

Office of Environmental Information (OEI) Docket (Mail Code: 2822T)
Docket # EPA-HQ-ORD-2012-0276
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., N.W.
Washington, DC 20460

The Western Division of the American Fisheries Society (WDAFS) is a 3,000 member professional society composed of fishery biologists working in academia, government, NGOs, and the private sector. Because of the importance of Bristol Bay's fisheries and its supporting watersheds, the WDAFS formed a committee to review "An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska." The committee was composed of 9 WDAFS members with expertise in mining, fish ecology, anthropology/ethnology, and management/regulation—5 of whom had direct scientific experience in the proposed mining district. The remaining 4 scientists have worked and published on mining issues elsewhere.

The WDAFS agrees that the report is an excellent assessment of hypothetical mining scenarios, and raises an important (albeit not comprehensive) set of concerns. We commend the USEPA for considering operational risks (human error), not merely technological risks (random failure). We also appreciate that the document on multiple occasions listed caveats to its claims, as this is a very important feature to making such a document defensible. Some groups wanted the decision as to whether mining might be permitted to be handled exclusively at the state level. The land in question is held by the State of Alaska but it is entirely appropriate for the EPA to consider the likely future consequences of direct and indirect effects of mining on fishes, wildlife, humans, and water resources using its authority under the Clean Water Act. The law itself and the background on it in the federal register clearly indicate that Congress envisioned just such an application.

Second and equally important, the WDAFS commends the EPA for clearly outlining the scope of risks that it considered in this case, including both planned and unplanned processes. Specifically, the report indicates the effects of a "no failure" scenario under which all goes as planned, all permit stipulations are adhered to, and engineering functions as designed. The report then distinguishes this from "failure" scenarios in which a series of more or less likely and more or less catastrophic events occur, indicating both the likelihood of such an occurrence on a per year and a per project basis, and the likely consequences for fish, wildlife, water, and the local human community. These failures range from ones that are essentially certain to occur though not specifically planned for, based on extensive experience with unpaved roads, mines and other operations elsewhere, to less likely but increasingly devastating events whose likelihood is based on site-specific factors including local geology (e.g., geochemistry and soil porosity), hydrology (surface and groundwater), potential for seismic activity, and other natural processes. In addition, the report considered failures of tailings dams, pipelines, water collection and treatment processes, roads, and culverts. It is essential that this strength (i.e., looking beyond the activities to be subject to permits) of the report be noted.

Of course, we have a few major concerns also, and these are outlined below. Essentially we see the Pebble Mining District as a Pandora's Box—once a metallic sulfide ore body is opened, myriad potential

contamination sources (acid mine drainage, tailings, waste rock, etc.) to the abundant ground and surface water in the region will develop and expand over time. Managing such waste into perpetuity presents unprecedented challenges and poses significant threats to the sustainability of Bristol Bay fisheries. Our comments are intended to strengthen the assessment and we also include an explicit page/line Excel file listing specific statements that would benefit from modification.

Anthropological, Ethnological, and Language Issues

The report uses some rather subjective, and politically charged concepts, such as 'pristine' and 'traditional indigenous culture'. Such terms may open the report to unnecessary criticism. Too many critiques of these concepts have been provided over the last 20 years for them to be used in this important document so uncritically (see, e.g., Cole and Young 2010, Dagget 2005, Fitzsimmons 1999, Redman 1999, Wooley 2002). The authors are assigning value to the fact that little industrial development has occurred in the region, excepting the commercial fisheries, and this in itself is not problematic because there is sufficient literature to show that industrial development has repeatedly created negative impacts for salmon habitat (see NRC 1996). However, as environmental risk and impact assessments are so heavily oriented around the notion of environmental baselines, or pre-failure conditions, it is important that any such assessment present a more defensible characterization of those conditions. Reference to biocomplexity via work by Schindler and colleagues is already included; additionally, the authors might include reference to the literature on Alaska and elsewhere regarding how indigenous resource systems often play important roles in the biocomplexity and stability of ecosystems (e.g., Williams and Hunn 1982, Maschner et al. 2009), such that further disruption of these harvests may have cascading effects across near-shore and terrestrial ecosystems, through changes in harvest strategies and compensatory prey switching (e.g., Brashares et al 2004, Loring and Gerlach 2010a)

Regarding the treatment of Alaska Native culture, subsistence, and tradition, the intent of the authors is both appreciable and valid--to characterize in as strong a way as possible the importance of salmon to local peoples. However, they root too much of this discussion within an imaginary realm of indigeneity that locks native culture into something historical and unchanging. Take for example on page ES-8 where they lament, "two of the last *intact* sustainable salmon cultures in the world," or page ES23 where they argue that "indigenous culture *will decline*" should there be negative impacts on salmon, or finally page 2-19 where they claim that "salmon as the basis for Alaska Native Cultures are inseparable." We agree with these statements in general because salmon have historically been and continue to be very important to many Alaska Natives, as reflected in economies, traditions, story, art, etc. As such, loss of salmon resources would have significant nutritional, psychological, social, economic, and cultural impacts on residents of Bristol Bay and elsewhere. But it is problematic to make too direct a link between one resource (salmon) and indigeneity itself, because the hallmark of these cultures, if there is one, is flexibility and innovation, not some static reliance on one resource (see e.g., Loring and Gerlach 2010b). Also, consider the implications should the resource in fact be compromised by some failure. Would we then be forced to consider these cultures as "dead", precluding their ability to adapt, innovate, and self-determine? Certainly there is value that should be appreciated in the cultures and

livelihoods as they are now; an additional way to argue this, and one that seems relevant to existing policy, would be from the perspective of water security, food security, and food sovereignty, as the Clean Water Act and Magnuson-Stevens already provide existing protections to fishing communities and livelihoods at the federal level.

Impacts of natural resource development projects such as these are not limited to those associated with failures. The debate over developing Pebble has already caused social conflict in the region, dividing families, communities and friends. The very presence of industrial development can significantly alter the relationship between people and the land (Davis 2009) and EPA should note that its assessment is necessarily incomplete because it is bounded by the scope of its mandate.

Although some census and economic data associated with subsistence is provided in Appendix E, EPA stated that quantifying impacts to Native cultures was not attempted in the report. We believe that the scale of the projected mining development warrants a detailed quantitative evaluation of potential impacts to Native cultures that extends beyond risks posed by a potential decline in fish and wildlife. No discussion is provided on broader mine-mediated risks such as the introduction and assimilation of a subsistence-based community into a market based economy and the potential for culture clash between the Native population and newcomers. A comprehensive evaluation should take into account the large body of research and literature that addresses the impacts of extraction-based economies on small rural communities. An evaluation framed within this larger body of literature would suggest that, regardless of the magnitude of fish population declines caused by the mining development, the Native cultures will experience substantial negative impacts led by their incorporation into a mining based market economy that as noted by EPA has a finite lifespan and follows “boom-bust” cycles. What will be left of these cultures after the bust can be assessed from what has occurred elsewhere. See Chambers et al. (2012) for additional insights.

The report indicated that developing a quantitative relationship between development and cultural effects is not possible. However, although it may be difficult to quantitatively evaluate the relationships between salmon and health/culture, this would be possible by identifying indicators of human activity in the area that have cultural significance. For example, given that salmon are critical to the entire way of life in these Alaska Native cultures (both as a subsistence resource and as the foundation for their language, spirituality, and social structure), quantitative indicators could include socio-demographic and economic structure variables such as unemployment rates, the ratio of unemployment rates of Native and non-Native populations, occupational structure, health/disease, and the possibility to live in the area on present and projected income (or resources). Such a socioeconomic evaluation should not be limited to the Yup'ik and Dena'ina Alaska Native cultures in the Nushagak River and Kvichak River watersheds; rather, it should encompass the total population in the Bristol Bay Basin.

The document focuses on Alaska Native users of these salmon fisheries in a traditional/subsistence sense (endpoint 4, section 3.3), which puts the assessment at odds with the Alaska state constitution. The constitution mandates that Alaska's natural resources be developed for the benefit of all Alaskans. Whereas this has been a sticking point between state and federal managers in the past, the EPA has an opportunity to improve the relevance of this assessment to state policymakers by not narrowing or

limiting its assessment to just Alaska Native consumers of Bristol Bay salmon, and instead reviewing the risks to all Alaskans, including those engaged in commercial, personal use, sport, and subsistence fisheries and hunting. Alaska Native concerns definitely should be highlighted, but they are not the only people whose lives and livelihoods are at risk. For example, see Chambers et al. (2012).

Risk Assessment

EPA's approach to defining risk should come sooner in the document, around ES-14, where "overall risk" is invoked but not defined.

The failure scenarios consistently underestimate and understate the maximum impact expected in a worst case failure scenario.

- Whereas it is incorrect to say that a worst case failure will occur, given the perpetual life of the mine site and the performance record of existing mines (Chambers et al. 2012; Kuipers et al. 2006; Woody et al. 2010) there is a substantial probability that one or more of the failure scenarios will happen. Kuipers et al. (2006) reported that no modern permitted mine collection and treatment system was predicted to fail—but a majority did, especially when acidic drainage and ground and surface water were involved.
- No dam will persist forever, especially when abandoned. For example, among 18 stone-walled Roman dams studied in southern Portugal, all those that were abandoned held water for only 100-200 years after abandonment (Quintela et al. 1987). However, water dams can be drained and repaired when they begin to malfunction—but dams holding toxic wastewaters cannot be drained without building another reservoir and transferring the contents from the first reservoir to the second. The TSFs—and their leachate collection and treatment systems—must persist for tens of thousands of years, not hundreds of years.
- The risks of a TSF failure and recurrence frequencies are underestimated by a factor of 10 when multiple TSFs in the mining district, seismic threats, and rain on snow flood events are considered. We recommend including worst case estimates as well as best case estimates of TSF failures.
- Explain that a TSF >200 m tall and containing billions of tons of liquified tailings will perpetually leak at the bottom and all sides through valley walls to ground water, and that eventually the mine pit will fill with ground water and begin to pass contaminated water to surface waters.
- Ghaffari et al. (2011) estimated that the Pebble resource is 11.9 billion tons, not 6.5 billion tons; that means much larger mines and TSFs than estimated in the report or by the mining firms.
- If the entire mining district is developed, the mining footprint would double from that estimated in the report and additional haul roads, pipelines, and infrastructure would be needed. The models should model the entire district, as well as the proposed Pebble mine, because of the increased damage and failure risks and to inform the other mining companies.
- A 20% tailings release from a TSF and a 30 km limit for the tailings flow are both modeling underestimates; we suggest modeling a 50% release and flow to the sea as well. We

acknowledge that this is tricky, but model confidence intervals and probabilities can and should be estimated.

- The wetland area, stream length, and stream salmonid occupancies are all minimum estimates. From the perspective of those of us who work in that region, it would be preferable to assume that all the mine footprint area is wetland unless the soils, geology and vegetation suggest otherwise, and that all the stream length supports salmonids unless the stream slopes and sizes suggest otherwise.
- The lack of rigorously collected fish assemblage and salmonid population data seriously limit modeling accuracy and likely produce gross underestimates of the effects of the mine site, pipelines, and haul road. A carefully designed survey, implemented over multiple years and seasons, is needed to provide scientifically defensible fish distribution, abundance, spawning, and production data.
- The entire report refers to salmonids, when it apparently means salmon. Arctic char, rainbow trout, and Dolly Varden are also Salmoninae. Arctic grayling (Thymallinae) and whitefishes (Coregoninae) are also salmonids. Many of these are anadromous, as are Pacific lamprey. Thus the threats to salmonids are actually greater than assumed in the report because many other salmonid taxa were not incorporated in the assessments.
- Although the laboratory toxicity tests for Cu may be state of the art, they poorly represent sensitive macroinvertebrates and algae and the ambient effects of Cu toxicity on salmonid mechanosensory systems, olfaction dependent behaviors, growth, and migration (Marr et al. 1998, Linbo et al. 2009, Tierney et al. 2010). Nor do such tests adequately evaluate the potential synergistic effects of Cu and Zn (which is not projected to be recovered from the Pebble ore; Lorz and McPherson 1976; 1977). A recently published study (McIntyre et al. 2012) documented decreased predator avoidance by, and increased predation rates on, juvenile salmonids exposed to low levels of Cu. Thus the state and federal Cu criteria are under protective of macroinvertebrate assemblages (major salmonid prey) and salmonid populations (Chambers et al. 2012; Mebane & Arthaud 2010).
- There is no clear threshold for sediment effects on fish and macroinvertebrate assemblages or survival rates of incubating salmon eggs (Bryce et al. 2010). Any additions can reduce assemblage condition, but Bryce et al. (2010) estimated minimum-effect sediment levels of 3-5% for high gradient streams.
- Greater attention should be paid to the threats of spills to Iliamna Lake, especially the near-shore spawners and lake zooplankton and phytoplankton, which are sensitive to Cu and sediment levels above background.
- Mining and sensitive fish species do not mix. Essleman in Chambers et al. (2012) reported that one mine per 5 km² limited sensitive fish taxa (like salmonids) to less than 15% of the assemblage, and that is based on all mines. A copper mine is likely to be more toxic to salmonids, and a mining district is vastly more disruptive than a single mine.
- The report essential ignores the potential effects of climate change on the project area and its structures. In contrast to present thermal and precipitation regimes, coastal watersheds with

Pacific salmon are predicted to have 2 to 3 degree warmer air and 25 to 50% more precipitation during 2079-2099 based on the current rate of anthropogenic CO₂ inputs (Maurer et al. 2007). Increased frequency of rain-on-snow events and increased rainfall will increase the probabilities of TSF, road, culvert, and pipeline failures—as well as increasing wetland acreage and ground water movement. Soil creep and slides associated with the road cut and pipelines can be expected to increase as climate change produces larger storms and more mobilized soils.

- The report explicitly disregards the absolutely inevitable and necessary infrastructure development for a mining district of this scale. The numbers of employees, roads, structures, recreationalists, and their effluents will also threaten the character of the fisheries in, and outside, the mine district footprint—just as those activities have degraded salmonid populations elsewhere. Stanfield et al. (2006) and Stranko et al. (2008) found that 4-9% impervious catchment cover sufficed to eliminate salmonids from streams. Many of these infrastructure development processes will have very substantial effects on the fish and wildlife and the subsistence use by Native communities, and also the economic value of the resource such as recreational fishing lodges. Given the number of people likely to use the road and expand into the area, increased legal and illegal take of fish and wildlife, litter, water use and contamination, interference with subsistence uses, and other forms of interaction are inevitable.

We recommend that the report not only relate the height of the TSF to commonly known structure, but that it also relates the mining district footprint and the tons of ore/tailings to known areas and volumes. For example, the Pebble footprint is 10 times the area of Washington, DC, and over half the area of Rhode Island. The volume of rock being removed as ore and redeposited as tailings would fill a train long enough to circle Earth at the equator over 50 times (Chambers et al. 2012)

It is important to state clearly that much of the potential habitat and water quality effects that are displayed in the conceptual diagrams and outlined in the risk assessment would be long term, continuous impacts not independent data points. Therefore the cumulative impact of multiple years of a single one of the human activities or sources identified in the conceptual models is the "best case scenario" endpoint of these analyses. Chapter 8, Integrated Risk Assessment, scratches the surface of assessing the interdependent impacts of the mine construction, operation, and post closure. This sort of analysis is very difficult and is usually completed as population modeling. The lack of population modeling in the report limits what it can really say about how any potential mine, much less the cumulative impacts of a mining district with multiple mines, might affect the fisheries. On page 304 of the EPA's assessment there is a description of what would be required to complete a population model for the watershed. EPA's statement that the model could not be constructed because of a lack of information on these factors is very telling. However, just because a model would be complex or time consuming does not mean that analyzing the interdependent and cumulative effects of these negative impacts to salmon habitat quantity and quality is less important. Aquatic ecosystems are complex. Mining infrastructure is complex. The chemistry of mixing metals and or byproducts with surface and groundwater is complex. The natural fluxes in precipitation, groundwater, surface water, soils, and geology are complex. Superimposing a complex facility and its operations on multiple complex and poorly understood fish populations is going to be a very complicated and difficult task. However, difficulty or expense does not justify over-simplifying a system or the analysis to make it easier to

understand or easier to complete. If the easy answer is wrong, all that matters is that it is wrong. The report has done an admirable job of outlining most of the potential impact pathways and the interrelatedness of these potential impacts. Its conceptual models provide an excellent starting place for attempting to understand how proposed mining operations are likely to negatively alter the fisheries of Bristol Bay and its watershed. Therefore, this assessment is merely a starting place, for beginning to analyze how the listed potential impacts (and others explicitly not considered) will interact and potentially cascade over the life of the proposed mine and into perpetuity.

Emphasize that ground water movement--and TSF and mine seepage—will be away from the mine and TSF. This means that such water must be collected, pumped, and treated perpetually. There is no evidence of any industry or society successfully doing so for tens of thousands of years. The classic Egyptian pyramids are less than 5,000 years old and occur in the air in an arid climate atop a relatively seismically inactive zone, yet they have been eroded substantially. A rock dam TSF in a humid climate, surrounded by unstable soils and geological faults is highly likely to develop substantial leaks within that time horizon.

Financial assurances (bonds) required by regulatory agencies for mines do not cover TSF failure or all litigation. Obtaining funds for dam repairs and tailings clean-ups typically takes decades preceded by corporate bankruptcies, litigation, and taxes on citizens (for examples see Chambers et al. 2012 & Woody et al. 2010). The current and past history of hard rock mining in the USA and the world are replete with examples of mining companies that have extracted profits for foreign companies and left the local citizens with wastelands and huge clean-up costs, but only partial mitigation of the damages. Therefore, we recommend that the report include an economic risk assessment chapter. Such a chapter would provide a brief history of mine failures, their associated costs, the processes of litigating those costs, and the costs in terms of taxes and lost resources incurred by the local residents and state taxpayers. Evidence from the many abandoned mine sites that have become Superfund sites for which state and federal taxpayers are responsible for mitigating should be included (Chambers et al. 2012; Woody et al. 2010). The economic assessment should also evaluate the perpetual value of sustainable commercial, recreational, and indigenous Alaskan fisheries and hunting.

The report also explicitly refers to “cumulative risks” from both multiple mines and multiple effects acting in concert, and this is an essential consideration. Declines of Pacific salmon and other fisheries typically have been accompanied by frustration over the difficulty in discerning which specific process contributed most heavily to the decline (e.g., fishing, logging, agriculture, hydroelectric dams, estuarine development, toxic chemicals, pathogens, natural variation, etc.). Based on the review committee’s over 300 years of research on salmonids, the mining process in anything approaching the scale described here would result in substantial reductions in fish and wildlife and water quality even without any of the catastrophic events considered in the report. Routine “no failure” operations alone would certainly diminish fish resources greatly. Combined with the inevitable human errors, unauthorized shortcuts, equipment failures, and unusual environmental events, the declines in fishes would occur at multiple spatial and temporal scales. There would, just an inevitably, be workshops, consulting companies and government scientists in meetings, white papers, and other forms of communication back and forth in an effort to determine what proportion of the decline was caused by each of the various factors. Just as the decline will surely occur, there will always be uncertainty as to precisely what proportion of the decline was caused by one factor or another. There will be peaks and troughs of salmonid abundance, and optimists or defenders of the mining operation will seize on the upticks as

proof that all is or soon will be well, and that the latest fix has done the job. The modelers will have a field day but the fisheries will continue to decline. In discussing cumulative effects, we recommend that the EPA explicitly point out the ways in which the very nature of cumulative effects typically is used to avoid responsibility, delay redress, and further increase losses of fishery resources that need protection.

Based on the preponderance of scientific evidence, significant impacts to Bristol Bay water and fisheries will likely occur based on the report's conservative mine scenarios. Should the full 11.9 billion ton Pebble deposit (Ghaffari et al. 2011), as well as the deposits elsewhere in the mining district, be extracted instead of the 6.5 billion tons in the Assessment, impacts and risks will be much greater. In light of our proven inability to conserve wild salmon concurrent with large-scale development (Stouder et al. 1997, Lackey 2003, Montgomery 2003, Rand et al. 2012), we strongly recommend that the final report include (1) an Agency denial of use of the area because of unacceptable adverse effects on fishery areas (including spawning & breeding) under Section 404c of the Clean Water Act, and (2) an explicit explanation of the legal bases for that denial in light of the science included in the report.

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