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Topic: Quantity and Quality of Quarry Rock:

My analysis of the West Quarry revealed that there appears to be an adequate quantity of rock, perhaps 3 to 4 times in excess of needs. However, the quality of the rock for construction is highly questionable. The rock is simply too soft and too fractured to be of value.

The draft EIS needs to point out the environmental impacts of obtaining quality quarry rock from more distant sources, like the Columbia River Basalt 9 miles south in Wahkiakum County or 15 miles to the north in the Doty hills. Let me explain the logic behind this recommendation.

Geology seems to be one of the least understood aspects of the proposed dam project. Geology studies of the Pe Ell area use words unfamiliar to most of the general public.

For example, who knows what "weathered rock" means? And there is "slightly weathered, moderately weathered and severely weathered." How does that compare with "slightly fractured, moderately fractured and severely fractured" rock?

I have observed drilling operations on my property at the site of the proposed dam several times and one time the basalt sample came back empty.

I asked what happened. The answer was that the basalt 100 feet deep or more had fractured so badly that it was mostly sand which was washed out by the drilling mud. In other words, it was sand. The geologist who was recording the drill samples was on their first job 2 months out of college did not write "washed out." The wrote "severely weathered" in the drill log.

Thus, "washed out" or "severely weathered" mean the same thing to certain geologists. Other geologists may think differently. I learned that labeling rock samples is highly subjective, depending on the person making the decision.

How can Ecology staff figure out the environmental impacts associated with rock quarry development EXCEPT to just accept whatever FCZD contractors provide?

In the supporting reports for this EIS, the FCZD contractor wrote there is much uncertainty about rock quarry development and the details will be worked out in the future. How can Ecology describe the environmental impact of uncertainty? How can decision makers make decisions about uncertainty?

An EIS about uncertainty is worthless. This draft EIS needs to be postponed until the uncertainty is eliminated.

You have to ask yourself, why is there uncertainty after 15 years of drilling hundreds of boreholes in the project site? If the first borehole sample found "great" rock 15 years ago, why would hundreds more boreholes be needed? Maybe I can provide the answer.

1. Every borehole drilled in the past 15 years has revealed thick layers of pillow basalt. Pillow basalt is everywhere in the Willapa Hills.

2. Every borehole drilled in the past 15 years has revealed alternating layers of soft marine sediment with alternating layers of soft pillow basalt. Soft marine sediment is basically sand which has been compacted under extremely high pressure. These layers are known as siltstone, sandstone, claystone etc which can easily be broken by a hammer (because, afterall, they are just compressed sand).

3. Every borehole drilled in the past 15 years has revealed severe fracturing of the pillow basalt. This is exactly what you would expect because pillow basalt is the softest of the basalt family.

4. Every borehole drilled in the past 15 years has revealed 5 to 15 healed fractures per foot as well as wide open (visible) fractures. What is a healed fracture? That is where sometime in the past hundreds to thousands of years, the basalt fractured due to uplifting and twisting pressures, and the fractured joint resealed with local compounds.

Healed fractures are weak points, many of which break during borehole sampling (or any handling). The 2025 draft HDR Geologic Data Report contains photos of the rock samples obtained for the current project site. Every photo shows at least one visible fracture every foot or so with numerous white lines of healed fractures every inch or so. Sometimes there are sections of basalt crumbles, fractured into tiny pieces.

5. Every borehole drilled in the past 15 years has revealed that there is no competent basalt in the Willapa Hills. Every borehole reveals the same severely fractured (severely weathered) pillow basalt. This has been known by local geologists for decades.

Comparable photos of highly competent basalt from other sites in Washington State will show rock samples 3 to 4 feet long with no fractures whatsoever. Thus, Willapa Hills pillow basalt is unusually fractured and essentially worthless for construction purposes.

Weyerhaeuser crushes pillow basalt for their use on roads. My retired friends who once drove road graders for Weyerhaeuser told me that the soft rock is quickly destroyed by logging truck traffic and they are repeatedly replacing rock on logging roads. Willapa Hills basalt is so soft and easily fragmented that the Dept of Transportation refuses to use it in building hiways.

And the reason for the softness of pillow basalt is obvious to geologists, but not so much for the general public. Lava which flows from cracks in the bottom of the ocean contacts sea water. The molten lava quickly cools and traps water bubbles which turn into air bubbles. These underwater volcanoes eventually grow into islands over millions of years with alternating period of inactivity which allow layers of marine sediment to collect between layers of solidified lava. Thus, the air bubbles make pillow basalt the softest rock in the basalt family and useless for construction.

One of the ways to measure the hardness of basalt is to determine how much pressure it takes to fracture a sample of basalt. Table 14 (page 50 of the May 16, 2025 draft HDR Geologic Data Reports)
provides Unconfined Compressive Strength (UCS) numbers for Siltstone (marine sediment) and pillow basalt taken from boreholes at the project site.

Siltstone minimum UCS = 295 psi.
Siltstone average UCS = 2,617 psi.
Siltstone maximum UCS = 5,691 psi.

Pillow Basalt minimum = 2,600 psi.
Pillow Basalt average = 5,455 psi
Pillow Basalt maximum = 17,520 psi.

These numbers can be compared with Grande Ronde basalt (member of the Columbia River Basalt originating in Eastern Washington) which ranges from 14,500 to 29,000 psi.

Table 14 reveals several important conclusions which should be explained in the draft EIS.

1. The average basalt UCS is below the highest siltstone value. Remember, siltstone can be broken by a hammer.

2. There are basalt UCS values below the average siltstone value.

3. The average UCS of Willapa Hills soft pillow basalt is 3 times lower than the lowest value of competent basalt in eastern Washington.

4. Only one maximum UCS for Willipa Hills basalt is comparable with the lowest Grande Ronde Basalt UCS.

If Willipa Hills basalt is so fractured upon removal from the ground, imagine what will happen to it inside a cement mixer. It will be broken up into sand and small fragments. If you have made concrete at home you will realize that excess sand in the cement mix will result in early cracking of the concrete (sidewalks in my case). Excess sand in the cement mix for the dam will result in a weaker structure. Exactly how will that be prevented using severely fractured pillow basalt?

One other measurement of rock quality is how much water can be absorbed. While this might seem strange at first, when you consider the rock has microscopic air bubbles, absorption seems reasonable.

Table 18 of the 2025 draft Geologic Data Report gave the following absorption results for the West Quarry.

Minimum value = 3.5%
Average value = 4.5%
Maximum value = 6.4%

Compare these values with the DOT standard for construction of LESS THAN 3%.

The Willapa Hills pillow basalt is not only more easily broken (weaker) but absorbs water which after several freeze and thaw cycles produces cracking....which explains why pillow basalt breaks down over time more easily than competent rock. This is why it is important that rock used in construction must have low absorption values (under 3%).

One last thought: Between 2010 and 2015 the geologists working on the dam project were familiar with the incompetent Willapa pillow basalt, and focused on obtaining quality rock from outside the Willapa Hills area. Sometime after 2015 the focus changed to saving money by using rock from the project site. The attempt to find competent rock at the project site has been fruitless and great uncertainty remains.

Competent Columbia River Basalt lies just 9 miles south in Wahkiakum County. A finger of that flow went up the Cowlitz divide over Chehalis, Centralia, Rochester and Oakville millions of years ago. Therefore, quality basalt also exists in the Doty Hills roughly 15 miles to the north of Pe Ell.

Either of these alternate sources need to be reflected in the draft EIS with their associated environmental impacts, which are mainly transportation related.

As stated above, decision makers cannot make decisions about uncertainties. The uncertainties have to be eliminated before the next draft EIS is presented to the public.

And that includes creating quarries with competent rock for construction of the dam.