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Subject: Comments on the development of a metal mining district in the headwaters of the Stikine, Taku, and Unuk rivers, with examples from the KSM (Kerr-Sulphurets-Mitchell) Proposed Mine Environmental Assessment

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The American Fisheries Society (AFS) is the world's oldest and largest professional society of fishery and aquatic scientists and managers. Our 7,000 members are employed by academia, industry, consulting firms, nongovernmental organizations, and federal and state/provincial agencies. The AFS mission is to improve the conservation and sustainability of fishery resources and aquatic ecosystems by advancing fisheries and aquatic science and promoting the development of fisheries professionals. Because development of a metal mining district in the headwaters of the Stikine, Taku, and Unuk rivers is likely to negatively affect both Alaskan and

British Columbian waters and fisheries (Daniel et al. 2014), we formally request International Joint Commission (IJC) review of the mining district proposed for the Alaska/British Columbia border region. To support this request, we respectfully submit the following comments on the Kerr-Sulphurets-Mitchell (KSM) Application for Environmental Assessment Certificate (Seabridge Gold 2013; EIS), the Canadian Environmental Assessment Agency (2014) study report (EA), and the British Columbia Environmental Assessment Office (2014) assessment report (EA)

AFS has a long-standing interest in science and management issues related to watersheds that support valued fisheries. Projects such as the proposed mining district carry the strong likelihood of affecting habitats of commercial and recreational fisheries. The following AFS policy statements affirm the Society's concerns about projects that will affect water quality, fish movements, and related services:

#1 ***North American Fisheries Policy*** - provides a broad focus on the economic and ecological value of healthy fish populations.

#2 ***Overview Policy on Man-Induced Ecological Problems*** - connects population growth and technology, with concern about how new technology can impose biological, chemical, physical, and geological impacts on fish populations and related societal values.

#4 ***Sedimentation*** - expresses concern about human activities that change movement of silt, sand, and gravel through a watershed, often with unintended impacts to valued fishes.

#9 ***Effects of Altered Stream Flows on Fisheries Resources*** - speaks directly to the effects of new flow regimes on river systems, especially habitat that supports fishes.

#13 ***Effects of Surface Mining on Aquatic Resources in North America*** - describes concerns regarding the on-site and off-site effects of mining operations at the watershed level.

The breadth of those five policies confirms AFS's standing in the broad fields related to mining and watersheds. The cumulative knowledge on which those policies were based confirms the difficulty of designing an environmentally benign, or even environmentally responsible, mine or mining district. At the same time, our efforts confirm the enormous difficulty of mitigating for impacts that promise to change the structure and function of entire watersheds.

GENERAL COMMENTS

Six British Columbia mines in the headwaters of the Stikine, Taku, and Unuk rivers are in various stages of permitting and development. One of them, Red Chris, may open at any time and the KSM environmental assessment has been approved. Each of the transboundary rivers, which begin in British Columbia and drain into Southeast Alaska, support prime salmon habitat and produce millions of wild salmon. Mines and mining districts of similar size, complexity, and geology have and are expected to result in acid mine drainage (AMD), and few of the previous mitigation plans have been successful. Therefore, If the mining district is developed, these transboundary waters and salmon are likely to experience contamination from acid mine drainage, heavy metals, toxic sediments, and other pollutants as projected for the Pebble Mining District in Alaska (USEPA 2014). These toxins could leach slowly from the mines or be released in a catastrophic spill like that at the Mount Polley mine in central British Columbia on 4 August 2014. Because rivers and salmon do not recognize national boundaries, it is the responsibility of the United States and Canada to collaborate in maintaining healthy ecosystems. The Boundary Waters Treaty of 1909 established the International Joint Commission to ensure that "waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."

Seabridge Gold at the proposed KSM Mine plans to use conventional open pit and underground block caving mines with froth flotation of the crushed ore, which will require large amounts of cyanide, and will affect unprecedented amounts of water requiring water treatment in perpetuity. The proposed copper mine is under an active glacier in an area of unstable fish habitat, high precipitation, and extremely rugged terrain. Two 23 km tunnels under the glacier are proposed for pipelines and transporting ore and personnel. If implemented, it will produce 1.62 billion tons of tailings stored behind two Hoover-sized earthen dams just above the Unuk River. This project will dump 2.3 billion tons of acid generating waste rock into a valley-fill of a tributary of the Unuk River, which flows through Misty Fjords National Monument and is one of the top salmon producers in Alaska (Hendrich et al. 2008). The location, type, and size of the mine, the environmental records of similar mines, problems related to acid mine drainage, and protecting water quality in the long term are issues of substantial concern to fish, other aquatic biota, subsistence fishers, and the professionals charged with conserving those resources. The mitigation measures proposed are technically challenging and unproven, including the construction of long diversion and maintenance access tunnels that need to be kept open and functional in perpetuity; the operation of water treatment plants at an unprecedented scale, again in perpetuity; the installation of a novel liner system to protect the pit from acid rock drainage; and the collection and rerouting of acid rock drainage for treatment. The amount of the financial assurance bonds for the operation and maintenance of the post-closure facilities is not addressed in the proposal. The net present value will probably exceed C$1 billion dollars, which has significant potential impact to taxpayers if it is not calculated and managed properly (USEPA 2000; 2004; NRC 2005). A firm with no experience in operating a mine, let alone a mine of this scale, is proposing the mine. It is likely that a partner will be necessary to finance the project, and will likely become the mine operator. Whether this new company will address environmental and social concerns adequately is of considerable concern (Chambers 2013).

The EIS and EAs predict habitat loss during all project phases, as well as at road and transmission line crossings. They rely on habitat suitability criteria developed in rainfall-dominated Washington rivers that differ markedly from the glacially-influenced project area rivers. Therefore, estimates of habitat loss and impact are highly uncertain. Two critical physical habitat parameters for salmonids (flow and temperature) lack sufficient measurement and analysis in the EIS and EAs. Historic flow data were estimated from historic climate data and temperature and apparently was measured continuously in only two locations, making effects of altered flows and temperatures on fish habitat uncertain. Both flows and temperatures are likely to be altered by climate change and glacier melting, which receive no consideration in the fish and aquatics chapter of the EIS and EAs. Few parameters other than sediment were measured for more than two years, resulting in poor estimates of interannual variation. Consequently, most of the fish and aquatic habitat data cannot be used for separating mine impacts from natural interannual variability.

Indirect impacts on fishes of concern are neither calculated nor discussed in the EIS and EAs. For example, increased metals concentrations may not only affect fish directly via lethal and/or sublethal effects, but also indirectly by reducing invertebrate prey (Schmidt et al. 2010) and periphyton (Lavoie et al. 2012). Nonfish-bearing headwaters are generally referred to as 'poor quality,' however headwaters are crucial in determining physical, chemical, and biological characteristics of receiving waters downstream (Alexander et al. 2015).

The EIS and EAs rely upon consistent efforts to minimize project effects through use of monitoring, and to mitigate unavoidable effects. Rigorous monitoring would be required along roads and transmission lines and throughout mine facilities, particularly during extreme weather events when failures are more likely to occur and access is difficult. Rigorous post-closure monitoring may be impractical and costly. The EIS and EAs fail to document the effectiveness of proposed mitigation techniques, many of which have been unsuccessfully implemented at other similar mines (Kuipers et al. 2006; USEPA 2014) and at the Mount Polley tailings pond that failed in 2014.

Therefore, because of the uncertainty surrounding the assumptions underpinning the EIS and EAs, the known impacts of mines on fish (Daniel et al. 2014), and the lack of sufficient financial sureties should failures occur, the conclusions of non-significant impacts to fish and aquatic resources are not supported by the science or the history of mining.

SPECIFIC COMMENTS (in reference to Seabridge 2014)

4.5.1.7.4 Stability Analysis

It appears that there has been no seismic dynamic modeling performed for the waste rock facilities. The waste rock dumps will contain more than a billion tons of potentially acid-generating material located in very steep terrain with the potential for a large earthquake. These facilities must be designed to maintain their structural integrity in perpetuity or the potentially acid-generating material will not be confined to the area designed to collect the acid seepage. Seismic stability analysis using numerical modeling should be conducted for the waste rock dumps.

4.5.1.11 Mine Site Water Management Facilities

The diversion tunnels, high flows, steep elevation changes, and contaminated water will inevitably lead to substantial problems that must be resolved to prevent off-site contamination such as occurred during the tailings spill at the Polley Mine in British Columbia last year. This is of significant concern for the post-closure period when there are few personnel on site, when funding is limited by the assumptions made in establishing a financial assurance bond, and if the financial assurance omits funding for unplanned events.

4.5.1.11.4 Water Storage Facility

The horizontal acceleration provided in the EIS for a maximum credible earthquake, 0.14 g, is low for this area given its proximity to the Juan de Fuca-North American Plate boundary. Horizontal acceleration is typically 0.3 to 0.6 g – but it depends on the size of the assumed seismic event, and the assumed distance from the event to the dam site. The distance to the assumed seismic event is not disclosed in the EA or supporting documents, and that is another critical variable (Hull et al. 2003).

4.5.1.11.5 Mine Site Water Treatment Plant

Post-closure water treatment is planned for only 200 years. Perpetual post-closure treatment should be assumed in calculating the financial surety.

4.5.3.10.2 Geology and Surficial Geology

It appears that the dams will lie on top of whatever native material is present, except for loose, shallow deposits. Like the Mount Polley tailings dam, the proposed KSM rock storage dam appears to lie on glacial deposits, a key factor in that dam's failure. Construction on non-bedrock material adds uncertainty to dam stability and seepage predictions (U.S. Bureau of Reclamation 2012). This is a serious concern for dams designed to last in perpetuity (ICOLD 2001; WISE 2011). Monitoring wells need to be located to measure the flow of contaminants beneath the tailings dam, and an adaptive management plan is needed for managing any detected contaminants.

Some non-potentially acid-generating material will be required for construction. Selection and identification of this material should be done carefully, especially for road material off the mine site proper.

4.5.3.10.3 Dam Structures

The tailings pond will be equipped with an impermeable geomembrane liner to restrict seepage of tailings water into the groundwater. However, only the Residue Cell, between the Splitter Dam and Saddle Dam, is proposed to be fully lined. The North and South TSF dams, which back floatation tailings up against the Residue Cell, is not proposed to be lined. Those cells contain the bulk of the tailings, and leakage of sulfate, and possibly selenium, is probable. The proposed seepage mitigation (adaptive management) plan is only for the Water Storage Facility, not for the Tailings Storage Facility. The BC EA notes that the proponent has committed to develop a seepage monitoring plan for the TSF and minesite, but it has not yet done so. Because we do not know the details of those plans, we recommend developing a comprehensive seepage collection system to monitor liner performance and a rigorous adaptive management plan is needed for collecting and treating unplanned seepage. The EIS and EAs predicted that dam failures would be unlikely because the mine owner would monitor the dams and repair them as needed. Such plans have not precluded previous dam failures.

Access roads will be susceptible to avalanches (Sakals et al 2012). After mine closure, maintaining access roads for water monitoring and treatment facilities will become a significant post-closure expense. Pre- and post-maintenance costs should be considered as a cost item in the project cost calculations.

It will be very difficult to maintain earthen dams in perpetuity in a region that now exceeds 60 inches of precipitation annually, especially in a region predicted to have increased precipitation and an increased number of extreme storm events as a result of climate change (Healey 2011; Mote et al 2014).

12.1.4 Processing and Tailing Management Area (PTMA)

The proposed PTMA is within a valley spanning two creeks with high permeability surficial fluvial deposits, low-permeability glacial till approximately 30 m thick in the valley bottom, and moderate permeability alluvial fans up to 90 m thick along the valley edges. Given the geology and related hydrologic characteristics, seepage is likely from the unlined portions of the PTMA. Even though the tailings in the unlined portions of the tailings management area are not acid generating, arsenic, selenium, and sulfate are likely to contaminate ground water because of the highly permeable soils. As indicated above, sufficient monitoring wells to detect any unplanned leaching must be incorporated in the groundwater monitoring network at the PTMA, and an adaptive management plan is needed for collecting and treating unplanned seepage.

12.11 Groundwater Quality

The proposed project assumes that degradation of groundwater quality will be confined to the mine site. The history of large mines of this type is that groundwater contamination is difficult to restrict to the mine site (Woody et al. 2010). It is not in the public interest to allow contamination off the mine site, especially contamination that could occur in perpetuity. Sufficient monitoring wells to detect any unplanned leaching must be incorporated in the groundwater monitoring network at the PTMA, and an adaptive management plan is needed for collecting and treating unplanned seepage.

Table 14.6-1. Potential Effects from Project on Surface Water Quality

Of the 49 project facilities listed, 42 could degrade surface waters.

14.7.1.2.2 Mine Site Water Quality Model

A portion of the dispersive plume was predicted to become reconnected with Sulphurets Creek beyond the seepage dam, with an average concentration estimated to be 5% of that in the water storage facility (WSF) source. The flow rate of the contact groundwater beyond the seepage dam was estimated to be 1 L/s. 1 L/s = 8.3 million gal/year. If the average concentration of the plume is 5% of the water in the WSF, the copper concentration in the groundwater plume would be 15.07 mg/L x 0.05 = 0.75 mg/L. Water with this copper concentration would cause significant contamination unless diluted at least 100:1 to avoid impacts to fish (Chambers et al. 2012). There is no commitment to confine surface water contamination within the mine boundary. It is not in the public interest to allow contamination off the mine site, especially surface water contamination to occur in perpetuity.

Table 14.7-23. Mine Site Water Treatment Plant Effluent Quality

The discharge from the mine site water treatment plant will not meet British Columbia water quality guidelines for copper, lead, or selenium. This means a mixing zone would be required, but the size of a mixing zone and its potential impacts are not mentioned in the proposal. The water quality standards that would be applied to mine discharges should be included in the proposal.

Table 14.7-34. Water Quality Predictions for the Unuk River (site UR1)

The mean water quality prediction for copper for the expected case is 0.0219 mg/L. It would take a hardness of approximately 250 mg/L for copper to avoid having chronic impacts on aquatic organisms (Chambers et al. 2012). This is an atypically high hardness level for surface waters in this region. The 95th percentile water quality prediction for copper for the expected case is 0.0821 mg/L. Copper in surface water at this concentration will be acutely toxic to aquatic organisms regardless of the hardness level (Chambers et al. 2012).

Table 14.7-38. Water Quality Predictions for the Unuk River (site UR2)

Site UR2 is at the US border. The mean water quality prediction for the expected case exceeds the Alaska aquatic organisms water quality standards (WQS) for iron (1.89 mg/L versus 1.0 mg/L for the WQS), and the predicted water quality concentrations for copper and lead (7.7 ug/L and 1.25 ug/L, respectively) require a hardness of approximately 75 mg/L or greater to be within Alaska WQS. Copper, lead, and iron are likely to exceed Alaska WQS in the Unuk River at the U.S. border based on the 95th percentile of the expected case, which is what the Alaska Department of Environmental Conservation uses to compute Alaska Water Quality Standards. The predicted iron level for the 95th percentile is 8.89 mg/L versus 1 mg/L for the WQS. At the same assumed 75 mg/L hardness, the 95th percentile for copper is predicted to be 0.0309 mg/L vs. 0.0076 mg/L for the WQS, and for lead it is 0.052 mg/L versus 0.0026 mg/L for the WQS. It is unlikely that Alaska WQS will be met in the Unuk River at the border for iron, copper, or lead.

14.8.2.4 Degradation of Water Quality in the Unuk River

Selenium concentrations are predicted to exceed the BC water quality guidelines at site UR1, indicating degradation of water quality in the operation, closure, and postclosure phases of the project. At high concentrations, selenium poses significant risk to both aquatic organisms and terrestrial wildlife (USEPA 2004). There is no discussion of what WQS will be imposed, or if a mixing zone will be granted. Water treatment should be designed to meet BC water quality guidelines in the Unuk River.

14.8.2.6 Degradation of Water Quality in the Teigen Watershed

Nitrogen is predicted to exceed BC water quality guidelines in both the Treaty and Teigen watersheds.

15.1.2.1 Fisheries Act

Although Dolly Varden is considered the most widespread fish species in the immediate project area, it is not considered a salmonid species in the EIS. It should be recognized as such and it should be determined if resident and/or migratory populations occur in the area. In addition, as a critically important indicator species, rigorous pre-project monitoring of those populations and their habitats should be incorporated as part of the proposed mine and mining district.

Table 15.1-3. Summary of Fish and Aquatic Habitat Studies for the KSM Project

Because periphyton and invertebrates are ubiquitous and exhibit very little movement relative to fish, they are important components of any freshwater monitoring program. Consequently, estimating their interannual variability is essential to estimating mine impacts. None of the stream sites were sampled with enough replication to estimate interannual or spatial variability or the potential effects of a mine or mining district on physical and chemical habitat or biota (Stevens and Olsen 1999; Cao et al. 2002; Hughes and Peck 2008; Smith and Jones 2008; Anlauf et al. 2011; Gitzen et al. 2012; Bowen et al. 2015; Irvine et al. 2014). Additionally, salmonid escapement numbers tend to vary widely from year to year, but sampling was insufficient to estimate that variability as well. This is a serious shortcoming given that the Wild Salmon Policy bases biological status on the abundance and distribution of spawners.

15.1.4.2.3 Unuk River Watershed

Although only Dolly Varden were reported captured in the Unuk River upstream of Storie Creek, sampling sites on the Unuk River above Storie Creek are too sparse to determine accurate presence/absence of other fish species with known confidence limits (Stevens and Olsen 1999; Cao et al. 2002; Hughes and Peck 2008; Smith and Jones 2008; Anlauf et al. 2011; Gitzen et al. 2012; Bowen et al. 2015; Irvine et al. 2014).

15.1.4.3.2 Fish Habitat

The majority of stream sites were considered non-fish-bearing because of channel slopes greater than 30%, natural barriers, and poor quality fish habitat. Assumptions regarding natural barriers and poor quality fish habitat should be defined, and a subset of streams should be surveyed to verify whether fish are present or not.

15.7 Potential for Residual Effects for Fish and Aquatic Habitat

Given that the proposal relies on a myriad of measures to mitigate the effects of mining, a literature review regarding the effectiveness of those techniques is warranted.

15.7.4 Water Quality Degradation

High, acutely lethal concentrations of metals or changes in pH are not expected to occur except in the event of a lethal spill. However, this prediction is surprising given the extremely high potential for acid generation in the mine area and the high concentrations of metals in the mine area and its surroundings (Sengupta 1993).

15.7.4.3.1 Potential for Residual Effects Due to Metals

The predictions in this section rely on flawless operation without spills, overflows, or accidents caused by extreme weather events, earthquakes, mechanical failures, or human error. Experience from similar projects indicates that this scenario is highly unlikely (Earthworks 2012).

15.7.4.7 Pacific Salmon: Potential Residual Effects Due to Water Quality Degradation

Potential residual effects to Pacific salmon may occur due to water quality degradation from both point and non-point sources associated with the project, as was found in Idaho (NRC 2005) and other western USA states (Woody et al. 2010) and projected in Alaska (USEPA 2014). This is of particular concern to Alaskans because of the migratory life history of Pacific salmon, and the cultural and economic importance of those species. This also applies to residual effects to aquatic habitat for fish spawning, incubation, rearing, and migration.

Tables 15.8-2-6. Summary of Residual Effects on Bull Trout, Dolly Varden, Rainbow Trout/Steelhead, Pacific Salmon, and Aquatic Habitat.

Although all residual effects for all fish taxa and aquatic habitat included were determined as 'Not Significant' and most direct and cumulative effects were described as 'Minor,' the environmental record indicates that impacts to fishes and aquatic biota from large-scale, porphyry copper mining are virtually inevitable and neither minor nor insignificant (Farag et al. 2003; Earthworks 2012; Daniel et al. 2014).

15.8.4.1.2. Project Infrastructure Habitat Compensation

The EIS stated that most beaver ponds at the site provided poor quality overwintering habitat and obstructed fish access upstream of dams. However, the EIS presented no empirical data to support those conclusions and beaver habitat is known to benefit aquatic biota by increasing habitat heterogeneity, rearing and overwintering habitat, flow refuges, and invertebrate production (Bryant 1984; DeVries et al. 2012).

Table 27.11-1. Closure and Reclamation Costing

Nothing in the EAs discussed financial sureties. The reclamation and closure costing information in the EIS should be addressed in terms of financial security rather than cost to the company. Financial security costs assume bankruptcy of the operator, and typically include interim operations costs, general and administrative costs, and long-term costs commonly estimated on the basis of a trust fund. The estimated total reclamation costs of $131,771,857 do not include interim operations costs. Interim operations, which might be required for as long as five years or more prior to site reclamation beginning in the event of operator default, could be expected to cost up to $50 million. All reclamation costs should be increased by at least 30% to reflect general and administrative costs consistent with BC guidance for financial security.

27.12 Post-closure

The post-closure water treatment costs have been estimated at $20,383,500/year. The annual cost of operating the selenium treatment plant has been estimated at $6,656,620, including labor.

These costs do not include replacement costs, which would be expected to occur over the life of the water treatment plant, including replacement of moving parts (every 10 years), stationary parts (every 20 years), and the plant itself (every 50 years). Nor do the costs include those resulting from avalanches or earthquakes that would affect road access or treatment plant function. A financial security based on a 2.5% discount rate consistent with BC guidance would therefore be approximately $1.3 billion. It is highly questionable whether any project proponent is capable of providing real financial security in this amount, and that amount represents the extremely high risk to taxpayer liability over both the short and long terms for this project. The proposal should be deemed inadequate because it does not disclose any detail on how the project proponent or regulatory agencies will ensure that funds will be available in perpetuity to implement the closure and post-closure obligations. Without this information, it is unlikely that essential mitigation would be adequately funded in the long term.

35.3 Catastrophic Dam Break Analysis

There is inadequate discussion of seismic-induced failure in the EIS and EAs. The British Columbia EA offers fairly detailed estimates of economic benefits of the mines, but omits the potential costs of tailings pond and water storage facility failures. This seems unconscionable given the recent Mount Polley tailings pond failure, its $600 million rehabilitation costs, and the inability of the mine owner, Imperial Metals, to fund those costs. There should be discussions of seismic failure, the effects of contaminated water and deposited contaminated sediment from a dam failure, and the need for the very large water storage dam and the tailings dams to persist in perpetuity.

Like the waste rock dump analysis, it appears that only a pseudostatic analysis (seismic coefficient analysis) of dam failure was performed, which does not consider the build-up of earthen dam pore pressure from shaking. Today, few U.S. regulatory agencies accept pseudostatic methods for seismic design of new dam projects. The most rigorous method is to use finite element or finite difference programs in which dynamic response, pore-pressure development, and deformations can be fully coupled (e.g., Jibson 2011). All large, permanent dams and waste rock dumps should be analyzed for potential seismic failure using such a dynamic model. The maximum credible earthquake, determined by a probabilistic method and assuming a location conservatively close to the mine site, should be used.

Last, the estimated $600 million cost of rehabilitating the recent spill from the much smaller Mount Polley mine indicates that cost of rehabilitating a spill from a much larger KSM mine would exceed $1 billion.

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