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Subject: Pebble Mine Draft EIS Comments on Alternatives Analyses, Cumulative Effects, Water Management, Wetlands Mitigation and Air Quality

Dear Mr. McCoy,

The Draft Environmental Impact Statement (DEIS) analysis of alternatives, cumulative effects, water management, wetlands mitigation and air quality for the Pebble Project is clearly inadequate.

Much of the analysis contains insufficient detail to determine if the planned actions are adequate or practicable; the DEIS commonly understates potential impacts; essential analyses and designs are deferred to the post-EIS permitting period; and in a number of significant instances, its conclusions are clearly wrong. In particular:

- There are several important alternatives which could significantly reduce the environmental impacts and risks of the project which were either not evaluated or were eliminated prematurely. Conversely, the proposed 20-year mine plan was selected for evaluation despite the near certainty that it is not economically feasible. The financial analysis that has been provided for the 20-year mine plan is fatally flawed. It ignores smelter and refining costs, understates capital and operating costs and fails to provide even a placeholder cost for closure. With the incorporation of these corrections, the Pebble Limited Partnership financial evaluation has a strongly negative net present value.
- The impacts of the expanded 78-year mine plan are significantly understated in the cumulative effects analysis. For example, the expanded mine would almost certainly lead to measurable and permanent harm to fisheries in the Bristol Bay watershed even if everything were to go according to plan. The innate containment risks posed by the expanded mine plan are also substantially greater. If a large-scale catastrophic failure in tailings containment were to occur, the fish values throughout the Koktukli/Nushagak River System would almost certainly be profoundly and permanently damaged.

- Many of the water management strategies and systems described in the DEIS are flawed or lack sufficient design detail to evaluate if they are adequate and practicable to meet the required very high standard for water management. In particular the proposed water treatment strategy for the mine is extremely complex, still has significant uncertainties, and to my knowledge has not been attempted at this scale anywhere else in the world.
- It will be exceedingly difficult for Pebble to find any meaningful wetland mitigation projects of sufficient size within the Bristol Bay watershed because it is an unimpacted pristine environment which is not threatened by any large-scale development other than the Pebble Project itself. However, many of the mitigation actions presented in the DEIS are so poorly-defined that it is impossible to assess if they if they would provide adequate and meaningful mitigation for the project's significant impacts to an extremely sensitive environment.
- Air quality predictions for the mining operation appear to have omitted tailpipe emissions and thus may have excluded 97% of NOx emissions from the dispersion analysis. If this is correct, potential air quality impacts are grossly underestimated.

Professional Background

I am an environmental scientist and manager with over thirty years of experience in the mining and consulting industries. During my 23 years with the global mining company Rio Tinto I have been involved in the strategic environmental design of several new mines. I have performed environmental, permitting and closure work at over fifty mines, projects and operations. This included over seven years as Head of Environment for Rio Tinto's Copper, Copper & Diamonds and Copper & Coal Product Groups. I have published numerous papers on mine environmental performance and management in peer reviewed scientific journals, conference proceedings and books.

Alternatives Analysis

As detailed in Appendix B, the screening of different development options is intended to "determine reasonable and practicable options for detailed analysis in the EIS". However, there were several important alternatives which could significantly reduce the environmental impacts and risks of the project which were either not evaluated or were eliminated prematurely. This is evident in the anomalously small number of options which were actually selected for evaluation in the DEIS. Conversely the Pebble Limited Partnership's 180,000 tons per day (tpd) concentrator throughput case appears to have been approved without sufficient due diligence to determine if it meets the stated screening criteria that an option must be "practical or feasible from the technical and economic standpoint" (Appendix B).

Option TPD-001 - Option TPD-001 is the mining project proposed by the Pebble Limited Partnership (PLP) with concentrator throughput of 180,000 tons per day (tpd) for 20 years. This option forms the core basis of Action Alternative 1 in the DEIS. According to Appendix B this option has a positive Net Present Value (NPV) of approximately one billion dollars. The supporting documents for this estimate were provided by the PLP in response to Request for Information 059. The PLP NPV analysis is based on the 2011 financial evaluation completed by Wardrop (which the PLP has described as out of date) with minor modifications to account for the smaller mine plan. The PLP analysis is very preliminary and is based upon only two short spreadsheet pages of calculations. Even a cursory review of the estimate reveals several fatal flaws which wrongly increase the estimated 20-year project NPV:

- The PLP analysis is based on the original 2011 construction capital, sustaining capital and operating costs from the Wardrop Study. However, the PLP analysis fails to account for inflation from 2011 to today, which has totaled 13.8%. Cost inflation was ignored despite the fact that the PLP inflated the expected market value for metals sales by about ten percent compared to the Wardrop study. Accounting for inflation in sales revenue but ignoring inflation for costs is a fundamental accounting error which has a profound negative impact on the project NPV when it is corrected.
- The concentrate which is loaded at the port will need to be transported, smelted and refined before the final product can be sold. However, the PLP analysis fails to incorporate transport, smelting and refining charges into the economic analysis despite the fact that they are financially significant and clearly considered in the original Wardop study.
- The PLP analysis fails to provide even a placeholder cost to account for the large closure liability that will be created by the project. As detailed in the DEIS comment letter by Borden (May 31, 2019) the closure cost for the 20-year mine at Pebble is almost certain to exceed \$1.5 billion and is likely to exceed \$2.0 billion in the year of closure.

There are likely to be other errors in the PLP financial evaluation which would further erode project economics, but these three obvious issues alone reduce the NPV of the 20-year project by more than two billion dollars and make it strongly negative:

	NPV[1]
PLP financial estimate provided in Appendix B and RFI059 Responses	+\$1.0 Billion
Construction capital increase to account for inflation since 2011	-\$0.5 Billion
Operating expenditure and sustaining capital increase to account for inflation	-\$1.0 Billion
Smelting and refining charges	-\$0.5 Billion
Closure Costs	-\$0.4 Billion
Partially corrected NPV based on initial PLP 2018 Assessment	**-\$1.4 Billion**

1 The costs for each item were distributed appropriately over the four-year construction period, the twenty-year operating period and the first year of closure before being discounted at a seven percent rate.

As described in the comment letter by Borden (March 28, 2019) actual project NPV is likely closer to roughly negative three billion after 1) accounting for previously underestimated operational water treatment costs, 2) appropriately correcting for net smelter return and lower grades, and 3) incorporating the large additional capital and operating costs not included in the original 2011 Wardrop estimate such as pyritic tailings storage, quarries, extremely large contact water containment structures and the ferry. As such, the 20-year mine plan would almost certainly fail the DEIS alternatives screening criteria but even more importantly would not meet the overarching strategic goal to select the "least environmentally damaging practicable alternative". Despite this, there is no indication that the Army Corps of Engineers or its contractors performed any due diligence on the reliability of the PLP estimate. Although other mining options are rejected for analysis in the DEIS because they are considered uneconomic, Appendix B merely states that "Because this option [TPD-001] is included in the proposed project (Action Alternative 1) it is presumed to meet the three screening criteria for purposes of detailed environmental review."

Option LAY-005 - Option LAY-005 is based upon the smallest mine plan considered by the 2014 USEPA watershed assessment with total ore production of 230 million tons at 31,100 metric tpd. This development option only processes about 18% as much ore as Action Alternative 1 and was rejected as "not economically practicable" by the DEIS. Although no option-specific financial analysis was completed, this conclusion is certainly reasonable given the extremely large capital costs required for such a small project and the almost certain marginal economics of Action Alternative 1. However, no reasonable smaller mine options that were sized between this extremely small case and the proposed full plan were even considered.

Although I do not believe the 20-year mine plan is economically feasible, if the Army Corps of Engineers has chosen to evaluate it anyway, then a slightly smaller mine with significant reductions in environmental impact should also be considered for evaluation. For example, a mine plan with the planned ore production rate of 180,000 tpd but a mine life of only 16 years instead of 20 would produce 20% less ore than Action Alternative 1. However, because the lost production would occur from years 17 to 20, once a discount rate of 7% is applied to the potential lost revenue, this would likely only reduce overall project NPV by roughly 10%. The environmental benefits of producing only 1050 million ton of ore instead of 1300 million tons could be substantial including: 1) a potential two square mile (>1200 acre) reduction in total disturbed footprint for the bulk tailings storage facility, the pyrite tailings storage facility, the open pit, water management ponds and the quarry sites; 2) a substantial reduction in the final height of the bulk tailings impoundment which will reduce the in perpetuity risk of catastrophic failure; 3) a substantial reduction in water treatment requirements during operation and after closure; 4) a reduction in dewatering impacts associated with the open pit; 5) a reduction in impacts to surface water quality, flow regime and temperature due to water extraction, use and discharge 6) a roughly 20% reduction in the mass of pyritic tailings and potentially acid forming waste rock that must be returned to the open pit at closure; and 7) a shortening of the period of operational risk associated with spills, leakage, noise, air and greenhouse gas emissions from 20 to 16 years.

Option TSF-003 - Option TSF-003 which considered the use of paste tailings in the bulk tailings storage facility was eliminated because “Paste tailings are mostly placed in abandoned underground workings and have minimal surface TSF history and interest. A paste TSF would provide no meaningful environmental benefit above that of the proposed project”. The rationale provided for the elimination of a paste tailings option from consideration is incorrect in several ways. Interest in large-scale use of paste and filtered tailings has been growing in recent years in response to several high-profile tailings dam failures. The Independent Expert Engineering Investigation and Review Panel for the Mount Polley TSF failure recommended that “best available technology should be actively encouraged for new tailings facilities” and strongly supported the use of filtered tailings for new impoundments. Both Toromocho in Peru and Minera Centinela in Chile are using paste tailings technology for their surface tailings dams at production rates of 120,000 and 100,000 tpd respectively.

The use of paste tailings at Pebble would also provide significant environmental benefits by reducing the initial volume of stored water within the tailings mass by fifteen percent or more compared to conventionally thickened tailings. Potential benefits include: 1) a more rapidly consolidated and stable tailings mass with lower geotechnical risk; 2) less contained pore water which will require long-term collection and treatment as the tailings slowly consolidate over decades after closure; 3) less makeup water demand for the mill, so that less water will need to be diverted from in-stream flow; 4) a potentially lower tailings dam because of more efficient storage of tailings solids; and 5) more rapid closure of the bulk tailings storage facility because of less settling and early vehicle accessibility on the final tailings surface.

Cumulative Effects

The cumulative effects analysis assumes an expansion of the Pebble project which processes 55% of the delineated resource over a 78-year period. This is the “Resource Case” which was evaluated by the Preliminary Assessment of the Pebble Project (Wardrop, 2011). It is also the same as the Pebble6.5 project subsequently evaluated by the Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay (USEPA, 2014). The cumulative effects analysis for this larger mine is of critical importance at Pebble because the 20-year mine plan being evaluated by the DEIS only processes 10% of the resource and is almost certainly not economically feasible (Borden DEIS comment letter dated March 28, 2019). If the 20-year mine was constructed it is almost certain that a much larger mine would ultimately be developed in an attempt to attain a positive rate of return on the initial investment.

The cumulative effects analysis presented in the DEIS contains insufficient detail, understates the impacts of a larger mine and, in some cases, its conclusions are clearly wrong. The impacts of the 78-year mine are discussed separately in each subsection of Section 4 in the DEIS. This fragmented presentation also makes it difficult for the reader to form a holistic understanding of the much larger impacts and risks posed by the larger mine. The table below compares some of the more significant differences between the 20- and 78- year mine plans.

	Action Alternative 1	Expanded Development Scenario	Relative increase
Direct Disturbance	14 square miles	> 46 square miles	3.3 times greater
Permanent Direct Wetland Disturbance	5.5 square miles	>19 square miles	3.5 times greater
Permanent Loss of Anadromous Fish Habitat	8.2 miles of stream and rivers	42 miles of streams and rivers	5 times greater
Bulk Tailings Production	1140 million tons	5700 million tons	5 times greater
Pyritic Tailings Production	155 million tons	800 million tons[1]	5 times greater
Non-Acid-Generating Waste Rock Production	95 million tons	13600 million tons[2]	140 times greater
Acid-Generating Waste Rock Production	50 million tons	3400 million tons	70 times greater
Fugitive Dust and Mobile Equipment Emissions	250,000 tons per day[3]	900,000 tons per day	3.6 times greater
Open Pit Footprint	608 acres	3600 acres	6 times greater
Maximum Pit Groundwater Inflow	2400 gallons per minute	12,000 gallons per minute[4]	5 times greater
Operational Spill Risk Duration	20 years	78 years	3.9 times greater
Green House Gas Emissions	>22 million tons of CO_2 equivalents[5]	>160 million tons of CO_2 equivalents	7 times greater

[1]Assumes same 12% split between whole tailings and pyrite tailings as described in the Pebble Project Description (Appendix N). [2]Assumes the same 20%/80% split between acid-generating and non-acid-generating waste rock as described in the Wardrop (2011) 25-year mine scenario. Note this results in about 1/3 less acid generating waste rock than assumed in the USEPA 2014 Bristol Bay Watershed Assessment. [3]Total tons of ore, waste rock and embankment fill rock that must be moved each day. The tons per day that must be moved is directly correlated with the amount of fugitive dust and vehicle tail-pipe emissions generated by blasting, loading, vehicle movement on haul roads, dumping and dozing. These sources contribute more than 90% of the emissions load calculated for the operation for NOx, CO and PM10 (Section 4.20). [4]Estimate from Section 4.16.7. [5]Greenhouse gas emissions for the 20-year mine plan are derived directly from the tables in Section 4.20. For the 78-year mine plan the emissions are modified from the 20-year case to account for the extra 58 years of operation, the 39% increase in mill throughput, the 3.6-fold increase in total rock movement due to much higher stripping ratios, and the roughly four billion tons of rock and tailings that must be returned to the open pit at closure.

As clearly shown in the table, most of the individual impacts of the larger mine will be at least three to seven times greater than for the small 20-year mine. However, the geochemical and water quality risks posed by the larger mine would be at least ten times greater. Many of these significantly greater impacts and risks are not identified in the DEIS. Key mischaracterizations in the cumulative effects analysis include:

Geochemical Risks – The total mass of tailings and waste rock that is prone to acid rock drainage formation rises from 205 million tons for the 20-year mine to 4200 million tons for the 78-year mine (a 20-fold increase). Given Pebble's extremely wet climate, all of this waste would pose an extremely high ARD risk to down gradient groundwater, streams and rivers.   If not controlled the resultant ARD could have metals concentrations hundreds to tens of thousands of times higher than discharge criteria. All of this material would require complex and costly management during operation; and at closure all of this material would need to be returned to the open pit where it could be permanently saturated.

Closure costs for this material movement alone would likely exceed five billion dollars.

The total mass of tailings and waste rock that is prone to neutral drainage but with concentrations of nitrate, sulfate, copper, molybdenum and selenium elevated above discharge criteria rises from 1235 million tons for the 20-year mine to 19300 million tons for the 73-year mine (a 15-fold increase). This material would pose a lesser, but still significant risk to down gradient groundwater and surface water quality. Given the large increase in chemically reactive rock mass and surface area, and the decades longer exposure period of pit walls, waste rock and tailings before closure, net on-site contaminant release rates are almost certain to be an order of magnitude higher than for the 20-year mine.

If actually implemented as designed in the DEIS, the 20-year mine plan also confines most of the geochemical risks to a single drainage (North Fork Koktuli) but in the expanded case geochemical risks would spread into all three drainages (NFK, SFK and UTC). Despite this order of magnitude, long-term increase in geochemical risk it is not clearly highlighted and in some cases is significantly understated in the cumulative effects descriptions. Section 4.18.7 of the DEIS (Water and Sediment Quality Cumulative Effects) acknowledges that new facilities to store waste rock and tailings "would contribute to cumulative effects on water and sediment quality due to the nearly tripled footprint area and substantially larger duration of mining activity". However, this statement fails to acknowledge the 20-fold increase in geochemically reactive mineral waste and it also wrongly states that "the magnitude of cumulative impacts to water and sediment quality would generally be temporary".

Direct Disturbance – The DEIS consistently highlights a greater than three-fold increase in direct mine disturbance largely related to expanded open pit, tailings and waste rock storage facilities. However, this may significantly understate the required footprint expansion to safely mine and store roughly 16 times more ore, tailings and waste rock. In particular, the proposed mine layout for the 78-year case assumes that the pyritic TSF footprint expands by only 2.5 times despite the fact that this facility must hold five times more pyritic tailings and at least 70 times more acid generating waste rock. It is unclear how so much chemically reactive material could be safely stored under saturated conditions in such an exceedingly small footprint. If the 78-

year mine plan is not designed to store acid generating waste rock in the lined pyritic TSFs, this should be clearly stated because it would increase the acid rock drainage generation rates, water treatment liabilities and metals release to the environment by orders of magnitude.

Groundwater Impacts – The 78-year mine plan would result in at least 20 square miles of new unlined waste rock dumps and tailings embankments. It would also more than double the unlined footprint occupied by bulk tailings. Given the very wet climate, average infiltration rates into these new facilities during operation would almost certainly exceed 10,000 gallons per minute. Most of this water would undoubtedly perch at the bedrock contact or travel via the shallow weathered bedrock flow path where it could be more easily captured. However, some would enter the deeper bedrock flow regime where it would be much more difficult to contain. This would undoubtedly significantly increase the amount of contaminated groundwater that ultimately discharges into down gradient rivers and streams. However, this issue is not addressed in the cumulative effects discussion for Groundwater Hydrology or Water and Sediment Quality.

Water Management Impacts – The 78-year mine plan would result in at least three to five times more contaminated water to be collected and treated than would be required for the 20-year mine plan. This results from the more than three-fold increase in the footprint of the open pit, waste rock dumps and tailings storage facilities as well as a predicted five-fold increase in pit dewatering requirements (Section 4.17.7). Near the end of mine life this would result in an enormous water management liability of 40,000 to 65,000 gallons per minute on average. It would be extremely challenging and costly to consistently collect, store, treat and discharge this much contaminated water. The dewatering impacts and changes in flow regime and temperature would also be much more significant than for the 20-year mine. However, the cumulative effects assessment does not directly address this significant risk.

Geotechnical and Spill Risks – The 78-year mine plan would need to safely contain up to 6.5 billion tons of tailings during operation and 5.7 billion tons of bulk tailings in perpetuity after closure. This is a five-fold increase in the mass of tailings requiring management compared to the 20-year mine. As previously described, the mine would also need to continuously collect, store, treat and discharge at least three to five times more contaminated water. The number of separate storage and collection facilities would more than double. Bulk tailings, pyritic tailings, waste rock dumps, water storage ponds and seepage collection ponds would need to be located in upper Talarik Creek, South Fork Koktuli and North Fork Koktuli instead of a single drainage. All of these facilities would need to be operated for at least 78 instead of 20 years. The risks posed by catastrophic failure and the release of tailings or contaminated water are clearly substantially greater for the expanded mine case. Despite this, the cumulative effects discussion in Section 4.15.6 (Geohazards) states "The magnitude of potential geohazard-related impacts would be similar to the proposed project [the 20-year mine]……"; and Section 4.27.8 (Spill Risk) states "In summary, the cumulative effects of unintentional releases associated with the Pebble Mine Expansion would be similar to those discussed previously in this section [for the 20-year case], but potentially involve larger volumes over a slightly larger geographic area."

Air Emissions – The amount of waste rock, ore and construction fill that would need to be moved every day would increase from 250,000 tpd for the 20-year mine to 900,000 tons per day for the 78-year mine. This is mostly due to the large increase in waste rock stripping required for the expanded mine, but also because of the larger mill throughput planned. This 3.6-fold increase in daily materials movement would require a roughly similar increase in blasting, loading, trucking, dumping and dozing operations. Annual air emissions of NOx, CO and dust would almost certainly more than triple compared to the 20-year mine plan because they are almost entirely generated by mobile equipment and fugitive emissions. For example, particulate matter less than ten microns in diameter (PM10) would almost certainly increase from an estimated 3000 tons per year to over 10,000 tons per year at the mine. Among other impacts, this could have significant implications for metals loading into nearby streams and wetlands. Despite the clear increase in required material movement and air emissions associated with the mine expansion, Section 4.20.10 of the DEIS states "it is not anticipated that [expanded] mine operations would be meaningfully different than those analyzed for Alternative 1" and furthermore that "the expansion would result in similar magnitude, duration and geographic extent of the air quality impacts described under Alternative 1 for a given year". Both of these statements are clearly wrong.

Greenhouse Gas Emissions – The cumulative effects analysis in the DEIS does not address the roughly seven-fold increase in greenhouse gas emissions associated with the 78-year mine plan. This is largely driven by the massive increase in required waste rock stripping, higher mill throughputs, longer mine life and the need to move roughly four billion tons of acid generating waste rock and tailings back into the open pit at closure. During operation it is estimated that annual greenhouse gas emissions will increase from 940,000 tons of CO_2 equivalents to roughly 1,700,000 tons. Despite the clear increase in greenhouse gas emissions associated with the mine expansion, Section 4.20.10 of the DEIS states "it is not anticipated that [expanded] mine operations would be meaningfully different than those analyzed for Alternative 1" and furthermore that "the expansion would result in similar magnitude, duration and geographic extent of the air quality impacts described under Alternative 1 for a given year". Both of these statements are clearly wrong.

Fish Values – Under Section 4.24.6 Cumulative Effects for Fish Values it states that "These impacts [for the 78-year mine] would be similar to those described previously in this section [for the 20-year case] but take place over a geographic area combining components of Alternatives 1 and 3. With the mine expansion, the duration of these impacts would be extended by an additional 58 years of mining and 20 years of additional milling". This statement is clearly wrong and badly misleading given 1) the significant increase in cumulative impacts associated with direct disturbance, geochemical issues, water management and air emissions; 2) the significantly increased risk profile associated with catastrophic release of tailings and/or contaminated water associated with the 78-year mine case; and 3) the permanent harm which will be caused by the massively expanded bulk tailings impoundments, waste rock dumps, open pit and expanded water management infrastructure that would need to exist in perpetuity after closure. The 78-year expanded mine scenario would almost certainly lead to measurable and permanent harm to fisheries in the Bristol Bay watershed even if everything were to go according to plan. If a large-scale catastrophic failure in tailings containment were to occur the fish values throughout the Koktukli/Nushagak River System would almost certainly be profoundly and permanently damaged.

Water Management

Given the very high geochemical risk of the Pebble orebody, the extremely wet climate and the extreme sensitivity of the Bristol Bay watershed, water management at the proposed mine is an issue of critical importance. However, many of the water management strategies and systems described in the DEIS are flawed or lack sufficient design detail to evaluate if they are adequate and practicable to meet the required very high standard for water management. Several of these long-term water-related management issues and their deficiencies are discussed in an earlier DEIS commented letter (Borden May 31, 2019) which addresses closure issues. Problematic operational water management issues discussed in this letter include 1) water treatment practicability, 2) constructability and performance of water containment structures, 3) groundwater quality impacts, and 4) other water treatment requirements.

Water Treatment Practicability – The project proposes to construct and operate two water treatment plants capable of treating up to 19,000 gallons per minute. The proposed water treatment plant designs are extremely complex, still have significant uncertainties and are likely to have very high operating costs. Treatment technologies incorporated into the two plants vary but both include initial metals precipitation with lime, sodium hydroxide and other reagents, secondary metals precipitation using sodium hydrogen sulfide and other reagents, clarification and ultrafiltration. The open pit treatment plant also includes reverse osmosis and a biological reactor for selenium removal. The main water treatment plant also includes nanofiltration, followed by gypsum precipitation via lime addition, clarification, reverse osmosis and evaporation (Chapter 2 and Appendix K, 4.13). According to Section 4-18 of the DEIS "both facilities would employ treatment plant processes commonly used in mining and other industries around the world". While this is certainly true of individual plant components, I am not aware of a treatment flowsheet of this complexity being applied to such high flows anywhere else in the World. The flows proposed for treatment are almost certainly higher than 90% of mine water treatment plants operating around the world today (MEND 2013, Review of Mine Drainage Treatment and Sludge Management Options). Most operating mine treatment plants also have much simpler treatment strategies, rather than the five to ten steps that must all be consistently be applied in sequence at Pebble. By necessity the entire water treatment strategy is at best conceptual in nature and no laboratory or pilot scale tests appear to have been completed. During an internal review of the proposed treatment processes conducted in

October, 2018 (AECOM 2018i) it was stated that “While lack of specific detail and apparent contradictory information in planning documents is assumed to be a result of the current stage of planning for the project, it is difficult to fully assess the treatment process in a meaningful way without confidence in reliability of the design of the treatment process”. The DEIS also acknowledges that even if the plants can consistently operate as designed, solutes could still build up over time in the process water circuit. This could have significant negative environmental and operational consequences.

Given the current uncertainties and inconsistencies in the treatment strategy, the lack of engineering drawings, designs and specifications for review and the lack of any cost estimates, the ability of the proposed water treatment plants to consistently and reliably meet required throughputs and discharge water quality requirements in an economically practicable manner has not been demonstrated.

Constructability and Performance of Water Containment Facilities – The Main Water Management Pond and the Pyritic Tailings Storage Facility will be very large engineered structures covering about 1.5 and 1.7 square miles respectively. However, despite the importance of these facilities for water containment almost no information is provided on how they will be designed and constructed to prevent leakage.

The DEIS and its supporting documents repeatedly state that the two facilities will be “fully lined with HDPE and will be equipped with underdrains”. This is insufficient detail to evaluate the effectiveness of the facilities to prevent leakage, to determine their constructability or to accurately predict likely leakage rates to groundwater. Both of these large facilities will contain contaminated water with many solutes that are orders of magnitude above allowable discharge limits. There will consistently be more than 100 feet of head on both liners and the streams immediately downgradient represent an extremely sensitive environmental receptor. In order to protect underlying groundwater and downgradient surface water quality a robust composite liner system with at least a synthetic liner, low permeability compacted soil layer (or equivalent) and a leak detection or pressure relief layer will almost certainly be required. A credible argument could also be made for a full double composite liner system given the extreme sensitivity of the environmental setting. However, it is unclear if such a composite liner system is even feasible because it is not known if there is a local low permeability soil source available. These liners will cover over three-square miles and are much larger than water storage ponds at most other operating mines. They will be extremely challenging to construct at such a large-scale. There will be significant construction and operation risks associated with wind damage, wet- and cold-climate construction, ice damage, freeze-thaw and damage from rock placement. Despite these significant risks the seepage analysis for the DEIS assumes a near-perfect installation with no liner defects. This is almost certainly over-optimistic given the challenging conditions at Pebble and the actual field performance of liners at many other sites around the world. The liner leakage rate assumed in the DEIS is only 30 gallons/acre/day. However, using the same reference cited by Knight Piesold (2018n), but assuming only one small hole in the liner per acre, could result in a leakage rate of 1000 gallons/acre day (Giroud and Bonaparte, 1989). This assumption alone would result in a profound change in loading rates to groundwater from the two facilities with an increase from 40 gallons per minute to 1400 gallons per minute.

The DEIS must clearly state the design of the planned liner system, must detail how such a large liner will be successfully installed and only then can informed assumptions be made about design leakage rates over the three-square mile area. The single leakage scenario detailed in Section 4.27.7 under spill risk only assumes liner leakage of 900 gpm for one month and is clearly significantly undersized compared to a scenario of a poorly installed or badly damaged liner which could leak at rates of 1400 gpm for years.

Groundwater Quality Impacts – As noted in the DEIS there will be mine-impacted water leakage to groundwater from the Bulk TSF, the pyritic TSF and the main water management pond. Though not sufficiently considered in the DEIS there will also be impacted water seepage to groundwater from beneath the two square miles of unlined embankment footprints, seepage collection ponds and from ore and low-grade ore stockpiles. All of these sources in total could result in several hundred gallons per minute of mine impacted water reaching the bedrock groundwater flow system even if all the proposed primary containment systems perform as intended. As discussed in the previous section on performance of containment facilities, if they do not perform as intended, leakage in excess of 1000 gpm could be possible. Nevertheless, the PLP has committed to the performance objective that there will be "no detectable seepage downgradient of the collection and pump back systems (Section 4.18). The mine plan depends upon seepage collection ponds, sumps, grout curtains and extraction wells to recapture the impacted groundwater before it can migrate offsite and discharge into surface streams and rivers. Unfortunately, even the most basic design features of these important facilities such as the likely depth and lateral extent of cutoff walls, grout curtains and sumps is not available for review and as acknowledged in Section 4.18 the containment system designs "are currently conceptual only". As such there is currently an insufficient level of design detail available to determine if the primary and secondary containment systems will be effective, adequate and practicable.

The weathered bedrock zone has relatively high hydraulic conductivities (geomeans of 10^{-3} to 10^{-4} cm/second) which appear to extend to depths of 300 to 500 feet below the ground surface (Appendix K 3.17). Much of the mine-impacted waters which enter the weathered bedrock aquifer could pass beneath the likely shallow sumps, seepage collection ponds and grout curtains, so pump back wells could prove critical for containment. However, as noted in Section 4.18 "the final location and spacing of pump back wells would be determined based on additional hydrogeologic investigation as design progresses". The designs of the primary and secondary containment systems for groundwater need to be developed in greater detail to determine if they are adequate to protect downgradient water resources and to allow likely impacts to sensitive receiving environments to be better quantified.

Other Water Treatment Requirements – The project will need to house up to 2000 employees during construction and 850 employees during operation. The DEIS acknowledges that sewage treatment plants will be needed at the mine and port, but no detail is provided on throughput, sizing or design. It is also likely that tens of employees will need to be housed on site in perpetuity after major closure works are completed, but there is no discussion of sewage treatment requirements after closure.

The DEIS also acknowledges that water treatment capacity will be needed on site during the construction period before significant water storage is available and before the permanent treatment plants are built. Section 4.18 states "before completion of the bulk TSF embankments and water management structures, all contact water not meeting water quality standards would be treated in modular water treatment plants and released". Section 2 describes these modular treatment plants as "high density sludge [lime] treatment with additional polishing steps if required". However, no additional design detail is provided for these modular plants in the DEIS and there is also no discussion of sewage treatment for 2000 employees during the construction phase. This will likely prove to be a very challenging period for water management because without storage capacity any interim water treatment systems would need to be designed to treat maximum flows during the wet season and during storm events. As such, any interim treatment plants would likely need to be significantly oversized compared to average flows.

Without additional detail on design and management of contaminated water during the construction period, it is impossible to determine if the project will be protective of downgradient water resources.

<u>Wetlands Mitigation</u>

Mitigation actions at Pebble will be critically important given the project's unavoidable, permanent large-scale impacts to an extremely sensitive and economically valuable receiving environment. Unfortunately, many of the actions presented in Section 5 and Appendix M are so poorly-defined that it is impossible to assess if they would provide adequate and meaningful mitigation for the project's impacts. In many cases the proposed "actions" are little more than statements of theoretical, generalized principles without any concrete detail; or they are only commitments that the actual designs and management strategies will be developed in the future.

For example, in Table 5-2 it states that "The project would propose fish habitat mitigation measures to enhance or create new habitat outside of the immediate project footprint". However, no actual potential mitigation projects are identified in the DEIS or in the Draft Conceptual Compensatory Mitigation Plan (CMP) (Appendix M). Instead the CMP just discusses generic evaluation criteria for the selection of currently unidentified mitigation projects at some time in the future. It will be exceedingly difficult for Pebble to find any meaningful mitigation projects of sufficient size within the Bristol Bay watershed because, at present, it is an unimpacted pristine environment unthreatened by any large-scale development other than the Pebble Project itself. As acknowledged in the CMP restoration, enhancement and preservation options anywhere in the vicinity of the mine are likely unavailable.

Table 5-2 also states that "Where feasible, mine facilities would be reclaimed in such a manner as to create new wetland areas and ponds". No additional detail is provided on the location or even the approximate surface area of wetlands that might be re-established to mitigate the planned permanent loss of 3500 acres during mine construction and operation. As detailed in an earlier comment letter (Borden, May 31, 2019) no meaningful detail on closure or revegetation techniques is provided within the DEIS.

The EIS must include more detail on concrete and credible mitigation actions capable of offsetting the large-scale unavoidable impacts to the extremely sensitive Bristol Bay environment.

<u>Air Quality Predictions</u>

According to the project emissions inventory (Section 4.20) the mine will emit 4436 tons of NOx, 2970 tons of CO, 645 tons of $PM_{2.5}$ and 337 tons of volatile organic compounds each year during operation. The effect of these emissions on the surrounding airshed has been predicted with dispersion modelling. However as detailed in Appendix K4.20 and in the response to Request for Information 009, it appears that the dispersion modelling did not consider the impact of tailpipe (mobile) emissions on the surrounding airshed. If tailpipe emissions from haul trucks and other mobile equipment has truly been omitted from the dispersion modelling, this represents a fatal flaw in the air quality predictions, particularly for nitrogen oxides. The DEIS emissions inventory indicates that 97% of all NOx emissions from the mine result from tailpipe emissions. Tailpipe emissions also account for 89% of CO, 25% of $PM_{2.5}$ and 90% of volatile organic compounds. Air quality impacts are likely to be much greater than currently implied by the DEIS and it may be much more difficult for the project to meet air quality standards than currently assumed. If tailpipe emissions were excluded from the dispersion modelling, the current air quality predictions are clearly inadequate and new modelling would need to be performed with the tailpipe emissions incorporated.

Sincerely,

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