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SUMMARY

FLAMBEAU MINE: WATER CONTAMINATION AND SELECTIVE “ALTERNATIVE FACTS”

- 1. Roughly 20 years after the cessation of active mining, Flambeau Mine *ground waters* are contaminated by past Flambeau Mining Company (FMC) activities. FMC data confirm that, as a minimum, dissolved concentrations of the following constituents significantly exceed FMC’s baseline concentrations (1987-88): copper, iron, manganese, zinc, sulfate, alkalinity, hardness, total dissolved solids, specific conductance (field). Interestingly, these are practically the only parameters routinely reported by FMC in their quarterly monitoring.**

FMC wells within the backfilled pit have *median* dissolved concentrations as high as the following (2014-16): Copper = 503ug/L; Iron = 14,000 ug/L; Manganese = 33,500 ug/L; Zinc = 1200 ug/L; Arsenic = 23 ug/L; Sulfate = 1600 mg/L; Alkalinity = 610 mg/L; Hardness – 2150 mg/L; Total Dissolved Solids – 3110 mg/L; Specific Conductance = 3180 uS. These values greatly exceed

- baseline data and relevant water quality standards and aquatic life criteria. FMC's "baseline" ground water data report that uranium was detected in between 64 to 100% of their samples, yet uranium was not included in the routine monitoring.**
- 2. These ground waters are also being contaminated with numerous minor / trace constituents (e.g. aluminum, arsenic, chromium, lead, nickel, uranium, etc.) as a result of FMC operations. Drawing reliable, *quantitative* conclusions about these constituents is difficult as *FMC has been allowed to characterize the water quality using data that are not representative of the actual, chemically-unstable ground waters.***
 - 3. Parameter concentrations from most FMC wells are not quantitatively-reliable due to inadequate well construction, well development and purging, and sampling procedures. Frequently, important chemical constituents were missing from analyses, inappropriate analytical detection limits were employed, and crucial data were not reported. FMC permit reports and subsequent public documents were based on these inadequate data.**
 - 4. FMC has constructed dozens of monitoring wells since the early 1970s. Many older wells still exist, but are no longer monitored; several have been replaced,**

sometimes under questionable circumstances, breaking the historical data continuity.

- 5. FMC has incorrectly defined baseline conditions, thereby biasing later conclusions. Exploration drilling has been conducted at Flambeau since roughly 1970. Thus, hundreds or more exploration boreholes, together with road and site construction, trenches, dozens of monitoring wells and piezometers, and possibly tunnels have been constructed at the site prior to actual mining of ore. Such activities increase sediment loads and create pathways interconnecting the various horizontal and vertical portions of the local rocks, introducing atmospheric oxygen and other gases, microbes, and surface water, all of which alter the original baseline water quality and geochemical conditions. Hence, FMC's 1987-88 baseline data actually represent water quality that has been altered and somewhat degraded by these pre-mining activities.**

- 6. FMC waste rocks were acidic and releasing contaminated leachates long before they were returned to the pit (both "low" sulfur and "high" sulfur waste rock pile had a dissolved copper concentration = 50,000 ug/L. Other waste rock leachate waters were already mildly acidic by 1994 and became more acidic by the first quarter of 1996**

- (“low” sulfide pH = 6.3; “high” sulfide pH – 6.3); by the fourth quarter of 1996 the high sulfide waste leachates had pH = 3.1 and copper concentration = 450,000 ug/L. Chromium was reported in low sulfide waste effluents. At a pH of 3.1, it is clear that many other trace and minor elements would also be present in these leachates, but FMC failed to report them, and has failed to identify the results as “Dissolved” or “Total Recoverable.”**
- 7. During active mining (1993-97) and immediately after, FMC reported limited water quality data from wells outside the pit on a quarterly basis. A more extensive, but still inadequate list of trace constituents was not reported until 1999, and to the present time is still reported only once per year. Review of company reports revealed no actual water quality data reported for waters being discharged from the exposed pit walls, floor or ore piles.**
 - 8. Monitoring wells located outside the pit in the downgradient flow direction show clear evidence of contamination relative to baseline concentrations. For example, a well 175 feet from the Flambeau River shows dissolved manganese concentrations of 13,800 ug/L and a specific conductance of 660 uS (Oct 2016).**

- 9. FMC has failed to define either the actual flow pathways for ground waters exiting the backfilled pit, or to define the ground water-surface water interactions. FMC has not determined whether pit seepage is limited to shallow pathways through alluvium and fractured bedrock into the river, or whether deeper pathways under the bed of the river may be viable. Apparently no recent monitoring of wells on the west side of the river (opposite side from pit) has been conducted by FMC or the State. Thus, it is also not possible to determine whether ground waters west of the Flambeau River have been negatively-impacted by FMC operations.**

- 10. Similar sulfide deposits, worldwide, routinely contain elevated concentrations of: aluminum, antimony, arsenic, barium, cadmium, copper, chromium, cobalt, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, zinc, sulfate, sulfide, nitrate, ammonia, boron, fluoride, chloride, natural radioactive constituents (sometimes uranium, radium, thorium, potassium-40, gross alpha and beta). Flambeau rocks and waters likely contain these constituents, but adequate *analytical results for many of these constituents were never made public*. All similar massive sulfide deposits generate degraded water quality in the long-term.**

- 11. The Flambeau River also received contaminants from numerous other sources of FMC property effluents: surface inflows from a tributary of the Flambeau River that crosses the southeast corner of the mine site (Stream C); the Copper Park Lane drainage ditch and other facilities adjacent to the ore crusher and rail spur; wetlands, storm runoff; stockpiled waste rock leachates and seeps; ore stockpiles; releases from the settling ponds; interceptor well discharges; inadequately-treated effluents from the Waste Water Treatment Plant (WWTP); clarifier underflow solids (sludges from WWTP). Several sources are presently contributing contaminants to the Flambeau River via surface water pathways, and possibly also via ground water pathways.**

Contaminated discharges from the southeast corner of the FMC site have resulted in Stream C being added to the Environmental Protection Agency (EPA) impaired waters list for exceedances of acute aquatic toxicity criteria for copper and zinc. Since 1998, FMC has instituted six different work plans to address this soil and water contamination issue. As of fall 2016, copper levels in the Flambeau River tributary still exceed the acute toxicity criterion, and FMC has not secured a mine reclamation Certificate of Completion (COC) for this portion of the mine site.

12. Data are inadequate to demonstrate that Flambeau River chemical concentrations have been degraded, but loads (mass) of various metals, metalloids, sulfate, sediments, etc. have increased. Increasing the mass of metals in the Flambeau River, either as dissolved or particulate forms (suspended or bedload sediments), has the potential to harm the aquatic biota because these organisms are capable of consuming metal-laden particulates.

13. As the west end of the Flambeau pit is within 140 ft. of the Flambeau River, FMC should have been required to report all water quality constituents that have relevant Standards and Criteria (during both baseline and routine monitoring), to determine whether FMC releases might be damaging to any of the relevant water uses: human consumption; aquatic life; agricultural and irrigation. Such data would have required collection of both *filtered (Dissolved)* and *unfiltered (Total) samples for analysis of a much wider list of chemical constituents employing appropriate detection limits*. Unfiltered sample data are especially relevant where impacts to aquatic life may be anticipated. *Fish and macroinvertebrates are capable of ingesting both dissolved and particulate forms of chemicals discharged into aquatic environments, aggravating potentially-toxic impacts to*

the aquatic species and concentration up the food chain.

- 14. The narrative “predictions” made by FMC’s main Wisconsin consultant in the various permit-related and Annual Reports appear to be large naïve geochemically and hydrogeologically. It is doubtful that these statements represented the opinions of FMC’s technical experts. Such statements are most useful for obtaining permits, less so for generating quantitatively-reliable predictions.**

- 15. Backfilled waste rock was mixed with limestone to minimize the formation of acid and release of trace constituents into the pit waters. However, the rise in pH due to the addition of limestone (or especially lime) can also generate conditions that increase the water concentrations of those trace elements that form mobile species *at elevated pHs, such as aluminum, arsenic, antimony, chromium, manganese, nickel, selenium, molybdenum, uranium, zinc, etc.* The Flambeau Mining Feasibility Study by Pincock, Allen & Holt Inc. likely contains data on such testing. *Feasibility studies are required to inform potential investors, but normally are not released to the public.***

- 16. Wastes from the FMC operation will remain onsite forever. While limestone was added to the waste rock**

as it was backfilled into the pit, the ability of the limestone to neutralize the formation of acid waters is limited and finite. After the limestone has reacted with the waste rock, its neutralizing action will cease and the *pit waters are likely to become increasingly acidic and the concentrations of potentially-toxic contaminants are likely to increase.* The deeper pit well waters already show evidence of increased degradation of water quality, in roughly 20 years, post-closure. It is reasonable to conclude that the Flambeau ground and surface water quality will further degrade in the coming decades if current site maintenance practices continue.

- 17. I know of no metal-sulfide mines anywhere in the world that have met the criteria of Wisconsin's 1998 moratorium on issuance of permits for mining of sulfide ore bodies without degrading the original water quality, long-term.**
- 18. Obviously the mining and remediation practices employed at Flambeau do not represent a *sustainable, long-term solution.* While FMC may have satisfied State oversight and disclosure requirements, the site ground waters are contaminated, and *these waters would require expensive, active water treatment to be made suitable for most foreseeable uses. Historically, most such costs are paid by the taxpayers.***

- 19. FMC and their contractors supplied all of the data and interpretations used to compile the permit-related reports and subsequent Annual Reports. Such an approach obviously reflects FMC’s interests, but is likely quite different from financially-independent, public-interest science. In short, the Flambeau Mine is the poster child for a severely-flawed permitting and oversight process, that has likely generated long-term public liabilities.**

- 20. Flambeau ground and surface water quality is being and has been degraded—despite years of industry public relations statements touting the success of the FMC operation. Rio Tinto said in a 2013 public relations (PR) release regarding the Flambeau Mine: “Testing shows conclusively that ground water quality surrounding the site is as good as it was before mining.” In efforts to encourage development of the other metal-sulfide deposits in northern Wisconsin and the Great Lakes region, the industry approach has been to simply repeat this false statement over and over, assuming that repetition will make it believed. Unfortunately, the FMC data show otherwise.**

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With over 45 years of experience in water quality monitoring, geochemical and hydrological work, Dr. Moran has been invaluable in the fight for clean water and responsible mining worldwide.

His work as an expert on the environmental impacts of mining has led him to collaborate with a wide range of organizations, from non-governmental entities and indigenous communities, to private sector and government clients.

Some of Dr. Moran's recent projects in Latin America include: a review of technical issues at the Veladero GOLD MINE in Argentina following a TOXIC CYANIDE SPILL; providing assistance and training to Colombian government officials on coal mine inspection and water quality monitoring; and preparing reports evaluating the environmental impact statements of the Minero Progreso Derivada II project in La Puya, Guatemala.

Dr. Moran also conducted reviews of mining operations and their impacts in Peru, Bolivia, Colombia, and Honduras, as well as in Africa, Europe, Central Asia, the Middle East, and the United States. He has dedicated his life to helping others understand and better evaluate the true costs of mining activities.