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Re: Stibnite Gold Draft Environmental Impact Statement

I. BACKGROUND

Sarah O'Neal has over 20 years of international experience in freshwater ecology of salmonid ecosystems spanning the Pacific Rim and the southern Atlantic Ocean. Her expertise includes water quality, freshwater foodwebs, resident and anadromous fishes, and interactions between them in lakes and streams. She has worked for private and public agencies, tribes, and non-governmental organizations. She has a Bachelor's Degree in conservation biology from the University of Washington, a Master's Degree in freshwater ecology from the University of Montana's Flathead Lake Biological Station, and is currently a Ph.D. Candidate in the School of Aquatic and Fisheries Sciences at the University of Washington conducting research specific to characterizing temporal and spatial variability of multiple aspects of salmon habitat.

II. SCOPE OF REVIEW

This review was requested by Idaho Rivers United (IRU) for the purpose of providing fisheries information and analysis of the Stibnite Gold project. It includes an assessment of data validity and assumptions in fisheries and associated models that affect predictions of mining impacts to fish and their habitat. Material reviewed all or in part included are summarized in Table 1.

Table 1. Stibnite Gold Project material reviewed for the purposes of this document.

Author	Date	Title	Section/s if applicable
US Forest Service (USFS)	2020	Stibnite Gold Project Draft Environmental Impact Statement	Chapter 3.12
USFS	2020	Stibnite Gold Project Draft Environmental Impact Statement	Chapter 4.12
USFS	2020	Stibnite Gold Project EIS Appendix D	
USFS	2020	Stibnite Gold Project EIS Appendix J	
MWH Americas, Inc.	2017	Aquatic Resources 2016 Baseline Study	
Brown and Caldwell	2018	Final Stibnite Gold Project Stream and Pit Lake Network Temperature Model Existing Conditions Report	
Brown and Caldwell and others	2019	Draft Fishway Operations and Management Plan	
Brown and Caldwell and others	2019	Final Fisheries and Aquatic Resources Mitigation Plan	
GeoEngineers	2017	Aquatic Resources 2016 Baseline Study Addendum Study	

III. GENERAL FINDINGS

This review of the Stibnite Mine Draft Environmental Impact Statement (DEIS) and associated documents focused on the evaluation of baseline conditions and predicted impacts to fish and their habitat. All four species of salmonids (Family *Salmonidae*) evaluated in the DEIS are of conservation concern, with Chinook (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and bull trout (*Salvelinus confluentus*) listed under the US Endangered Species Act, and westslope cutthroat trout (*O. clarki lewisi*) federally designated as a sensitive species. In general, with some exceptions especially for steelhead, the DEIS predicts Stibnite Mine development will result in net decreases in habitat quantity and quality relative to current baseline conditions for the species evaluated. However, **the habitat decreases predicted in the DEIS are vast underestimates of direct, indirect, and cumulative impacts that would result from mining** due to the currently impacted nature of the habitat, mischaracterization of current baseline conditions, underpredictions of impacts to water quantity and quality, and glaring omissions of physical, chemical, and biological components of fish habitat and productivity. Moreover, **mitigation methods proposed are not sufficient to reliably to reverse impacts**, much less improve existing, impaired habitat during or after additional mining occurs.

Salmonids in the proposed Stibnite Gold Project Area exhibit diverse life histories and habitat exploitation, though all species are highly migratory and require habitat complexity for population persistence. The maintenance of both habitat and life history diversity are essential to the sustainability of salmonid populations—a concept widely recognized as the portfolio effect (Schindler et al. 2010). The importance of the portfolio effect—and the ability to mitigate for or restore it—is generally overlooked by the DEIS. While mining and associated development impacts are extensively (if inaccurately) evaluated in the document, it assumes little interaction between impacts which ultimately work to simplify habitat and subsequently life history diversity.

III-A. IMPACTS OF MINING AND ASSOCIATED DEVELOPMENT

Very little literature describes the spatial and temporal extent or variability of mine and associated development impacts, but there are general conceptual models describing far reaching and long lasting impacts (Figure 1). Although dozens of specific impacts have been described, most are interrelated, and many fall within the broad categories briefly described below.

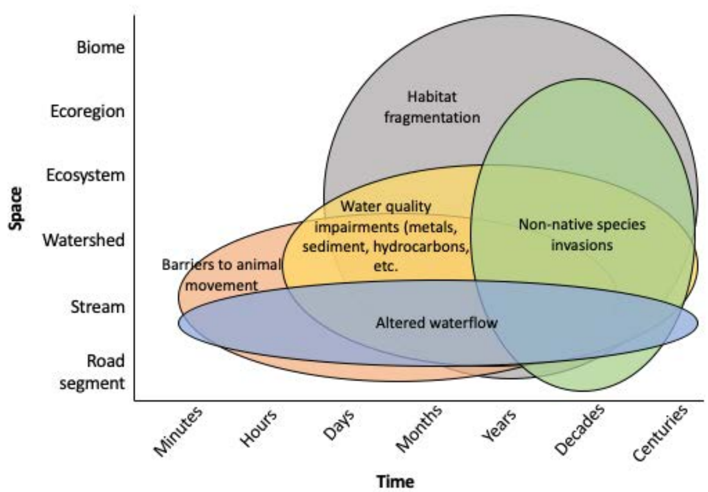

Figure 1. Temporal and spatial dimensions of ecological effects of mine and road development. Adapted from Angermeier et al. 2004 and NRC 2005.

1. Habitat Simplification

Particularly in floodplain (but in many if not most) stream habitats, simplified flow patterns resulting from mining related water withdrawals and road crossings prevent and/or restrict the migration of river channels across their valley bottom, and thus their connection to riparian, wetland, other groundwater-influenced, and headwater habitats crucial to their overall function (Vannote 1980, Stanford and Ward 1993, Forman and Alexander 1998, Hancock 2002, Colvin et al. 2019; Figure 2). River channel migration creates and manages side channels, pools, surface water and groundwater interactions, and nutrient dynamics, creating the habitat complexity essential to the productivity and sustainability of all native aquatic life (Stanford et al. 2005, Whited et al. 2012, Luck et al. 2015, Bellmore et al. 2017). In undeveloped watersheds, channel migration and associated cut and fill of riverbanks and instream habitat, respectively, are further facilitated by beaver and debris dams, and ice processes (e.g., Malison et al. 2015). These natural processes combine to create the complex habitat that Pacific salmon and associated fishes have relied upon for their millennia-long sustainability. Most often, bridge and especially culvert widths do not span the zone of channel migration, in spite of permitting requirements and best management practices. While the up and downstream up and downstream extent of habitat simplification remains difficult to quantify, impacts last for beyond the construction, use, and even closure of mines and roads.

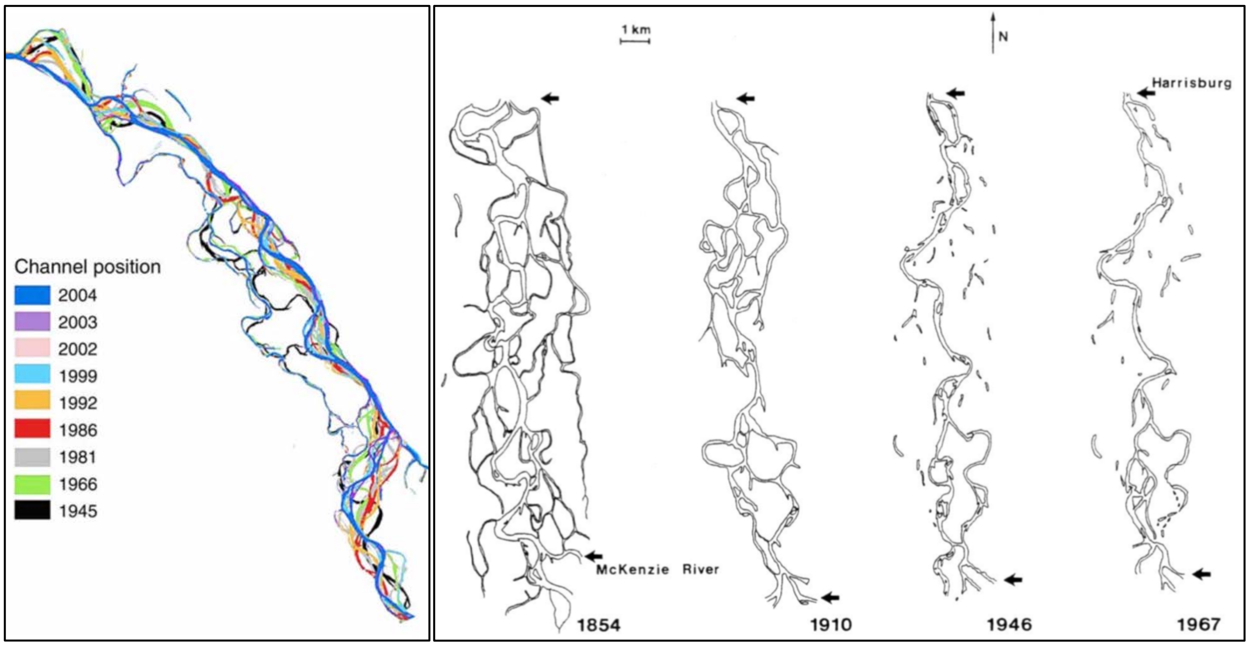

Figure 2. Habitat complexity driven by channel movement over time in the undeveloped Nyack River, MT floodplain (left), compared to habitat simplification driven by development in a Willamette River, OR floodplain (right). Images from Whited et al. 2007, and Sedell and Froggatt 1984.

Because streams simplified by reduced flows and/or encumbered by culverts and bridges become disconnected from the valley bottoms they historically migrated across, they often become incised into a narrower, deeper channel than occurs in undeveloped watersheds (Figure 3). This alters stream hydrology (frequently increasing stream velocity), channel structure, and generally leads to increased fine sediment deposition in the vicinity of the crossing (Figure 3). These changes can lead to velocity barriers, lack of resting habitat, and direct loss of salmonid spawning and incubation habitat which requires gravel to cobble-sized substrates. The velocity and sediment influences of road crossings alone can extend about 0.5 km (0.3 mi) upstream and 1 km (0.6 mi) downstream of (Forman and Alexander 1998), alter groundwater and surface water interactions, nutrient dynamics, and ultimately biological productivity. Ultimately, habitat simplification resulting from Stibnite mine development would last beyond the end of the mine and road operation.

Figure 3. Examples of complex, free flowing habitat in an undeveloped watershed (A, B), compared to simplified, incised habitat in a developed watershed (C, D). The undeveloped stream reach illustrates ideal fish spawning, incubating, and rearing habitat, while that in the developed stream reach is impaired habitat resulting from disconnection from its floodplain, a lack of complexity and shade from riparian vegetation, and imbedded substrates resulting from fine sediment deposition. From Whited et al. 2017.

2. Decreased water quality

The United States Environmental Protection Agency (USEPA 2000) estimates 40% of western US headwater streams are contaminated by hard rock mining. Persistent impacts of mining to aquatic insects, fish including salmon, and habitat are widely documented (e.g., Kemble et al. 1994, Pascoe et al. 1994, Farag et al. 1998, Maret and McCoy et al. 2002). Metals can be toxic to fish and other aquatic life at lethal and sublethal levels, and through direct and indirect pathways. Impacts to water quality from mine and associated road development alone include: altered temperatures, decreased surface water and groundwater interactions; increased turbidity and, potential acid and metals generation from the road cut itself; and spills, runoff, and dust deposition of metals, hydrocarbons, reagents, and deicing salts). Many of these pollutants will deter, impair, or kill migrating salmonids and other aquatic species, depending on their concentrations. Very little existing data describe the spatial extent of these impacts, though acid and metals from road cuts have been documented over 7 km (4.3 mi) downstream of road crossings (Morgan et al. 1984). Impacts can persist for decades to millennia (e.g., Davis et al. 2000).

In addition to impacts to from increased metals concentrations, mining and associated road construction will increase sediment inputs causing cascading effects through aquatic foodwebs that negatively impact salmonid growth, survival and reproduction. Sediment deposition can impair instream spawning and incubation conditions by filling interstitial spaces between gravels used for egg deposition and incubation, thus decreasing availability of oxygen to incubating embryos and altering thermal regimes influenced by groundwater (Bisson and Bilby 1982, Hartman et al. 1996, Malcom et al. 2003, Stanford et al. 2005, Sear et al. 2008). Embryo survival decreases with increased sedimentation in spawning redds (Greig et al. 2005). Suspended sediments generated from soil disturbance and erosion caused by mining and road construction on floodplains and other near-stream locations increase turbidity and decrease growth and survival of fishes (Newcombe and MacDonald 1991, Newcombe and Jensen 1996). Mechanisms of impact caused by elevated suspended sediment include: alteration of behavior and reduced physiological health of juvenile steelhead and coho salmon (Berg and Northcote 1985, Michel et al. 2013); decreased productivity of stream food webs, which can deplete the aquatic food sources that support fish growth (Newcombe and MacDonald 1991, Henley et al. 2000); and interference with foraging by trout and salmon, increasing feeding costs and reducing growth (Platts et al. 1989, Barrett et al. 1992, Waters 1995, Shaw and Richardson 2001).

3. Migration barriers

Tailings dams, road crossings, and other mine infrastructure frequently become barriers to migratory salmon, resident fishes, and lamprey migration because of physical, chemical, and biological factors. In addition to the physical factors described above (habitat simplification, increased velocities and sedimentation), mine infrastructure and associated stream crossings may become physically impassable to fish. The Yellow Pine Pit Lake is already a permanent migration barrier, and other proposed mine-associated features could become permanent barriers—i.e., bridges and culverts planned for fish passage could become temporarily blocked (e.g. with wood, ice, or overflowing water; Figure 4). For example, one recent evaluation in Montana indicated 76-85% of culverts acted as migration barriers during low flow (Blank et al. 2005). Impacts of blocked migration extend to the upstream and downstream ranges of anadromous and resident migrating fishes—potentially miles up and downstream, collectively accumulating dozens of stream miles in total. The duration of impact would equal that of the blockage, which could be hours (until inspection or repair) to years (after the mine and/or roads are abandoned).

Figure 4. Examples of common causes of culvert blockages: beaver activity (left), ice on Alaska's North Slope (middle), and flooding (right). Images from lizottesolutions.com, Michael Baker International 2019, and thurstontalk.com.

Even without blockage, culverts can delay upstream migration by 1-20 days by funneling high flows (and thereby exceeding velocity thresholds), or during low flows (when water depth becomes insufficient; Lang et al. 2004). Although culvert design has improved with increased consideration for fish passage, passage effectiveness is still mixed, and depends heavily on information describing species presence and stream flows. Even culverts appropriately designed according to modern standards intended to allow for fish passage still fail because:

- Some culverts are still installed incorrectly or improperly maintained,
- After a culvert is installed, stream geomorphology changes, so the culvert design no longer allows fish passage, and
- Opportunities for improving fish passage are lost due to the "emergency" status of culvert replacements following a flood or other culvert failure (Lang et al. 2004).

4. Introduction of non-native species

Increased human traffic of any kind increases the likelihood of non-native species introduction and/or proliferation. Brook trout (*Salvelinus fontinalis*) are an existing non-native species in the Stibnite Gold Project Area that impact native salmonids and aquatic foodwebs in general. Not only do brook trout compete for local food resources, they can hybridize with bull trout making field identification difficult and compromising the genetic integrity of a species of conservation concern (USFS 2000, Appendix J). Other aquatic species of potential concern include (but are not limited to) terrestrial and wetland plant species which may simplify and alter important riparian habitat, e.g., sweetclover, (*Melilotus alba*), Canadian waterweed (*Elodea canadensis*), salmon and other fish pathogens (e.g., whirling disease, *Myxobolus cerebralis*). The upstream and downstream extent of the impact of non-native species is not known, but could extend at least meters to kilometers from the mine and associated infrastructure. Invasive species inevitably cause cascading impacts to entire terrestrial and aquatic food webs and are considered amongst the largest threats to global species and habitat diversity (Vander Zanden et al. 1999, White et al. 2017). Given the difficulty of eradicating non-native species, impacts would likely last for decades to centuries.

5. **Indirect and cumulative impacts**

Multiple stressors in combination (e.g., increased metals concentrations and sediment, increased temperatures, altered stream flows, channelization of habitat and associated loss of floodplain and other habitat connectivity) accumulate through developed river networks. This can result in a loss of spawning, incubating, and rearing habitat for all fish species over time and space. Because Chinook salmon, steelhead, bull trout, and westslope cutthroat trout are migratory, adverse impacts can accumulate even when fish are absent from a particular reach. Not only does mine development directly impact habitat coincident with the mine footprint, impacts propagate through trophic levels, time, and space. These cascading effects are largely overlooked in the DEIS. The overall result of similar indirect and cumulative effects throughout the Pacific Northwest and other salmon habitat has resulted in the reduction and in some cases extinction of many salmonid populations (NRC 1996).

III-B. SHORTCOMINGS OF THE STIBNITE GOLD PROJECT DEIS

1. **Comparing impacts to current habitat conditions drastically underestimates cumulative impacts of mining.** In the DEIS, mine impacts are compared to current baseline conditions. Habitat considered in the DEIS is already severely impacted by historic mining in the area and other development activities. Undoubtedly, historic mining impacts contributed to the current conservation status of all species evaluated. While the proposed alternatives describe some remediation of historic impacts, mine cleanup efforts simply cannot restore habitat to pre-mining conditions and cannot outweigh impacts from currently proposed mining. Previous domestic and global efforts have shown habitat restoration and mitigation is difficult, expensive, and often ineffective. Impacts should be predicted relative to estimated habitat conditions prior to mine development.

The historic Stibnite/Yellow Pine mining site was located in the same watershed as the newly proposed Stibnite Mine described by the DEIS. The historic site was mined from the early 1900's to the late 1990s largely for antimony (Sb) and gold (Au). Contaminants associated with those operations resulted in heavy metals and cyanide contamination in area soils, groundwater, seeps, sediments, and thus surface waters (EPA 2020). An initial assessment conducted by the US Environmental Protection Agency (EPA) in 1985 determined habitat impairments in the watershed significant enough to consider it amongst the US's most contaminated sites in (EPA 2020). Despite some cleanup efforts, the site remains contaminated, with designation as a Superfund site. Moreover, numerous streams in the East Fork drainage of the South Fork Salmon River (EFSFSR) as well as the South Fork Salmon River (SFSR) exceed Idaho standards for drinking water and aquatic habitat, and thereby are considered 'impaired.' Exceedances are documented for arsenic (As), Sb, mercury (Hg), temperature, and sediment in watersheds and subwatersheds that will be impacted by mining (IDEQ 2018). While the DEIS indicates that water quality will be improved by treatment associated with the proposed Stibnite mining project, ground and surface water flows are poorly characterized and treatment is neither sufficiently described nor tested for effectiveness (see Prucha 2020, Semmens 2020, Zamzow 2020).

2. **Current baseline conditions are insufficiently—and frequently inaccurately—characterized, rendering predictions of impact unreliable.**

    a. Hydrologic models lack appropriate spatial and temporal resolution, fail to robustly integrate groundwater and surface water interactions, and include additional flaws and inadequacies, ultimately resulting in mischaracterization of existing hydrologic conditions (see Prucha 2020, Semmens 2020, Zamzow 2020).
    b. With the exception of descriptions of proposed mitigation methods, physical habitat characteristics—past or present—are virtually ignored in the DEIS despite their fundamental role in fish population productivity. Besides stream channel dimensions, gradient, stream flow and substrate, off-channel habitat, floodplain connectivity, and other habitat elements known to influence salmonid productivity receive virtually no consideration in the main body of the document or the main appendix regarding fish resources and habitat.
    c. While current water quality may be accurately described, many area waters are considered impaired due to high temperatures and excessive sedimentation, As, Sb, and HG. As discussed above, the current state of impaired water quality should not be measured as baseline from which to predict allowable impact.
    d. Multiple models used to describe various aspects of habitat are flawed oversimplifications of salmonid ecosystems, and/or rely on model inputs generated by other flawed and inaccurate models. This renders their utility for predicting and measuring impact questionable at best. Flawed models include the Stream and Pit Lake Network Temperature (SPLNT), Intrinsic Potential (IP), Occupancy (OMs), and Physical Habitat Simulation (PHABSIM) models. See detailed comments below for specifics.
    e. Salmonid distribution, abundance, and density estimates use flawed methodology and interpretation, and lack the spatial and temporal resolution to characterize baseline variability. Consequently, adequate characterization of existing, listed salmon and trout populations are lacking. The DEIS concludes that population level impacts to salmonids are unlikely to result from Stibnite Mine development. However, given underestimations of impacts and the lack of adequate baseline characterization of salmon populations, population level impacts from mine development (and other contributing factors) could simply not be readily detected from information provided in the DEIS.
    f. Metals concentrations of tissue from fish and other aquatic species can be a useful indicator of baseline conditions and an early indicator of low-level, chronic and/or indirectly accumulating increases of metals concentrations that may go undetected by routine monitoring. The DEIS evaluation of baseline metals concentrations in tissues are limited to a very small number of highly mobile westslope cutthroat trout specimens, and two sculpin specimens. Because of their mobility, cutthroat trout are a poor indicator of local conditions. Sculpin tend to more closely reflect their environment, though sample size is vastly insufficient for any utility in characterizing baseline or measuring future impacts. Moreover, metals concentrations in tissues of biota inhabiting lower trophic levels is absent in the DEIS. More baseline metals concentration data from area biota should be required prior to any permitting decisions.

3. **Physical habitat impacts from mining are underestimated in the DEIS**. While some important aspects of habitat complexity and connectivity were characterized in baseline assessments referenced in the document (e.g., off channel and riparian habitat, existing large woody debris, zones of groundwater and surface water exchange, etc.), they are ignored in the DEIS predictions of impacts. Degradation of those habitats from decreased flows, road crossings, increased sediment loads, spills, and other activities associated with mine development will inevitably impact salmonid populations.

4. **Impacts to water quantity and quality from Stibnite Mine development are vastly underestimated in the DEIS**. Flawed assumptions and conclusions from the baseline hydrologic model are compounded in predictions of hydrological impacts. Water temperature predictions rely on the same baseline hydrologic model outputs (indicating they are also flawed), predict substantial

temperature increases, but fail to incorporate well documented impacts of climate change. Because water temperature is fundamental to salmonid growth and survival during multiple (and for some species all) aspects of their freshwater life history, seemingly small deviations from predictions could result in drastic underestimations of mining impacts. Water chemistry impact predictions consider unjustifiably limited parameters of concern. The DEIS qualitatively evaluates impacts to fish from potential increases in concentrations of few metals (mainly As—arsenic, Cu—copper, Hg—mercury, and Sb—antimony). Those described impacts are largely minimized in the document. Copper is considered amongst the most toxic elements to all aquatic life with increases of 2-20 parts per billion imparting deleterious indirect impacts on salmonid survival. Mercury biomagnifies with increasing trophic levels, ultimately leading to grave concerns for human health. Information regarding toxicological impacts of both As and Sb are insufficient in the literature at large, and virtually non-existent for the Stibnite Gold project area.

Moreover, multiple other contaminants of significant concern to salmonids and other aquatic life receive no consideration in the DEIS. Some overlooked impacts of metals considered, in addition to impacts of several other EXISTING contaminants at the site most likely related to historic mining activities (Al—aluminum, Cd—cadmium, Fe—iron, Mn—manganese, Se—selenium, and Zn—zinc; see Zamzow 2020). Other metals are likely to increase as a result of Stibnite Gold Project development, but given the certainty of increases in these metals, some potential impacts of lesser considered metals are described below. In particular, because they biomagnify, Hg and Se should both be considered in much more depth than they are in the DEIS. Moreover, information regarding toxicity (direct, indirect, lethal, and/or sublethal) of Sb (antimony) is widely lacking (Eisler 2010). Given the near certainty of increases in Sb concentrations resulting from Stibnite Mine development, laboratory toxicity testing (including laboratory tests using site specific waters) should be required prior to permitting.

a. Aluminum

Aluminum (Al) is geologically abundant but serves no known biological function and exposure to Al could potentially be deleterious to all forms of aquatic life (Gensemer and Playle 1999). Aluminum contamination is typically associated with acid rain or deliberate addition of Al for algae or other plant control purposes, however elevated Al levels occur in the Stibnite mining area (Zamzow 2020).

Acute and Chronic Toxicity

Mechanisms of Al toxicity to fish are either:

1. Ionoregulatory, meaning they disrupt salt and water balances across the gill and other cellular membranes, and/or
2. Respiratory, leading to clogging of gills by mucus at high Al concentrations and insufficient oxygen exchange (hyperventilation and eventually suffocation).

Like most metals, Al toxicity increases in the acidic environments associated with metal-sulfide mines. Calcium, or increased hardness, provides some protection against Al toxicity (Gensemer and Playle 1999). Larvae emerging from gravels may be the most sensitive salmonid life stage to Al (Delonay et al. 1993), which is concerning given that salmonid species including Chinook, steelhead, bull trout, and cutthroat trout incubate in the gravels around and downstream of the Sibnite Mine site. Salmonids have demonstrated an ability to acclimate to increased Al concentrations in laboratory environments (Orr et al. 1986), however a metabolic cost may be associated with acclimation (Wilson and Wood 1992).

Sublethal Toxicity of Aluminum

Below levels known to induce mortality, Al can have sublethal impacts on salmonid physiology and behavior. When Al accumulates on the gill surface, mucous production can increase by up to four times normal levels, inhibiting respiration (Wilson et al. 1994). Stress associated with impaired respiration can inhibit the ability of salmonids to deal with additional stressors, including natural stressors like smoltification for anadromous (i.e., Chinook and steelhead salmon) species (Dennis and Clair 2012). For example, juvenile Atlantic salmon exposed to Al exhibited a 20-30% reduction in survival and reduced seawater tolerance (Krogland and Finstad 2003, Monette et al. 2008). In addition, Al can reduce salmonid growth rates and swimming speeds. Aluminum can also impair salmonid olfaction which is critical to locating predators and prey, mates and kin, and homing to natal streams. Interference with any of these processes essential to survival and successful reproduction could ultimately lead to populations level impacts.

Indirect Effects of Aluminum

Although less toxic to invertebrates than fish, Al does have deleterious effects on zooplankton and insects known to be important diet items for salmonids (Wilson and Wood 1992, Wilson et al., 1994). Aluminum is also toxic to algal species which form the base of the aquatic foodweb and are a main diet item for many macroinvertebrate species. Consequently, deleterious effects of Al can reverberate throughout the foodweb with ultimately negative impacts on salmonid growth and survival, particularly for those species which spend time rearing in freshwater (i.e., Chinook, rainbow/steelhead, westlsope cutthroat, and bull trout).

b. Cadmium

Like Al, Cadmium (Cd) is biologically non-essential. Although it occurs at low concentrations in aquatic systems, it commonly occurs in sulfide-ore bodies. Historic mine sites are frequently contaminated with cadmium exceeding background levels by as much four orders of magnitude—the Stibnite area exhibits occasional exceedances of Cd standards (Farag et al. 2003, Mebane et al. 2012, Johnson et al. 2016; Zamzow 2020). Cadmium is extremely toxic to aquatic life.

Acute and Chronic Toxicity

Exposure to cadmium (Cd) in fish occurs primarily through water in the gill and kidney (waterborne exposure) or in the intestine (dietary exposure; Franklin et al. 2002b). Cadmium mimics calcium (which *is* biologically essential), inhibiting its uptake which can lead to death (McGeer et al. 2011). Consequently, waters naturally high in Ca (naturally hard) waters ameliorate the toxic effects of Cd. Dissolved organic matter can also decrease the bioavailability or overall toxicity of Cd. Salmonids are more sensitive to acute levels of Cd toxicity than aquatic macroinvertebrates or other fishes (Farag et al. 2003, Mebane et al. 2012). However invertebrates (particularly amphipods) are more sensitive to chronic exposures of Cd (Mebane 2010). Less is known about mechanisms of dietary exposure to cadmium, though dietary uptake has been proven more toxic than waterborne exposure for some invertebrate species (Mebane 2010). Cadmium also induces neurotoxic effects in fish including hyperactivity leading to decreased growth and increased detection by predators (Mebane 2010). Examinations of life-stage sensitivity suggest that emerging fry are most sensitive in Chinook salmon, while emerging fry and rearing parr are equally sensitive to Cd in rainbow/steelhead (Chapman 1978).

Sublethal Toxicity of Cadmium

Sublethal physiological impacts of Cd include reduced growth and condition factor (unit weight per unit growth—an index of fish health; Riddell et al. 2005, Lizardo-Daudt and Kennedy 2008). Reproduction is also impacted, with impaired egg development and premature hatching (Lizardo-

Daudt and Kennedy 2008). Furthermore, immune response may be depressed after Cd exposure as evidenced by elevated stress chemicals in exposed salmonids (Ricard et al. 1998). Documented behavioral effects of Cd on salmonids include a diminished ability to avoid predators—possibly due to olfactory inhibition (Scott et al. 2003), diminished foraging success (Riddell et al. 2005), and altered social behavior including less aggressive competition (Sloman et al. 2003). At extremely elevated Cd levels, salmonids have been documented avoiding waters altogether (Mebane 2010). If contamination from groundwater, a tailings dam breach, storage water spill, or treatment plant failure occurred at Stibnite Mine, particularly during salmon spawning, spawners could fail to reproduce altogether, or stray to nearby streams, potentially eroding the diversity essential to maintaining overall sustainability.

Indirect Effects of Cadmium

Deleterious effects of Cd can reverberate throughout the foodweb with ultimately negative impacts on salmonid growth and survival, particularly for those species which spend time rearing in freshwater (i.e., Chinook, rainbow/steelhead, and bull trout). Although invertebrates are less sensitive to acutely toxic levels of Cd, some invertebrates exhibit increased sensitivity to Cd at chronic levels of toxicity. Because dietary exposure is a known pathway of Cd contamination to fishes, indirect effects of Cd through food is poorly understood but highly likely.

c. Copper

Copper (Cu) is a naturally occurring, essential element that frequently increases in areas with active sulfide mining. It is one of the most pervasive and toxic elements to aquatic life and has been documented at levels one to three orders of magnitude greater than background in mining areas (Grosell 2011). Copper is utilized in growth and metabolism of all aerobic organisms.

Acute and Chronic Toxicity

Copper toxicity increases in acidic conditions, soft waters (low hardness), and in waters depauperate of dissolved organic matter. Exposure to Cu in fish occurs primarily through water in the gill, kidney, olfactory receptors, and lateral line cilia (waterborne exposure), or in the intestine (dietary exposure; Grosell 2011). Because it is essential to biological function, it is readily incorporated into fish tissues. Olfactory inhibition resulting from Cu exposure occurs within minutes and lasts for weeks or longer, with the potential to affect all aspects of salmonid biology (Grosell 2011). It is known to reduce growth, immune response, reproduction, and survival (Eisler 2000). Specific examples of toxic effects include disrupted migration; altered swimming; oxidative damage; impaired respiration; disrupted osmoregulation and pathology of kidneys, liver, gills, and other stem cells; impaired mechanoreception of lateral line canals; impaired function of olfactory organs and brain; and altered behavior, blood chemistry, enzyme activity, corticosteroid, metabolism, and gene transcription and expression (Hodson et al. 1979, Knittel 1981, Rougier et al. 1994, Eisler 2000, Craig et al. 2010, Tierney et al. 2010). The effects have been demonstrated for juvenile and adult life stages primarily of coho and Chinook salmon and rainbow trout.

Sublethal Toxicity of Copper

Many sublethal effects of Cu are identical to those causing mortality. Physiological effects of Cu exposure include decreased growth, swimming speed or activity, and feeding rates (Waiwood and Beamish 1978a, Waiwood and Beamish 1978b, Marr et al. 1996). Coho salmon exhibit diminished immune response after exposure to Cu (Stevens 1977, Schreck and Lorz 1978). Reproductive performance also decreases in adult salmonid (Jaensson and Olsen 2010). Very slight increases in Cu concentrations (5-25 parts per billion) inhibit olfaction in coho and Chinook salmon and rainbow trout, with potential to inhibit recognition of predators, prey, mates, kin, and natal streams

(Hansen et al. 1999a, Hansen et al. 1999b, Sandahl et al. 2007, Baldwin et al. 2011, McIntyre et al. 2012). Chinook salmon and rainbow trout avoid Cu contaminated waters altogether, except after long-term sublethal Cu exposure, after which their avoidance response may be impaired (Hansen et al. 1999a, Meyer and Adams 2010). Avoidance can lead to degradation of spawning patterns and resulting genetic diversity which are essential to maintaining overall population structure and sustainability. Adult spawning migrations are delayed or interrupted in Cu contaminated streams, and downstream smolt migration is likewise delayed and osmoregulation of smolts in seawater is impaired (Lorz and McPherson 1976, Schreck and Lorz 1978, Hecht et al. 2007). Copper-exposed salmon are also more vulnerable to predation (Sandahl et al. 2007, McIntyre et al. 2012).

Indirect Effects of Copper

Numerous studies document adverse effects of Cu on freshwater algae, zooplankton, mussels, and other invertebrates, which could result in reduced prey abundance and quality to support fish growth and reproduction (Wootton 1990, Scannell 2009). Copper is one of the most toxic metals to algae, which form the base of the salmonid food chain. Algae production can decline at Cu increases of only 1-2 parts per billion (ppb; Franklin et al. 2002). Zooplankton and other invertebrates that rely on algae for food suffer decreased growth and reproduction when primary production decreases (Urabe 1991). Zooplankton and lotic macroinvertebrates are also extremely sensitive to Cu increases (Farag 1998, Zipper et al. 2016).

d. Iron

Iron (Fe) is an essential element involved in oxygen transfer, DNA synthesis, and immune function in all life. Like other metals, it is frequently associated with mining activity and its effects tend to increase in the presence of acidic conditions and the absence of dissolved organic matter. Relatively little is known about mechanisms of Fe toxicity.

Acute and Chronic Toxicity

Primary mechanisms of Fe exposure are waterborne and dietary. On the gills, iron precipitate accumulates causing physical damage and clogging. Resulting respiratory impairment is likely the main toxic effect of Fe contamination to salmonids (Dalzell and MacFarlane 1999). Additionally, elevated Fe concentrations during fertilization caused hardening of eggs.

Sublethal toxicity of Iron

Little information is available regarding sublethal effects of Fe. Coho salmon actively avoided Fe-enriched water in one study, which has implications for degradation of genetic diversity and population structure and sustainability (Updegraff and Sykora 1976). In studies of other vertebrates, Fe had impacts on brain function and social behavior (Bury et al. 2011).

Indirect Effects of Iron

Similar to fish gills, red-colored Fe-precipitate commonly associated with mine waste also settles on aquatic insect gills, resulting in decreased insect abundance and diversity, ultimately decreasing food resources for rearing fishes (Gray and Delaney 2010).

e. Mercury

Mercury is a metal which is non-essential to physiologic functions of life. While mercury occurs naturally at low levels in the environment, anthropogenic actions including mining have increased background mercury levels by two to four times in the aquatic environment even in remote places due to atmospheric deposition (Jewett and Duffy 2007, Kidd and Batchelar 2011).

Acute and chronic toxicity

While mercury can be acutely toxic, its toxicity to wild fish is more commonly related to chronic exposure to methylmercury (a bioavailable form of mercury) via diet (Kidd and Batchelar 2011). Like selenium, methylmercury bioaccumulates up aquatic food webs, with highest concentrations generally occurring in largest, oldest, piscivorous fish (e.g., Northern pike—*Esox lucius*, Arctic grayling—*Thymallus arcticus*, Dolly Varden—*Salvelinus malma*; Jewett and Duffy 2007). In freshwater environments, methylmercury bioaccumulates in both lakes and streams (McIntyre and Beauchamp 2007, Kwon et al. 2012), though mercury concentrations in fish in rivers generally exceed those of fish in lakes in the western US and Canada (Eagles-Smith et al. 2016). Chronic methylmercury exposure has impacts at very low levels (muscle or whole-body concentrations of 0.5-1.2 µg/g; Kidd and Batchelar 2012), including: neurotoxicity causing brain lesions and organ damage that impairs abilities to locate and capture prey and avoid predation; inhibition of reproductive success and growth; damage to intestines, digestion, cellular metabolism, organs; and alteration of stress hormones (Kidd and Batchelar 2012).

Indirect effects of Mercury

Indirect effects of methylmercury exposure which alter behavior and ultimately survival include decreased competitive feeding abilities, swimming performance, and predator avoidance (Kidd and Batchelar 2012). Of additional concern is the bioaccumulation of methylmercury in important subsistence species (e.g., Northern pike and Arctic grayling) which can lead to increased risk of heart disease, higher miscarriage rates, lower female fertility, decreased coordination, brain damage *in utero*, and higher blood pressure in children of adult consumers (Loring et al. 2010).

f. Selenium

Selenium (Se) is an essential trace element important to protein synthesis, but is one of the most hazardous elements to fish. The margin between essentiality and toxicity of Se is very slim (Janz 2012), and successful methods of water treatment are not yet developed. Unlike other metals, decreased water temperatures increase Se toxicity. Some metals mining operations and ore smelting are commonly associated with Se contamination. There are no examples of modern, operating mines which have successfully treated selenium to biologically acceptable levels.

Acute and Chronic Toxicity

Acute Se toxicity rarely results from anthropogenic activity. Chronic Se exposure, however, is teratogenic (causing malformation) to early life stages of fish (i.e., embryos, alevins, and fry; Lemly 2004). Unlike other metals, toxic effects occur primarily through dietary as opposed to waterborne pathways. Adult life stages are relatively tolerant of dietary Se intake, but can pass its effects to their offspring (Janz 2012). Selenium is deposited into eggs during their formation resulting in deformations typically in the skeleton, skull, or fins (Janz 2012).

Sublethal Toxicity of Selenium

Few studies have investigated sublethal Se effects. Avoidance of Se contaminated waters has not been documented, nor have changes in reproductive behavior of fishes in increased Se concentrations (Janz 2012). In one study, swimming speed, frequency, and distance were reduced after Se exposure in non-salmonid fishes (Janz 2012).

Indirect Effects of Selenium

Unlike most trace elements, selenium bioaccumulates (accumulates faster than metabolic or excretory loss) and sometimes biomagnifies (increases in animal tissue at successively higher levels of the food chain). Bioaccumulation and biomagnification cannot be predicted from Se concentrations, making sufficiently protective water quality guidelines exceedingly difficult to estimate. Since diet is the primary source of Se to fish, its efficient uptake by algae and macroinvertebrates contributes to Se toxicity. Interestingly, algae and invertebrates themselves exhibit little sensitivity to Se exposure (Janz 2012). Consequently, relatively low Se concentrations can lead to fish toxicity via bioaccumulation. Population level effects of Se contamination have been documented in multiple freshwater ecosystems, though further investigation is needed. In multiple case studies, the majority of fish species have been extirpated as a result of Se exposure (Lemly 2004, Janz 2012).

g. Zinc

Zinc (Zn) is an essential element used by vertebrates in protein (including hemoglobin) synthesis. It is a common contaminant associated with mining activity. Like Cd, Zn mimics calcium, inhibiting its uptake which ultimately leads to death (McGeer et al. 2011). Consequently, waters naturally high in Ca (naturally hard) waters ameliorate the toxic effects of Zn.

Acute and Chronic Toxicity

Dietary uptake poses lower risk to fish than waterborne exposure primarily through gills. Waterborne exposure competitively inhibits Ca, binding to sites on fish gills and leading to impaired gas exchange, gill inflammation, and ultimately suffocation, or decreased survival, growth, reproduction, and hatching (Hogstrand 2011). Dissolved organic matter can also decrease the bioavailability or overall toxicity of Zn. Fish kills and/or the absence of fish (including salmonid) species are commonly associated with elevated Zn, Cu, and Cd concentrations downstream of mining activity (Farag et al. 2003, Hogstrand 2011).

Sublethal Toxicity of Zinc

Increased stress and decreased immune response has been attributed to Zn exposure in rainbow trout (Wagner and McKeown 1982, Sanchez-Darden et al. 1999). Juvenile rainbow trout and other salmonids have also been documented avoiding Zn-contaminated waters (Hogstrand 2011). Other effects of Zn on behavior include increased ventilation and cough rates, altered swimming patterns, and decreased growth (Hogstrand 2011).

Indirect Effects of Zinc

Like other metals, effects of Zn can reverberate throughout the foodweb with ultimately negative impacts on salmonid growth and survival, particularly for those species which spend time rearing in freshwater (i.e., Chinook, trout, and bull trout). Invertebrates are more sensitive to acutely toxic levels of Zn than fish, so decreased feeding opportunities are a likely pathway for indirect effects of Zn (Santore et al. 2002).

5. **Impacts to salmonids from project related groundwater changes are ignored in the DEIS.** Groundwater and hyporheic inputs increase salmonid incubation and emergence success, and often support higher densities of fish due to their temperature and oxygen profiles relative to surface waters. Not only are groundwater flows poorly predicted in the DEIS, their role in salmonid survival and resulting impacts to it from changing groundwater levels is unaddressed.

6. **Temperature increases ignore climate change, are otherwise underestimated and their impacts are unreasonably minimized.** In addition to other shortcomings of the model used to predict project related temperature changes, it fails to incorporate temperature increases due to

climate change. Climate change is already impacting bull trout and cutthroat trout habitat and those impacts will only be compounded by project related temperature increases. Moreover, even impacts of predicted temperature changes (up to about 4º) are minimized despite the pivotal role of temperature in determining spawn and emergence timing, incubation rates, and salmonid growth and subsequent survival.

7. **Impacts to all non-salmon/trout species—fish and other aquatic life that support them—are ignored in the DEIS.** Mountain whitefish (*Prosopium williamsoni*), suckers (*Catostomus* sp.), anadromous Pacific lamprey (*Entosphenus tridentatus*) and other important fish, freshwater insects, algae, and other primary producers are all critical elements of the foodwebs supporting salmonids considered in the EIS. Ignoring impacts to salmonid foodwebs is equivalent to ignoring impacts to salmonids at large.

8. **The DEIS assumes no interactions among impacts**. By considering fish species, stream reaches, and limited habitat impacts (e.g., stream dewatering, temperature increases, increases of metals concentrations, migration barriers) all separately, the DEIS fails to acknowledge the broad ecological understanding that multiple stressors will amplify one another's effects on the ecosystem. This assumption ignores volumes of peer reviewed and other literature contradicting it, particularly that related to the so-called "death of a thousand cuts" leading to salmon population declines (NRC 1996). It results in a serious underestimate of impacts to fish and their habitat.

9. **Loss of headwater streams are falsely assumed to have no downstream impacts**. While loss of stream miles are estimated for the project area itself, those estimates exclude consideration of the function of upstream, contributing waterbodies, and downstream, receiving waterbodies. Headwater and/or upstream habitats are fundamental drivers of physical, chemical, and biological characteristics of their downstream receiving waters. Intact headwaters and wetlands comprise fundamental elements of thriving salmon habitat, and their fragmentation is considered a leading cause of global salmon declines (Colvin et al. 2019). Both long-term small scale and short-term largescale development fragment and simplify the complex physical habitat mosaics upon which all fish and aquatic life depend, introduce contaminants into the environment, and ultimately degrade the biological interactions that support robust fish populations. Failure to incorporate those impacts in the DEIS result in a substantial underestimation of project development.

10. **The DEIS assumes that mitigation and restoration efforts are possible and effective.** The DEIS assumes that mitigation for historic mining efforts will offset impacts from proposed mining efforts. Experience has shown that habitat restoration and mitigation are difficult, expensive, and often ineffective. Restoration activities to restore salmon, trout, lamprey, and other fish restoration are ongoing and extremely expensive. The US General Accounting Office estimates approximately $1.5 billion were spent on Columbia River salmon and steelhead restoration activities from 1997-2001 (USGAO 2002). Multi-billion dollar expenditures continue, although no Pacific salmon population has been removed from the ESA list of threatened and endangered species. Even modern fish passage design simply cannot account for spatial and temporal variability of historic baseline conditions, current conditions, and future conditions that will result from mining and associated development activity in addition to climate change. Moreover, other mitigation methods proposed (Appendix D, Table D-2) rely heavily on unspecified and/or unproven habitat "improvements," fish salvage, and trap and haul operations. While a slight improvement over constructed fishways, trap and haul operations are well documented inducing significant stress (e.g., increased cortisol levels, gill flaring, etc.), disorientation (particularly in salmon homing to natal rivers and streams), deleterious changes to migration timing, increased mortality, and direct injury (e.g., Lusardi and Moyle 2017). Experience throughout Pacific salmon habitat, and particularly in the Columbia River basin indicates beyond question that trap and haul operations and most other restoration techniques are simply palliative. Already threatened salmonid populations will not be restored by (and may not survive) mining activity and the mitigation methods loosely proposed in the DEIS.

IV. SPECIFIC COMMENTS

The Stibnite Project DEIS conclusions regarding the Affected Environment (Chapter 3.12) and Environmental Consequences (Chapter 4.12) rely on Appendix J in addition to dozens of supporting documents cited in that appendix. Each document consists of tens to thousands of pages and an unwieldy association between multiple flawed models. Locating and downloading documents from the project website is cumbersome at best, and many of the documents cited within them were not readily available (https://usfspublic.app.box.com/s/4r3aeu4waxlvu1r7aew2ydpgpiq1pkpj/folder/120404461032). While the most cited, recent, and seemingly relevant supporting documents were reviewed to varying degrees, time and logistical constraints limited the ability for an exhaustive review. A more thorough review may have identified myriad more flaws in impact predictions. However the lack of consideration for the basic ecology of salmonids and their freshwater habitat, integration of temporal, spatial, indirect, and cumulative variability of baseline habitat (i.e., Affected Environment), and general effects of mining and associated development (i.e., Environmental Consequences) would be unlikely to add worthwhile insight to overarching conclusions regarding the insufficiencies of the DEIS. While different project alternatives draw different conclusions about the amount of habitat impacted, the flaws associated with the conclusions are consistent throughout alternatives. Consequently, specific comments were written with regard only to Alternative 1, but generally apply to all mine development alternatives.

IV-A. CHAPTER 3.12 – Affected Environment (Fisheries)

p. 3.12-18: "The 2017 NMFS Recovery Plan identified recovery strategies for Snake River spring/summer Chinook salmon for the Lower EFSFSR and Upper EFSFSR watersheds (proposed mine site location) including…

- Maintain current wilderness protection and protect pristine tributary habitat;
- Provide/improve passage to and from areas with high intrinsic potential through barrier removal;
- Reduce and prevent sediment delivery to streams by improving road systems and riparian communities, and rehabilitating abandoned mine sites; and
- Manage risks from tributary fisheries according to an abundance-based schedule."

Comment: The proposed Stibnite Gold project is not in accordance with the NMFS Snake River Chinook recovery plan.

> p. 3.12-22: "**Table 3.12-2** shows that of the entire 16.72 km of potential habitat is within the temperature thresholds for adult migration, adult spawning, juvenile rearing, and common summer habitat use; however, only 4.99 km (30 percent) is within the water temperature threshold for incubation and emergence. The length of potential habitat was based on access and Intrinsic Potential modeling, which is described further in Section 3.12.4.2.5, Intrinsic Potential Modeling – Chinook Salmon.

Comment: This statement discounts any actual use of impacted streams for incubation and emergence, and also appears to discount the importance of microhabitats (e.g., areas of upwelling groundwater, undercut banks, etc.) that often provide critical habitat to salmonids, but are not sufficiently characterized by typical temperature sampling or modeling. Moreover, the reference to the source table is not trackable (i.e., The source information for Table 3.12-1 is described as baseline from Brown and Caldwell (2019b Table C-19. No such Table could be found in Brown and Caldwell references in this Chapter, nor in the Appendix J-2 referred to in the text as the source). In addition to adequate ecological interpretation, the DEIS should include trackable citations.

> p. 2.12-31: "Habitat limiting factors for the South Fork Salmon River steelhead population are linked to human disturbances, such as mining and road construction. Human disturbances and heavy precipitation make the subbasin susceptible to large sediment-producing events that degrade

habitat quality for steelhead. Roads located near streams encroach on riparian habitat, limit potential sources of large woody debris, and create passage barriers at road-stream crossings. Priorities for addressing limiting factors in the South Fork Salmon River steelhead population include mitigation and elimination of sediment inputs from human-caused disturbances and elimination of artificial fish passage barriers."

Comment: While not abundant according to DEIS data, steelhead (and Chinook) do currently use habitat above the Yellow Pine Pit Lake, indicating that although habitat may be degraded, it is still used. Undoubtedly, mine expansion will worsen sediment and other habitat impairments for already listed fish.

p. 3.12-35: "The 2017 NMFS Recovery Plan included recovery strategies for Salmon River steelhead. Priorities for steelhead populations specific to the EFSFSR watershed include: (1) collect and analyze population-specific data to accurately determine population status; (2) maintain wilderness protection and protect pristine tributary habitat; (3) eliminate artificial passage barriers and improve connectivity to historical habitat; (4) reduce and prevent sediment delivery to streams by rehabilitating roads and mining sites; and (5) manage risks from tributary fisheries through updated Fisheries Management Evaluation Plans and Tribal Resource Management Plans according to an abundance-based schedule."

Comment: At the least, mine development would interfere with recovery strategies (2) and (4

p. 3.12-36:

Table 3.12-7 Steelhead Trout Temperature Thresholds

Steelhead Trout Life Stage	Range of Water Temperature Thresholds in degrees Celsius and (season)	Baseline Maximum Temperature (degrees Celsius)
Adult Migration	15-22 (Summer)	13.4 – 19.8
Adult Spawning	4-14 (Spring)	13.4 – 19.8
Incubation/Emergence	6-10 (Spring/Summer)	11.1 – 16.2
Juvenile Rearing	10-20 (Year-round)	11.1 – 19.8
Common Summer Habitat Use	10-17 (Summer)	13.4 – 19.8

Table Source: **Appendix J-2**, Stream Temperature Impacts on Fish Technical Memorandum. Baseline temperatures from Brown and Caldwell (2019b: Table C-19).

Comment: According to the table, steelhead spawning and incubation/emergence will be most sensitive to mine development. The citation could not be located in spite of significant effort to locate it.

p. 3.12-36: "Overall, findings show there is 2.13 km of available habitat (**Appendix J-2**), all of it is within the thresholds for adult migration, adult spawning, juvenile rearing, and common summer habitat use; however, there is no available habitat (0 km) within the water temperature threshold for incubation/emergence."

Comment: It appears this is likely to be used to justify further degradation to habitat, despite clear evidence (e.g., Figure 3.12-8) that steelhead occur throughout the study area. Although the figures do not display life stage of steelhead detected, they present clear evidence that some incubation/emergence does indeed occur in the study area. It is likely that temperature measurements do not consider microhabitat complexities such as groundwater upwelling that may provide cold water refugia for incubation.

p. 3.12-37: "**Figure 3.12-8** displays the distribution of steelhead in the analysis area. Steelhead trout occur throughout the EFSFSR, up to Yellow Pine pit where a steep high gradient riffle/cascade caused by past mining activities is thought to preclude upstream migration. Steelhead can maneuver through higher gradients than Chinook salmon; however, genetic surveys (eDNA sampling) suggest such migration does not occur above the Yellow Pine pit lake. Genetic surveys (eDNA sampling) can give positive results for steelhead trout when the fish is actually another type of trout (e.g., cutthroat, rainbow, or golden trout) because they are trout species and they can hybridize. Hybridization between cutthroat trout and rainbow trout (*Oncorhynchus mykiss* spp.), in waters where they co-occur, is common. Of the 153 individual fish tissue genetic samples collected in 2015 in Meadow Creek and the EFSFSR near Meadow Creek (upstream of the Yellow Pine pit), 146 tissue samples were pure westslope cutthroat trout (95.4 percent), and seven tissue samples were westslope cutthroat trout/rainbow trout hybrids (MWH 2017). An additional 33 eDNA fish tissue samples from various locations upstream of the Yellow Pine pit lake (between 2014–2016) were collected and two fish tested positive for rainbow trout DNA (0.6 percent), one in Meadow Creek Lake and one in the East Fork Meadow Creek (Blowout Creek). It is likely that the rainbow trout genetics detected from these locations are, in fact, California golden trout (*Oncorhynchus mykiss aguabonita*). Golden trout are a recognized subspecies of rainbow trout and are not native to the region."

Comment: While the interpretation of these data may be true, it should be verified with either on the ground sampling or use (and development if needed) of more specific eDNA primers. Moreover, any occurrence of rainbow (but not cutthroat or golden trout) should be considered occurrence of steelhead given the exceptional life history flexibility of rainbow/steelhead. Given the conservation status of steelhead in the study area, it is essential to determine the baseline distribution of rainbow/steelhead trout prior to EIS finalization.

p. 3.12-37: "This study concluded that the eDNA-based detections of rainbow trout could be explained by the presence of California golden trout originating from the stocked fish in Meadow Creek Lake."

Comment: Clear, positive evidence that species cannot be separated must be provided. The reference cited herein (Carim et al. 2017) indicates some ability of eDNA to distinguish hybrid rainbow/cutthroat trout from pure rainbow trout (which may be steelhead).

p. 16 of Carim et al. 2017: "These data demonstrate that the rainbow trout eDNA assay developed by Wilcox et al. (2015) will detect golden trout in an environmental sample, although the assay may be less sensitive for golden trout with DNA sequences identical to the Eagle Lake strain of rainbow trout."

Comment: The authors explain that only one documented (and/or utilized) base pair difference between golden trout and the Eagle Lake strain of rainbow trout.

p. 3.12-37: "Unlike Chinook salmon (via trap and haul) and bull trout, steelhead have not been historically found upstream of the Yellow Pine Pit lake."

Comment: This is in direct contrast to a previous statement indicating the likelihood of historic distribution above the Yellow Pine Pit lake in the DEIS description of critical habitat on p. 3.12-31.

p. 3.12-58: "In summary, it was determined that fish densities based on the mark-recapture method represent fair to good estimates of the fish density for most stream reaches evaluated (GeoEngineers 2017)."

Comment: See above regarding limitations of snorkeling combined with low recapture rates.

IV-B. CHAPTER 4.12 – Environmental Consequences (Fisheries)

p. 4.12-23: "It is expected the risk associated with a spill large enough to negatively affect fish or aquatic habitat would generally be low."

Comment: This overlooks the inevitable cumulative, chronic, and potentially additive effects of multiple spills over time (see Lubetkin 2020).

> p. 4.12-23 -24: "However, the percentage of populations affected is expected to be small and population-level impacts are not expected."

Comment: The baseline data characterizing population abundances and variability are not sufficient to detect population-level impacts. See above discussion of limitations of mark-recapture and snorkeling estimates.

> p. 4.12-24: "The geographic extent of the impact would be limited to the streams within the mine site and those adjacent to, or crossed by, the access roads."

Comment: This ignores up and down stream effects of temporary or permanent road crossings, downstream effects of contamination and lack of connectivity with headwater streams, etc.

> p. 4.12-28: "It should be noted the SPLNT models (Brown and Caldwell 2018, 2019a,b,c) used for the temperature predictions in **Table 4.12-5** do not account for changes to stream temperatures caused by changing climate conditions. This means that modeled future water temperatures (e.g., EOY 112) assumed that without Alternative 1, stream temperatures would be similar to the historic water temperature data (Brown and Caldwell 2018). In reality, water temperatures would likely be higher if climate change had been incorporated into the model."

Comment: This is an unacceptable oversight that impacts multiple models predicting environmental consequences to fish and their habitat

> p. 4.12-29: "Meadow Creek downstream of the East Fork Meadow Creek would have potential water temperatures that are lethal to Chinook salmon during the summer in perpetuity. Under such circumstances, Meadow Creek would have a WCI rating for salmonids during the summer of functioning at risk at best, and potentially functionally unacceptable for much of the time."

Comment: This is one of myriad examples that discounts the importance of habitat connectivity, complexity, and consideration for the ecology of salmonids, other fishes, and the foodwebs that support them.

> p. 4.12-33: "The baseline WCI rating for sediment in the mine site stream reaches ("functioning at unacceptable risk") is likely to remain the same under Alternative 1 due to increased potential for erosion and sedimentation under this alternative compared to baseline."

Comment: Here the logic seems to be that since habitat is already 'functioning at unacceptable risk,' additional impacts will won't compound that problem. This implies the potential for underestimation of all WCI predictions under all mine development alternatives.

> p. 4.12-39: "Generally, the positive impacts of removing passage barriers would outweigh the potential negative impacts."

Comment: This statement and the models it relies upon are impossible to quantify. It is simply unreliable.

> p. 4.12-48: "Hence, post-closure impacts to fish [from copper] cannot be ruled out."

Comment: Copper is one of the most toxic elements too all aquatic life. It's direct, indirect, and cumulative impacts are widely documented. Failing to evaluate the ramifications of 'ruling those impacts out' constitutes a blatant disregard for characterizing even direct impacts of mine development.

> p. 4.12-50. "The impacts associated with exceeding copper and mercury levels may be minimal; however, there is some uncertainty."

Comment: Based on reviews of the DEIS and associated documentation conducted by Maest, Prucha, and Zamzow (all 2020), chemistry predictions are likely to be erroneous. Given that copper is one of the most toxic elements to all aquatic life and impact salmonid olfaction at increases as low as 2-20 parts per billion, this should be of grave concern for predicting potential impacts of mining activity. Moreover, it overlooks the toxic effects of myriad other metals that will be unearthed in the mining process with additional toxicological effects including notably omitting the impacts of antimony, for which site specific toxicology should be examined. Additive and synergistics effects of metals on aquatic foodwebs are overlooked entirely in the DEIS.

> p. 4.12-55: "There is substantial uncertainty in the prediction of impacts of flow reductions from a lack of understanding of the relationship between flow and fish populations and site and time-specific variations in how aquatic organisms react to habitat changes (Bradford and Heinonen 2008)."

Comment: Given the impaired nature of area receiving waters in their current state and the threatened conservation status of salmonid species, site specific variations should be sufficiently measured prior to finalization of the EIS or issuance of a Record of Decision.

Table 4.12-9 Predicted Changes to WCIs Related to Off-site Facilities, p. 4.12-56 – 59

Comment: While methodology for determining baseline watershed conditional indices (WCIs) are described in Appendix J-1, the methodology for predicting the *changes* in WCIs is not sufficiently described and the results are not logical. For example, it is unclear how changes in embeddedness (the degree to which stream bottom substrates essential to salmonid spawning, incubating, and early rearing are bound by fine sediments) are predicted. Further, with respect to ultimate model conclusions, impacts to baseline WCIs *are* predicted for multiple aspects of salmonid habitat (e.g., increased sedimentation and embeddedness, decreased riparian area), while other closely related indices (e.g., off-channel habitat, floodplain connectivity) are *not* predicted despite their integral dependence upon stream functions predicted to decline.

Ultimately, impacts to bull trout populations and life history parameters using WCIs are unsupported by the insufficient information provided in the DEIS. Given that bull trout populations are already threatened, and their continued decline has been extensively related to climate change, omitting the compounding impacts of mine development with otherwise increasing stream temperatures is nothing short of negligent with respect to overall impact prediction (e.g., Isaak et al., 2015).

Section 4.12.2.3.4 CHINOOK SALMON SPECIFIC IMPACTS – ALTERNATIVE 1 (starting p. 4.12-59)

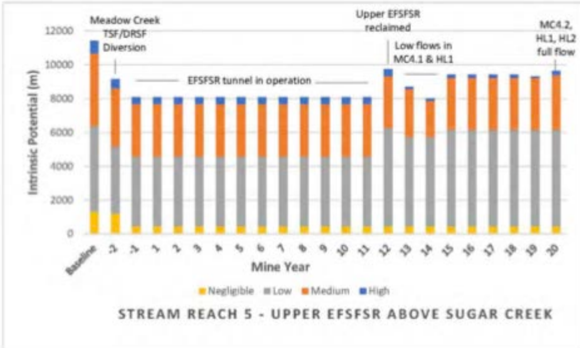

Figure Source: **Appendix J-4**, Intrinsic Potential Technical Memoranda, with modifications.

Figure Notes:

MC4.1 & MC4.2= Meadow Creek SFA reaches upstream of Hangar Flats pit lake; HL1 and HL2 = Meadow Creek SFA reaches through the Hangar Flats pit lake. "None" IP rating not included in the figure.

Figure 4.12-4 Changes to Chinook Salmon IP Habitat

Comment: As a rule, ecological models are oversimplifications of the temporal and spatial variability that comprise natural systems. The intrinsic potential (IP) models used in the DEIS, for example, reduce the intricate complexities of salmon habitat to stream flow, valley constraint, and stream gradient. While these are all driving factors combining to create "potential" salmon habitat, they entirely overlook the chemical and biological/foodweb processes which will be altered by mining activity. Moreover, the IP model relies on model inputs (specifically stream flow) which were poorly predicted by hydrologic models also produced for the DEIS (see Prucha 2020). With that said, the IP models still predict a substantial decrease in the amount and quality/"potential" of Chinook salmon habitat in the upper reaches of the EFSFSR. Given the uncertainty involved with mathematical models in general, combined with the unreliability of stream flow estimates used as model inputs, the IP predictions could be off by orders of magnitude.

4.12.2.3.4.2 Streamflow/Productivity Analysis pp. 4.12-63 – 65

Comment: Again, the productivity analysis used to predict Chinook salmon habitat losses depend on erroneous flow predictions as described by Prucha (2020). Even with those faulty model inputs, a substantial decrease in Chinook "productivity" is predicted by this modeling effort—a conclusion which is poorly reflected by the DEIS conclusions.

> p. 4.12-63 "Resident fish upstream of barriers (existing or new) may have access to habitat upstream of barrier, such as released Chinook salmon."

Comment: Chinook salmon are not resident fish. This further underscores the general negligence for consideration of impacts especially to non-salmonid resident fishes which play important roles in general stream/freshwater ecology.

4.12.2.3.4.3 Water Temperature Changes pp. 4.12-66 – 68

Comment: Temperature modeling relies on erroneous results from the water balance and hydrologic models (Prucha 2020). Temperature modeling also eliminates stream reaches considered unsuitable as salmonid habitat according to intrinsic potential, occupancy, and watershed condition models and fails to incorporate climate change. Climate change is a known factor contributing to the conservation status of salmonids, and particularly for bull trout and westslope cutthroat trout, mine impact resulting from barriers will eliminate habitat most likely to have provided summer refugia from warming (Isaak et al., 2015).

> p. 4.12-69. "Following closure and reclamation, the overall net effect from the SGP would be a loss of both quantity and quality of habitat for Chinook salmon."

Comment: In spite of major shortcomings of virtually every factor used to evaluate impacts to endangered Chinook salmon (particularly, intrinsic potential, streamflow productivity, barrier, and stream temperature models), the DEIS still concludes extremely negative impacts to hook salmon habitat. It does so without consideration of climate change, accidents and spills, and the cumulative and synergistic effects of overall habitat simplification and degradation. In general, the conclusion of negative impacts to habitat quantity and quality is oversimplified and underestimated.

4.12.2.3.5 STEELHEAD TROUT SPECIFIC IMPACTS – ALTERNATIVE 1 (starting p. 4.12-70

Comment: Comments above regarding Chinook salmon modeling generally apply to steelhead modeling (intrinsic potential, and temperature, and critical habitat modeling were all evaluated while streamflow productivity was not evaluated for steelhead). However, the DEIS concludes:

> p. 4.12-75: "Certain potential negative effects to fish and fish habitat are expected to be less intense for steelhead trout than those anticipated for Chinook salmon, or in some cases improve future habitat conditions to better than the baseline conditions. Despite some improvement to access, there remains potential effects which may cause injury or mortality to individuals and temporary displacement of steelhead trout from several mine site streams during certain periods when habitat conditions become unsuitable. This would cause a temporal loss of habitat."

Comment: again, by relying on multiple embedded, erroneous models and neglecting consideration of climate change and multiple other aspects of habitat complexity critical to the overall sustainability of salmon populations, the DEIS vastly underestimates impacts likely to result from Stinbnite Mine development.

4.12.2.3.6 BULL TROUT SPECIFIC IMPACTS – ALTERNATIVE 1 (starting p. 4.12-75)

Comment: Models/tools used to predict impacts to bull trout habitat included occupancy models (OMs), a Physical Habitat Simulation Model (PHABSIM) in addition to the temperature and critical habitat models discussed above for Chinook salmon. Consequently, temperature and critical habitat comments regarding bull trout are largely described above for Chinook salmon.

4.12.2.3.6.1 Occupancy Modeling – Alternative 1 (pp. 4.12-75 – 77 and Appendix J-7)

Comment: Like other models, OMs necessarily simplify habitat. The independent variables primarily used for the Stibnite DEIS were stream temperature, stream flow, and channel slope. It is unclear how temperature modeling could be used to inform OMs while OMs were also used to inform temperature models as the logic is circular. Moreover, temperature models rely on faulty water balance and hydrologic models (Prucha 2020). Multiple transformations used for OMs are poorly described and their uncertainty and accuracy are consequently unknown (Appendix J-7 cites personal communication). But the most glaring assumptions of OMs follow:

- Mean summer flow describes the warmest and are the most limiting time period to fish (Appendix J-7). While this may be true, it should be verified with site specific information before using OMs to draw conclusions about their utility. For example, depending on winter conditions, winter incubation and rearing habitat may be limited by groundwater upwelling with the potential to be less abundant than mean summer flows (e.g., Reynolds 1997). Given the highly migratory life history especially of bull trout, but also westslope cutthroat trout, limiting OMs to one season is likely to underestimate the importance of varying habitats during the rest of thee year.
- No false absences. Detection probability (the estimation of the rate of false absences—failing to detect a fish in habitat where it does or will occur) is essential to characterizing bias of OMs particularly for species in low abundance like bull trout (Al-Chokhachy et al. 2010, Rodtka et al. 2015). Estimation of the false-absence rate requires repeat sampling of multiple sites over time. It

is unclear that either repeat sampling was performed or that detection probability was estimated for the OMs developed for the DEIS.

Comment: PHABSIMs predict habitat area by modeling stream hydraulics at stream cross sections (e.g. streamflow depths and velocities across said transect) and translating these into habitat quality with habitat suitability criteria (HSC) curves. Transects are divided into cells, each represented by a depth and average velocity at a given discharge. The longitudinal (upstream-downstream) extent of these cells is controlled by a weighting scheme that is based on the mesohabitat type represented by the transect and the distribution of that mesohabitat (e.g. riffles, runs, pools, glides, and tailouts). The area of these cells is used to calculate what is called weighted usable area (WUA), which is the surface area of the cell multiplied by the combined suitability of the cell. As such, WUA combines habitat quantity and quality. The hydraulics of the cell are represented by the transect, the area of the cell represents habitat quantity, and the quality of habitat is a translation of the hydraulics based on HSC curves.

The PHABSIMs used in the Stibnite DEIS are spatially and temporally limited (relied on partial datasets for limited locations throughout the study site, and were conducted between 1986 and 1990 as per Appendix J-8). Although physical habitat characteristics may be less variable than chemical and biological characteristics, channel structure, flow regimes, and other factors are highly like to have changed over a period of three decades. The models also assume substrate will remain constant over time—an unlikely assumption under any circumstances, but particularly in light of mine and road development and operation which will inevitably introduce sediment into area streams, thereby decreasing the suitability of habitat. Moreover, PHABSIMs are overly simplified in many ways, but perhaps most importantly ignore the critical role of groundwater influence on intragravel water temperature and dissolved oxygen. Bull trout in particular are likely to spawn in zones of upwelling groundwater which likely plays at least as important a role in habitat selection as simple surface water hydraulics (Baxter and Hauer 2000).

Another major issue with habitat modeling in PHABSIM is that there is usually no real connection between hydraulic modeling and habitat utilization because modeling transects are usually selected based on hydraulic criteria. Not only, then, is there a potential disconnect between the locations where habitat is modeled and the distribution of fish, the models ignore seasonal movements of fish. As such, modeling habitat at hydraulic modeling transects substitutes an evaluation of habitat in time, at fixed locations, with one that should be conducted in space, over time. In order to indiscriminately characterize habitat in terms of stream hydraulics, modelers must (essentially) assume habitat to be uniform throughout stream reaches. They must also assume that this pattern of uniformity remains true in all seasons (Railsback 2016). Overall, PHABSIMs are outdated and overly simplistic models that fail to consider habitat complexity now known to influence the habitat selection and the overall sustainability of fish populations. PHABSIMs lack the spatial and temporal resolution to produce biologically meaningful results, thereby underestimated (and/or simply mischaracterizing) potential impacts of project development.

4.12.2.3.7 CUTTHROAT TROUT SPECIFIC IMPACTS – ALTERNATIVE 1 (p. 4.12-87 – 93)

Comment: Estimations of impacts to cutthroat trout are essentially identical to those of bull trout and thus the comments above are equally relevant, rendering estimation of impacts to bull trout essentially meaningless.

4.12.2.3.8 IMPACTS TO OTHER FISH SPECIES – ALTERNATIVE 1 (p. 4.12-93)

Comment: The consideration of impacts resident fishes comprises three paragraphs generally concluding minimal impact. As discussed in the introduction, resident fishes are an important component of freshwater foodwebs and as such, warrant considerably more attention than received in the DEIS. Changes in resident fish population structure is likely to have cascading effects on insect and primary producer communities, which also may ultimately impact salmonid species. True, foodweb mediated indirect effects of mine development are virtually ignored in the DEIS.

4.12.3 **Cumulative Effects** (p. 4.12-193 – 196)

Comment: The cumulative effects analysis in the DEIS fails to consider the additive and synergistic impacts of each individual aspect of habitat evaluated for fishes. For example, the increased stress from a combination of altered metals concentrations, higher temperatures, lower flows, and altered foodwebs could have dramatic impacts to salmonids and other fishes that are largely ignored by the DEIS

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