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29 July 2013

Rep. Paul Broun, M.D.
Chairman, Subcommittee on Oversight
Committee on Science, Space and Technology
House of Representatives
2321 Rayburn House Office Building
Washington DC 20515-6301

Subject: Written Statement of Dr. Michael Kavanaugh for August 1, 2013 Hearing on "EPA's Bristol Bay Watershed Assessment – A Factual Review of a Hypothetical Scenario"

Dear Representative Broun:

In the summer of 2012, Geosyntec Consultants, Inc, (Geosyntec) was retained by Steptoe and Johnson (Steptoe) on behalf of Northern Dynasty Minerals, Inc (NDM), to provide an independent assessment of the quality of the scientific foundations used by Region 10 of the US Environmental Protection Agency (USEPA) in preparation of the draft report, "An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska" (USEPA, May, 2012)[1]. At the time, that document, designated by the USEPA as a "watershed assessment" (referred to herein as the Bristol Bay Watershed Assessment (BBWA or "2012 Assessment")[2]) was available for public comment. Geosyntec submitted its independent technical review of the 2012 Assessment to Steptoe on 18 July 2012[3] (referred to herein as the "2012 Review").

At approximately the same time, the USEPA had convened an Independent Peer Review Panel consisting of eleven scientists and one engineer to review the same document. The Peer Review

[1] USEPA. 2012. *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*. External Review Draft. EPA 910-R-12-004a. Seattle, Washington. May 2012.

[2] For this report, the term "BBWA" will refer to the watershed assessment as a whole. "2012 Assessment" will refer to the first draft of the report. "2013 Assessment" will refer to the second draft of the report.

[3] Geosyntec. 2012. *Technical Review of May 2012 Draft Report EPA 910-R-12-004a, An Assessment of Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*. Prepared by Geosyntec Consultants, 18 July 2012.

Panel's comments were compiled by Versar, a USEPA contractor, in a Final Peer Review Report dated 17 September 2012[4]. Following receipt of the Peer Review Panel Report, which included a summary of comments received during the public comment period, the USEPA revised the BBWA and on 26 April 2013 released the second external review draft ("2013 Assessment")[5]. Geosyntec was again retained by Steptoe on behalf of NDM to review the revised BBWA, and submitted its independent technical review of the 2013 Assessment to Steptoe on 22 May 2013[6] (referred to herein as the "2013 Review"). Both of these reviews were subsequently submitted to USEPA by NDM.

To perform our reviews, Geosyntec established a team of internal experts with expertise on key technical issues raised in the BBWA, with a particular focus on the engineering components of water and residuals management as described in the document (see Attachment A for a brief overview of Geosyntec, website at www.Geosyntec.com). Each team member was asked to review the BBWA and supporting documents and to assess the scientific credibility and quality of the analysis prepared by USEPA regarding risks to the environment from possible failures of these engineering components. Geosyntec undertook this analysis as an independent entity. Please be advised that Geosyntec has no commercial contracts dependent on the outcome of our evaluation.

This written statement presents a summary of key elements of Geosyntec's independent technical reviews of the 2012 and 2013 Assessments. Note that while USEPA issued the 2013 Assessment as a second draft, it is for all practical purposes a new document compared to the 2012 Assessment. Volume 1 alone almost doubled in size from 339 pages in 2012 to 618 pages in 2013 and many additions have been made to the appendices. This expansion resulted from a complete reorganization of the report, removal of a limited amount of material, and addition of significant new technical content, including new and updated analyses. Even with all of this additional content, in our 2013 Review we found that a substantial majority of our 2012 comments were still valid and in general, had not been adequately addressed in the revised document.

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[4] Versar. 2012. Final Peer Review Report, External Peer Review of EPA's Draft Document, An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska. Prepared by Versar, Inc., 17 September 2012.

[5] USEPA. 2013. *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska.* Second External Review Draft. EPA 910-R-12-004Ba. Seattle, Washington. April 2013.

[6] Geosyntec. 2013. *Assessment of USEPA Response to Geosyntec's Comments on the Brisol Bay Watershed Assessment.* Letter to Mr. Thomas C. Collier, Steptoe & Johnson, 22 May 2013.

The BBWA document essentially describes the potential consequences of a project where major "failure" of one or more of the engineered systems is considered by USEPA to be inevitable over the lifetime of the project. By failing to adequately consider that such a mining project could be engineered using best modern practices to reduce any major failure scenario to a very low probability event, with controllable and repairable consequences, and by often relying upon historical data on failures of engineered systems not applicable to a modern mine, the BBWA does not meet the standards of a credible and independent scientific analysis. Failure to meet established criteria for a credible assessment or risk analysis, even of hypothetical mining scenarios, reduces the utility of the BBWA to a catalogue of issues that will be addressed during the rigorous engineering design and mine permit review process.

The sections that follow present a commentary on the Peer Review process and the risk assessment approach applied to the BBWA, followed by general themes and specific examples identified by Geosyntec during both reviews that raise significant concerns on the scientific credibility of the BBWA and the appropriateness of using this document to inform stakeholders on the future of mining in the Bristol Bay watershed.

1. USEPA'S LATEST PEER REVIEW FAILS TO MEET FEDERAL CRITERIA FOR A CREDIBLE PROCESS

The reported objective of the BBWA is to inform decision making on the future of large scale mining in the Bristol Bay watershed. The 2013 Assessment represents USEPA's assessment of the potential impacts of hypothetical mining scenarios in the Bristol Bay watershed. Both the 2012 and 2013 Assessments have been subjected to external peer review as described on the EPA website[7]. While the peer review process conducted during the review of the 2012 Assessment met most of the criteria established by USEPA and other federal agencies required for a credible peer review process, the peer review process currently in progress for review of the 2013 Assessment fails to meet those criteria on several accounts.

USEPA first published a formal policy on peer review of major EPA scientific assessments in 1993. The details of conducting formal peer reviews were documented in the *Peer Review*

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[7] http://www2.epa.gov/ bristolbay

Handbook (3rd Edition, USEPA, 2006)[8]. The handbook provides explicit directions for external peer reviews when the work product is considered "influential scientific information" (ISI), or "highly influential scientific assessments". The BBWA clearly falls in the latter category. The preamble in USEPAs' Peer Review Handbook establishes the key criterion for publication of a credible scientific document:

> *"Science is the foundation that supports all of our work here at EPA. Strong, independent science is of paramount importance to our environmental policies. The quality of science that underlies our regulations is vital to the credibility of EPA's decisions and ultimately the Agency's effectiveness in protecting human health and the environment. One important way to ensure decisions are based on defensible science is to have an open and transparent peer review process."*

Both USEPA and the Office of Management and Budget (OMB) provide clear definitions of what constitutes "open and transparent peer review process". For example, OMB states (OMB, 2004)[9], that for peer review of "highly influential scientific assessments", transparency requires that the *"agency shall prepare a written response to the peer review report explaining (a) the agency's agreement or disagreement with the views expressed in the report, (b) the actions the agency has undertaken or will undertake in response to the report, and (c) the reasons the agency believes those actions satisfy the key concerns stated in the report (if applicable). The agency shall disseminate its response to the peer review report on the agency's website."*

This criterion was only partially met during the review of the 2012 Assessment, with only limited responses to peer committee or public comments, and only limited information available on the website. Furthermore, USEPA's peer review process for the 2013 Assessment does not meet the criterion for an "open" process. Even though the 2013 Assessment nearly doubled in size, with major organizational changes and substantial amounts of new information, no opportunities have been provided to allow for public interaction with the external peer review panel. Neither the charge to the external peer committee in this latest round, nor procedures to respond to committee questions have been made available on USEPA's website. As OMB (OMB, 2004) points out: *"Without access to the comments of reviewers, the public is incapable*

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[8] USEPA. 2006. Peer Review Handbook, 3rd Edition. Prepared for the U.S. Environmental Protection Agency by Members of the Peer Review Advisory Group, for EPA's Science Policy Council. EPA/100/B-06/002.

[9] Office of Management and Budget (OMB), 2004. Final Information Quality Bulletin for Peer Review. December 2004.

of determining whether the government has seriously considered the comments of reviewers and made appropriate revisions."

In addition, following peer review of the 2012 BBWA, USEPA undertook additional external peer review of seven documents selected by the agency as relevant to mining activities in Alaska. This component of the peer review process was not done in a transparent manner, with little information provided on how or why these seven documents were chosen, how the peer reviewers were selected, and how the USEPA responded to the comments prepared by the reviewers of these seven reports. The lack of transparency on this aspect of the peer review process is disturbing since the documents were widely quoted in the 2013 BBWA. Such lack of transparency on these highly relevant documents undermines the credibility of the final document.

The lack of an open and transparent external peer review process for review of the 2013 Assessment and other documents relied upon by USEPA seriously erodes the credibility of the Assessment and the validity of basing any future management decisions on mining in the Bristol Bay watershed on the findings of the BBWA.

2. COMMENTARY ON RISK ASSESSMENT APPROACH APPLIED TO A HYPOTHETICAL MINING SCENARIO

USEPA undertook the BBWA in response to concerns raised by numerous stakeholders on the potential impacts of future mining operations in the watershed. The fundamental flaw in the BBWA is the use of a "hypothetical" series of mining scenarios to establish the baseline conditions in attempting to assess the impacts of potential failure scenarios for selected components of a "hypothetical" mine. Such an approach is inherently speculative because the technical details of the mine have not yet been proposed. Both the footprint impacts as well as potential impacts from mine operation are unknown until an actual project is proposed. An actual mine proposal would contain extensive detail on all aspects of a large mining project, including assessment of the reliability of all engineered systems, and extensive presentations on mitigation measures designed to ensure that all systems would likely meet regulatory requirements and standards of safety for a mine in Alaska. Thus, the reliance on these hypothetical scenarios is technically invalid and contradicts requirements normally associated with assessments such as an ecological risk assessment or an environmental impact analysis. Both of these processes can only be applied to known or proposed conditions related to an actual project. There is thus no precedence or guidance followed by USEPA in conducting the BBWA, and the assessment relies on assumptions of the authors, which raises serious issues on the scientific validity of the methodology applied. The reliance on hypothetical mining scenarios was criticized by many of the peer reviewers of the 2012 BBWA; however the 2013 BBWA continues to rely on these scenarios.

The methodology for conducting the BBWA is purportedly based on USEPA guidelines for ecological risk assessments (ERAs) published in 1998 (USEPA, 1998)[10]. USEPA guidance documents for ERAs are primarily focused on Superfund sites where releases of hazardous substances have occurred and not on "hypothetical" hazardous waste sites. The outcome of such an ERA is used to inform decisions on the extent to which remedial measures need to be implemented to reduce the ecological risks associated with past and any future potential releases from the contaminated site. The use of this methodology to assess the "potential impacts" of a hypothetical project is inconsistent with the intent of the CERCLA process at Superfund sites since no releases have yet occurred.

The BBWA developed a set of conceptual models of sources, stressors and end points or receptors to conduct an ERA of two primary hypothetical mining scenarios: (i) mine operations without system failures; and (ii) mine operations with various major failures of the engineered systems required for normal mining operations. The stated purpose of the assessment is to inform USEPA on whether any mining proponents should be allowed to submit an application for a permit to construct and operate a mine in the Bristol Bay watershed at some time in the future.

The conclusions of such an assessment are only valid for decision making, however, if the assumptions and analyses used in the development of the conceptual models can meet criteria that represent an unbiased evaluation of the hypothetical mining scenario. Such criteria should include:

- Site data and case studies of other mining operations that are applicable to the likely conditions at the hypothetical mining scenario;
- Appropriate characterization of the probabilities of failure of any given component of mine operations;

[10] U.S. Environmental Protection Agency (USEPA). 1998. *Guidelines for Ecological Risk Assessment.* EPA Document No. 630-R-95-002F. April 1998.

- Appropriate use of available data to assess the magnitude and consequences of system failures; and
- Full consideration of appropriate application of modern mining design, construction, operations and maintenance strategies to prevent potential system failures and control or mitigate adverse consequences of such failures.

Geosyntec undertook the review of the BBWA to evaluate whether the assessment met these criteria as applied to the engineering components of the hypothetical mining scenario. Our primary focus was on the scientific and engineering credibility of USEPA's assessments of failures for the mine tailings storage facilities (TSFs), water collection and treatment systems, pipelines, roads and culverts. Our focus was also on the appropriateness of USEPAs analyses related to the potential impacts of these failure scenarios. The examples that follow will show how in each of these areas, the BBWA fails to satisfy these criteria. In particular, the Assessment is fundamentally flawed because the hypothetical mine scenarios would not satisfy known permitting requirements in Alaska for a large scale mining operation. The limitations in attempting a risk analysis based on a binary ("no failure" vs. "major failure") hypothetical mining scenario are readily apparent. The BBWA exaggerates the probability of failures, relies on worst case scenarios to support a qualitative judgment on the potential impacts of these failures, and thus provides an unscientific assessment of the potential impacts of the hypothetical mining project.

3. THEMES OF GEOSYNTEC 2012 AND 2013 REVIEWS

3.1 <u>Failure to Consider Modern Mining Practices</u>

The BBWA focuses on "potential impacts" of the Pebble Project on the ecological resources of the Bristol Bay watershed. These "potential impacts" include impacts that may occur during normal development and operation of the mining project, as well as those that may occur should any specific engineering system (e.g. TSF or pipelines) incur partial or total failure. Considerable effort was expended in the BBWA to predict the effects of these potential failures on the ecological resources in the watershed, with particular attention given to the salmonid fish populations. In both the 2012 and 2013 Assessments, the authors failed to consider that modern mining practices are designed to reduce the probabilities of failure of these engineered systems to some established standard of safety, and to minimize the consequences of any failure scenario through the use of modern monitoring systems, contingency planning as part of a mining operations plan, and the establishment of response systems and strategies to control quickly any releases of potentially harmful materials at the mine site. By failing to consider the implications of applying modern mine operating best practices that are (i) designed to reduce the probability of failures and (ii) mitigate quickly the consequences of any such failures, the BBWA unfairly and negatively biases the project by implicitly assuming that "worst case" outcomes for operation of most of the engineered systems at the future mine site are inevitable.

3.2 Zero-Risk Framework – A Misapplication of Engineering Design Principles

The BBWA is misleading in addressing the likelihood of system failures through the use of data on past mining operations that are not applicable to a modern, engineered mining project. USEPA has applied this approach for all system elements evaluated in the BBWA, including TSFs, pipelines, culverts, water collection and waste water treatment systems and post closure residuals management systems. The assessment fails to consider modern engineering design principles that would be applied under stringent regulatory oversight, particularly when such a significant project is implemented in a sensitive ecosystem. The BBWA consistently postulates scenarios for each of the main engineered systems that would not be allowed under existing threshold requirements for a modern mine in Alaska. In other words, the hypothetical mining scenario evaluated by the USEPA would not be permitted.

Today, properly engineered systems are designed to meet appropriate safety standards commensurate with the nature and consequences of failure and these systems include appropriate mitigation strategies should such events occur. Systems are designed to reduce the probability of failures to as low a level as is technically achievable in the context of potential consequences of credible scenarios. However, in no circumstances are engineered systems designed or constructed to eliminate the complete possibility of failure. The "zero-risk" framework in the BBWA is apparent in the use of historical data to suggest that failure of all engineering systems at the hypothetical mine are inevitable. The BBWA implies that because failures of TSFs and other engineered systems have occurred elsewhere in the past, such failures are an inevitable outcome of any future mining operation. Use of case studies of past failures of engineered systems to predict the probabilities of future failures is inherently flawed, however, because of different project histories, variability in site characteristics, and the evolution and application of improved engineering design, construction monitoring, contingency, and mitigation practices based on improving engineering technology, more stringent regulations, and "lessons learned" from previous projects.

4. EXAMPLES OF INADEQUACY OF 2012 AND 2013 ASSESSMENTS

4.1 Improper Use of Case Histories of Tailings Dam Failures

The BBWA references case histories of tailings dam failures, illustrating that tailings dams can fail and thus raising fears that such failures are inevitable during the life cycle of any mine. The most widely quoted reference in relation to the historical record of tailings dam failures is the 2001 ICOLD[11] report which documents accidents and failures at 220 tailings dams from around the world reported between 1917 and 2000. The tailings dams in these case histories failed from various causes, including overtopping, poor embankment materials, or inadequacies in foundation preparation, seepage control, freeboard, or earthquake resistance. A close examination of the ICOLD report reveals that each of the tailings dam failures could have been avoided by proper design and construction. The rigorous mine permitting process in the state of Alaska requires hydrologic and geologic investigations, tailings dam design with a high factor of safety against all modes of failure, and oversight during construction, operations, and maintenance. By comparison, the mine tailings failures referenced in the ICOLD report are from a global database and typically represent older dams, some unregulated and many designed using outdated dam engineering and construction techniques. Such a dam would not be permitted in the current regulatory environment in Alaska or any other state in the U.S.

The ICOLD report, while instructive, is not appropriate for estimating the probability of a tailings dam designed, constructed, operated, and maintained using modern practices. Regulators, engineers, scientists, and owners learn from the mistakes of others in the past. We have shown in our analysis (Geosyntec, 2012) that none of the 135 case histories of TSFs included in the BBWA are applicable to the design of a TSF at a modern mine. All of the failure mechanisms described in case histories can be mitigated with proper investigation, design, construction, operations, maintenance, and oversight. Consistent with the intent of the ICOLD (2001) report, we consider that it is more appropriate to use these case histories of failures *"to learn from them, not to condemn."*

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[11] ICOLD (International Commission on Large Dams). 2001. *Tailings Dams, Risk of Dangerous Occurrences, Lessons Learnt from Practical Experiences.* United Nations Environmental Programme, Bulletin 121.

4.2 Unreliable Dam Breach Analysis

4.2.1 *Overtopping as Cause of Failure*

As the BBWA correctly points out, one potential mode of failure for mine tailings dams is overtopping, leading to erosion of the dam embankment material and dam breach. The overtopping mode of failure is considered in detail during the design and permitting of modern tailings dams. However, this mode of failure is readily mitigated by providing sufficient freeboard distance between the maximum water level in the dam and the dam crest consistent with regulatory requirements.

According to the BBWA, runoff from a probable maximum precipitation (PMP) storm event may be the catalyst for a dam breach from overtopping. The PMP is defined as "the theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage area at a certain time of year," (American Meteorological Society. 1959)[12]. With the Pebble 2.0 TSF scenario in the 2013 Assessment, the PMP, which is clearly an extreme precipitation event, would increase the water surface elevation behind the TSF by 0.36 m (0.2% of the TSF dam height of 209 m). This freeboard requirement to manage the runoff generated from the PMP will be far exceeded in design and operation of the TSF dam, where freeboard will likely be maintained at a magnitude of several meters. The probability of overtopping would be extremely small for a modern TSF of this size and importance. Such an extremely small probability does not warrant the alarmist dam breach analysis included in the 2013 Assessment.

4.2.2 *Dam Breach Analysis*

Geosyntec's 2012 Review pointed out that the model used for the dam breach analysis in the 2012 Assessment was likely flawed, resulting in an over prediction of flow depth and velocities following the overtopping of the hypothetical TSF. A table with questionable data from the 2012 Assessment that was referenced in the Geosyntec comment was removed from the 2013 Assessment, but that was the limit of the changes made in response to our 2012 Review on this issue.

In fact, the maximum flow depths in the overtopping failure scenario increased dramatically between 2012 and 2013. One set of assumptions was made in 2012. A very different set of assumptions was made in 2013, with very different results. For example, in the 2013

[12] American Meteorological Society. 1959. *Glossary of Meteorology*, Boston, MA.

Assessment, the maximum discharge rate from the dam breach for the Pebble 2.0 scenario increased over twelve-fold, from 11,915 cubic meters per second (m^3/s) in 2012 to 149,300 m^3/s for what is presumably the same failure scenario. Given the limitations of the model, the coarse nature of the inputs to the model, and the sensitivity of the model to changes in parameters, it is clear that neither result is a reasonable representation of what would actually happen in the very unlikely event of a dam breach due to overtopping. Either full details of the model should have been provided in an appendix to the report for proper peer review, or the model results should not have been included in the report.

4.3 <u>Seismic Considerations</u>

4.3.1 ***Overstated Uncertainty of Seismic Environment***

The BBWA gives significant attention to the seismic environment within the project vicinity. Seismic criteria are a critical component of design of major infrastructure projects within seismically active areas such as the Bristol Bay region of Alaska. However, many of the concerns raised in the BBWA are overstated and inconsistent with a modern understanding of seismic risks to engineered structures such as the TSF. The most significant seismic hazard in the project vicinity is likely from the potentially active Lake Clark Fault. As stated in the 2013 Assessment:

> *"The USGS has concluded that there is no evidence for fault activity or seismic hazard associated with the Lake Clark Fault in the past 1.8 million years, and no evidence of movement along the fault northeast of the Pebble deposit since the last glaciations 11,000 to 12,000 years ago (Haeussler and Waythomas, 2011)."* (Pg. 3-33)

Following these statements of findings from the literature on the Lake Clark Fault which present a case of relatively low seismic risk, the 2013 Assessment overstates the uncertainty of the seismic environment:

> *"Although there is no evidence that the Lake Clark Fault extends closer than 16 km to the Pebble deposit, and there is no evidence of a continuous link between the Lake Clark Fault and the northeast-trending faults at the mine site, mapping the extent of subsurface faults over long, remote distances is difficult and has a high level of uncertainty."* (Pg. 3-35)

> *"Not all earthquakes occur along the mapped sections of faults. In some instances, stresses build up and cause earthquakes in rock outside of known pre-existing faults. Earthquakes*

> *can occur on previously unidentified, minor, or otherwise inactive faults, or along deeper faults that are not exposed at the surface."* (Pg. 3-35)

> *"Large earthquakes have return periods of hundreds to thousands of years, so there may be no recorded or anecdotal evidence of the largest earthquakes on which to base future predictions."* (Pg. 3-35)

As required in the design of a project of this magnitude, the extent of the Lake Clark Fault and its potential seismic risk to the project is being considered in detail. The Wardrop (2011)[13] report indicates that the TSF design will be conservatively based on the Maximum Credible Earthquake (MCE). The MCE, as defined by the Alaska Department of Natural Resources (ADNR, 2005)[14] is "the greatest earthquake that reasonably could be generated by a specific seismic source, based on seismological and geologic evidence and interpretations." As such, every potential fault that could impact a project has its own MCE, and the design must consider the most critical fault(s) for the project. Once the MCE for a site is identified, the engineered structures are designed to withstand the anticipated level of seismic shaking with an acceptable degree of certainty.

None of this is meant to downplay the hazards associated with earthquakes in Southwestern Alaska and at the Pebble Project. Seismic shaking, deformation, liquefaction, landslides, seiche and other seismic hazards are real and must be accounted for during design. However, based on our review of the Wardrop (2011) report and the Environmental Baseline Document (PLP, 2011)[15], indications are that the project engineers are aware of those hazards, and current design standards provide means to mitigate the impact of seismic events. The formal permit review process should be sufficient to ensure that seismic hazards are being considered sufficiently and designed for accordingly.

4.3.2 *Recent Record of Successful Tailings Dam Performance*

Performing a review of tailings dams that are successful is challenging, as the literature focuses more on problems than success stories. However, the literature does provide documentation related to several recent earthquakes that have subjected modern tailings dams to significant

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[13] Wardrop. 2011. Preliminary Assessment of the Pebble Project, Southwest Alaska. Prepared for Northern Dynasty Minerals Ltd., February 15, Prepared by Wardrop (A Tetra Tech Company), Vancouver, BC.

[14] ADNR (Alaska Department of Natural Resources). 2005. *Guidelines for Cooperation with the Alaska Dam Safety Program*. Dam Safety and Construction Unit, Water Resources Section, Division of Mining, Land, and Waters. 230 pp.

[15] PLP (Pebble Limited Partnership). 2011. Environmental Baseline Document 2004 through 2008. Anchorage, AK.

stresses. The following four case histories of large active tailings dams, while certainly not an exhaustive review, do indicate that analogies to seismic risks at the Pebble site exist showing that applying modern design, construction, and operations and management practices can result in successful performance under significant stress with no, or minimal, damage reported.

- **Tranque Ovejeria and Tortolas, Chile:** These dams are located approximately 230 miles north of the epicenter of the February 2010 Magnitude 8.8 Chilean earthquake. No damage was observed at the dams (GEER, 2010)[16].
- **Tranque Caren, Chile:** This tailings dam is located 150 miles north of the epicenter of the February 2010 Magnitude 8.8 Chilean earthquake. Dam raising was in progress at the time of the February earthquake. After the earthquake, some minor (e.g. millimeter wide) transverse cracking was visible near each abutment (GEER, 2010). Such minor cracking can be readily repaired.
- **Antamina Copper-Zinc Mine Tailings Dam, Peru:** Construction of this TSF began in 2001 and the structure has undergone several dam raisings to approximately 705 ft tall. It is located 275 miles from the epicenter of the August 2007 Magnitude 8.0 Peru earthquake. No damage was observed at the dam (Chanjaroen, 2007)[17].
- **Fort Knox Gold Mine Tailings Dam, Alaska:** Construction began in 1995 and is planned to reach ultimate height of approximately 360 ft in 2013. It is located 100 miles from the epicenter of the November 2002 Magnitude 7.9 Denali earthquake. No damage was observed at the dam (ADNR, 2007)[18].

4.4 Unreasonable Pipeline Release Scenario

The BBWA considers the potential impact of a concentrate pipeline failure along the proposed road alignment, which includes several creek crossings. Statistical methods used in the assessment of piping failure rates are of questionable validity. Failure statistics are taken primarily from oil and gas industry literature, which are not likely to be consistent with pipeline failures in the mining industry. The statistics are then developed inappropriately, using an

[16] GEER. 2010. *Geo-Engineering Reconnaissance of the February 27, 2010 Maule, Chile Earthquake.* Version 2: May 25, 2010. By Geo-Engineering Extreme Events Reconnaissance (GEER) team.

[17] Chanjaroen. C. 2007. "BHP Says No Impact on Antamina Copper Mine from Peru Earthquake." August 16, 2007. http://www.bloomberg.com/

[18] ADNR (Alaska Department of Natural Resources). 2007. State Agency Response to Public Comments on Draft Authorizations for the Fort Knox Mine Heap Leach Project. July 3, 2007.

exponential distribution to model pipeline failures, and assumptions of constant failure rate along the length of a pipe. The failure rates thus derived (98% chance of line failure over 25 years) are misleading at best.

Armed with these misleading statistics, the BBWA then develops a failure scenario resulting in significant release of concentrate to a creek. Geosyntec's 2012 Review pointed out that the pipeline release scenario, which incorporated an assumption of 14 km separation between pipeline isolation valves, resulted in unrealistically high release volumes as 14 km worth of concentrate was considered to drain by gravity into the creek. Proper design would include more frequent and strategically placed isolation valves, which would work in concert with automatic leak detection and shutdown capability to minimize potential leakage along critical stretches of the pipeline. The 2013 Assessment removes this 14 km scenario. In its place, they include the following scenario:

> *"In the concentrate pipeline failure scenarios, a single complete break of the pipeline would occur at the edge of the stream, just upstream of an isolation valve. These valves would be placed on either side of major crossings (Ghaffari et al. 2011) and could be remotely activated. Pumping would continue for 5 minutes until the alarm condition was assessed and an operator shut down the pumps. The estimated total slurry volume draining to the stream would equal the pumped flow rate times 5 minutes, plus the volume between the break and local high point in the pipeline (i.e., the nearest watershed boundary) (Table 11-2). During the entire spill, gravity drainage governs the flow rate based on calculations for free-flowing pipes."* (Pg. 11-8)

The 2013 Assessment replaces one unjustified scenario with another. The assumption that the *"volume draining to the stream would equal the pumped flow rate times 5 minutes, plus the volume between the break and the local high point in the pipeline (i.e. the nearest watershed boundary)"* disregards proper planning and design for the stream crossings. By forcing the failure upstream of the isolation valve and still allowing all of the spilled material to enter the creek, the existence of the isolation valves and any other features that might be designed to protect the streams from failures on land are made obsolete. If the topography and alignment are such that this extreme scenario could exist, unlikely as it may be that a failure would occur in exactly the worst place for the creek, other engineering and/or operational controls would logically be established as part of the design to mitigate the consequences of the potentially harmful release scenario.

4.5 Improper Use of Case Histories of Culvert Failures

The 2013 Assessment identifies as many as 35 stream crossings along the proposed road alignment, an increase from 14 stream crossings in the 2012 Assessment. Road culverts would be used to cross these streams, where properly designed and maintained culverts would allow for the unimpeded passage of salmonid fish under the roadway, while improperly designed and maintained road culverts would obstruct the passage of fish.

The BBWA cites literature supporting culvert failure rates of 30-58%, using these values to indicate the near certainty of fish passage obstruction. One study showing the 58% failure rate (Langill and Zamora, 2002)[19], focused on 50 small culverts in Nova Scotia that only needed a notification prior to construction and not a permit, and hence were never inspected prior to the study. In each of the referenced studies the authors note that the issues observed could have been prevented with proper design, construction and/or maintenance. Therefore a project being designed and constructed under current regulations in Alaska with stringent environmental standards and regulatory oversight should be expected to be executed with much greater care such that fish passage standards would be met at each crossing.

4.6 Overstated Water Treatment System Failures

According to permit requirements for modern mines, all runoff and water used in mine operations must be treated before being released to the environment. The BBWA presents failure of the water management systems as a certainty. For example, the 2013 Assessment states the following:

> *"There are innumerable ways in which wastewater treatment could fail under the mine scenarios in terms of failure type (e.g., breakdown of treatment equipment, ineffective leachate collection, wastewater pipeline failure), location, duration, and magnitude (e.g., partial vs. no treatment). Box 8-1 presents an example wastewater collection failure, and mechanisms of treatment failure are discussed in Box 8-2. To bound the range of reasonable possibilities, we assess a serious failure in which the WWTP allows untreated water to discharge directly to streams. This type of failure could result from a lack of storage or treatment capacity or treatment efficacy problems. Chronic releases would*

[19] Langill, D. A. and P. J. Zamora. 2002. *An Audit of Small Culvert Installations in Nova Scotia: Habitat Loss and Habitat Fragmentation*. 2422, Canadian Department of Fisheries and Oceans, Habitat Management Division, Dartmouth, Nova Scotia.

> *occur during operation if a lengthy process were required to repair a failure. We evaluate potential effects of this type of failure using the following assumptions...Duration of a release could range from a few days to several months, depending on the nature of the failure and difficulty of repair and replacement.*" (Pg. 8-19)

Although a range of outcomes is presented, the relative likelihood of each is not given weight in the Assessment. Based on our experience with industrial facilities, most equipment breakdowns would be resolved within hours, while some might require a few days for replacement parts to arrive at the site. The only malfunctions that take months to remedy are those that depend on suitable weather to facilitate the repair; these are quite rare and usually temporary measures are constructed to manage the situation during the interim period.

The scenario described in the 2013 Assessment is considered extremely unlikely given the multiple redundancies that will be incorporated within the treatment plant system design, and the proposed operational approach where untreated water will be stored in the TSF such that if the treatment plant were to go offline, water would be stored either at the TSF or in storage at the plant until the plant was brought back into service.

The 2013 Assessment goes on to state the following:

> "*The USEPA has observed that some operators continue to operate when they know that treatment is ineffective and not meeting standards. Hence, the record of analogous mines indicates that releases of water contaminated beyond permit limits would be likely over the life of any mine at the Pebble deposit.*" (Pg. 8-22)

Such an event is of low probability for the redundant treatment systems and practices anticipated for the Pebble Project. Additionally, this latter scenario based on analogy to other mines and without any documentation beyond anecdotal evidence, would constitute direct violation of wastewater discharge regulations with severe penalties imposed. To call this "likely over the life of any mine at the Pebble deposit" is a mischaracterization of wastewater treatment practices at modern mines. The Assessment is misleading because it leaves the reader with the impression that the long-term release of untreated waters and leachates is a certainty, even during routine operations.

5. CONCLUSIONS

Geosyntec's primary focus in reviewing the 2012 and 2013 Assessments was the scientific and engineering credibility of assessments of failures for the TSFs, water collection and treatment systems, pipelines, road, and culverts, and the accuracy of analyses related to potential impacts of the potential failure scenarios considered by USEPA for the hypothetical mining scenarios considered. Our findings were that the BBWA exaggerates the probability of failures, relies on worst case scenarios to support a qualitative judgment on the potential impacts of these failures, does not adequately consider modern engineering, construction, operations, and maintenance practices, and thus provides an unrealistic and unscientific assessment of the potential impacts of the hypothetical mining project.

Although the BBWA conceptualizes the important engineered components of a large mining project, it fails to consider design and operational mitigation measures essential for permitting of a modern large scale mine in Alaska. The risk analysis presented for the hypothetical mine scenarios by the USEPA is fundamentally flawed because: a) it is not based on data applicable to a mining scenario that would be permitted, b) it does not incorporate appropriate estimates of the low probabilities of failure for selected mine components, and c) it does not account for modern mining design and permitted operations strategies that would reduce both the probability and consequences of the low probability failure events hypothesized.

Geosyntec considers that these limitations raise significant concerns on the scientific credibility of the 2013 BBWA and the appropriateness of using this document to inform stakeholders on the future of mining in the Bristol Bay watershed.

Sincerely,

Michael Kavanaugh

Michael Kavanaugh, PhD, PE, NAE
Senior Principal

Attachment: Geosyntec's Review Team

Attachment – Geosyntec's Review Team

Geosyntec (www.Geosyntec.com) is a 1000 person independent consulting engineering and science company, owned by the employees, with core competencies in geoenvironmental sciences and engineering disciplines, with particular expertise in geotechnical engineering and water resources management. Founded in 1983, Geosyntec, based on 2012 data, is ranked as number 62 in the Engineering News Record (ENR) listing of the top 500 engineering design firms in the US (ENR, April 24, 2013).

To perform the reviews of the 2012 and 2013 Assessments, Geosyntec established a team of internal experts on key technical issues raised in the BBWA, with a particular focus on the engineering components of water and residuals management as described in the document. Each team member was asked to carefully review the BBWA and supporting documents and to assess the scientific credibility and quality of the analysis regarding risks to the environment from possible failures of these engineering components.

The list of primary contributors to Geosyntec's reviews include:

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