lot from the original contour line.

Pros:

With smoothing you can keep use barriers and set tolerance. This can be easily built into models and automated for the entire country.

Cons

The negatives of this techniques are you may find it moves too much from the original contour. The valleys/peaks are removed, so you can get an overall more consistent line. The other downside is you again will have to set a tolerance that suits, and the line will move if that tolerance is pushed out or has higher values.

Overall, this could be a viable option for your needs, but the main issue would be deciding on the appropriate distance of tolerance.

As discussed in our meeting, this can be done in ArcGIS, FME and QGIS, but I would only recommend ArcGIS or FME for this task and to allow for integration with automation/existing models. More detail is available from ArcGIS provider ESRI: <https://pro.arcgis.com/en/pro-app/latest/tool-reference/cartography/smooth-line.htm>.

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