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Groundwater Resource Assessment of the deep confined Peninsula Aquifer in Blossoms (Oudtshoorn), Western Cape, South Africa

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The Oudtshoorn Groundwater Project aims to target deep groundwater as a long-term option to augment the water supply to the greater Oudtshoorn Local Municipality. Located 15 km south of Oudtshoorn towards the Outeniqua Mountain range, the Blossoms Wellfield lies within a potentially high-yielding artesian basin. The Peninsula Formation (of the Table Mountain Group [TMG]), hydrostratigraphically known as the Peninsula Aquifer, is exposed in the Outeniqua Mountains (high rainfall recharge area), and is deeply confined northwards by the overlying Bokkeveld Group.

The project is currently emerging from an exploration phase, with nine boreholes that target the deeper Peninsula Aquifer and three that monitor the shallower Nardouw Aquifer. In the absence of actual groundwater usage over a period of at least several years, long-term sustainability of the development is assessed from short- to medium-term (weeks to months), experimental free-flow and pumping tests, supplemented by numerical, groundwater-flow modelling of the aquifer system.

During the May-June 2014 continuous aquifer-testing experiment, the flow from four artesian (freely flowing) boreholes stabilized at a combined rate (non-pumping) of 44.6 l/s (C1g3 = 5.5 l/s; C1d2 = 2.91 l/s; C1g1 = 10.9 l/s and C1b3 = 25.3 l/s). With the augmentation of flow by pumping at wells C1b3 and C1g3 at safe yields of 40 l/s and 8.7 l/s, respectively, a combined flow rate of 62 l/s was delivered with the additional free-flowing yields of (monitoring wells) C1d2 and C1g1. Extrapolated continuously over a full year, this rate (62 l/s) amounts to an annual yield of 1.955 gigalitres (Gl) from only one and one-half (designed) production boreholes (C1b3 and C1g3). When the planned full complement of ~10 production wells is completed, it is reasonable to expect, with a high degree of confidence, that a safe yield of 10 Gl/a is technically achievable; i.e., considerably more than the maximum extraction rate of the water-users licence (WUL) of 8 Gl/a.

The question of the longer-term sustainability and environmental impacts of extracting groundwater from the Peninsula Aquifer must, at this developmental stage, rely on theoretical analysis and numerical groundwater-flow-simulation experiments. Until the 'radius of influence' ('ROI') reaches the recharge boundary all of the groundwater extracted is coming entirely from storage depletion and only once the recharge boundary is reached (15 km south of the wellfield) will it begin to "capture" recharge, which could affect surface water flow.

The 2010 and 2014 test-pumping data is analysed using Theis's theory and groundwater-flow modelling to demonstrate the effects of pumping at various groundwater extraction rates (WUL stages) and pumping schedules, and to determine the time it takes for the 'ROI' to reach the recharge boundary. From this analytical perspective, the rate of aquifer recharge to the Peninsula Aquifer is practically irrelevant to the question about sustainable development, at least until the 'ROI' reaches the recharge boundary. Previous results of numerically modelled through-flow, range between 1.6-6.2 Gl/a, which

already brackets the annual extraction totals for WUL Phases 1 and 2, viz., 3.5 GL and 5 Gl, respectively. Results also demonstrate that after 2.3 continuous (full-time) years of groundwater extraction at 3.5 Gl, almost all (>90%) of the aquifer yield will be delivered from aquifer-storage depletion. Provided that the Blossoms Wellfield is conservatively operated (e.g., not pumping for 24 hr/d) and scientifically monitored, the initial 2.3-year period of the 'groundwater mining' phase offers abundant opportunity to refine the estimation of aquifer parameters, establish observational infrastructure close to the recharge boundary, and develop a far better understanding of the larger-scale and longer-term aspects of aquifer behaviour under both natural and anthropogenic forcing factors.