Tionscadal Soláthair Uisce
Water Supply Project

# Environmental Impact Assessment Report (EIAR)

## Volume 6 of 6: Appendices

### (Appendix 10.16) Dewatering Calculations

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Uisce Éireann Irish Water

Jacobs

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# 1. RWI&PS

1. The proposed development involves the construction of a 13m – 14.6m deep excavation. Groundwater levels are <1m bgl. The proposed RWI&PS will require dewatering; however, the groundwater is subsequently discharged back into the same catchment and therefore there is no loss of baseflow to Parteen Basin.

2. The proposed design is for a depth of 14.6m. The Sichardt formula is a mathematical solution that was developed from Theim (1972) to calculate drawdowns in a confined aquifer of infinite extent where the only source of water is from storage. The idealized aquifers and associated calculations of aquifer response to pumping from Sichardt represent ideal end members of a continuum; that is, the response of many real aquifers lies somewhere between the responses in these idealized examples.

3. A summary of the permeability test results is provided in Table 1.1. A review of the permeability test results indicates that several tests appear to have been carried out over depth ranges exceeding 6m in length and over several different strata. On this basis, the tests may actually indicate the connectivity of the most permeable strata (such as a sand or gravel lens) for the depth range over which the test was taken.

**Table 1.1: Permeability tests**

| Horizon | Depth | Permeability test results |
|---|---|---|
| Silty Sand and gravel lens | 0-5.5 | >5 $x10^{-4}$ |
| Sandy till and clayey till with gravel lens | 0-13.3 | $4.7x10^{-4}$ to $5.1x10^{-6}$ |
| Limestone | 13.3 ->15 | $2.08x10^{-7}$ to $9x10^{-8}$ |

4. The proposed design will exclude the potential inflows from the shallow sand and gravel material due to the piling design. Lugeon tests were undertaken on the underlying bedrock. The Lugeon test is widely used to calculate average hydraulic conductivity of bedrock. Tests indicate a low permeability bedrock with values ranging from 2 x $10^{-7}$ m/s to 9 x $10^{-8}$ m/s. The calculated discharge volumes are 15 $m^3$/hr based on the site specific testing.

**Table 1.2: Distance drawdown calculation**

| Schardt's Formula: | | Units | Notes |
|---|---|---|---|
| Thiem Sichardts Formula (steady state radius of influence): | | Ro = C (H – hw) {k}0.5 | Cashman P.M., Preene M. (2001) Groundwater lowering in construction, a practical guide, Spon Press. |
| C (Radial) | 3000 | | |
| H | 31 | mAOD | Site data |
| hw | 17 | mAOD | Proposed excavation depth |
| H | 50 | m (pressure head in aquifer) | Assumed permeability data |
| hw | 36 | m (pressure head after drawdown) | Proposed design |
| H – hw | 14 | mAOD | Proposed design |
| T | 1-5 | $m^2$/d | SI Data - lugeon tests of bedrock aquifer |
| D | 30 | m | Thickness of bedrock aquifer |

| Schardt's Formula: | | Units | Notes |
|---|---|---|---|
| k | 0.07 | m/d | Site data from Lugeon indicates lower values for bedrock |
| k | 2.1 E-08 | m/s | Site data from Lugeon indicates lower values for bedrock |
| a (excavation length) | 40 | m | RWI design |
| b (excavation width) | 30 | m | RWI design |
| re (whole site equivalent well) | 22 | m | If calculated Ro > re => use calculated Ro.<br>If calculated Ro < re => calculated discharge is negative => use {(Ro calc)+re} to give the Ro used in the discharge calculation i.e the Ro becomes the radius of the excavation plus the calculated radius of influence of the drawdown in the aquifer |
| Ro calc = | 58 | m | |
| Q | 15 | $m^3$/hr | |

5. Based on the above the downgradient distance is 58m. The cone of depression is not likely to extend as far as 58m due to the presence of recharge boundaries adjacent to the works. As stated above, the groundwater will be discharged to the same catchment and therefore will not result in a reduction in low flows / base flows.

# 2. Ballinagar/Geashill

6. The proposed development involves the construction of an 8m deep excavation. Groundwater levels are <1m bgl. The proposed caisson will require dewatering; however, the groundwater is subsequently discharged back into the same catchment and therefore there is no loss of baseflow to the Tullamore river.

7. The proposed design is for a depth of 8m. The Sichardt formula is a mathematical solution that was developed from Theim (1972) to calculate drawdowns in a confined aquifer of infinite extent where the only source of water is from storage. The idealized aquifers and associated calculations of aquifer response to pumping from Sichardt represent ideal end members of a continuum; that is, the response of many real aquifers lies somewhere between the responses in these idealized examples.

8. A summary of the geology results is provided in Table 2.1. A review of the Geashill GWS indicates that transmissivity is estimated at 10 $m^2$/day. On this basis, the tests may actually indicate the connectivity of the most permeable strata (such as a sand or gravel lens) for the depth range over which the test was taken.

**Table 2.1: Horizon summary Ballinagar**

| Horizon | Depth | Transmissivity m2/day |
|---|---|---|
| Peat | 0-2m | |
| Sandy SILT with gravel horizons | 2-5.0m | <10 |
| Limestone | 5.0 - >10m | 10 $m^2$/day– based on PWS report<br>2-20 $m^2$/day based on GWB |

9. The proposed design will exclude the potential inflows from the shallow sand and gravel material due to the caisson design.

**Table 2.2: Distance drawdown calculation**

| Schardt's Formula | | $R_o = C (H – h_w) \{k\}^{0.5}$ | Notes |
|---|---|---|---|
| Thiem Sichardts Formula (steady state radius of influence): | | $R_o = C (H – h_w) \{k\}^{0.5}$ | Cashman P.M., Preene M. (2001) Groundwater lowering in construction, a practical guide, Spon Press. |
| C (Radial) | 3000 | | |
| H | 66 | mAOD | |
| hw | 56 | mAOD | Proposed excavation depth |
| H | 50 | m (pressure head in aquifer) | Site data |
| hw | 40 | m (pressure head after drawdown) | Proposed design |
| H – hw | 10 | m | Proposed design |
| T | 20 | m2/d | GWS report estimate at 10$m^2$/day – conservatively assumed as 20$m^2$/day |
| D | 50 | m | Thickness of bedrock aquifer |
| a (excavation length) | 10 | m | Design detail |
| b (excavation width) | 10 | m | Design detail |
| re (whole site equivalent well) | 6 | m | If calculated Ro > re => use calculated Ro. If calculated Ro < re => calculated discharge is negative => use {(Ro calc)+re} to give the Ro used in the discharge calculation i.e the Ro becomes the radius of the excavation plus the calculated |
| Ro calc = | 102 | M | |

| Schardt's Formula | | $R_o = C (H – h_w) \{k\}^{0.5}$ | Notes |
|---|---|---|---|
| | | | radius of influence of the drawdown in the aquifer |
| Q | 20.5 | $m^3$/hr | |

10. Based on the above the downgradient distance is 102m. As stated above, the groundwater will be discharged to the same catchment and therefore will not result in a reduction in low flows / base flows.

# 3. Sensitivity analysis for Aquifer Transmissivity values

11. When calculating the radius of influence (Ro) or drawdown in a partially penetrating well, additional factors must be considered compared to a fully penetrating well. Partial penetration occurs when the well screen does not extend through the entire thickness of the aquifer, which can lead to vertical flow components and affect the drawdown distribution.

| Sichardts Formula: | | $R_o = C (H - h_w) \{k\}^{0.5}$ | T=5 | T=20 | T=50 | T=150 |
|---|---|---|---|---|---|---|
| C (Radial) | 3000 | | | | | |
| C (Planar) | 1500 | (range 1500 -2000; larger Lo gives smaller discharge result) | | | | |
| H | 66 | mAOD | | | | |
| hw | 60 | mAOD | | | | |
| H | 50 | m (pressure head in aquifer | | | | |
| hw | 44 | m (pressure head after drawdown) | | | | |
| H – hw | 6 | mAOD | | | | |
| T | range | m2/d | 5 | 20 | 50 | 150 |
| D | 50 | m | | | | |
| k | range | m/d | 0.1 | 0.4 | 1 | 3 |
| k | range | m/s | 1.16E-06 | 4.63E-06 | 1.16E-05 | 3.47E-05 |
| | | | | | | |
| Ro = | range | m | 19 | 39 | 61 | 106 |
| Ro for calculations = | range | m | 19 | 39 | 61 | 106 |

12. The above example assumes steady-state conditions and a simplified approach. Groundwater body data and Field data (e.g., permeability test, pumping tests) are used to validate calculations and refine estimates.

13. When there is recharge (e.g., from rainfall or recharge boundaries) into the aquifer, it will reduce the radius of influence of dewatering. Recharge provides additional water to the aquifer, counteracting the drawdown caused by pumping.

| Sichardts Formula: | | $R_o = C (H - h_w) \{k\}^{0.5}$ | T=5 | T=20 | T=50 | T=150 |
|---|---|---|---|---|---|---|
| *all units used in calcs to be in m and sec* | | | | | | |
| C (Radial) | 3000 | | | | | |
| C (Planar) | 1500 | (range 1500 -2000; larger Lo gives smaller discharge result) | | | | |
| H | 66 | mAOD | | | | |
| hw | 60 | mAOD | | | | |
| H | 50 | m (pressure head in aquifer | | | | |
| hw | 44 | m (pressure head after drawdown) | | | | |
| H – hw | 6 | mAOD | | | | |
| T | range | m2/d | 5 | 20 | 50 | 150 |
| D | 20 | m | | | | |
| k | range | m/d | 0.25 | 1 | 2.5 | 7.5 |
| k | range | m/s | 2.89E-06 | 1.16E-05 | 2.89E-05 | 8.68E-05 |
| | | | | | | |
| Ro = | range | m | 31 | 61 | 97 | 168 |
| Ro for calculations = | range | m | 31 | 61 | 97 | 168 |
| | | | | | | |

14. Whenever sump pumping is carried out as part of the caisson construction, arrangements will be made, before final discharge, to remove any suspended solids. Details are included in Appendix 5.1 CEMP.