# memorandum

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| TO | Jo Young | FROM | Parviz Namjou |
| | Stevenson Aggregates Ltd | DATE | 11 November 2025 |
| RE | Drury Quarry – Sutton Block Expansion, Response to WWLA Review Report | | |

Mr Jon Williamson, WWLA (2025) was commissioned by the Environmental Protection Authority to complete a peer review on the groundwater-related impacts from the proposed expansion of the Drury Quarry Sutton Block expansion project. A report was prepared by WWLA titled the Fast Track Approval Act – Drury Quarry Expansion Sutton Block Hydrogeological Review (WWLA1632) dated 4 November 2025.

PDP has reviewed the WWLA Hydrogeological Review. In response to the FTAA Panel's Minute 9, the following comments are provided where there remains disagreement between WWLA and PDP.

For ease of reference, the numbered heading corresponds to the section numbers in WWLA (2025).

**WWLD - Section 2.3.2: Groundwater Inflow (Page 8)**

*Whilst I accept that different methodologies have been used, this was not explained particularly clearly in the PDP report. Nevertheless, I am comfortable with the explanation, particularly noting:*

*c) greywacke hydraulic conductivity over a much larger area much of which is unaffected by faulting is unlikely to be as high as 10-6 m/s;*

*d) the quarry development is staged occurs over decades, which enables monitoring to progressively capture any changes that are expected to only slowly manifest; and*

*e) the proposed adaptive management conditions and monitoring will appropriately address the inherent uncertainty in pit inflow estimation and drawdown.*

**PDP Response:**

For each stage the source of inflow is clearly stated in the technical report (PDP 2025). For example, for Stage 5 (Page 50, Section 4.6.1, Second paragraph) it is stated: *"Using the recharge applied in the analytical model (60mm/year), and the contributing zone of influence to the east of the Drury Fault, the inflow for the final stage is calculated to be about 18,243m3/d."* which means recharge x area = inflow. We consider this to be clear.

**WWLA – Section 2.4: Stream Flow Loss and Water Balance (Page 9)**

*PDP state that reduction in the streams baseflow occurs in downstream areas where the regional groundwater intercepts the streams. This is consistent with my conceptual model (Section 1.2) of the area.*

*Table 4 summarises the flow reductions estimated by PDP. These do not appear to match the estimated dewatering flows calculated by PDP as summarised in Table 4, hence a key question is where is the* *"missing" groundwater is derived from (i.e. water balance closure)? This matter was also discussed at Expert Conferencing with Mr. Namjou, and I do not accept his explanation (i.e. we agree to disagree) on this point.*

**PDP Response:**

The reviewer may be overlooking the compartmental nature of the greywacke (directional flow) and the conservative approach we have undertaken to address this in terms of water balance. These are explained further below:

***Inflow Water Balance***

For the conservative assessment of the inflow to the sump, it was assumed that all regional groundwater recharge within the zone of influence will be discharged to the sump. Therefore, the water balance for the inflow calculations (PDP 2025) is:

**Recharge to the zone of influence** = **Inflow to the Sump**

Applying this to Stage 5 (PDP 2025):

Recharge = 60mm/year = $1.64 \times 10^{-4}$ m/d

Zone of influence area = 110,978,704.2 $m^2$

Therefore:

110,978,704.2 $m^2 \times 1.64 \times 10^{-4}$ m/d = 18,243 $m^3$/d

Therefore:

Recharge of **18,243**m3/d = Inflow of **18,243**m3/d

So, in terms of groundwater inflow there is no "missing groundwater" as asserted by Mr Williamson.

***Stream Flow Loss Water Balance***

Streams intercept the regional groundwater especially in downstream areas of the zone of influence so some of the above recharge forms throughflow to maintain the existing baseflow of the streams. The quantity of this baseflow is unknown because:

- a portion of the baseflow is maintained by the shallow groundwater; and
- The compartmental nature of the aquifer causes non-uniform interception of the throughflow.

This does not mean some groundwater is missing, it just means not all groundwater ends up in the sump. Some groundwater will be removed from the zone of influence by the streams (as baseflow).

We have established a relationship between flow loss and drawdown in each catchment (Page 56, Section 4.9.2, PDP 2025). This model allows us to estimate the portion of throughflow that will be diverted from the stream to the sump.

The loss of flow in each stream (Tables 10 to 13, PDP 2025) within the zone of influence is not equally distributed. The streams in catchments with more predicted drawdown will be affected more than catchments with less predicted drawdowns. For example, for NT1 catchment (quarry catchment) with maximum drawdown, 100% of throughflow will be lost to the sump while for Mangawheau Stream (5km away) with 61m predicted drawdown, only 26% of throughflow will be lost to the sump. This relationship was incorporated in the calculations of the flow loss (Tables 10 to 13, PDP 2025).

Therefore:

Total Recharge: 18,243 $m^3$/d

Flow Loss to Sump: 6,801 $m^3$/d

Remaining Baseflow: 11,442 $m^3$/d

This remaining volume (11,442 $m^3$/d) is retained as baseflow in the streams and exits the model's zone of influence. Consequently, the model accounts for all groundwater, with no missing component.

It is important to note that the inflow was conservatively set equal to total recharge, disregarding the potential for streams to retain a portion of the throughflow, due to uncertainties in quantifying that process under varying drawdown conditions.

**WWLA – Section 2.6: Wetland (Page 11)**

*The PDP report lacks detail on effects on wetlands or whether in fact any wetlands reside within the area of groundwater influence. As was discussed at Expert Conferencing, my understanding is that a wetland resides immediately adjacent to the southern boundary of the pit. Given the conceptual hydrogeological model, I expect this will be maintained by rainfall and shallow/perched groundwater, subject to a low permeability clay bund being keyed into the sub-soil to prevent direct lateral shallow groundwater seepage out of the wetland into the pit. This bund could also be raised above ground level to prevent surface water losses directly into the pit.*

**PDP Response**

Wetlands form part of the shallow groundwater system. Effects on the shallow groundwater is covered in the AEE report (Section 4, PDP 2025). Considering there is no zone of influence for shallow groundwater outside the quarry catchment (PDP 2025), no effects on wetlands outside the pit catchment is likely to occur. Therefore, effects of the shallow groundwater (including wetlands) are limited to areas in the vicinity of the pit - this is addressed by the proposed conditions 46(c) and 66-67. In addition, the updated conditions also address any effects on wetlands in other catchments if drawdowns or stream flow loss is detected (see conditions 44, 78-81 and 121(d)).

**WWLA – Section 3.1: Condition 182 (Page 11)**

*Condition 182 states that stream augmentation rates must be in accordance with the rates specified in Schedule C. However, assuming the augmentation volumes are linked to quarry stages rather than pit inflow rates per se (which are subject to some debate) the key issue with this condition is prescribing the augmentation flow as a percentage of the pit inflow. A better that contribute to wetlands approach is to maintain mean annual low flows, as proposed for the Mangawheau and Hingaia Tributary catchments.*

**PDP Response**

Since the streams' mean annual low flow can be affected by factors unrelated to dewatering (e.g., drought, other surface water takes), the inflow to the sump serves as the best indicator of flow loss specifically for the neighbouring streams. The required augmentation volume is therefore initially based on the percentage of flow captured by the sump. In response to the reviewer's comments, we will clarify that augmentation as per Schedule C will commence if a reduction in the mean annual low flows of these streams is detected, and the augmentation specified in Schedule C will be updated as part of the conditions to ensure the mean annual low flow is maintained. This is reflected in updated conditions 187 - 189 and 195-197.

**WWLA – Section 3.2: Condition 191 (Page 12)**

*Condition 191 states that augmentation must be undertaken only if three consecutive years (i.e. 6 rounds of stream flow gauging) of reduced specific discharge (L/s/km2) for the new gauging stations have been detected that:*

*a) Can be attributed to the Site's dewatering; and*

*b) Is not caused by drought conditions.*

*My concern with this condition is that to detect a reduction in baseflow specific discharge, dry (and/or drought) conditions are required, where the stream flow is unaffected by surface runoff and interflow, and less affected by perched groundwater discharges. It therefore follows that three years of such conditions prevailing would be required before augmentation could even be considered. The probability of getting three such dry year conditions back to back could be quite low.*

*My suggestion is that other hydrological metrics are considered, which could include the slope of the recessional trends during summer months. The technical premise is that catchments drain in a consistent manner between rainfall events (all things being equal). However, if changes in the catchment occur e.g. quarry dewatering or afforestation, baseflow recessional trends will accelerate to reflect the additional draw on groundwater resources. This is reflected in the slope of the recessional trends.*

**PDP Response**

The dewatering effects are gradual. The time lag for a cone of depression to reach a stream and establish a new equilibrium can be years to decades, depending on the hydrogeological conditions.

The proposed three-year timeframe is proposed to have a better chance of capturing at least one average-to-wet year and one drier year, allowing more accurate confirmation of the cause of the loss of flow before commencing any augmentation measures.

Three years of data enables the collection of sufficient data to establish a preliminary trend. For example, if we see a progressively lower starting baseflow each year while concurrently monitoring groundwater levels and increase in dewatering rates, we can build a more compelling case that the trend is due to dewatering and not just caused by weather conditions. This timeframe demonstrates appropriate due diligence without jumping to the potentially large expense of augmentation before the cause is confirmed.

Regarding the use of slope of the recessional trends during summer months for assessing the effects, the suggested methodology by WWLA assumes that the only thing that has changed over a period of time (or before/after dewatering) is the dewatering itself. Baseflow recession is highly sensitive to the preceding recharge conditions. A steeper recession (suggesting faster drop in flow) in one summer compared to another could be due to a drier winter (i.e. less groundwater recharge leads to a lower starting groundwater level and a steeper recession, even without any dewatering). Similarly, a higher summer temperature will cause an increase in evapotranspiration which will directly pull more water from the groundwater, steepening the recession). Therefore, without accounting for these natural climatic variations, it is not appropriate to attribute a steeper recession slope solely to the quarry dewatering. In addition, the shape and slope of a recession curve are dependent on the initial discharge at the start of the recession period. A recession that begins from a very high flow will have a steeper initial slope than one that begins from a moderate flow. This pattern can follow the non-linear nature of the groundwater especially in the compartmental greywacke aquifer.

It should be noted that the presence of fracture zones and multiple layers (e.g. coal measures or ECBF over greywacke, i.e., shallow groundwater system) with different hydraulic properties, and preferential flow paths can make the recession behaviour complex and not well-represented by a single slope and the impact of dewatering on a stream may not be instantaneous.

Furthermore, the stream flow monitoring will be undertaken based on the low flow stream flow gauging which even if correlated with the data from the station with continuous flow monitoring record, can misrepresent the details characteristics of the recession curve.

In summary, we consider Mr Williamson suggestion of using summer baseflow recession slope is a poor tool for quantification of the streams flow loss.

## References

WWLA (2025) Fast Track Approvals Act (FTAA): Drury Quarry Expansion – Sutton Block, 4 November 2025.

Pattle Delamore Partners (2025), Proposed Sutton Block Expansion Groundwater & Surface Water Effects Assessment, Prepared for Stevenson Aggregates Limited, March 2025.

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Please contact me if you require any additional information.

Prepared and approved by

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