



BETTERLINE WATER LTD

Water Pumps, Irrigation, Solar Equipment, Generators,
Boreholes, Swimming Pools and Water Treatment

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REPORT ON BOREHOLE TEST PUMPING AND WATER QUALITY ANALYSIS

CLIENT: OLOMANIRA PRIMARY SCHOOL

BOREHOLE LOCATION: OLOMANIRA

Testing Contractor: BETTERLINE WATER LIMITED

Compiled by

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Dated: SEPTEMBER, 2023

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GLOSSARY OF TERMS

Aquifer: A geological formation or structure, which stores and transmits water and which is able to supply water to wells, boreholes or springs to satisfy a particular water demand.

Aquifer characteristics: Ability of the aquifer to store and transmit ground water

Confined aquifer: Are those aquifers in which the piezometric level is higher than the elevation at which the aquifer was encountered. Static water levels are higher than the top of the formations.

Drawdown: The distance between the static water level and the pumped water level.

Hydro geological: Those factors that deal with subsurface water and related geological aspects of surface water

Pumping Water Level: The level at which water stands in a well when pumping is in progress, this is also called the dynamic water level when measured as measured in the well.

Recharge: General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, and lateral ground water flow) to the aquifer zones.

Recovery: Return to static water level following abstraction of groundwater.

Residual Drawdown: During water level recovery, the distance between pumped water level and the static water level.

Semi-confined aquifer: An aquifer partially confined by soil layers of low permeability through which recharge and discharge can still occur.

Specific Capacity: Ratio of pumping rate and drawdown ($\text{m}^3/\text{hr}/\text{m}$), a measure of the well performance.

Static Water Level: The level of water in a well that is not affected by abstraction of ground water.

Test Pumping: A test that is conducted to determine aquifer or well characteristics.

Transmissivity: A measure of the aquifer characteristics to conduct water through its saturated thickness (m^2/day)

Well Yield: Is the volume of water per unit of time discharged as litres or cubic metres from a well either by pumping or free flow.

Yield: Volume of water discharge from a well, usually in m³/hr

INTRODUCTION

Getting an adequate supply of safe clean water has a great deal of advantages from ensuring availability of enough quantities by the client for various domestic processes, reducing health risks associated with insufficient water in the upcoming projects, to provision of reliable water.

Taking these into account, the client needing to know the quantity of production from his borehole contracted Test Pumping Unit to carry out a Test Pumping procedure, this is the report.

OBJECTIVES

1. To establish the borehole's potential by estimating the sustainable yield and hydraulic performance for water supply.
2. To collect a water sample for submission to a reputable laboratory for quality analysis.

CONCEPT

The test pumping consists of pumping the borehole at variable rates and recording the water level (and therefore the drawdown) in the pumping well, the Recovery rate is thereafter recorded with the pump now switched off.

Discharge Measurement and Recovery Measurements

Discharge measurement was done by an approved volumetric method. A calibrated container of 20litres capacity when full was used. When time to fill measurement is made, each discharge measurement is calculated from the average of three-time measurements. Discharge varies by no more than 15% across the constant discharge test. A globe valve was used to control the discharge as the case demanded. **See Discharge Drawdown Test data sheet.**

The recovery test is very useful in qualitatively assessing the pumping effect and possible dewatering of aquifers that may result due to the limited extent of an aquifer. Furthermore, the recovery test will indicate the level to which the aquifer is actually dewatered by measuring the residual drawdown after the borehole is allowed to recover.

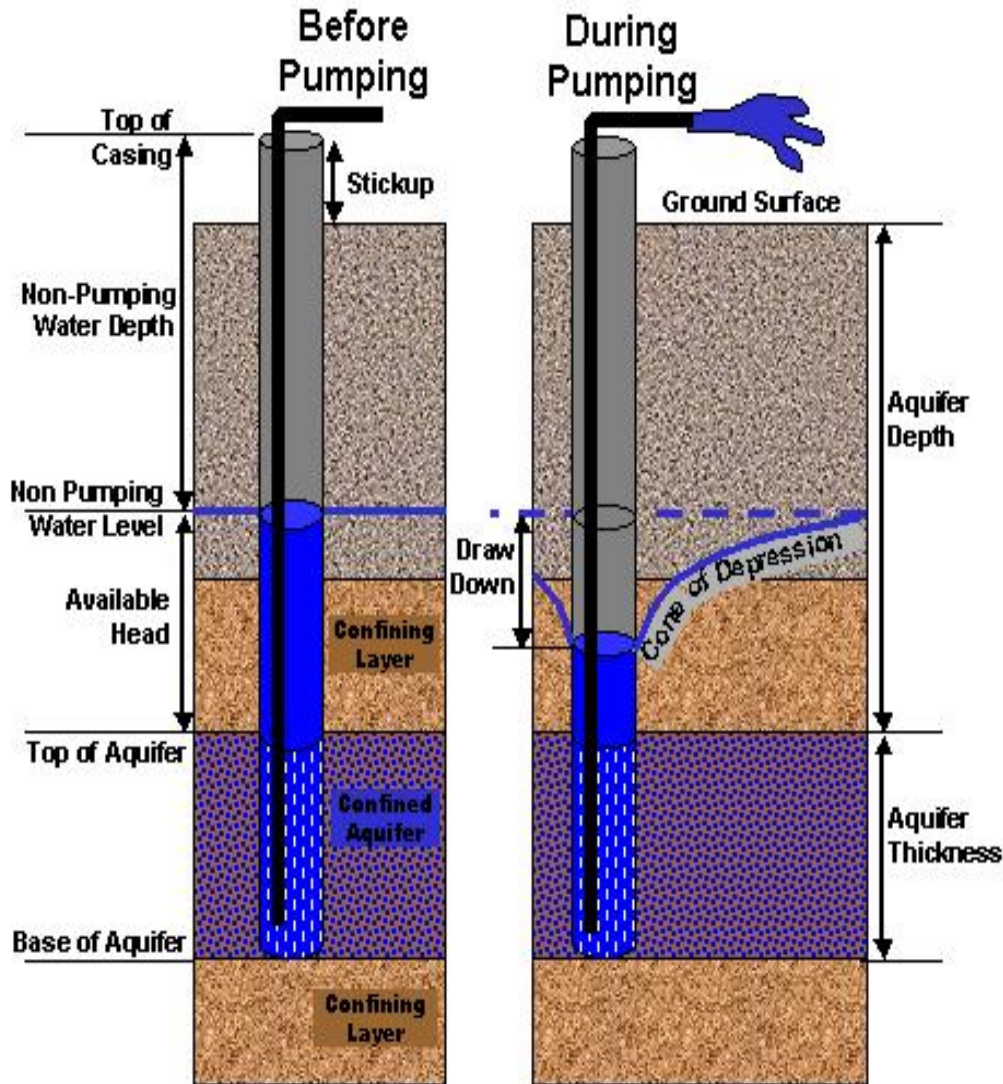
Water Quality

A water sample is generally taken in a clean sterilized container at the end of the test and submitted to qualified laboratories for full quality analysis. The water quality is also of importance to determine whether it is suitable for domestic, irrigation or industrial processes. Water quality standards vary from country to country and are determined by the local Bureau of Standards and intended use of water.

The results of the analyzed water sample are attached

PROCEDURE

TEST PUMPING CALIBRATION



Continuous Rate Test (CRT)

24th to 25TH SEPTEMBER, 2023.

The team lowered a **Submersible pump SP 3-60 Pump** and 1 1/2'' inches GI pipes down to **210m**. The pump was powered by a generator 40KVA. The Static Water Level was measured at **26.48m** before starting the test.

11:28:00hours: Commenced testing. An average flow of **0.7m³/hr.** was recorded during the test with the gate valve fully opened as was with respect to flow.

Recovery Test Measurements (RTM)

25TH Sep 2023

11:28:00 hours: The RTM begun immediately after the CRT, when the pump was switched off. A total of **27.55%** recovery coefficient was recorded during the 150mins recovery test measurement. This resulted into **55.21M** residual drawdown. **See annexed Recovery data sheet.**

The test unit was pulled out thereafter.

RESULTS AND ANALYSIS

Specific Yield/Specific Capacity

A borehole Specific Capacity (an estimate of borehole transmissibility) is calculated as yield per meter of drawdown.

Using (**Driscoll, 1986**) formula

$$\begin{aligned}\text{Specific capacity } S &= Q/s \\ &= \text{discharge per hour (m}^3/\text{hr) / maximum drawdown (m)} \\ &= (0.7/173.89) \\ &= 0.004025533383\text{m}^3/\text{hr/m}\end{aligned}$$

Table 1: Summary of bore hole and test data results

| DETAILS/LOCATION | OLOMANIRA PRIMARY SCHOOL |
|----------------------------------|---|
| Date drilled | Refer to drilling records |
| Measured depth | 230m |
| Water Struck Levels | Refer to drilling records |
| Date of Test | 24 TH to 25 TH Sep 2023 |
| Static Water Level (SWL) | 26.48m |
| Pump Intake Depth | 210m |
| Pumping Water Level (PWL) | 200.37m |
| Drawdown | 173.89m |
| Average tested Well Yield | 0.7m ³ /hr. |
| Duration of Test Pumping | 1440min (24hrs) |
| Recovery Time | 150mins |
| Recovery Coefficient | 27.55% |
| Residual Drawdown | 55.21m |
| Specific Capacity | 0.004025533383m ² /hr |
| Transmissivity | 0.133489644m ² /day |
| Maximum safe design yield | 0.7m³/hr. |

Aquifer Transmissivity (T)

It is a measure of the aquifer characteristics to conduct water through its saturated thickness

By using (**Logan, 1964**) formula,

Transmissivity, T= 1.22 Q/s expressed in m²/day: 1.22 is a constant,

Q is discharge per day and S is drawdown

$$= 1.22 \times (0.7 \times 24) / 153.54$$

$$= 0.133489644 \text{ m}^2/\text{day}$$

Analysis of Ground Water Potential

With a Specific Capacity of **0.004025533383 m³/hr./m**, an aquifer Transmissivity of **0.133489644 m²/day** and a recovery coefficient of **27.55%** it is conclusive that the borehole is of a fair recharge potential and is fed mainly from unconfined aquifers. The drilled well depth is assumed to have fully explored all the available upper aquifers in this geological set up.

Design Yield

Therefore, the recommended maximum calculated discharge limit is **0.7 m³/hr.** being the average abstraction during the test pumping. This yield is considered feasible in this well pumped for not more than **10 hours in a day**. Continuous over pumping of boreholes may lead to the depletion of aquifers feeding them hence result in the drying up of the borehole

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. With a Specific Capacity of **0.004025533383 m³/hr/m** and an aquifer Transmissivity of **0.133489644 m²/day**, the borehole is of a fair recharge potential.
2. The drilled depth in this hydro geological setup is assumed to have fully explored all the available upper aquifers in this geological setup.
3. The average tested well yield was **0.7 m³/hr.**

RECOMMENDATIONS

The following recommendations are made

1. The Design Yield considering a **173.89m** drop from the SWL during abstraction should be a maximum of **0.7 m³/hr.**
2. Abstraction should not exceed 10 hours a day, since over pumping would lead to the aquifer depletion.
3. The drop pipes used for lowering the pump into position should be of either class B GI or UPVC pipes with sufficient tensile strength to withstand the stresses and vibrations associated with pumping water
4. A water master meter and an airline must be installed in the borehole, for monitoring ground water abstraction and to facilitate regular static water level measurements/monitoring if and when necessary as stipulated by water resource management authority (WRMA)

5. Microbiological tests should be carried out after borehole equipping (i.e. pump installation) to test for Coliform and E-coli counts. These are disease causing organisms dangerous to human life if consumed.
6. The borehole should be disinfected by injecting appropriate amount of chlorine thereafter to kill disease causing pathogens that may be present.



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Well No: C
Contract: Borehole Testing Pumping
Client: Olomanira Pri. Sch.
Location: OLOMANIRA
Well Type: Drilled
Testing Contractor: Betterline Water Ltd
Static Water Level: 26.48M
Total Depth of Well: 230M
Depth of Pump Intake: 210M
Datum Level: 40cm
Pump Type: SP3/60
Pipe Type & Size: GI 1.5" Class 'B'
Power Source: Generator 40 KVA
Pumping Water Level: 200.37M

DISCHARGE DRAWDOWN TEST

| Date | Time | Elapsed Time (min) | Water Level (m bdl) | Drawdown (m) | Yield (m3/hr) | EC (uS/cm) | Remarks |
|------------|----------|--------------------|---------------------|--------------|---------------|------------|----------------------------------|
| 24.09.2023 | 11:28:00 | 0 | 26.48 | 0.00 | | | Start of constant discharge test |
| | 11:29:00 | 1 | 27.70 | 1.22 | | | Gate Valve Fully Open |
| | 11:30:00 | 2 | 30.52 | 4.04 | 4.30 | | |
| | 11:31:00 | 3 | 34.44 | 7.96 | | | |
| | 11:32:00 | 4 | 37.27 | 10.79 | | | brownish |
| | 11:33:00 | 5 | 40.69 | 14.21 | | | |
| | 11:34:00 | 6 | 42.47 | 15.99 | | | |
| | 11:35:00 | 7 | 44.66 | 18.18 | | | |
| | 11:36:00 | 8 | 46.50 | 20.02 | | | |
| | 11:37:00 | 9 | 46.55 | 20.07 | | | |
| | 11:38:00 | 10 | 47.70 | 21.22 | | | |
| | 11:40:00 | 12 | 49.40 | 22.92 | 2.50 | | |
| | 11:42:00 | 14 | 53.97 | 27.49 | | | |
| | 11:44:00 | 16 | 56.25 | 29.77 | | | |
| | 11:46:00 | 18 | 58.95 | 32.47 | | | |
| | 11:48:00 | 20 | 62.66 | 36.18 | | | |
| | 11:53:00 | 25 | 72.38 | 45.90 | | | |
| | 11:58:00 | 30 | 82.64 | 56.16 | | | |
| | 12:03:00 | 35 | 91.53 | 65.05 | | | |
| | 12:08:00 | 40 | 104.90 | 78.42 | | | |
| | 12:13:00 | 45 | 113.60 | 87.12 | | | |
| | 12:18:00 | 50 | 117.40 | 90.92 | | | brownish |
| | 12:23:00 | 55 | 124.94 | 98.46 | | | |
| | 12:28:00 | 60 | 131.30 | 104.82 | 2.50 | | |
| | 12:43:00 | 75 | 143.20 | 116.72 | | | |
| | 12:58:00 | 90 | 153.98 | 127.50 | | | |
| | 13:13:00 | 105 | 165.00 | 138.52 | | | |
| | 13:28:00 | 120 | 184.99 | 158.51 | 0.96 | | |
| | 13:58:00 | 150 | 187.20 | 160.72 | | | |
| | 14:28:00 | 180 | 189.58 | 163.10 | | | |
| | 14:58:00 | 210 | 190.02 | 163.54 | | | brownish |
| | 15:28:00 | 240 | 190.88 | 164.40 | | | |
| | 16:28:00 | 300 | 191.36 | 164.88 | 0.72 | | |
| | 17:28:00 | 360 | 191.88 | 165.40 | | | |
| | 18:28:00 | 420 | 192.40 | 165.92 | | | |
| | 19:28:00 | 480 | 192.60 | 166.12 | | | |
| | 20:28:00 | 540 | 192.68 | 166.20 | | | |
| | 21:28:00 | 600 | 192.82 | 166.34 | | | |
| | 22:28:00 | 660 | 192.95 | 166.47 | | | Start of constant discharge test |
| | 23:28:00 | 720 | 193.10 | 166.62 | | | |
| | 00:28:00 | 780 | 193.36 | 166.88 | | | |
| | 01:28:00 | 840 | 193.56 | 167.08 | 0.72 | | |
| | 02:28:00 | 900 | 193.90 | 167.42 | | | |
| | 03:28:00 | 960 | 194.08 | 167.60 | | | |
| | 04:28:00 | 1020 | 194.38 | 167.90 | | | |
| | 05:28:00 | 1080 | 194.62 | 168.14 | | | milky |
| | 06:28:00 | 1140 | 194.92 | 168.44 | 0.70 | | |
| | 07:28:00 | 1200 | 195.14 | 168.66 | | | |
| | 08:28:00 | 1260 | 195.30 | 168.82 | | | |
| | 09:28:00 | 1320 | 195.48 | 169.00 | | | |
| | 10:28:00 | 1380 | 197.08 | 170.60 | | | Collected water sample for FCA |
| | 11:28:00 | 1440 | 200.37 | 173.89 | | | End of drawdown test |

RECOVERY OF DISCHARGE DRAWDOWN TEST

| Date | Time | Elapsed Time (min) | Water level (m bdl) | Residual Drawdown (m) | Recovery % | Remarks |
|------------|----------|--------------------|---------------------|-----------------------|------------|----------------------------------|
| 25.09.2023 | | 0 | 200.37 | 0.00 | 0.00% | Start of constant discharge test |
| | 11:29:00 | 1 | 200.00 | 0.37 | 0.18% | Gate Valve Fully Open |
| | 11:30:00 | 2 | 199.79 | 0.58 | 0.29% | |
| | 11:31:00 | 3 | 198.86 | 1.51 | 0.75% | |
| | 11:32:00 | 4 | 197.88 | 2.49 | 1.24% | |
| | 11:33:00 | 5 | 196.79 | 3.58 | 1.79% | |
| | 11:34:00 | 6 | 195.39 | 4.98 | 2.49% | |
| | 11:35:00 | 7 | 194.77 | 5.60 | 2.79% | |
| | 11:36:00 | 8 | 194.14 | 6.23 | 3.11% | |
| | 11:37:00 | 9 | 193.60 | 6.77 | 3.38% | |
| | 11:38:00 | 10 | 192.43 | 7.94 | 3.96% | |
| | 11:40:00 | 12 | 191.48 | 8.89 | 4.44% | |
| | 11:42:00 | 14 | 190.39 | 9.98 | 4.98% | |
| | 11:44:00 | 16 | 188.80 | 11.57 | 5.77% | |
| | 11:46:00 | 18 | 187.88 | 12.49 | 6.23% | |
| | 11:48:00 | 20 | 186.95 | 13.42 | 6.70% | |
| | 11:53:00 | 25 | 185.90 | 14.47 | 7.22% | |
| | 11:58:00 | 30 | 184.77 | 15.60 | 7.79% | |
| | 12:03:00 | 35 | 181.97 | 18.40 | 9.18% | |
| | 12:08:00 | 40 | 179.29 | 21.08 | 10.52% | |
| | 12:13:00 | 45 | 176.36 | 24.01 | 11.98% | |
| | 12:18:00 | 50 | 174.60 | 25.77 | 12.86% | |
| | 12:23:00 | 55 | 173.20 | 27.17 | 13.56% | |
| | 12:28:00 | 60 | 171.84 | 28.53 | 14.24% | |
| | 12:43:00 | 75 | 168.01 | 32.36 | 16.15% | |
| | 12:58:00 | 90 | 163.19 | 37.18 | 18.56% | |
| | 13:13:00 | 105 | 160.20 | 40.17 | 20.05% | |
| | 13:28:00 | 120 | 152.68 | 47.69 | 23.80% | |
| | 13:58:00 | 150 | 145.16 | 55.21 | 27.55% | |