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AN ASSESSMENT OF POTENTIAL MINING IMPACTS ON SALMON ECOSYSTEMS OF BRISTOL BAY, ALASKA

VOLUME 1—MAIN REPORT

U.S. Environmental Protection Agency
Region 10
Seattle, WA

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Acronyms and Abbreviations

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOT	Alaska Department of Transportation and Public Facilities
AFFI	Alaska Freshwater Fish Inventory
ANCSA	Alaska Native Claims Settlement Act
AP	acid-generation potential
APDES	Alaska Pollutant Discharge Elimination System
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AUC	area under curve
AVS	acid volatile sulfides
AW	ambient waters
AWC	Anadromous Waters Catalog
BBAP	Bristol Bay Area Plan for State Lands
BLM	biotic ligand model
BMP	best management practice
CCC	criterion continuous concentration
CFR	Code of Federal Regulations
CH	Channel
CIBB	Cook Inlet-to-Bristol Bay
CMC	criterion maximum concentration
CRU	Climate Research Unit
CWA	Clean Water Act
DBB	Dillingham/Bristol Bay
DEM	digital elevation model
DOC	dissolved organic carbon
EC ₂₀	20% effective concentration
EC ₅₀	median effective concentration
EL ₅₀	median effective level
E-R	exposure-response relationship
ERA	ecological risk assessment
FA	fish avoidance
FERC	Federal Energy Regulatory Commission
FK	fish kill
FP	high floodplain potential
FR	fish reproduction
FS	fish sensory
GCM	global climate model
GIS	geographic information system
GMU	Game Management Unit
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HUC	hydrologic unit code
IA	invertebrate acute
IC	invertebrate chronic
IC ₂₀	20% inhibitory concentration
IC ₅₀	median inhibitory concentration
IFIM	Instream Flow Incremental Methodology

IGTT	Intergovernmental Technical Team
LC ₅₀	median lethal concentration
LFP	left floodplain
MAF	mean annual streamflow
MCE	maximum credible earthquake
MDE	maximum design earthquake
MDN	marine-derived nutrients
Mi	Minerals
MOA	memorandum of agreement
NA	not applicable
NAG	non-acid-generating
NANA	NANA Regional Corporation, Inc.
NDM	Northern Dynasty Minerals
NED	National Elevation Dataset
NFP	no or low floodplain potential
NHD	National Hydrography Dataset
NNP	net neutralizing potential
NP	neutralizing potential
NPR	neutralizing potential ratio
NWI	National Wetlands Inventory
OBE	operating basis earthquake
OHW	ordinary high water
PAG	potentially acid-generating
PEC	probable effect concentration
PEL	probable effect level
PET	potential evapotranspiration
PHABSIM	Physical Habitat Simulation
PLP	Pebble Limited Partnership
PRISM	Parameter-elevation Regressions on Independent Slopes Model
Reclamation	Bureau of Reclamation
RFP	right floodplain
SCADA	supervisory control and data acquisition
SEM	simultaneously extracted metals
SNAP	Scenarios Network for Alaska and Arctic Planning
SWATP	Southwest Alaska Transportation Plan
SWPPP	stormwater pollution prevention plan
TDS	total dissolved solids
TEC	threshold effect concentration
TEL	threshold effect level
TLm	equivalent to LC ₅₀
TSF	tailings storage facility
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WWTP	wastewater treatment plant

Units of Measure

µg	microgram
µS	micro-Siemens
°C	degrees Celsius
cm	centimeter
g	gram
ha	hectare
kg	kilogram
km	kilometer
km ²	square kilometers
km-yr	kilometer-year
L	liter
m	meter
m ²	square meter
m ³	cubic meter
mg	milligram
mm	millimeter
s	second
t	ton
yr	year

Unit of Measure Conversion Chart

Metric

1 μg (microgram)

1 mg (milligram)

1 g (gram)

1 kg (kilogram)

1 metric ton

1 mm (millimeter)

1 cm (centimeter)

1 m (meter)

1 m² (square meter)

1 m³ (cubic meter)

1 km (kilometer)

1 km² (square kilometer) or 100 ha (hectares)

1 ha (hectare)

1 L (liter)

1^oC (degrees Celsius)

Standard

3.527396 x 10⁻⁰⁸ ounces

3.527396 x 10⁻⁰⁵ ounces

0.035 ounce

2.202 pounds

1.103 tons

0.039 inch

0.39 inch

3.28 feet

10.764 square feet

35.314 cubic feet

0.621 mile

0.386 square mile

2.47 acres

0.264 gallon

1.8^oC + 32^o Fahrenheit

Elements and Chemical Symbols

Ag	silver
Al	aluminum
As	arsenic
B	boron
Ba	barium
Be	beryllium
Bi	bismuth
Ca	calcium
CaCO ₃	calcium carbonate
Cd	cadmium
Cl	chlorine
CN	cyanide
Co	cobalt
Cr	chromium
Cu	copper
F	fluorine
Fe	iron
Ga	gallium
Hg	mercury
In	indium
K	potassium
Mg	magnesium
Mn	manganese
Mo	molybdenum
Na	sodium
Ni	nickel
O	oxygen
Pb	lead
S	sulfur
Sb	antimony
Se	selenium
Se ⁺⁴	selenate
Se ⁺⁶	selenite
Si	silicon
SiO ₂	silicon dioxide
Sn	tin
SO ₄	sulfate
Sr	strontium
Te	tellurium
Th	thorium
Tl	thallium
U	uranium
V	vanadium
Zn	zinc

PREFACE

This assessment represents a collaboration among the U.S. Environmental Protection Agency's (USEPA's) Region 10, Office of Water, and Office of Research and Development. It was conducted as an ecological risk assessment to evaluate the potential impacts of large-scale porphyry copper mine development on salmon and other salmonid fishes and their habitats and consequent effects on wildlife and Alaska Native cultures in the Nushagak and Kvichak River watersheds of Bristol Bay, Alaska. It is not an assessment of a specific mine proposal for development, but the mine scenarios considered in the assessment are based on a published plan to mine the Pebble deposit. The assessment does not outline or evaluate decisions made or to be made by USEPA.

The first external review draft of this assessment (EPA 910-R-12-004) was released in May 2012 for a 60-day public comment period and external peer review by 12 independent expert reviewers. The revised, second external review draft was released in April 2013 (EPA 910-R-12-004B) for another 60-day public comment period and follow-on review by the same 12 peer reviewers. All public and peer review comments on the two drafts were considered in the development of this final assessment.

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PHOTO CREDITS

Front cover	Main photo: Upper Talarik Creek (Joe Ebersole, USEPA) Thumbnail 1: Brown bear (Steve Hillebrand, USFWS) Thumbnail 2: Fishing boats at Naknek, Alaska (USEPA) Thumbnail 3: Iliamna Lake (Lorraine Edmond, USEPA) Thumbnail 4: Sockeye salmon in the Wood River (Thomas Quinn, University of Washington)
Title Pages	
Executive Summary	Area of tailings storage facility 1 in the mine scenarios (Michael Wiedmer) Sockeye salmon near Gibraltar Lake (Thomas Quinn, University of Washington) Tributary of Napotoli Creek, near the Humble claim (Michael Wiedmer)
Chapter 1	Kvichak River below Iliamna Lake and Igiugig (Joe Ebersole, USEPA) Salmon art on a building in Dillingham (Alan Boraas, Kenai Peninsula College) Sockeye salmon in Gibraltar Creek (Thomas Quinn, University of Washington)
Chapter 2	Pebble deposit area (Lorraine Edmond, USEPA) Sockeye salmon in Wood River (Thomas Quinn, University of Washington) Knutson Creek draining into the Knutson Bay area of Iliamna Lake (Keith Denton)
Chapter 3	Iliamna Lake (Lorraine Edmond, USEPA) Homes in Nondalton (Alan Boraas, Kenai Peninsula College) Groundwater upwelling near Kaskanak Creek, Lower Talarik basin (Joe Ebersole, USEPA)
Chapter 4	Area of the Pebble deposit (Joe Ebersole, USEPA) Brown bear feeding on salmon (Steve Hillebrand, USFWS) Lodge on the Kvichak River (Joe Ebersole, USEPA)
Chapter 5	Nushagak River at Koliganek (Alan Boraas, Kenai Peninsula College) Sockeye salmon in Wood River (Thomas Quinn, University of Washington) Fishing boats at Naknek, Alaska (USEPA)
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Chapter 12	Area of the Pebble deposit (Joe Ebersole, USEPA) Brown bear feeding on salmon (Steve Hillebrand, USFWS) Lodge on the Kvichak River (Joe Ebersole, USEPA)
Chapter 13	Nushagak River at Koliganek (Alan Boraas, Kenai Peninsula College) Sockeye salmon in Wood River (Thomas Quinn, University of Washington) Fishing boats at Naknek, Alaska (USEPA)

- Chapter 14** Subsistence skiffs at New Stuyahok (Alan Boraas, Kenai Peninsula College)
Sockeye salmon near Pedro Bay, Iliamna Lake (Thomas Quinn, University of Washington)
Tributary near the Humble claim and Ekwok (Joe Ebersole, USEPA)
- Chapter 15** Salmon drying at Koliganek (Alan Boraas, Kenai Peninsula College)
Beaver pond succession in Upper Talarik Creek (Joe Ebersole, USEPA)
Rainbow trout (USEPA)

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