## Geologically Hazardous Areas

1. Page 1. The Draft Synthesis starts with the proposition that: "Regulations for Geologically Hazardous Areas should protect both the public and other critical areas from the impacts of development." What is the basis for this proposition? Shouldn't the proposition instead be that CAO regulations for Geologically Hazardous Areas should protect public safety, public works and other structures and improvements from geological hazards?

The State's inclusion of geologically hazardous areas as a "Critical Area," subject to regulations that require the protection of their functions and values, implies that they have inherent value and perform ecosystem functions. Their functions and values include sediment deposition, habitat alteration, creating protective land features, and modifying the land form.

No.

2. Page 2. The Draft Synthesis states: "Some engineered solutions for shoreline erosion (e.g., shoreline armoring) can have unintended, adverse, cumulative environmental impacts such as reduced beach nourishment, beach lowering and coarsening." Please see our questions regarding Chapter 3 for questions regarding the basis for and specific aspects of this proposition.

3. Page 5. The Draft Synthesis states: "Landslides are caused by wave attack at the toe of a coastal slope, hydrologic processes, and [the impacts of] land use and development." What specific development activities are thought to cause landslides?

The list of specific actions includes but is not limited to: the removal of vegetation, exposing deep subsurface soil layers to heavy precipitation, changing hydrologic conditions, improperly installing drainage systems, irrigation systems, and septic system drainfields.

4. Page 8. The Draft Synthesis states: "If the bank is modified by either natural (e.g., wave attack) or engineered means (e.g., vegetation removal, terra-forming), it will seek a new equilibrium to return to this desired degree of slope. This is achieved through events of mass soil movement." What is the authority for this proposition?

Manashe 1993. A Guide for Puget Sound Bluff Property Owners. Shorelands and Coastal Zone Management Program, Washington Department of Ecology.

5. Page 8. The Draft Synthesis states: "Although development can and does exacerbate erosion problems and landslides, they also occur naturally throughout the Puget Sound region." What data are there regarding landslides and other erosion events within San Juan County?

A large landslide occurred the week of January 30, 2011 on the west side of San Juan Island. A 3.2-magnitude earthquake occurred, centered near Friday Harbor, on February 8, 2011.

6. Page 9. The Draft Synthesis states that drainage collection:

> [E]ffectively reduces surface erosion and the saturation of the top soil layers, if not managed properly, it can also concentrate and deposit runoff water and associated pollutants (e.g., zinc and surfactants from moss control products, sediments) directly into the aquatic environment without the benefit of filtration through vegetative cover or soils. All runoff with the potential to contain sediment

and pollutants should be treated prior to discharge to drainageways, streams, wetlands, or marine waters. (Emphasis added.) Please explain how this is to be accomplished (e.g., drainage without drainageways) and why it is necessary to relieve wetlands of this wetland function (i.e., removal of sediment and pollutants)? What is the authority for this proposition? Why are water quality issues being discussed in this chapter regarding geological hazards?

Typically, this would be accomplished through vegetation, but other methods (particularly through Low Impact Development practices) are available to provide added filtration.

The draft synthesis does not state that it is necessary to "relieve" wetlands of this wetland function; however, it is widely known that reducing the amount of pollutant load entering a wetland is beneficial.

Impacts to water quality resulting from methods employed to remove water from saturated soils (and thereby enhance the geologic stability) are only mentioned here as a side note, since critical areas and the issues associated with them overlap and are not exclusive of each other.

7. Pages 10-11. What is the authority supporting the "feeder bluff" and so-called "sediment starvation" theory? Isn't true that this is not universally accepted? (Please see additional questions regarding these issues in our questions on Chapter 3.)

This is a well-accepted "heuristic," a model for understanding how sediment moves. It is not a computer model and is not cited as such. It is a very old concept, which is used around the world. Here, since our sediment is so dependent upon being locally-sourced, it is cited more often than in other places.

8. Pages 10-11. Although the Draft Synthesis acknowledges that "[t]he impacts of shoreline modification, including bulkheads, are not yet completely understood" and that "[d]isagreement within the literature drives ongoing research in the Puget Sound region and beyond," no authority is cited for the propositions in the second paragraph of Section 6.4.2. What authority is there for these propositions? What counter authority should be considered in discussion BAS for San Juan County?

This is common knowledge.

9. Pages 10-11. The Draft Synthesis identified some safety related issues that it ascribes to "sediment starvation" as follows:

10. Pages 10-11. Regarding safety impacts, sediment starvation has several implications. First, spits that would naturally form in front of shoreline homes will shrink in height and length and eventually disappear. As the spit retreats, this would allow storm waves to overtop the land feature. When the spit completely disappears, so does its protection as a barrier, and shoreline development is exposed to the full force of storm waves. The beach directly in front of bulkhead structures also diminishes over time. Without the protection of a beach, stormwaters must only overtop the bulkhead itself to gain access to the structure.

11. Pages 10-11. What authority is there for these propositions? Is there any data establishing such events (e.g., complete disappearance of spits) within San Juan County? Isn't it true that within San Juan County there are areas in which beaches have formed seaward of bulkheads? We assume that in this context the term "stormwaters" refers to ocean water and not rain runoff.

This is common knowledge.

Longitudinal studies of individual spits eroding over time have not been published for San Juan County.

Not that I am aware of.

12. Pages 10-11. At Section 6.4.2, generally: Feeder bluffs are composed of glacially compacted soils and as a result are generally stable in high near vertical slopes. As stated in the Data Gaps section of this chapter very little is known about the erosion rates of these slopes and more importantly what happens to the sediments from these bluffs. Isn't it true that the rate of erosion of these very dense and hard soils is low? Do these sediments remain on the beach or are they washed away during the winter storms? Is there any scientifically sound reason to restrict the building bulkheads on these bluffs, as long as they are professionally designed?

Generally speaking, the erosion rates of soils in the San Juans is low. There are, however, places where erodible soils exist and, additionally, can occur in combination with steep slopes or other site conditions that facilitate erosion.

I believe they are ultimately washed away.

Yes, depending on the site conditions.

13. Pages 10-11. At Section 6.4.2, generally: The local studies done on our shorelines are only inventory in nature. They show how many bulkheads are present, where eel grass is located. Are there any studies in the San Juan Islands showing a cause-effect relationship between the bulkheads, the beaches, and the marine environment? Are there are any local studies demonstrating that bulkheads prevent sediment transportation in San Juan County?

Not that I am aware of.

Yes.

**From:** Brendan Cowan
**Sent:** Tuesday, January 18, 2011 10:19 AM
**To:** Janice Biletnikoff
**Subject:** Re: San Juan County Best Available Science (BAS) Synthesis

Greetings Janice- thanks so much for the incredible work you've put into this, and thanks for keeping me in the loop.
When it comes to the Natural Hazards portion of your efforts, clearly we're handicapped by the challenge of planning for events that happen on a geologic timescale. That, coupled with a dearth of good science and data only makes your job that much more difficult.
I looked over what you've done, and think that you've done a great job of walking that tightrope between excessive caution on one side and carelessness on the other. I have a very few quick comments, but for the most part am quite satisfied with the final product:
1. (ch.5, p.6) "Although other counties in the Puget Sound region maintain an official tsunami hazard map, San Juan County does not currently have one."
Just to clarify this: the tsunami mapping that's been done (as far as I know) has been done by WA DNR. Now that we have LiDAR (much of which was paid for by DNR), we're on their list for a map, but I'm guessing it'll be 2-3 years until that happens. The modeling that's required is fairly sophisticated, and is out of the reach of most County GIS teams. Hope this doesn't sound defensive- I just want to clarify that we'd love to have a tsunami map, and are eagerly awaiting DNR support.
2. (ch.6, p.6) "San Juan County also contains several small surface faults, particularly on Orcas Island and the south end of Lopez Island."

I'm not aware of any hard science that clearly shows there are active faults running through the San Juans. There are some features that show up on LiDAR that may be faults, but as far as I know, no one has ever done the ground truthing required to confirm and understand the seismic history. There proably are some active faults here, but I'm wary of sounding concrete in our understanding of the islands' seismicity. I think it's important to mention that there has been little work done on local faults and that the science is apt to change considerably in years to come.
3. The Flood Zone map for San Juan: I think it is a slightly misleading to include the dam failure innundation map for Trout Lake as an innundation zone. Yes, this is a potentially catastrophic flood that is worth mentioning, but there are many, many dams throughout the islands that would have dramatic flood potential for downstream properties. Trout Lake is the only one modeled/mapped (as required by WA State Dam Safety Office) but dams at Mountain and Cascade Lake on Orcas, or Briggs Lake on San Juan also have major flodding potential. This might be worth clarifying within the text (apologies if I missed it somewhere), as at the moment the maps make it appear that there is only one dam hazard in the County, when in reality there are many. Something to talk over perhaps.
Again, overall I think this looks really solid, and I'm very appreciative of your work.
Thanks,
Brendan

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We agree that it is appropriate to remove the Trout Lake flood inundation study from the map for San Juan Island and will do so in the next draft.

Regarding the faults: It is true that most of the faults in the islands are Cretaceous and are inactive; however, the Devil's Mountain fault is only about 5 km south Lopez Island and has several mapped strands projecting onto the island. The Devil's Mountain fault displaces upper Pleistocene deposits (and possibly Holocene) and is considered active by the USGS.

I think we could be a bit more concrete in the seismic discussion. We will incorporate the following USGS report and cite it in the text in order to expand the discussion of the seismicity of the county:
http://earthquake.usgs.gov/regional/pacnw/activefaults/dmf/

## Frequently Flooded Areas

1. Page 1. The Draft Synthesis states: "The entire shoreline of San Juan County is identified as an Area of Special Flood Hazard because tidewaters rise above the ordinary high water mark (OHWM) during storm events of this type." Isn't it true that some shoreline properties are over 30 feet above OHWM? Why should these properties be subject to additional regulation based on alleged flooding risk?

Yes, some shoreline properties are over 30 feet above OHWM. These properties are subject to the same regulations as all coastal properties, per the requirements of the National Flood Insurance Program, which the County participates in.

2. Page 1. At Section 5.1, Exhibit A: FEMA shows a 100 year flood hazard marked by the color "red" at the headwaters of many of the streams on San Juan Islands. Did the County use the FEMA maps to identify existing ponds?

No. Not all ponds are shown. Only those areas at risk of flooding.

3. Page 1. FEMA contends that all of the shorelines are believed by FEMA to be

subject to flooding depending on high water, wind, and elevation. There's no mention in FEMA documents that less than 20 percent of the Islands are low-bank, or no-bank, and possibly subject to flooding during high tide - storm periods with high winds. Did the County or FEMA consider the percentage of shoreline parcels that are not low-bank or no-bank parcels? What is the percentage?

No. We are bound to use the FIRMs as they currently exist. When individual landowners have coastal surveys done, they can submit them to FEMA and request that they incorporate them into the official maps. Otherwise we must wait our turn in the map revision queue.

4. Page 1. At Sections 5.2 and 5.3: Many shoreline properties are not developed. The BAS Synthesis mentions that much of the Islands development is situated in shoreline areas. Has the County quantified as a percentage the number of residences actually constructed along shorelines, compared to the number of residences not on shorelines, including—but not limited to—the Town of Friday Harbor, Roche Harbor (including apartments and condominiums), Eastsound, Deer Harbor, Lopez Village, and all other inland or shoreline village areas not immediately adjacent to shoreline for the San Juans for parcels that do not intersect Salish Sea waters?

No.

5. Page 1. Of the properties situated along a shoreline, what percentage of those residences/buildings are above Elevations 13.1 feet and 23.1 feet (the approximate expected height of general flooding and Tsunami flooding)? Are we creating a number of regulations for a small number of residences and parcels that have not been improved?

We have not run GIS calculations of field-verified all of the shoreline properties to identify the percentage that currently have any structures above these elevations. No regulations are proposed at this time.

6. Pages 2-3. The Draft Synthesis states: “Although some inconsistencies have been found in the maps in San Juan County, they remain the most accurate and comprehensive source of inundation data available.” At page 12, however, the Draft Synthesis states: “San Juan County’s Flood Insurance Rate Maps (FIRMs) are inaccurate.” Accordingly, even if these maps are the best available, how can they reasonably be used for any planning purpose, much less to impose additional regulation on any land owner?

The County is required to use them, as part of the County’s participation in the National Flood Insurance Program.

7. Pages 2-3. Is it asserted that the FIRMs are BAS? If so, on what basis?

No.

8. Page 4. “The impacts of impervious surfaces related to commercial and residential development affect Frequently Flooded Areas by facilitating the rapid accumulation of large volumes of water in concentrated areas.” What impact do agricultural lands have on frequently flooded areas?

Agricultural activities (such as field clearing or other manipulation of soils or vegetation) are expressly excluded from this synthesis, due to the moratorium from SSB 5248.

9. Page 4. The Draft Synthesis states: “In San Juan County, the increase in impervious cover related to development also has the potential to impact the rural

character." What does "rural character" have to do with protection of frequently flooded areas? In any event, for purposes of BAS, how would the authors define "rural character"?

Rural character is not directly affiliated with the protection of frequently flooded areas. Generally speaking, when impervious area is increased, there is the potential for the designated frequently flooded areas to expand as well, because increased impervious surfaces facilitate the accumulation of water. Ultimately, this can lead to the need for a more expansive, sophisticated, urban drainage system.

The second question is not clearly stated and therefore staff cannot respond to it.

10. Page 4. Please explain why the Draft Synthesis suggests decreased reliance on Best Management Practices (BMPs)?

The synthesis does not suggest decreased reliance on BMPs. It recommends using stormwater management methods (i.e., LID practices) that decrease the need for using BMPs in the first place. Better management of runoff leads to fewer impacts that would then require the use of BMPs to mitigate those impacts.

11. Page 4. The Draft Synthesis states:
It should be noted that the site specific implementation of LID practices does not compensate for the cumulative adverse impacts of road networks, parking areas, and development, but LID can and should be included as part of a local, comprehensive stormwater program due to its cumulative benefits on a watershed scale (Puget Sound Action Team 2005).
What is the basis for the suggestion that each development project must "compensate for the cumulative adverse impacts" of prior developments within the County?

That is not being suggested.

12. Page 4. It is asserted that the "Low Impact Development Technical Guidance Manual for Puget Sound, Publication No. PSAT 05-03. January 2005" is BAS applicable for San Juan County? If so, what is the WAC 365-195-905 basis for that conclusion?

Yes.

This manual is a well-referenced, peer-reviewed collection of the most current research and data for the collection and management of stormwater.

13. Page 4, Section 5.3.2, Paragraph 1, Line 10: The Draft Synthesis states: "Tsunami waves from these smaller, local sources would be larger and more damaging to San Juan County, due to their proximity." It is our understanding that the potential threat from the referenced "smaller faults" would depend on their activity, length, and structural origin—many factors not considered in the Draft Synthesis. Accordingly, the statement that the small faults would be larger and more damaging to San Juan County due to their proximity appears questionable. What is the authority for the geologic hazard conclusory statement regarding tsunami waves?

The statement was based in part on the known evidence of tsunami impacts on Whidbey Island, resulting from geologic activity in the inland waters of Washington, and the applicability of this information to the San Juan Islands. Additionally, Dr. Jeff Parsons provided USGS information that validates the activity of some local faults.

14. Page 4, Section 5.3.2, Paragraph 5, Line 11. The Draft Synthesis states: "The Washington State Department of Natural Resources has produced a soils liquefaction

map for San Juan County, which identifies areas of solid earth that can liquefy during periods of intense seismic shaking." Did the Department of Natural Resources collect SPT (standard penetration counts) using a drill rig recently calibrated for hammer efficiency, and draw cross sections showing continuous sand layers subject to liquefaction? What is the authority for proposition that solid earth liquefies? What application does LiDaR have with regard to liquefaction?

Staff cannot respond as to the methods used by DNR in creating statewide liquefaction maps.

Liquefaction, where water-saturated sandy soils lose strength during earthquake shaking, is a well-known geologic process. A great deal of photographic evidence of this phenomenon occurring throughout the Puget Sound region exists.

15. Page 7. The Draft Synthesis states: "[I]t is widely accepted throughout the scientific community that global climate change is occurring." The Draft Synthesis also states: "Rising global temperatures are largely attributable to increased carbon emissions into the Earth's atmosphere. Human activities are responsible for the majority of the carbon emissions currently being released into the atmosphere (IPCC 2007)."

16. Page 7. Were any of the following authorities considered in the preparation of the Draft Synthesis?

> Serveze, M.C., Holland, M.M. & Stroeve,J. (2007) SCIENCE 315 1533-1536; Bently, C.R,(1997) SCIENCE 275, 1077-1078; Nichols,K.W., (1997) NATURE 388, 460-462; Davis,C.H., Li,Y McConnell, J.R., Frey,M.M, & Hanna, E.(2005) SCIENCE 308 1898-1901; Monoghan, A.J.,et al., (2006) SCIENCE 313, 827-831; Lindzen, R.S.(1994) ANN. REVIEW FLUID MECHANICS,26 353-379; Sun, D.Z., & Lindzen, R.S.(1993) GEOPHYSCI 111 204-215; Spencer R.W. & Braswell W.D.(1997) BULL. AMER. METEORLOGICAL SOC. 82 1097-1106; Lindzen, R.S., Chou,M., &Hou, A.Y., BULL. AMER. METEORLOGICAL SOC.82,417-432; Spencer, R.W., Braswell,W.D., Christy, J.R. & Hnilo, J., (2007) GEOPHYSICAL RESEARCH LETTERS, 39,(GLO 029698); Soon,W., Baliunas,S., Idso, S.B., Kondratyer,Ya & Posmontier, E.S.,(2001) CLIMATE RES. 18 259-275.

No. A search in the County's database confirms that these documents were not submitted as BAS by the public nor were they found in the County's existing hardcopy documents or during research.

17. Page 7. Are the authors suggesting that San Juan County land use policy is adversely affecting global climate? If so, please explain how.

No.

18. Page 7. The Draft Synthesis states: "Climate change has been shown to increase stream temperatures (particularly in the summertime)," but in other chapters of the Draft Synthesis, increases in stream temperature are ascribed to various human activities within San Juan County. Please explain how these different conclusions should be understood for purposes of BAS for San Juan County?

There are several sources of increased temperatures in streams, which vary based on many factors, including but not limited to direct human alteration. The authors do not draw different conclusions.

19. Page 7. At Section 5.3.3 regarding Sea Level Rise: Has the County quantified the potential, or to what extent, that isostatic rebound may offset the effects of sea level rise?

No. The County has not quantified it although it has been addressed in several studies cited in the text.

20. Page 7. At Section 5.3.3.1: A reference cited by the County states what the temperature change has been during the past 1000 years. Since the first reliable thermometer was not developed until the early 18th century, how could it be known what the average Earth temperature was 1000 ago?

Science offers many proxy methods for determining temperatures from time periods prior to modern thermometers. These include but are not limited to ice core records, tree ring records, the fossilized remains of certain temperature-sensitive species of flora and fauna, the isotopic composition of coral, and reconstructed solar radiation records. The particular methods used by authors of the individual cited studies vary.

21. At Section 5.3.3 the Draft Synthesis states that according to the IPCC, thermal expansion, geologic movement, and the melting glaciers and ice fields contributed to 3.1 mm of sea level rise globally per year between 1993 and 2003. At the same rate, over the next one hundred years, the sea level will rise 31 mm (just over an inch). The Draft Synthesis claims that by the year 2100, the IPCC projected that global sea levels will rise between 7inches and 23 inches. What is the basis or reference for that estimate?

The Intergovernmental Panel on Climate Change's 2007 "Fourth " Assessment Report is the reference for that estimate. The basis for the projection is that sea level rise in the next 100 years will not continue at the same rate because the influencing factors are not anticipated to be exactly the same; therefore models must use current and anticipated levels of the relevant variables to estimate the projection.

22. At Section 5.3.3.2, Projections for Sea Level Rise: Has the County given any thought about planning for sea level fall? In the past, weather patterns have reversed abruptly; shouldn't we be covering all of our bases for planning?

No.

The preponderance of evidence exists for the opposite. The WAC specifically requires that sea level rise be considered in planning for frequently flooded areas.

23. At Exhibit A: Only the stream leading to False Bay shows a continuum along the banks where flood hazards may be present Are any of the areas identified by FEMA subject to a 100 year flood based on any ground proofing work (e.g., elevation survey data, direct observation, etc.)? From the map, Exhibit A, the map presented in the BAS synthesis is not legible; there are no reference points (roads, etc.) in order to identify the little red marks. Can the County provide a legible map for the BAS Synthesis?

Staff cannot attest to FEMA's methodologies.

Chapter Eight of the synthesis, entitled "Maps," includes the County's map of frequently flooded areas as designated on the FIRMs. Exhibit A, embedded within the text of the chapter, is in no place indicated to be the County's official map of frequently flooded areas. It is intended for illustrative purposes only, to show that the County contains some inland flood areas.

24. At Exhibit A: The red color areas on Exhibit A used to identify flood zones appear exaggerated within the inland areas as compared to FEMA maps available on line. The only drainage shown subject the flooding in its entirety is the main drainage leading to False Bay; on other drainages, potential flooding areas are shown at the headwaters of the drainages, which, from a geological perspective, is very strange.

25. At Exhibit A: Another awkward feature on the FEMA maps is that Trout Lake (Friday Harbor's water supply) is designated as Zone A. Does this mean that the dam at Trout Lake is expected to breach? It's an artificial impoundment with heavy seepage at the base of the dam. Does the identification of Zone A at the headwaters of many stream areas of San Juan Island indicate that these areas are ponds developed by landowners vs. FEMA's definition of Zone A (areas subject to flooding)?

At this time, the County does not expect the Trout Lake dam to breach, especially in a sudden, complete failure of the structure, as was modeled in the existing inundation study.

No.

From King Fitch, Town of Friday Harbor:
Yesterday, I received a call from someone from the Town of Friday Harbor who coordinates w/ Brendan (King Fitch). He was concerned about the map we included in the draft BAS document, b/c it included the inundation zone for San Juan Island. This inundation zone only reflects the area that would be affected if there were a sudden failure of the entire dam structure at Trout Lake. The dam was recently inspected and it is tip-top. So I don't think this really qualifies as a "frequently" flooded area, considering the odds are very miniscule of it being inundated (as opposed to the coastal areas, which are flooded during storms). He was worried that the inundation polygon could be used in determining which properties could have new restrictive regulations on them in the future. I don't think that we should include the inundation study on the map (and I'd be happy to address this during my presentation). First, the inundation study is not part of the FIRM. Second, we do not have the same information for Orcas, Lopez, or the other islands and they have dams, too. If we are going to start regulating on potential dam-failure hazard zones, then we should probably commence a county-wide study. What do you think?

We agree that it is appropriate to remove the Trout Lake flood inundation study from the map for San Juan Island.

**Councilmember Rich Peterson comments/questions in binder:**

J. Biletnikoff:

- Concerns noted; more emphasis will be given in the next draft to the inaccuracy of the existing FIRMs, and FEMA's requirement that the County use the maps although they are flawed.
- Regarding the modification of soft shore beaches: this was an error on staff's part; I stated the number from the study incorrectly and will correct it.