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MEMORANDUM | June 3, 2025

TO	Katie Daugherty and David Lacey, Oregon Department of Environmental Quality (DEQ)
FROM	Peter Shanahan, HydroAnalysis LLC (HALLC); Jennifer Hart and Gail Fricano, Industrial Economics, Inc. (IEc)
SUBJECT	Five Tribe review of "GWET System Effectiveness Evaluation, Arkema Inc. Facility," dated March 31, 2025

This memorandum, submitted on behalf of the Five Tribes,[1] reviews the *GWET* [Groundwater Extraction and Treatment] *System Effectiveness Evaluation* (2024 GWET SEE Report) prepared by Environmental Resource Management, Inc. (ERM) on behalf of Legacy Site Services, LLC (LSS) (ERM 2025).

General Comments

1. Section 4.1.3 of the 2024 GWET SEE Report indicates that "the TCZOs [Target Capture Zone Objectives] are not being fully achieved as of the end of the reporting period." An identical statement appears in Section 4.1.2 of the 2023 GWET SEE Report (ERM 2024) as does a similar conclusion in the 2022 GWET SEE Report (ERM 2023): "Target Capture Zone Objectives are unlikely to be achieved until Q3 or Q4 of 2023." Based on our review of the 2024 GWET SEE Report, we conclude that the upgraded system, like the system before it, is not performing so as to meet objectives. A variety of measures have been carried out and are proposed to remedy this situation; however, we are concerned that these minor adjustments will not achieve TCZOs. We recommend LSS conduct an exhaustive evaluation as to whether the existing system can achieve TCZOs, and if not, what type of system should replace it.

2. The 2024 GWET SEE Report emphasizes the improvements achieved over the past year but, with the exception of the single statement in Section 4.1.3 (cited in Comment #1), avoids the obvious conclusion that the system continues to underperform. Despite more than two years of operation and "improvements," the upgraded system still falls far short of a sustained extraction rate meeting the target of 60 gallons per minute (gpm) that was established during system design. We recommend that the report be revised to include a comprehensive evaluation of the system's performance relative to this target and TCZOs.

3. Section 7.4.1 states that based on trends observed in the data from 2007 through 2024, "most concentrations [of contaminants in groundwater] are either stable or decreasing." Stable concentrations are undesirable; the goal should be decreasing concentrations. Further, we note

[1] The five tribes are the Confederated Tribes of the Grand Ronde Community of Oregon, the Nez Perce Tribe, the Confederated Tribes of Siletz Indians, the Confederated Tribes of the Umatilla Indian Reservation, and the Confederated Tribes of the Warm Springs Reservation of Oregon.

that some contaminants continue to show a trend of increasing concentrations. While it is our understanding that concentrations of contaminants in groundwater may not show significant decreasing concentrations until sources of contaminants are removed through the interim remedial action measures (IRAMs) planned, those actions may not be completed for several years. Thus, we urge DEQ and LSS to evaluate additional or alternative options to improve the source control measures' performance and to meet TCZOs in the near-term.

4. The 2024 GWET SEE Report shows that clogging of the filter packs around the trench extraction wells is a fundamental impediment to meeting TCZOs. In response, LSS is redeveloping the extraction wells on a regular basis. This strikes us as a half-measure. It is not clear that redevelopment will lead to systematic improvement in the system's ability to sustain the required extraction rates. Rather, most of the improvement that has been achieved during 2024 appears to be the result of reducing unscheduled downtime rather than of increasing extraction rates, which are shown by Figure 3a to have decreased over the course of the year. We recommend that the report include a systematic evaluation of the long-term prospects for the current system, whether redevelopment can achieve long-lasting increases in extraction rates, and whether changes to the system design are instead needed to achieve TCZOs.

Substantive Comments

5. Section 3.3 indicates that RW-22 was non-operational during the entirety of 2024 and that work to improve the extraction rates from the groundwater trenches was prioritized over work on RW-22. Why are there are so few resources applied to this system as to leave RW-22 non-operational for so long? Section 6 of the report, while showing many short-term interruptions, does not seem to show such continuous work on the extraction trenches as to preclude dealing with RW-22.

6. Section 4.1 refers the reader to Appendix A as support for conclusions regarding capture zones. We continue to agree with EPA's Primary Comment #1 on the 2023 GWET SEE Report that Appendix A is overly voluminous and that "Future Reports should present relevant figures and information supporting the narrative, evaluation, and conclusions in the main body of the document." Like EPA, we find the current format makes systematic analysis virtually impossible. We recommend assembling the monthly groundwater contours for each subsurface zone into sequential sets of twelve plots to facilitate evaluation. Also, there was a change in the protocol for contouring to exclude head at trenches starting in November that impedes systematic comparison and evaluation. We recommend that a single contouring protocol be used.

7. Section 4.1 states "Cones of depression are present around extraction trenches throughout the year…" This does not seem to be the case for Extraction Trench 1, which does not show a clear extraction zone in any month in either the shallow or intermediate zones. Table 1b shows that this trench has the lowest extraction rate of any of the trenches. We recommend the report explain the lack of apparent drawdown at this trench and its implications for the effectiveness of the GWET.

8. Section 4.1.1 states that "Since…November 2022, horizontal gradients on average have trended towards inward across the GWBW [groundwater barrier wall]…" The language in this statement is misleading—"trend" is more easily read as a characterization of the tendency in the direction of the gradient over the course of the year rather than as a change in the strength of the gradient over time. Further, Figures 4a and 4b do not show an obvious or appreciable difference between pre-

2022 and post-2022 with respect to achieving positive gradients (inward flow). We recommend that more precise language be used. This comment also applies to the references to "trended inward" and "trending towards inward" in Sections 6.3 and 8.2, respectively.

9. More generally with respect to Section 4.1.1, observed horizontal gradients fall far short of the objective of a minimum inward gradient of 0.005 ft/ft set forth by ERM (2014, page 14). We recommend that the GWET SEE Report identity this specific goal and address the failure to meet it. The large discrepancy between observed performance and the objective set forth for the system raises fundamental questions about the system design and performance.

10. Section 4.1.1 also discusses vertical gradients but fails to state clearly that gradients are generally downwards from the shallow to the intermediate zone and from the intermediate to the deep zone. These downward gradients necessarily imply that groundwater is flowing beneath and/or around the GWBW at depth. We recommend that the report estimate the magnitude of these flows and discuss how those flows reflect upon the effectiveness of the GWET system. In particular, the potential for a continuing flux of contaminants to the Willamette River should be assessed.

11. Section 4.1.2 states that "The Willamette River's influence on groundwater elevations in the Shallow and Intermediate Zones can be seen in Figure 3a and 3b…" The language implies a cause-and-effect relationship that is contrary to the existence of the GWBW, which is supposed to provide hydraulic separation between the river and the upland groundwater. An alternative explanation is that both the river and the groundwater are responding to seasonal rainfall, but doing so independently. The explanation of the correlation between river stage and groundwater elevation is important in that a strong cause-and-effect relationship would imply that the GWBW is providing only weak hydraulic separation between the river and the upland groundwater. We recommend that the head relationships revealed by the data be examined more rigorously and that conclusions be drawn with respect to the effectiveness of the GWET.

12. Section 4.1.2 discusses the improvement in extraction rates compared to the prior poorly-performing system but fails to point out that the average annual extraction rate of 34 gpm remains well short of 61.8 gpm, which the Final Design Report (ERM 2022, Table 4-1) identifies as the "estimated required groundwater extraction rate at steady state to achieve capture zone objectives." We recommend that the report provide a comparison of system performance with this specific design objective.

13. Section 4.1.3 indicates that TCZOs are not being fully achieved, but without specificity as to the lack of achievement. The groundwater contour plots make clear that the objective listed in Section 2, "to induce inverse gradients across the GWBW," is rarely if ever achieved. This failure should be explicitly identified in the report and the likely causes and implications of this failure should be discussed. Similarly, the failure to achieve upward vertical gradients, its likely causes, and the implications of this failure should be discussed.

14. Section 4.1.3 states that Trenches 1, 4, 5, 6, and 7 are planned for "aggressive well redevelopment." We recommend the report discuss in detail how "aggressive redevelopment" will differ from the Hydropuls redevelopment that was carried out four times during 2024. We also recommend that the report discuss whether the clogging problems at these trenches are expected to be resolved by redevelopment or if clogging is expected to recur regularly in the future.

15. Section 5 discusses the groundwater model. As part of the design process, ERM (2022, Figures 9 and 10) used the groundwater model to predict the drawdown that would be achieved by the GWET system that is now in place. The elevation measurements made during 2024 provide an opportunity to evaluate the predictive power and utility of the groundwater model. We recommend that the report be revised to include a comparison of the model predictions with the groundwater elevations observed during 2024. Although the pumping rates sustained through 2023 (ERM 2024, Table 1a) and 2024 (ERM 2025, Table 1a) were only about half of the target pumping rate of 60 gpm, the observed system effects still provide a touchstone for the model.

16. Section 6.1 indicates that fine solids have accumulated in the filter pack around the extraction trenches, a distressing development so soon after the reconstruction of the extraction system. Persistent future clogging strikes us as a potentially fatal flaw in the GWET system. While Section 4.1.3 promises "aggressive redevelopment" of the trenches, we recommend a more comprehensive evaluation of the problem.

17. Section 6.3 attributes low extraction rates in part to "low river levels in 2024." We question this attribution. According to the Final Design Report (ERM 2022, page 5), the design considered low river stage as observed in October 2019, which the ERM (2020) shows as 7.6 feet. This is below the river levels throughout 2024 as shown in Figures 3a and 3b. If the system was designed based on river levels below those in 2024, why would low river level prevent effective performance?

18. Section 7.4.2 states that the decreasing concentrations of chloride on the exterior side of the GWBW at GCC5 indicates "that the GWBW is effectively preventing chloride migration towards the river…" In contrast, concentrations of perchlorate are increasing on the exterior side of the GWBW at GCC4. By the same logic as applied at GCC5, this trend indicates that the GWBW is not effective in this area. In other words, the GWBW is leaking at GCC5. We recommend that the report address the observations at GCC4 and GCC5 consistently.

19. Section 7.4.2 addresses the observed seasonal rise and fall in the chloride concentration at exterior well MWA-63 and offers this explanation: "The observed seasonal variation in chloride concentration is possibly related to river water influence on the Shallow Zone near MWA-63, with high river stages diluting groundwater concentrations." Note that this explanation necessarily implies that chloride continues to leak through or past the GWBW. While high river stages may cause concentrations to decrease by dilution, subsequent low river stage cannot physically cause chloride to become concentrated. The seasonal rise in chloride concentration necessarily implies groundwater contaminated by chloride is continuing to pass around or through the GWBW at MWA-63.

20. Section 8.2 presents a biased and misleading evaluation of the extraction system's effectiveness. To be clear, the system is persistently and markedly underperforming. It is achieving only slightly more than one half of the minimum required extraction rates identified during system design (ERM 2022), and it is missing numerical targets put forth in the performance monitoring plan (ERM 2014). We recommend that Section 8.2 be revised to state the specific objectives for the system as put forth in these prior documents and compare actual system performance to those objectives. We recommend that Section 8.2 include a statement that the upgrades to the GWET system have yet to achieve the forecasted 60 gpm extraction rate on a sustained basis. We also recommend the statement from Section 4.1.3 that "TCZOs are not being fully achieved as of the

end of the reporting period" be included in Section 8.2 as it is a significant conclusion from the 2024 GWET SEE results.

Editorial Comments

21. Tables 1a and 1b use footnotes to indicate why wells were not operational during some months and highlight all such notes in gray. We recommend that different highlighting colors be used for the different footnote types. This would allow the reader to scan the table more easily and would highlight that equipment issues are by far the most frequent cause of wells failing to operate. We also recommend that a column be added for the average pumping rate over the year for each recovery well and extraction trench. This would help identify the components of the system that are underperforming.

22. Section 4.1 states "Groundwater is unable to flow around the north end of the GWBW due to the localized pressure zone ERM discussed in the Preliminary Design Investigation (PDI) report (ERM 2021b)…" Rather than require the reader to refer to this prior report to get this information, we recommend a brief explanation of the localized pressure zone be included in the GWET SEE Reports.

23. Section 4.1.3 promises "aggressive well redevelopment…at Trenches 1, 4, 5, 6, and 7 to continue improving extraction rates **in this part of the Site**" (emphasis added). We recommend the highlighted text be deleted since this is essentially every part of the site.

References

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