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Steven H. Emerman, Ph.D.
Specializing in Groundwater and Mining

shemerman@gmail.com • (801) 921-1228
785 N 200 W, Spanish Fork, Utah 84660, USA

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BAKUMSU
(Bantuan Hukum dan Advokasi Rakyat Sumatera Utara)
Bunga Kenanga Street No. 11 D
Padang Bulan Selayang II Village
Medan Selayang District, Medan 20156
Indonesia
Website: bakumsu@indo.net.id

Initial Impressions regarding 2025 Addendum to Environmental impact Assessment and Environmental Management Plan for Proposed DPM Lead-Zinc Mine

Dear Sir or Madam:

I am writing in response to your request for my initial impressions regarding the 2025 Addendum to the Environmental Impact Assessment and Environmental Management Plan for the proposed DPM (PT Dairi Prima Mineral) underground lead-zinc mine (DPM, 2025).

The key aspect of the 2025 Addendum is that the tailings management plan has now been changed, so that the formerly-proposed aboveground tailings storage facility would be replaced by backfill of 100% of the tailings into the depleted underground galleries using the cement paste fill method. The literal backfilling of all of the tailings is emphasized in numerous places throughout the 2025 Addendum together with statements that technical approval has already been obtained for the complete backfill of all tailings.

According to the 2025 Addendum, "*Seluruh tailing yang berasal dari konsentrator akan digunakan sebagai bahan penempatan kembali/backfill, yang terdiri dari campuran semen, agregat, dan air*" [All tailings originating from the concentrator will be used as backfill material, which consists of a mixture of cement, aggregate and water] (DPM, 2025). The 2025 Addendum continues, "*Pada dokumen lingkungan sebelumnya direncanakan menggunakan metode penempatan tailing pada fasilitas Tailing Storage Facilities (TSF), namun diubah menjadi metode penempatan kembali tailing semen pasta di area bekas tambang bawah tanah. Hal tersebut sesuai dengan Persetujuan Teknis di Bidang Pengelolaan Limbah B3 untuk Kegiatan Penimbunan Limbah B3 PT Dairi Prima Mineral dengan Nomor S.289/G/G.4/PLB.3.0/B/4/2025 tertanggal 30 April 2025 yang diterbitkan oleh Kementerian Lingkungan Hidup/Badan Pengendalian Lingkungan Hidup Deputi Bidang Pengelolaan Sampah, Limbah dan Bahan Berbahaya Beracun*" [In the previous environmental document, it was planned to use the tailings placement method in the Tailing Storage Facilities (TSF) facility, but it was changed to the cement paste tailings replacement method in the former underground mining area. This is in

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accordance with the Technical Approval in the Field of Hazardous Waste Management for PT Dairi Prima Mineral's Hazardous Waste Disposal Activities with Number S.289/G/G.4/PLB.3.0/B/4/2025, dated April 30, 2025, issued by the Ministry of Environment/Environmental Control Agency, Deputy for Waste Management, Waste and Hazardous and Toxic Materials] (DPM, 2025).

As one more example, the 2025 Addendum states, "*Tailing dikelola dalam bentuk tailing semen pasta dan dilakukan penempatan kembali di area bekas tambang bawah tanah sesuai dengan Persetujuan Teknis di Bidang Pengelolaan Limbah B3 untuk Kegiatan Penimbunan Limbah B3 PT Dairi Prima Mineral dengan Nomor S.289/G/G.4/PLB.3.0/B/4/2025 tertanggal 30 April 2025 yang diterbitkan oleh Kementerian Lingkungan Hidup/Badan Pengendalian Lingkungan Hidup Deputi Bidang Pengelolaan Sampah, Limbah dan Bahan Berbahaya Beracun. Berdasarkan rencana produksi PT DPM, jumlah tailing yang dihasilkan adalah sebesar 2.600.000 ton. Pertama, tailing akan melalui proses flotasi sulfur untuk mengurangi kadar sulfur yang masuk ke tambang bawah tanah, sebagai produk sampingnya diperoleh konsentrat sulfur. Tailing akan ditransportasikan dari lokasi pengentalan ke paste plant. Jika pabrik material pengisi dalam kondisi siaga (standby), tailing akan dialirkan ke kolam penampungan sementara (backfill material temporary storage pond), kemudian tailing ini nantinya akan diproses pada paste plant sesuai dengan perencanaan yang dilakukan. Setelah dari paste plant akan terbentuk tailing semen pasta yang dilakukan penempatan kembali di area bekas tambang bawah tanah*" [Tailings are managed in the form of paste cement tailings and replaced in the former underground mine area in accordance with the Technical Approval for Hazardous Waste Management for PT Dairi Prima Mineral's Hazardous Waste Disposal Activities, Number S.289/G/G.4/PLB.3.0/B/4/2025, dated April 30, 2025, issued by the Ministry of Environment/Environmental Control Agency, Deputy for Waste Management, Waste and Hazardous and Toxic Materials. Based on PT DPM's production plan, the total tailings produced will be 2,600,000 metric tons. First, the tailings will undergo a sulfur flotation process to reduce the sulfur content entering the underground mine, producing sulfur concentrate as a byproduct. The tailings will be transported from the thickening site to the paste plant. If the filler material plant is on standby, the tailings will be discharged to a temporary storage pond, where they will then be processed at the paste plant according to the planned schedule. After the paste plant, cement paste tailings will be formed, which will be placed back in the former underground mining area] (DPM, 2025).

Even in the absence of any backfill of waste rock, the cement paste fill method cannot backfill more than 50-60% of the tailings into the depleted underground galleries. The preceding statement is not simply my opinion, since the same information can be found in up-to-date mining industry handbooks.

The opening chapter of the SME (Society for Mining, Metallurgy and Exploration) Underground Mining Handbook even mocks the concept of backfilling all of the mine waste and much of the

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argument could be applied to backfilling even a large fraction of the mine waste. According to Darling (2023), "Some regulators have advocated returning *all* the waste to where it came from, which is an argument that does not survive even cursory scrutiny, although there are examples where some percentages of inactive tailings facilities are consumed via paste backfill (e.g. Meikle and Leeville). In underground mining, this would mean changing the whole mining sequence to ensure backfilling could *never* interfere or be a consideration if a change in technology, commodity price, or reserve horizons presented itself. Furthermore, whole development and access drives would have to be kept open, safe, and gas-free far longer than previously considered necessary. And there is then the whole question of how to backfill, which will be both expensive and time-consuming" (emphasis in original).

The most important factor limiting the percentage of tailings that can be returned to the mine is the expansion (also called bulking or swelling) that occurs throughout all of the processes that are involved in the conversion of an underground ore body into a commodity of value (such as lead and zinc concentrates) and tailings. These processes include the pressure release due to the removal of the overlying rock, blasting, crushing (also called comminution), and flotation (mixing with water and reagents to remove the commodity of value). The preceding quote by Darling (2023) continues, "In addition, such a notion [returning *all* the waste to where it came from] does not take into account the bulking that occurs when rock is blasted and processed." The most bulking results from comminution. According to the SME Tailings Management Handbook, "Comminution not only reduces the size of the ore particles but also increases the volume that those particles occupy (usually more than 1.8 times the volume of the in situ rock). This means that even after removing the economic minerals, it is impossible to place the remaining tailings volume back into the UG [Underground] void it previously occupied" (Veenstra, 2022).

Cement paste fill (CPF), which would be used at the DPM mine, is often contrasted with the older method of hydraulic fill (HF) (Stone, 2023). In the hydraulic fill method, the tailings are cycloned to separate the coarser tailings, which are then pumped to the exhausted mine workings (called stopes) as a slurry with a solids content of 55-65% by mass. The slurry is discharged from the top of the stope (depleted underground gallery) so that it fills the stope by gravity, after which the excess water drains out of the tailings and is pumped back into the mining operation. The tailings are not compacted into the stope, which limits the mass of tailings that can occupy a stope. The hydraulic fill can include a cement that will bind the tailings together as the mixture cures within the stope.

In the cement paste fill method, the whole tailings (without removal of finer tailings) are combined with water and cement to achieve a mixture with a solids content that is typically in the range 70-80% by mass (Veenstra, 2022). The SME Tailings Management Handbook qualified the preceding solids content by adding, "though concentrations can range from percentages in the

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low 60s to high 80s depending on the tailings" (Veenstra, 2022). Because of the inclusion of the finer tailings, water will not separate from the mixture after discharge into a stope. According to Stone (2023), "The term paste, as it applies to mine backfills, refers to a suspension of solids in a carrier fluid (typically water or process water) that is not subject to segregation or settling and has a measurable yield stress." A cement paste fill also flows or is pumped to the stope, from where it is discharged from the top of the stope so that it fills the stope by gravity. In the case of a paste, the presence of the finer tailings improves the pumpability or flowability of the mixture. The cement paste fill method increases the mass of tailings that can be placed into a given stope, although that mass is still limited by the permanent inclusion of water within the material that fills the void space, as well as by the lack of mechanical compaction. Stone (2023) continues, "The higher solids content in the paste translates into a higher density, and hence into a higher proportion of tailings being returned underground in a paste backfill. **A typical HF can only achieve a 40%-50% replacement rate, whereas paste fills can achieve 50%-60%"** (emphasis added).

Another limitation on the mass of tailings that can be backfilled into a stope using the cement paste fill method is the inability of a paste that is discharged from the top of a stope to fill all void space by gravity. According to Stone (2023), "It is important to recognize that most paste operations cannot achieve a tight fill to the back of the stope above. This is because the placement of paste involves an angle of repose from the discharge point, typically in the 2%-3% slope range, depending on the yield stress of the paste. This will ultimately leave a gap at the top of the paste pour under the back of the stope being filled." Efforts to completely fill all void spaces have sometimes ended in tragedy through over-pressurization of the walls. According to Veenstra (2022), "Wall failures have occurred in the past that led to an onrush of backfill into the UG workings and, in some cases, fatalities (Revell and Sainsbury 2007; Gray 2019). Figure 8.5 shows before and after photographs of UG backfill wall failures from two operations. Both failed while tight filling their respective stopes. Tight filling occurs when the stope is filled as completely as possible. Because of these failures, it is becoming increasingly common for operations to instrument walls to determine the loading pressure on the wall …"

The factors that constrain the fraction of tailings that can be backfilled into underground galleries using cement paste fill are summarized as follows:

1) Expansion (also called swelling or bulking) results from all of the processes that are involved in the conversion of an underground ore body into a commodity of value and tailings, including the pressure release due to the removal of the overlying rock, blasting, crushing (also called comminution), and flotation (mixing with water and reagents to remove the commodity of value).
2) Whole development and access drives need to be kept open, safe, and gas-free.

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3) The whole mining sequence cannot easily be adjusted to ensure that backfilling could never interfere or be a consideration if a change in technology, commodity price, or reserve horizons occurred.
4) The water that is added to create the cement paste does not separate, so that it is permanently included within the backfilled material.
5) A cement paste that is discharged from the top of a gallery cannot fill all void space by gravity.
6) The cement paste cannot be mechanically compacted into the gallery. Efforts to completely fill all void spaces have sometimes ended in mineworker fatalities through over-pressurization and collapse of the gallery walls.

Since it is impossible to backfill of the tailings, the Technical Approval in the Field of Hazardous Waste Management for PT Dairi Prima Mineral's Hazardous Waste Disposal Activities with Number S.289/G/G.4/PLB.3.0/B/4/2025, dated April 30, 2025, issued by the Ministry of Environment/Environmental Control Agency, Deputy for Waste Management, Waste and Hazardous and Toxic Materials (Kementerian Lingkungan Hidup [Ministry of Environment], 2025) should be regarded as irrelevant and not fit for purpose.

The 2025 Addendum mentions a "temporary storage pond" for the storage of tailings that are awaiting backfill and the same facility is approved in the above-mentioned Technical Approval. My primary concern at this point is that, if the mining project is approved, since only about one-half of the tailings can be backfilled, the "temporary storage pond" will gradually be used as a permanent storage pond, but without the engineering that would be expected for a permanent aboveground tailings storage facility.

Although this memo is described as "initial impressions," the opinion that it is not possible to backfill more than 50-60% of the tailings is not going to change, since this is standard knowledge in the mining industry.

I would be happy to carry out a more comprehensive review, which would address at least the following questions:

1) What assumptions, if any, led DPM to the conclusion that it was possible to backfill 100% of the tailings?
2) Besides the wildly optimistic prediction of the fraction of tailings that can be backfilled, are there other aspects of the backfill plan that are inconsistent with industry standards?
3) Does the backfill plan in the 2025 Addendum provide adequate protection for groundwater?
4) Is the engineering of the "temporary storage pond" adequate for even a temporary facility?

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5) What would be the consequences if the "temporary storage pond" became a permanent facility for the aboveground storage of tailings?
6) Is the issuance of Technical Approvals in advance of the Environmental Impact Assessment and Environmental Management Plan an acceptable practice both globally and in Indonesia?

Please let me know if I can help with anything else.

Best wishes,

Steven H. Emerman

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