Direct loss of salmon streams, tributaries, and wetlands under the proposed Pebble Mine compared with thresholds of unacceptable adverse effects in the EPA Proposed Determination pursuant to Section 404(c) of the Clean Water Act

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SUMMARY: This study compares the loss of salmon streams, tributaries and wetlands under the 2018 proposed Pebble Mine to thresholds determined to represent "unacceptable adverse effects" by the U.S. Environmental Protection Agency (EPA) in its Proposed Determination Pursuant to Section 404(c) of the Clean Water Act (EPA 2014a). Pebble Limited Partnership (PLP) is seeking authorization from U.S. Army Corps of Engineers (USACE) under Section 404 of the CWA to develop the mine, and the Corps has prepared a Draft Environmental Impact Statement (DEIS) describing the project and its impacts (USACE 2019).

Following criteria outlined by EPA, we considered direct and indirect effects that result in the loss of salmon streams, tributaries and wetlands from the discharge of dredged or fill material, inundation within a tailings impoundment, dewatering, or the fragmentation of previously contiguous streams or wetlands. Using data submitted by PLP to USACE on the size and proposed placement of the open pit, tailings storage, and associated facilities, the proposed mine (20-year mine scenario) would result in the loss of 7.5 miles of salmon streams, up to 56.4 miles of tributaries, and up to 4,350 acres of wetlands contiguous with salmon streams or tributaries. These values exceed the EPA thresholds for unacceptable adverse effects by more than half for the loss of documented salmon streams, up to fourfold for loss of tributaries and up to threefold for loss of wetlands.

We estimated that the 78-year mine scenario would result in the loss of 34 miles of salmon streams, 218.8 – 407.2 miles of tributaries, and 7,208 – 14,893 acres of wetlands. These values also exceed EPA criteria by substantial margins. The ranges reported herein can be attributed to variation between available datasets that estimate the distribution of streams and wetlands in the Pebble area. The most detailed data are only available for a limited area, but they suggest that data available for the wider area underestimate the extent of streams and wetlands, and therefore impacts to these resources, by around half.

Inasmuch as the 78-year mine scenario extends beyond this PJD study area, the actual extent of potential impacts to streams and jurisdictional wetlands remains unknown. Nonetheless, the ratios of mapped-to-unmapped streams and wetlands within the PJD study area can serve as a coarse-scale estimate of potential impacts within the larger 78-year mine scenario. The USACE Draft EIS did not evaluate the adequacy of available data to estimate effects of the 78-year mine scenario, or directly compare potential impacts to the criteria developed by EPA in the Proposed Determination. Data inadequacies, such as jurisdictional mapping of streams and wetlands within the 78-year mine scenario, should be overcome in order for USACE to thoroughly evaluate the environmental impact of the current permit application by PLP, because this reasonably foreseeable scenario is sufficiently likely that it will be needed for an accurate assessment of cumulative effects.

INTRODUCTION:

The Pebble deposit in the headwaters of Bristol Bay, lies within the north and south forks of the Koktuli River and Upper Talarik Creek watersheds (Fig. 1). In 2006, Northern Dynasty Minerals Ltd. (NDM; a founding member of the PLP) submitted water rights applications to Alaska Dept. of Natural Resources (ADNR) for rights to approximately 35 billion gallons of groundwater and surface water per year (ADNR 2014). In 2011, NDM submitted preliminary plans for open pit mining of the Pebble deposit to the U.S.

Security & Exchange Commission (SEC 2011). These plans described the potential for 3-phases of mine development: an initial 2-billion-ton open pit mine that would operate over a period of 25-years; a larger open pit mine of 3.8 billion tons to be mined over 45 years; and a 6.5-billion-ton open pit mine over 78 years (Ghaffari et al 2011). This report further estimated the total size of the Pebble deposit at 12 billion tons, which ranks among the largest porphyry copper deposits on earth (Singer et al. 2008).

Bristol Bay also ranks among the world's most important wild salmon fisheries, representing an estimated 50% of all sockeye salmon on earth, as well as diverse and globally significant populations of Chinook, coho, chum and pink salmon (Ruggerone et al. 2010). Salmon rely on the freshwater habitat of Bristol Bay rivers, streams and wetlands for critical parts of their lifecycle. In 2010, the economic value of commercial salmon alone, including the harvest and processing of salmon and multiplier effects of these activities, created an estimated $1.5 billion per year in output sales value nationwide (ISER 2014).

Because of these potentially conflicting land uses, proposed mineral development of the Pebble deposit has been a source of controversy for decades (EPA 2014b). As a result, in 2010 six federally recognized tribal governments in Bristol Bay petitioned the EPA to initiate a process under Section 404(c) of the Clean Water Act (CWA) to protect fisheries, wildlife, subsistence and other values from metallic sulfide mining, including a potential Pebble Mine. Under the CWA, Section 404(c) authorizes the EPA to restrict the use of any defined area in waters of the United States as a disposal site for discharge of dredge or fill material, whenever it determines that such discharge will have an unacceptable adverse effect on fishery areas (EPA 2014a).

In response to this petition, EPA conducted a comprehensive *Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska* (Bristol Bay Assessment, BBA) of the ecological, social and economic values of Bristol Bay region, and assessed specific risk factors associated with potential mining of the Pebble deposit (EPA 2014b). This BBA process included an extensive literature and data review, public meetings with opportunity for testimony by stakeholders in Bristol Bay and in Anchorage, consultation with mine proponents to provide specific information and analysis, consultation with State of Alaska and federal management agencies, and an independent peer-review of the draft BBA, including a public meeting on this peer-review with public and scientific testimony.

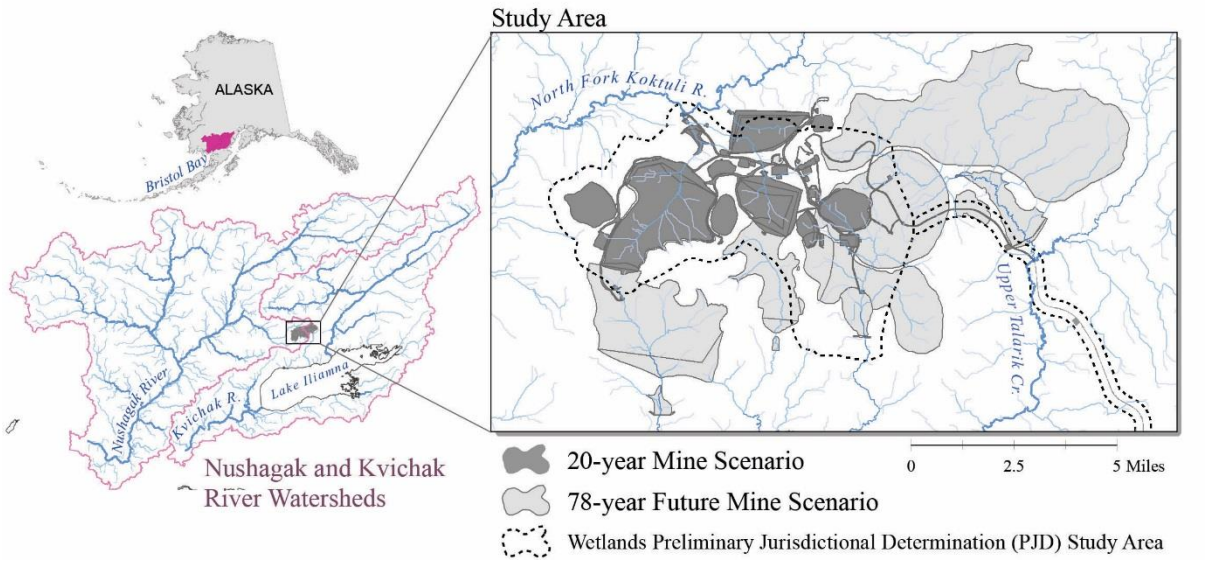

Figure 1. The Pebble Study Area is located at the headwaters of the Nushagak and Kvichak Rivers in Bristol Bay, Alaska.

Based on the BBA, as well as on public comment and consultation with mine proponents and regulatory agencies, the EPA issued a Proposed Determination Pursuant to Section 404(c) of the CWA (PD), citing unacceptable adverse effects on fisheries and other resources could result from the discharge of dredge or fill material associated with construction and routine operation of Pebble Mine, even under the smallest reasonable mining scenarios (EPA 2014a). This smallest scenario EPA analyzed was a 0.25-billion-ton open-pit mine operated over a 20-year period, which was based on the median size of all known porphyry copper deposits world-wide. Based on their analysis of direct effects on streams and wetlands from this hypothetical 0.25 billion-ton mine scenario, EPA proposed that discharge of dredge or fill material not be allowed that would result in any of the following conditions:

1) Loss of streams:
    - The loss of 5 or more linear miles of streams with documented anadromous fish occurrence; or
    - The loss of 19 or more linear miles of streams where anadromous fish are not currently documented, but that are tributaries of streams with documented anadromous fish occurrence;

    or:

2) Loss of wetlands, lakes and ponds:
    - The loss of 1,100 or more acres of wetlands, lakes, and ponds contiguous with either streams with documented anadromous fish or tributaries of those streams;

    or:

3) Streamflow alterations:
    - Streamflow alterations greater than 20% or more of daily flow in 9 or more linear miles of streams with documented anadromous fish occurrence.

The purpose of this study was to analyze direct effects of the 2018 Pebble Mine proposal to the USACE, including the 78-year scenario for reasonably foreseeable future development, based on the size and location of the open pit, tailings storage and other mining facilities, on documented anadromous streams, tributaries to anadromous streams and on wetlands, lakes and ponds.

METHODS:

Definitions

We followed definitions of EPA (2014; p.5-2) for "loss" in streams, wetlands, lakes and ponds as:

- Elimination, either as a direct result of the discharge of dredged or fill material or as a secondary (indirect) effect of such disposal; or
- Fragmentation, meaning creation of discontinuities that separate a previously contiguous (see definition below) aquatic habitat (stream, wetland, lake, pond) or complex of aquatic habitats from the tributary network in such a way that interferes with the efficient passage of fish species and life stages documented to occur in the habitat or reduces the downstream movement of water or dissolved or suspended material.

We further followed EPA definition of "contiguous" as physically connected by aquatic habitat, as in:

- Streams with no human-made breaks in open channels; or

- Wetlands that abut streams, ponds, or lakes without upland separation, except for micro-scale separation that occur naturally as part of wetland mosaics that are too closely associated to be delineated easily or mapped separately (USACE 2007).

In the Pebble Draft EIS (USACE 2019, p. 4.22-11), the USACE defined Indirect Effects on wetlands to include fragmentation, dewatering and a 330' buffer around mine infrastructure to account for fugitive dust. Of these, only fragmentation and dewatering meet the EPA criteria for 'loss' and were counted toward that comparison.

Data Sources

Mine Features: Data on the size and location of mine site features and estimates of indirect effects were obtained from the USACE (PLP 2018-RFI 082, PLP 2018-RFI 062). In the 20-year mine scenario, we considered direct loss of streams and wetlands due to placement of mine facilities, dewatering of wetlands post closure, fragmentation of streams and wetlands above embankments and major mine features. In the 78-year scenario, data on dewatering impacts to wetlands were not available so we considered only losses by elimination, and fragmentation behind embankments and major mine features (USACE, p. 4.22-39).

Salmon Streams: The distribution of anadromous fish in Alaska are documented in the ADF&G Anadromous Waters Catalog (AWC) (Johnson & Blossom 2017). Because the AWC requires a physical survey of streams, with "fish-in-hand" criteria for streams to be added to the catalog, it may represent less than 50% of the waters used by anadromous fish in Alaska (Johnson 2015). As another point of reference, a landscape model of stream characteristics known to support anadromous fish provides a coarse-scale estimate of the potential distribution of waters that support anadromous fish in the Nushagak and Kvichak watersheds (Woll et al. 2014). These data are provided for comparative purposes only and were not used to evaluate potential impacts to salmon.

Tributaries: While the mapping of streams and rivers in Alaska has advanced in recent years (Maune 2008), hydrographic data in Bristol Bay have not been updated at a regional scale. In the Pebble Area, hydrography was updated as part of the Pebble Environmental Baseline Studies using aerial photographs and field surveys (PLP 2011, Appendix E). Hydrography from the Pebble Environmental Baseline Data (EBD) were used to estimate effects on streams in the Pebble Draft EIS (USACE 2019, Table 4.22-1).

Another source of data on the distribution of tributary streams is available in the form of the delineation of riverine channel wetlands as part of the Preliminary Jurisdictional Determination (PJD) report (Figure 2 panel b2; HDR 2018). Riverine channels include wetlands and waters contained in the active channel of intermittent or perennial streams or rivers (USACE 2019, p. 3.22-6). These riverine channels were originally delineated from aerial photographs and mapped as part of polygonal wetland features. We mapped the centerlines of these riverine wetlands using a specialized 'centerline' tool in XTools Pro (Ver. 19.0; Data East, LLC) and ArcGIS (Ver. 10.4.1; Environmental Systems Research Institute). We reviewed PJD Wetland field plot data and photographs to verify the accuracy of these riverine channel designations, as well visual inspection of predicted suitability to support anadromous fish (Woll et al. 2014; Figure 2).

Because these three hydrography datasets (AWC, EBD and PJD riverine channels) were derived from different sources, they were not spatially identical, and we were unable to synthesize them into a single hydrographic network. We excluded the salmon streams from calculations of tributaries by subtracting the length as measured the AWC database from the lengths as measured in the EBD and PJD riverine channels (Table 1).

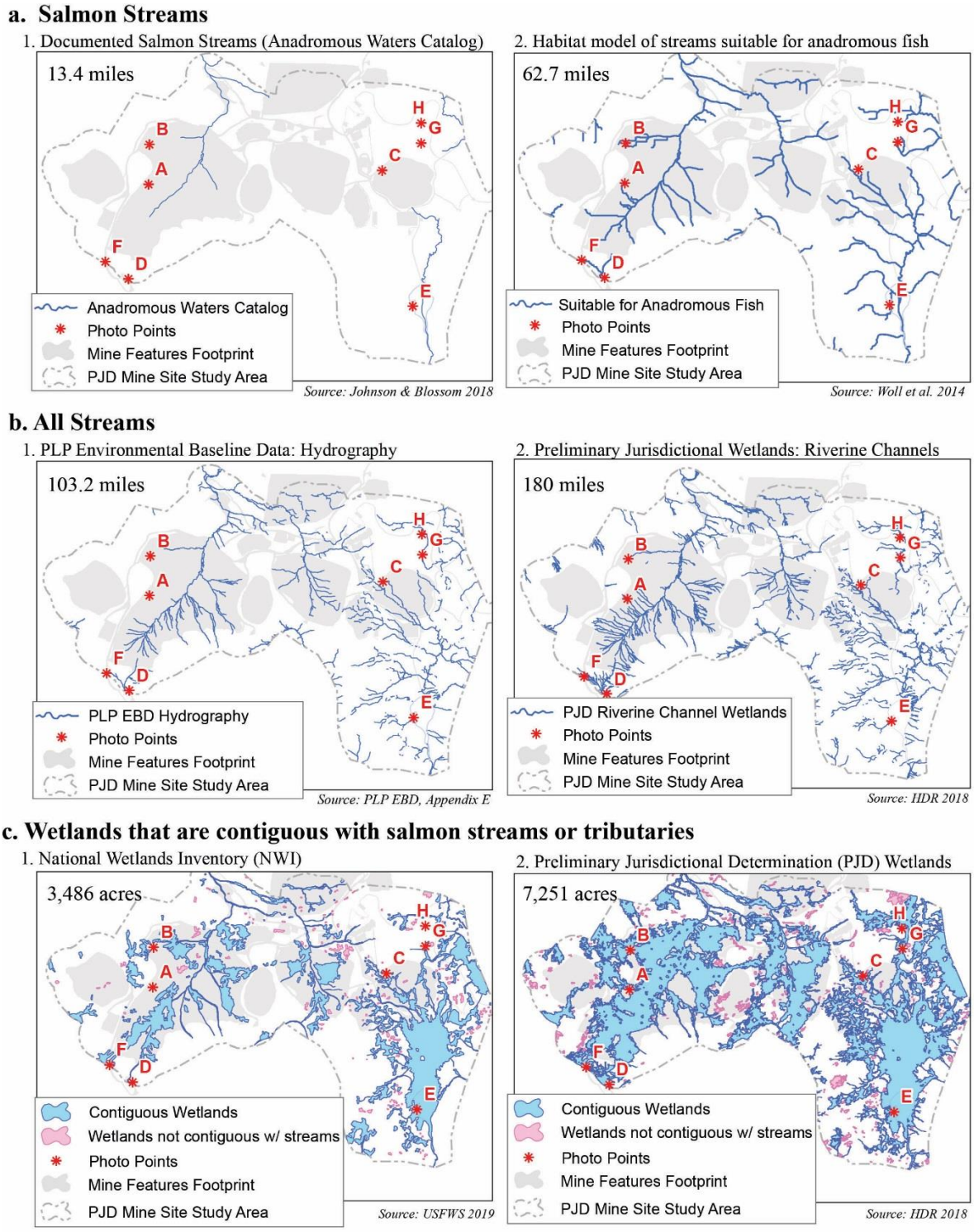

Figure 2. A comparison of available data sources on documented and potentially suitable salmon streams (a), tributaries (b) and wetlands that are contiguous with salmon streams or tributaries (c) in the Mine Site Preliminary Jurisdictional Wetlands Determination (PJD) Study Area. Photo points show riverine stream channels not represented in the PLP EBD Hydrography (See Fig. 3).

A. NFK Wetland Study Plot: 3PP6421

B. NFK Wetland Study Plot: 3PP2363a

C. SFK Wetland Study Site: 3PP1173

D. SFK Wetland Study Plot: 3PP2559

E. SFK Wetland Study Site: 3PP1711

F. SKF Wetland Study Plot: 3PP6382

G. UT Wetland Study Site: 3PP1157

H. UT Wetland Study Site: 3PP1099

Figure 3. Photo points from Preliminary Jurisdictional Wetland Determination (PJD) of riverine channel wetlands in the North Fork (NFK) and South Fork (SFK) of the Kokuli River and Upper Talarik Creek (UT) that were not represented in the Pebble Environmental Baseline Data hydrography or sampled for fish or aquatic habitats in the Draft Environmental Impact Statement (Source: HDR 2018).

Wetlands: Two sources of data for mapping of wetlands are available in the Pebble Area. These include the National Wetlands Inventory (NWI; USF&WS 2018; Fig. 2 panel c1) and the PJD wetlands database (Fig. 2 panel c2; HDR 2017). The source imagery for the NWI in the Pebble area was current in 1978. NWI are intended only for region- and watershed-scale display and analysis, and not designed to represent legal delineations for jurisdictional purposes at a project scale. The source imagery used for wetlands PJD study was acquired in 2004-2005. Wetland polygons were delineated at a scale of approximately 1:1,200 - 1:1,500, and open water polygons such as those of riverine channel wetlands were delineated at a scale of 1:400, with a minimum polygon size of 0.05 acres (HDR 2017). To evaluate contiguity of wetlands with salmon streams and tributaries, we dissolved the boundaries of contiguous wetlands to identify the full extent of connected wetland systems. We then performed a spatial overlay to identify those contiguous wetland systems with a direct surface connection to salmon streams or tributaries. All analyses were conducted using ArcGIS software.

Wetland and Stream Correction Factors: The full extent of streams and wetlands outside of the Preliminary Jurisdictional Determination (PJD) Study Area is not known. We wanted to use the best estimate of the wetlands and tributary streams potentially lost under the 78-year mine scenario, so we applied a correction factor to coarser estimates based on the best available information. PJD wetlands were mapped more recently and at greater accuracy than NWI, but not over the entire area of the analysis (HDR 2018). In the area where both sets of data were available, the PJD mapped 2.08 times more area of wetlands that were contiguous with salmon streams or tributaries than the NWI (Fig. 2, panels c1 & c2). To estimate the extent of wetland lost in areas lacking PJD mapping, we multiplied NWI acres by correction factor by 2.08. Similarly, in the area where both EBD and PJD hydrography were available, the PJD mapped 1.74 times more miles of riverine channels than were contained within the EBD hydrography (Fig. 2, panels b1 & b2). To estimate the extent of tributary streams that could be lost under the 78-year mine scenario, we multiplied the miles of streams in the EBD hydrography dataset by a factor of 1.74.

RESULTS:

Mine Impacts: The footprint of mine site development in the 20-year mine scenario is approximately 8,086 acres (12.6 miles^2) (USACE 2019, Table 4.22-12). In this scenario, the fragmentation of surface waters behind embankments covers an additional 4,880 acres. Other indirect effects (outside zone of fragmentation) cover 762 acres, and dewatering covers 264 acres (PLP 2018-RFI 082). Combined, the zone of direct and indirect effects in the 20-year mine scenario covers an estimated 13,997 acres (21.9 miles^2, Fig. 4). In the 78-year mine future mine scenario, the footprint of mine facilities is approximately 29,632 acres (USACE 2019, Table 4.22-12), the zone of fragmentation above embankments and major mine features is approximately 44,267 acres, and other indirect effects beyond the zone of fragmentation include an additional 621 acres, for an estimated total footprint of direct and indirect effects of 44,888 acres (70.1 miles^2, Fig. 5). Less than half of this 78-year impact zone (19,046 acres, 43.6%) was evaluated in the PJD wetlands study.

Salmon Streams: Within the PJD wetland study area, the AWC contains 13.4 miles of documented salmon stream (Fig 2, panel a.1). In that same area, the coarse-scale model of salmon habitat identified 62.7 miles of streams with characteristics potentially suitable for anadromous fish (Fig. 2, panel a.2). We estimated that 7.5 miles of salmon streams would be lost under the 20-year mine scenario, including approximately 5.8 miles of AWC streams directly eliminated, and an additional 1.7 miles that would be subject to indirect effects or fragmentation (Table 1, Fig. 4). We further estimated that this scenario would result in the loss of 38.2 miles of streams potentially suitable for anadromous fish.

Table 1. Estimated loss of salmon streams, tributaries and wetlands that are contiguous with salmon streams or tributaries from the 2018 proposed Pebble Mine (20-year scenario) and reasonably foreseeable future development (78-year scenario) in comparison with EPA Proposed Determination criteria for unacceptable adverse effects pursuant to Section 404(c) of the Clean Water Act.

	Loss under 20-year Mine Scenario				Loss under 78-year Mine Scenario			
	Direct Effect	Indirect Effects	Total	% Exceedance of EPA Criteria under 404(c)	Direct Effects	Indirect Effects	Total	% Exceedance of EPA Criteria under 404(c)
SALMON STREAMS (miles):								
Documented Salmon Streams[1]	5.8	1.7	7.5	+ 51%	29.5	4.5	34.0	+ 581%
Streams Suitable for Anadromous Fish[2]	28.4	9.7	38.2	N/A	125.2	19.9	145.1	N/A
TRIBUTARIES TO SALMON STREAMS (miles):								
National Hydrography Dataset (NHD)[3,8]	18.9	8.6	27.5	+ 45%	84.6	13.5	98.1	+ 416%
Pebble EBD Hydrography [4,8]	41.7	14.7	56.4	+ 197%	180.9	37.9	218.8	+ 1,052%
Preliminary Jurisdictional Wetlands (PJD): Riverine Channels[5,8]	75.5	24.3	99.8	+ 425%	337.6[9]	69.4[9]	407[9]	+ 2,042%
CONTIGUOUS WETLANDS (acres):								
National Wetlands Inventory[6]	1,428	439	1,866	+ 70%	5,972	1,236	7,208	+ 555%
Preliminary Jurisdictional Wetlands: All wetlands and wetland mosaic[7]	3,211	1,139	4,351	+ 295%	12,422[9]	2,571[9]	14,994[9]	+ 1,263%

Data Sources: [1] Johnson & Blossom 2017; [2]Woll et al. 2014; [3]USGS 2013; [4]PLP 2011, Appendix E; [5]HDR 2017; [6]USF&WS 2018; [7]HDR 2017
[8] This hydrographic dataset included stream reaches that were also mapped in the AWC. To estimate miles of tributary streams, we subtracted the miles of AWC streams from the total miles of streams represented in this data set to avoid double counting of documented salmon streams.
[9]The full extent of streams and wetlands outside of the Preliminary Jurisdictional Determination (PJD) Study Area is not known, so we multiplied NWI acres by correction factor by 2.08, and Pebble EBD hydrography by a factor of 1.74 as the best estimate the actual acres of wetland and miles of tributaries lost under the 78-year mine scenario (see Methods).

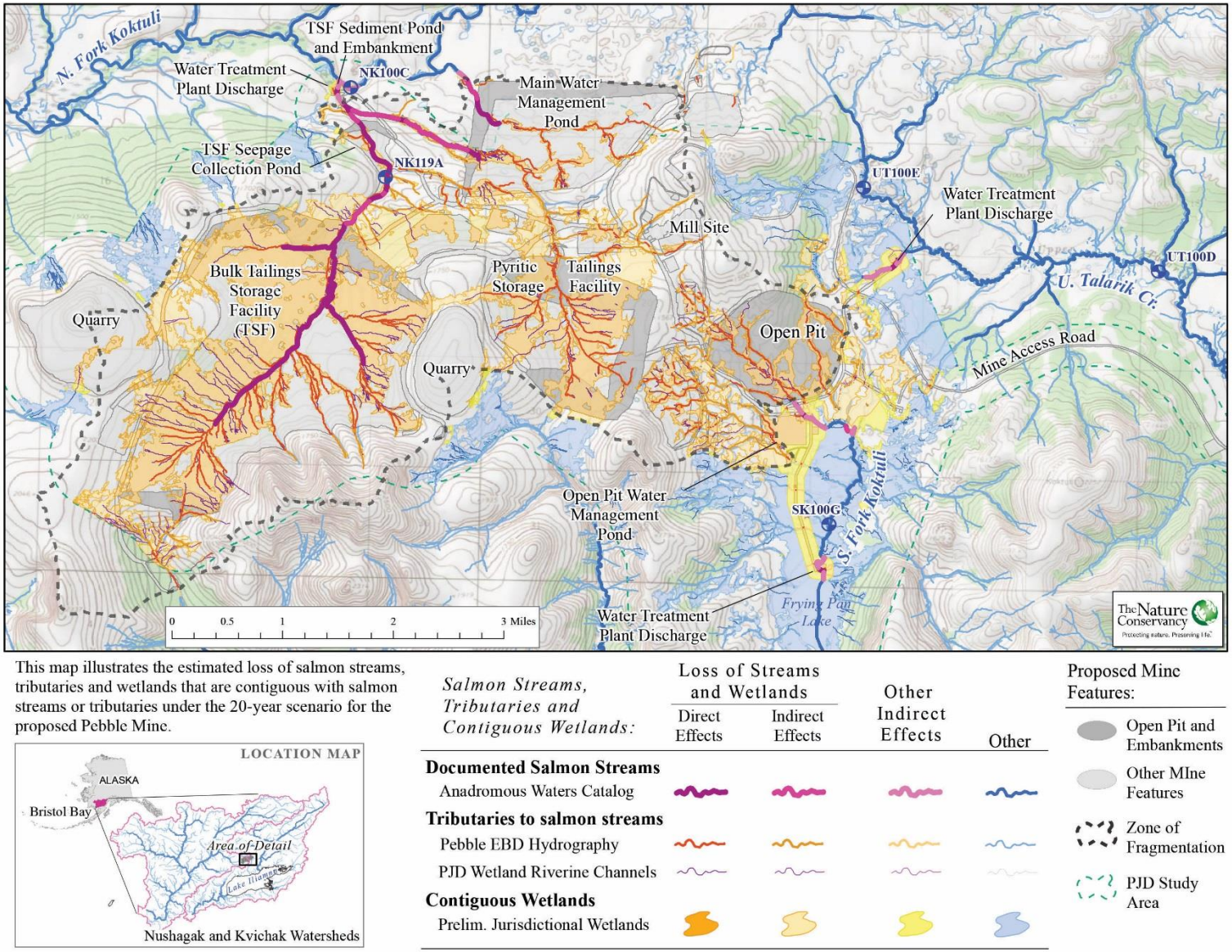

Figure 4. Estimated loss of salmon streams, tributaries and contiguous wetlands under 2018 proposed Pebble Mine, 20-year scenario

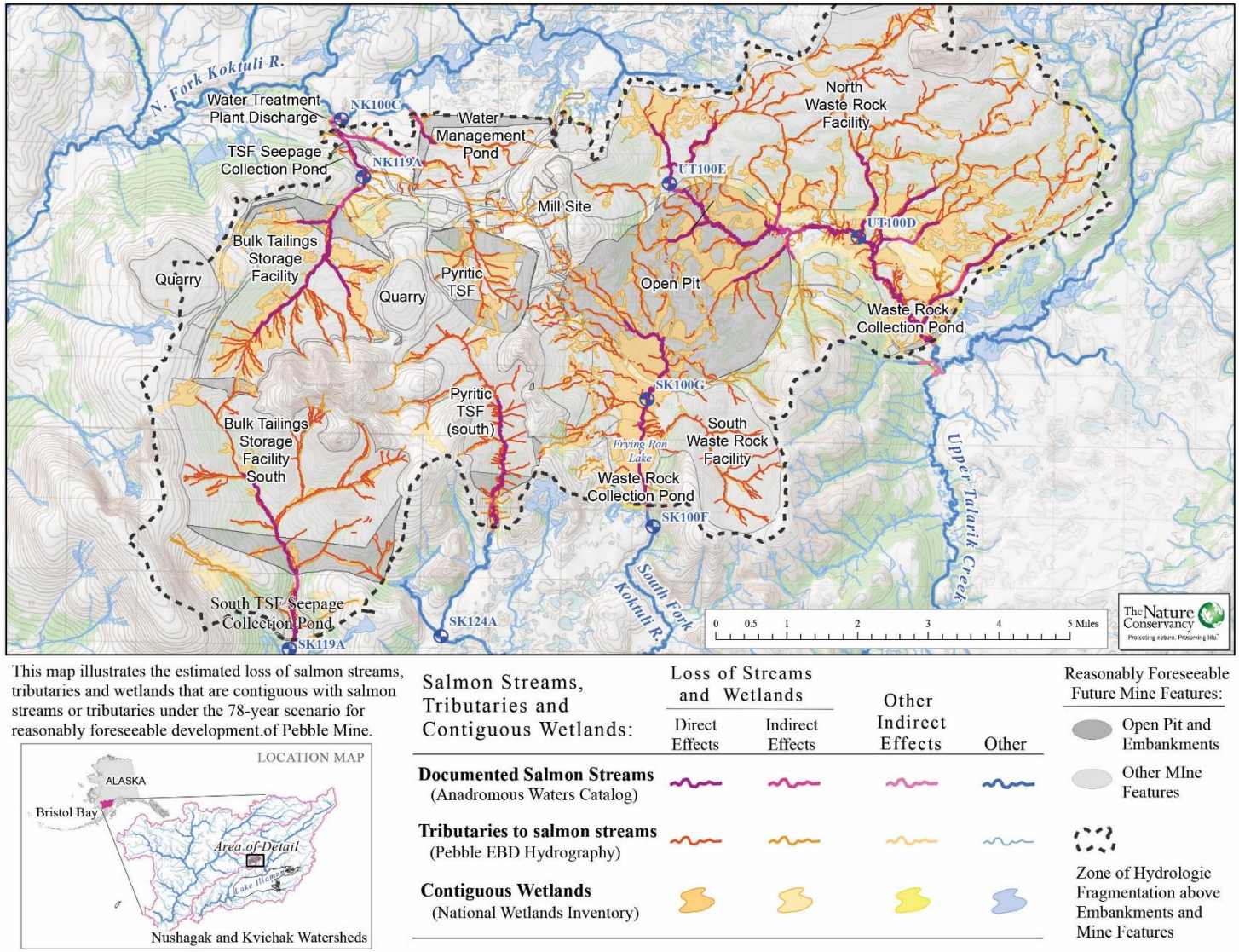

Figure 5. Estimated loss of salmon streams, tributaries and contiguous wetlands under the reasonably foreseeable future development of the 2018 proposed Pebble Mine.

We estimated that the 78-year mine scenario would result in loss of approximately 35.2 miles of AWC streams, including elimination of 29.5 miles and fragmentation of 4.5 miles documented in the Anadromous Waters Catalog (Fig. 5). These estimates exceed EPA proposed determination criteria for unacceptable adverse effects by 51% in the 20-year scenario and 581% in the 78-year scenario. We further estimated that this scenario would result in the loss of 145.1 miles of streams potentially suitable for anadromous fish.

Tributaries: The EBD hydrography dataset contains 103.2 miles of stream within the PJD Mine Site Study Area (Fig. 2, panel b.1). In this same area, the PJD wetlands database contains an estimated 180 miles of riverine channel wetlands. Our review of field study plots indicates that at least some have bank, substrate and flow characteristics consistent with perennial streams (Fig. 4). If we assume that this PJD estimate is a more complete representation, then the EBD hydrography represents only 57.3% of all perennial and intermittent streams in the study area.

The combined direct and indirect effects of the 20-year mine scenario would result in loss of approximately 56.4 miles of tributaries to salmon streams according to the EBD hydrography dataset, and 99.8 miles according to the database of PJD riverine channels. Within the 78-year mine scenario, the combined direct and indirect effects would result in loss of approximately 218.8 miles of streams according to the EBD hydrography dataset (Table 1, Fig. 5).

Under the assumption that the ratio of mapped to unmapped streams within this 78-year footprint is similar to that of the PJD study, we estimated that the loss of tributaries to salmon streams would be approximately 407 miles. These estimates exceed the EPA criteria for unacceptable adverse effects by 197% - 425% for the 20-year scenario, and approximately 1,052% - 2,043% in the 78-year mine scenario (Table 1).

Wetlands: Within the PJD study area, the NWI database contains 3,664 acres of wetlands, 95% of which (3,486 ac.) were contiguous with salmon streams or tributaries (Fig. 2, panel c1). In this same area, the PJD wetlands study documented 7,571 acres of wetlands and wetland mosaic, 96% of which (7,251 ac.) were contiguous with salmon streams or tributaries (Fig. 2, panel c2). According to the NWI data, the loss of wetlands that are contiguous with salmon streams or tributaries in the 20-year mine scenario is estimated at 1,866 acres. Using the PJD dataset, the loss of wetlands is estimated at 4,351 acres (Table 1).

Within the 78-year mine scenario, the loss of contiguous wetlands is estimated at 7,208 acres under the NWI. Under the assumption that the relative accuracy of NWI mapping of contiguous wetlands within this larger 78-year footprint is similar to that of the PJD study area (48.1%), we estimate that the loss of wetlands contiguous with salmon streams or tributaries within the 78-year mine scenario would be approximately 14,994 acres.

DISCUSSION:

After several years of study, extensive consultation with stakeholders, scientists, state and federal agencies and mine proponents, the US EPA issued a Proposed Determination pursuant to their authority under the CWA Section 404(c). This determination identified a set of specific thresholds for the loss of documented salmon streams, tributaries and wetlands that would constitute an unacceptable adverse effect to fisheries and other resources of Bristol Bay, Alaska (EPA 2014a). These findings were based on analysis of a range of plausible mining scenarios (2.0 – 6.5 billion-tons) submitted to the SEC by NDM in 2011, as well as a hypothetical 0.25 billion-ton mine scenario calibrated from the median size of all known porphyry copper deposits worldwide (Singer et al. 2008). Based on this consultation and analysis, EPA concluded that development of an open pit mine at any of these scales at the specific location of the

Pebble deposit, would result in unacceptable adverse effects. Using the 0.25 billion-ton scenario as a benchmark, they developed a series of specific metrics related to the loss of salmon streams, tributaries, and associated wetlands which, in this Proposed Determination, would trigger implementation of EPA authority to safeguard waters of the U.S. under Section 404(c) of the CWA. Our analysis demonstrates that the 2018 proposal by PLP to the USACE exceeds these thresholds (Table 1).

However, substantial uncertainties exist about the extent of salmon streams, tributaries and wetlands potentially affected by the proposed Pebble Mine and reasonably foreseeable development scenarios. In the most intensively surveyed PJD wetlands study area, anadromous fish have been documented in 13.4 miles of streams, yet 62.7 miles exhibit stream characteristics known to support anadromous fish (Fig. 2). Visual inspection of stream habitat characteristics in wetland field study plots provides some support for the conclusion that other streams in the area are also suitable for anadromous fish (Fig. 3). In the Pebble Draft EIS, studies of fish distribution are only reported for a subset of all tributary streams within the mine site study area (USACE 2019, Fig. 4.24-1), so the full extent of anadromous fish remains unknown.

Further uncertainty exists in the range of data sets available to evaluate the loss of tributary streams. Estimates of streams potentially at risk range from a low of 27.5 miles in the National Hydrographic Dataset, a mid-range estimate of 56.4 miles in the Pebble EBD hydrography, to a high of 99.8 miles in the distribution of riverine channel wetlands identified in the wetlands PJD study for the 20-year mine scenario (Table 1). This uncertainty becomes most problematic to estimate loss of streams within the 78-year mine scenario, the majority of which was not included in the PJD wetlands study. The low estimate of streams lost under the 78-year mine scenario is 98.1 miles from the National Hydrography Dataset and an upper estimate of 282.8 miles in the Pebble EBD hydrography. An extrapolation based on the ratio of mapped to unmapped streams in the Pebble EBD hydrography relative to the wetland riverine channels within the PJD study area suggests that over 400 miles of tributaries to salmon streams may be lost under the larger 78-year future mine scenario. All of these estimates, however, are still well above the criteria of 5 miles of salmon streams or 19 miles of tributaries connected to salmon streams that was established by the EPA in the proposed determination under 404(c).

A similar problem exists in evaluating potential loss of wetlands within the footprint of the 78-year future mine scenario. A comparison of available data within the PJD study area suggests that the NWI only represents 48.8% of wetland and wetland mosaics compared with the more intensive PJD wetland study. A simple extrapolation of this mapped-to-unmapped ratio within the larger 78-year mine scenario suggests that loss of wetlands contiguous with salmon streams or tributaries could be approximately 14,993 acres (Table 1). This method of extrapolation based on the relative distribution of wetlands in the NWI is different than that of the Pebble Draft EIS, which assumed a constant proportion of 42% in wetlands (USACE 2019, p. 4.22-39). The estimated loss of wetlands reported here also differs from those presented in the Draft EIS in that (a) we evaluated only wetlands that were contiguous with salmon streams or tributaries; and (b) we considered only indirect effects that would result in the loss of wetlands as outlined in the EPA Proposed Determination. However, the lowest estimates are still well above the criteria of 1,100 acres of wetlands contiguous with salmon streams or tributaries that was established by the EPA in the proposed determination under 404(c).

To protect important fishery areas in the North and South Forks of the Koktuli River and Upper Talarik Creek, the EPA Region 10 recognized that losses of salmon streams, tributaries and wetlands each provide a basis to issue the Section 404(c) Proposed Determination. Our analysis of the 2018 proposed design for Pebble Mine and reasonably foreseeable future development scenarios demonstrate that these criteria are exceeded in all cases. Further, we have identified significant uncertainties in available data to inform this evaluation, specifically within the footprint of the 78-year mine scenario. We recommend that

these uncertainties be resolved to better estimate the potential impact of the proposed mine on salmon habitat in this area prior to judication of the current permit application for the development of Pebble Mine.

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