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Potential Air Quality and Wind Effects of New Shine Quarry Operations
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Introduction and Conclusions

Public comments in response to the environmental analysis scoping document regarding air quality issues for the New Shine Quarry focused on three areas: the potential for dust and its possible hazards, emissions from vehicles and the potential for change in wind patterns due to the lowering of a section of ridgeline. Because of the extensive controls imposed on quarry operations and motor vehicles by the U.S. Environmental Protection Agency (hereafter "EPA") and local clean air agencies it is highly unlikely that there will be significant adverse air quality effects. Detailed topographic and meteorological analysis shows that it is highly unlikely that there will be significant downwind increases in wind speed from the planned reduction in the height of the ridgeline at the north end of the quarry site. This report also describes expected greenhouse gas emissions from the operations of the plant and compares them to residential development. The greenhouse gas emissions from annual operations at maximum production are expected to be equivalent to the annual emissions of about 40 homes.

Composition of Dust

Dust at the quarry operations will be composed, in part, of the soil that overlays the site and makes up the floor of the processing operations area and, in part, the underlying rock that is being extracted as a part of the quarry operations. The *Geologic and Geohazard Assessment* (AMEC, 2008) prepared for New Shine Quarry reports that the soil is mostly gravelly silt loam and gravelly sandy loam. This is a mixture of clay, organic matter from decayed vegetation and broken bits of underlying rock of various sizes from small (gravel) to very small (sand) and very, very small (silt). The Assessment reports that the underlying rock is recent volcanic basalt. Basalt is primarily oxidized silicon (about 50%), oxidized aluminum (about 15%), oxidized iron (about 10%), oxidized calcium, magnesium, sodium and titanium (together about 25%) and trace amounts of other chemicals. The actual trace element composition of this particular basalt is not reported but typically, basalt contains minerals that incorporate less than about 300 ppm each of chrome, nickel, strontium and zirconium and less than about10 ppm each of other trace chemicals. Although arsenic has been identified in the public comments as a possible constituent of concern it is not normally found in basalts in sufficient quantity to even be listed. (K.C. Condie, *Plate Tectonics and Crustal Evolution*, 1982) Such low concentration chemicals can be present in aquifer water simply because the water has passed through such a great quantity of rock that even a very tiny amount of chemical can

become sufficiently concentrated in the aquifer water that it can be measured by sensitive instrumentation

Trace Chemicals in Dust and Air Quality

The Washington Department of Ecology (hereafter "Ecology") has adopted some of the most stringent and detailed regulations on toxic air pollutants of any U.S. state. "Nickel refinery dust" is included on that list, but that is a concentrated form of nickel dust that would not be found in the basalt dust. None of the other constituents of the basalt dust are on the Ecology list (WAC 173-400-460). A similar list has been published by the EPA Administrator, which does not include any of the compounds expected in basalt dust (40 CFR 61.01). A list of restricted chemicals in the U.S. Clean Air Act does include generic "chromium compounds" and "nickel compounds" (42 USC 7412) but, here again, this is directed toward concentrated industrial materials rather than naturally-occurring minerals. Instead, the Clean Air Act identifies generic particulate matter as a pollutant of concern and requires the Administrator of the EPA to establish a limit that will protect the public health with "an adequate margin of safety" (42 USC 7409).

Dust and Air Quality

In the 1970's regulations were issued for Total Suspended Particulate (TSP). In the 1980's this was revised to emphasize the size of the particles, restricting the concern to particles less than 10 micrometers in diameter. Most recently the Administrator has issued rules that restrict ambient concentrations of dusts smaller than 2.5 micrometers in diameter to less than 35 micrograms per cubic meter (hereafter "ug/m^3") in the air (24-hour average) (40 CFR 50.13). The larger particles can be assumed to be found closest to the original source. The smaller, 2.5 micrometer particles will be carried greater distances with the wind before the are removed by trees and fall to the ground. And the health effects are now believed to be primarily due to these smallest particles, in particular the emissions from diesel engines. Thus we will focus here only on the 2.5 micrometer particles.

Achieving and enforcing the ambient particulate matter limit is the responsibility of Ecology and the Olympic Region Clean Air Agency (hereafter "ORCAA"). To minimize public exposure to such dusts, the Administrator of the EPA has also established rules for the operation of mineral processing plants, such as the New Shine Quarry (40 CFR 60.670, Subpart OOO).

Subpart OOO of the EPA New Source Performance Standards (hereafter "NSPS") applies to crushers, grinding mills, screening operations, bucket elevators, belt conveyors, bagging operations, storage bins and enclosed truck loading stations at quarries that process more than 25 tons per hour of materials, which does include the New Shine Quarry. The amount of dust that can be seen to be released to the air above each of the applicable sources is limited to that which is barely visible to an observer (7 percent opacity), except for crushers, which have a slightly less stringent limit (12 percent opacity). It is assumed that the operator will utilize water sprays onto the processed rock

to minimize the dust. The NSPS rule requires periodic documented inspections of the water spray system to ensure it is working as designed.

The EPA rules are enforced by local inspectors from ORCAA, which additionally places its own limits on the quarry operations when it issues an air quality permit to construct and operate the facility. Typically a permit for a quarry operation will also require the development and implementation of a dust control program that includes:

- Using water suppression dust controls as necessary to prevent visible fugitive emissions from rock crushing equipment;
- Standard procedures for operating and maintaining wet suppression dust control equipment including a prescribed operating pressure, nozzle cleaning procedures and cleaning frequency;
- Applying water or another ORCAA approved dust suppressant to non-paved haul roads and access roads to the plant site;
- Cleaning or sweeping paved roads within the plant site;
- Taking appropriate measures to prevent the track out of dirt and debris onto paved roadways;
- Standard procedures and criteria for transport truck wheel washing;
- Standard procedures, criteria and prescribed frequency for watering unpaved roads at the site and for cleaning track out of mud and debris;
- Adopting a plant wide speed limit of 10 miles per hour;
- Posting the plant speed limit on major haul roads;
- A designated person at the plant for responding to and resolving fugitive emissions related complaints.

See, for example, ORCAA permit 09NOC664 for the Haller Quarry in Sequim, WA. That permit also regulates diesel engines, which will not be present at the New Shine Quarry. While these rules do not prevent any and all dust from leaving the quarry site, they do reduce it to a very low amount.

The Haller Quarry is permitted at about twice the hourly operating rate of the intended operation of the New Shine Quarry. ORCAA estimated dust emissions from the rock processing equipment at Haller to be about 1.6 lbs/hour (note that the values reported in the Appendix to the permit include the emissions from the Haller diesel engines). At half that hourly rate and for 2000 operating hours per year, the annual particulate matter generated on the site at New Shine Quarry would be 1600 lbs per year, or 0.8 tons per year. ORCAA used their estimates of emissions to calculate the expected concentrations of dust at the quarry property boundaries. If we scale the estimate by ORCAA to the New Shine Quarry maximum operating rate, the 24-hour average maximum concentration would be 4.3 ug/m^3 of dust carried off the quarry site.

The ORCAA calculation was for the 10 micrometer particulate matter. The values for the amount of 2.5 micrometer particulate matter generated from the quarry operations ranges from 6 to 25% of the factors used by ORCAA in their calculations (EPA, *AP-42, Fifth Edition*, Section 11.19.2). The equivalent off-site concentration of the particulate matter covered by the recent EPA regulations would then be less than 1 ug/m^3 for a 24-hour average period, significantly less than the EPA standard of 35 ug/m^3.

Emissions from Vehicles

The *Traffic Impact Analysis* prepared for New Shine Quarry by Transportation Solutions provides estimates of the increases in traffic due to rock haul operations. It provides estimates at both the near term probable operations level and the maximum operations level, which is not expected to be met until beyond year 5, or about 2016. At the maximum operations level the New Shine Quarry is expected to add about 1 truck traveling northwest and about 6 trucks travelling southeast on SR 104 during the morning peak drive time. About 7 employees (presumably driving passenger cars and light trucks) will be entering the site before or during the morning peak drive time, some along Beaver Valley Road and the rest from SR 104, mostly from the northwest. These haul truck trips will represent an approximately 3% increase in the heavy truck traffic on SR 104 during the morning peak. But the haul trucks and employee vehicles will represent less than 1% of the total morning peak traffic.

The new operations are expected to add over the entire day about 20 employee trips and 108 haul truck trips, again apportioned in the same ratio to the northwest (15) and southeast (93). The 108 daily haul truck trips compares to the estimated average total daily traffic of 13,000 trips on SR 104 or less than 1%.

The total emissions of 2.5 micrometer particulate matter by all vehicles travelling in both directions on the segment of SR 104 southeast of the Beaver Valley Road intersection before the project (in 2014) can be calculated from EPA's MOVES2010 model as 1.00 lb per mile per day, if we use the traffic data from the *Traffic Impact Analysis* and make reasonable assumptions about the mix of types of cars and trucks on the road segment and an average speed. After the project (again in 2014 but assuming it is at full production) the total emissions along that segment would be 1.04 lbs per mile, a 4% increase due to the long haul trucks.

Effects on Wind Speed

The effect of lowering the ridge at the north end of the proposed New Shine Quarry can be estimated using standard models used by meteorologists to estimate the flows of wind over terrain obstacles. It is possible to gain an initial understanding of the effects by using the "shallow water theory" model, which is not a theory of water movement but a theory of air movement. But first it is necessary to determine the distribution of wind speeds and direction in the vicinity of the quarry and Port Ludlow.

Wind speed and direction data are available from two meteorological towers located reasonably close to the site. The towers at Quilcene and Crow's Nest provide useful data. The Quilcene station is located about 9 miles west southwest, at 62 feet elevation. The Crow's Nest station is located about 15 miles southwest, at 1280 feet elevation. The Quilcene station is in a clearing within the forest while the Crow's Nest station is located on a ridge, although a ridge at higher elevation than the one being examined here. The Quilcene data are useful to describe the surface winds in the vicinity and the Crow's Nest data are useful for describing the more general, upper air winds.

Examining the data from these two sites, we are able to say that, as is typical for the Puget Sound region, the wind tends to blow north and south, with a likely twist in the surface winds to the southeast, due to the local terrain and Squamish Harbor. The upper air winds will be more often out of the southwest, reflecting the general movement of winds at this latitude. The surface winds are mostly less than 8 miles per hour although the upper air winds can have high velocities and will occasionally, especially during storms, result in winds up to 40 miles per hour at the surface near the ridge north of the quarry.

It is also necessary to examine the upper air data from the coastal weather balloon site at Quillayute to determine the height of the boundary layer of the atmosphere, which will be fairly constant over the Olympic Peninsula. Analysis of the data gives us a value ranging from about 660 feet to about 4000 feet. Using the lower limit will provide a more conservative answer (that is, predicting greater effects from lowering the ridge).

The ridge within the NSQ site is itself about 340 feet high and 1600 feet wide. Downwind to the northeast are a series of other hills and ridges between NSQ and the valleys that lead to the Port Ludlow resort properties. These are rather substantial ridges 200 to 300 feet in elevation. These hills and ridges can be expected to have roughly the same effects on the wind field as either the existing NSQ ridge or the NSQ ridge after its height has been reduced to approximately 240 to 270 feet elevation.

We can use "shallow water theory" to estimate the distance downwind where an effect might be felt from lowering the NSQ ridge with calculations involving the ratio of the height of the ridge before and after quarry operations to the height of the boundary layer and the wind speeds. This is shown in the table below.

Wind speed of wind from SW	Frequency (% of total hours per year)	Description	Downwind impact
10 mph	~10%	Slight acceleration at peak, split of flow around peak	None, return to normal before edge of ridge
20 mph	~15%	Slight acceleration at peak, split of flow around peak	None, return to normal before edge of ridge
30 mph	~ 5%	Moderate acceleration at peak, split of flow around peak	None, return to normal before edge of ridge
40 mph	~ 1%	Acceleration downwind of peak, downwind hydraulic jump (region of strong gusty winds downwind of the ridge)	Strong gusty winds in lee extending ~1600 feet downwind

If we ignore the intervening ridges downwind, it is estimated that lowering the ridge distorts the wind field for up to 1600 feet downwind of its peak during the strongest southwesterly winds. Any effects downwind will more likely be erased by the changes in

the wind due to the peaks the airflow must pass before reaching the downwind valleys. Lowering the ridge, even under these very conservative assumptions, will therefore have a minimal to no impact on the wind climatology at the Master Planned Resort (2500 feet northeast of the ridge) and the Port Ludlow Golf Course (3300 feet northeast of the ridge). It is extremely unlikely that lowering the ridge will affect wind climatology at the Port Ludlow Marina (2.5 miles northeast of the ridge) in any manner. The changes, if any, in wind characteristics would not be noticeable by persons playing golf at the Port Ludlow Golf Course or sailing off the Port Ludlow Marina.

Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions estimates for SEPA review are expected to follow the common protocols for voluntary GHG reporting. The most commonly used protocol for this type of facility is the World Business Council for Sustainable Development-World Resources Institute (WBCSD-WRI) *Greenhouse Gas Protocol, Revised Edition* (2004). It is very similar to the other widely used protocols, such as that of The Climate Registry. The WBCSD-WRI protocol divides the calculation effort into three bins:

- Scope 1 – Direct emissions from the facility operations and offsite activities
- Scope 2 – Indirect emissions from purchased electricity, steam, etc.
- Scope 3 – (optional) Indirect emissions from the supply chain or end users

In Scopes 1 and 2 the emissions are to be included if they are within the direct control of the facility. Emissions in Scope 3 are presumed not to be in the direct control of the facility. Because they are not under the control of the facility it is assumed it will be more difficult to obtain data to develop the estimates, so the inclusion of Scope 3 estimates is generally optional. Direct control is determined by ownership or leased responsibility for the choice of and operation of the emitting process.

Because it is difficult to judge how meaningful a particular level of calculated emissions might be, a comparison is presented for a residential development of the same size as the New Shine Quarry, 142 acres. The calculation of this estimate is based on a worksheet developed by the King County, Washington Department of Development and Environmental Services to aid in its own evaluation of GHG emissions from new building projects.

<u>Assumptions and Data</u>

The current zoning of the New Shine Quarry is for commercial forest, which allows mineral extraction activities. Thus if the quarry is not developed the most likely alternative use of the land is commercial harvest of the timber on the site. Thus the removal of the forest during the development of the quarry would result in the same loss in in-place carbon stock in the trees as the alternate development. And as the regrowth of the forest after commercial harvest would be approximately the same as the regrowth of forest after the quarry is closed and revegetation completed that gain in carbon stock would be about the same. Thus neither is included here. (It should be noted that requirements for revegetation, replanting and replacement of damaged wetlands are more stringent and more likely to be implemented for a quarry operation than for small

woodlot harvesting, although there will be a longer time between the end of commercial harvest and the end of the quarry operation.)

In the case of the New Shine Quarry there are two sources of emissions on-site: electric powered crushers, conveyors, screens, etc. and diesel-powered front-end loaders and similar mobile units. It is expected that the New Shine Quarry will operate in a very similar, but smaller, way to the Iron Mountain Quarry near Granite Falls. No on-site generation of electricity is planned at New Shine and it is not done at Iron Mountain either. The operations are so similar that data from Iron Mountain can be used for this calculation.

A GHG study done for Iron Mountain developed GHG emission factors for the on-site emissions. The Scope 1 diesel fuel consumption was 0.204082 gallons of diesel per ton of aggregate produced. The Scope 2 electricity consumption was 0.016667 kWh per ton of aggregate produced. The conventional emission factor for diesel fuel is 0.01015 tonnes CO_2 per gallon of diesel fuel. Puget Sound Energy reports that for their portfolio of sources, their emission factor for 2009 was 0.93 tonnes CO_2 per kWh of electricity. Thus the total emission factor for aggregate production would be 0.002078 tonnes CO_2 per ton of aggregate. (A “tonne” is 1000 kilograms or 2200 lbs.)

Transport of aggregate from the New Shine Quarry to the job site could be either a Scope 1 offsite emission or a Scope 3 emission, depending on the control the facility has over the transport trucks. That is, if the transport truck is owned or leased by the facility, it would be a Scope 1 emission. If it is owned or leased by the purchaser of the aggregate it is a Scope 3 emission. When a purchaser buys aggregate “delivered” the New Shine Quarry will contract with a hauler to deliver the load. While this is not quite the same as owning or leasing the vehicle, for the purposes of this estimate those trips will be assumed to be Scope 1 emissions. It is estimated that about 15% of aggregate sales, and therefore truck trips, will be of this type.

It is not really possible to include anything beyond the emissions from delivery trucks into Scope 3. The uses of aggregate are so many and varied that it would not be possible to even guess what the end user activities might be that would generate GHG emissions on the basis of each ton of aggregate delivered. Emissions from the vehicles of commuting workers at the site could also be Scope 3 emissions but the locations of their homes cannot be estimated at this time, so the distances travelled would be nothing more than a guess.

The primary vehicle traffic associated with the proposed New Shine Quarry will be diesel-powered short haul trucks. It can be assumed from experience with the Iron Mountain quarry operations that the trucks will be approximately 40% single bed trucks and 60% combination trucks (truck and trailer). The latter will generally have higher emissions because they are heavier and put more of a load on the engine. The haul weight of the single bed trucks is 15 tons and the haul weight of the combination trucks is 30 tons.

The aggregate delivery truck will run out full and back empty. The average fuel consumption for a trip can be estimated to be 6.3 miles per gallon (based on data from Kenworth Truck for their T-800 model) for the single bed trucks and 5.75 mpg for the tandem truck and trailer. The weighted average fuel consumption would then be 5.97 mpg.

It was estimated for the *Traffic Impact Analysis* document prepared for the New Shine Quarry project that 86% of the trucks will travel toward Bremerton and 14% will travel toward Sequim. For a maximum estimate, it can be assumed that each truck travels to either Bremerton or Sequim, both about 30 miles. For a 60 mile round trip, the fuel consumption per trip would be 10 gallons of diesel.

The initial production rate is projected at 200,000 tons/year and the final production rate at 400,000 tons/year. For a weighted average of 24 tons per trip, this is 16,667 trips per year at the final production rate or 8,334 at the initial production rate.

Calculations

For Scope 1 and Scope 2 emissions at the final production rate we multiply the operations factor of 0.002079 tonnes CO_2 per ton of aggregate times the estimated 400,000 tons/year of aggregate production for total emissions of 832 tonnes. We add to this the emissions from the 15% of transport trucks that are under contract to New Shine for delivery of aggregate, which will be 254 tonnes. The total Scope 1 and Scope 2 GHG emissions is then 1086 tonnes per year.

The Scope 3 GHG emissions from the remaining 85% of the transport trucks are 1,438 tonnes.

The initial GHG emissions would be half these calculated values.

Comparison

The King County worksheet draws its estimates of the GHG emissions of residential development from three sources:

- A life cycle calculation made by the Aetna Institute (http://www.athenasmi.org/tools/ ecoCalculator/index.html) for the GHG emissions in building a 2,527 square foot house, specific to the Pacific Northwest, which can be spread over their assumed 58 year building life;
- A variety of studies conducted by or for the Energy Information Administration of the U.S. Department of Energy on the average energy use by single family residences, although using national averages and not data specific to the Pacific Northwest;
- Annual transportation uses by an average Washington family of 2.8 persons with 1.1 persons employed outside the home (2000 U.S. Census data and Washington Dept. of Transportation data).

These would all be Scope 1 and Scope 2 emissions.

With a commonly used development density of 4 dwelling units per acre a 142 acre site would allow 568 single family residences. This does not suggest that the New Shine Quarry site could be developed at that density. This estimate is intended only to provide a comparison to the expected emissions from the proposed project.

Using the data developed by King County the estimate for annual emissions for the development and its residents would by 15,322 tonnes. Of this total, half is from their transportation uses, 43% from the energy consumption in and around the building and 6 percent (each year over its life) from the initial construction and eventual demolition of the building. This does not include the emissions from development of roads, schools and other common areas and common buildings.

The estimated 1086 tonnes of annual Scope 1 and Scope 2 GHG emissions from the New Shine Quarry operations is approximately 7% of the estimated annual GHG emissions from a similarly sized residential development. That would be about 40 homes. The comparison for the initial production rate would be half that.

Please contact Mike Ruby at (206) 633-4456 should you have questions or comments regarding this report.

Very truly yours,

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