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Mr. Hugh Bevan
Interim Municipal Administrator
City and Borough of Sitka
100 Lincoln St.
Sitka, AK 99835

Dear Mr. Bevan,

Thank you for your email of December 26, 2019, requesting additional clarification regarding our draft report on landslides in Sitka. This work was conducted in response to the 2015 debris flows, in which three Sitka residents were killed. In 2019, another person died as a result of ground failure in Sitka. Just like the City & Borough of Sitka, DNR takes public safety issues very seriously, and with four deaths in an equal number of years, slope failures pose an obvious life and safety hazard.

The report and maps referenced in your email are from a debris flow analysis, not a landslide analysis. We will be re-wording the report to make that distinction clear, as the two are not the same. The draft products you have present a community-scale, model-based analysis. The model used was developed for lahars, which are simply defined as volcanic mudflows. The liquid nature of the debris flows in Sitka resemble mudflows rather than landslides, and for that reason we consider the model appropriate. As much of the shallow soil in Sitka is fine-grained volcanic ash from Mount Edgecumbe, any debris flows will generally have a significant fine-grained volcanic component.

While I believe it is a sound piece of work, it, like many such assessments, has its strengths and weaknesses. I hope this letter, and accompanying changes to the maps and report, will help you better understand this analysis so it can be appropriately used to decrease the likelihood of further fatalities. Much of the following discussion will be included in the report in an attempt to explain in lay terms how to use the analysis, what its strengths and weaknesses are, and what it should and should not be used for. As you will see from this letter, this is still a work in process.

As expanded on below, this is not a site-specific assessment of any particular area, and we feel it would be inappropriate to use it for site-specific decision making. The maps show what the computer models predict could occur based on the selected inputs, and with the assumption that the input conditions actually occur, unvaryingly, throughout the entire model area. They delineate the potential runout from four different-sized debris flows under those assumed conditions.

The assessment proceeded according to the following path:

1. Determine which slopes can release debris flows. We calculated a factor of safety for the slopes based on slope angles (calculated from LIDAR digital elevation models) and soil conditions (from U.S. Department of Agriculture data, assuming saturated soils). This established which slopes might source debris flows. We divided these potential source areas into three categories based on their size, elevation range, and slope characteristics.
2. Determine the volume of potential debris flows, using data from four known debris flows (North and South Kramer, Silver Bay, and Starrigavan).
3. Establish the point on the slope where the debris flows slow to the point that deposition begins; a 20-degree slope was used.
4. Determine shape factors for the known debris flows. These represent the length, thickness, and width of the known debris flows, and allow calibration of the model to known flows.
5. Run the model assuming flows of various sizes and with the determined shape factors. The combination of these inputs, and the local topography, determine how far the debris flows will run out.

This is a model-based analysis, and the results are only as good as the programming, input data, and assumptions. Some things to consider with this model are:

- This factor of safety determination used input parameters for soil conditions derived from existing regional soils mapping. Using site-specific data may change the factor of safety for an area, which could add or remove areas as potential sources of debris flows.
- Basins were divided into three categories related to the size, steepness, and length of each basin. The assumed debris flow volumes used in each basin varied based on the basin's category. The maps depict runout for *assumed* volumes of debris flows, and not basin-specific estimates. Site-specific data will allow better estimation of potential debris flow volumes from a basin, and thus better projections of runout areas.
- Runout distances for the debris flows are based on the shape factors (flow length, width, thickness) used in the model. Using shape factors that accurately reflect local conditions rather than the model's generalized shape parameters will change the depositional pattern of the debris flows. This could significantly change the extent of potential debris flow deposit areas shown on the maps.

We can reasonably assume that some, if not many, areas have conditions different from those used in this analysis, so the model output will not be accurate in those areas. On-site observations of soil thicknesses confirm that conditions are quite variable over short distances, and unequivocally non-uniform. Vegetation conditions are also variable throughout the study area. Without site-specific work in each of the basins to determine input parameters for each basin, it is not possible to know which areas have conditions similar to the model input parameters and which do not. More detailed and basin-specific input parameters will likely show some areas have greater, or lower, debris flows hazards.

The debris flow model was primarily calibrated to the width, length, and thickness of the deposition (runout) area of the South Kramer debris flow. The South Kramer debris flow runout area was mostly devoid of trees at the time of the debris flow, and the model is a good match to the actual limits of that debris flow, and appears reasonable under that set of conditions. These calibration parameters produce debris-flow runouts that also fit the smaller Silver Bay debris flow and larger Starrigavan Valley debris flow. (Notably, the Silver Bay runout area was deforested, and the Starrigavan area had been logged at the time of the debris flows). However, this model was less accurate at predicting the runout from the North Kramer debris flow, and over-predicted how far the debris flow would travel once it reached the base of the steep source gulley. This may be the result of trees present in the North Kramer debris flow runout area at the time of the debris flow providing resistance, slowing down the debris flow, and reducing the distance traveled. An additional factor at the North Kramer debris flow is the elevated roadway of Kramer Avenue, which acted to dam the forward progress of the flow. As the shape parameters used in the model are from flows in deforested areas, the model results are likely to be more accurate in cleared runout areas than in heavily forested runout areas. As you know, many areas around Sitka are still forested. This model is by nature conservative, and this can be seen in areas where potential debris flow runouts are longer than those observed from historic debris flows. I have asked our team to re-run the analysis with the model calibrated to parameters that more closely match the North Kramer debris flow to see if there is a significant difference. We will follow up and inform you of the results after running those models.

Debris flows like those in Sitka are very liquid phenomena, tend to travel in channels, and can be diverted by relatively small topographic features. Understanding the nature of the hazard suggests that, although a property may overlap one of the runout zones, it does not mean the entire property has the same hazard level. For example, a property could overlap a portion of a gulley susceptible to debris flows, but contain areas that are away from the gulley, or at higher elevations, and therefore safe to build on. More succinctly: just because a portion of a lot intersects a debris flow runout zone does not mean the entire lot is unsafe to build on. In our opinion, it would be unwarranted to condemn entire properties when only a portion may be exposed to the hazard.

The draft maps show three categories of potential debris flow inundation areas based on modeled debris flow frequency and size. These may be refined as our analysis evolves. In our opinion, a tiered set of building recommendations that reflect hazard level could be considered to balance the need for public safety and the value of community development.

As you can see from this letter, this analysis is still undergoing refinement. The information provided to the Federal Emergency Management Agency (FEMA) was meant to meet the terms of the grant funding we received; as our analysis was still ongoing, it was only an interim snapshot of the final product. We are continuing our analysis to ensure this effort is as complete, well-documented, and usable as we can make it. As additional work is performed, results can and do change, so we usually refrain from sharing draft products. To use the draft products from our work is, in our opinion, premature at best.

It is undeniable that some areas are hazardous, and we understand that there may be significant impacts to those who have unknowingly bought or built in some potentially hazardous areas. We are also aware of the need for balance among the goals of being accurate, portraying the appropriate level of hazard, and helping ensure public safety. We recognize this is an important issue for your community and it is unfortunate this has taken so long to complete; however, I believe everyone will be better served by our taking the time to ensure the final product is the best it can be.

I hope this helps answer your questions. Please feel free to reach out with any further questions.

Sincerely,

S. Masterman

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