Concept Definition Report Guide

Herefords Water System
Concept Definition Report
Herefords, Eswatini 2025
Engineers in Action Cornell & Duke Chapters

Prepared by:

Project Manager

Violeta Egan
vae5@cornell.edu

Catherine Papa
catherine.papa@duke.edu

Team Leads

Sara Buchta
srb289@cornell.edu

Abbie Jobe
abj44@cornell.edu

Zofia Chmiel
zofiafchmiel@gmail.com

Flabia Carbajal
flabia.carbajal@duke.edu

Travel Team Members (and universities)

Violeta Egan (CU)	Sara Buchta (CU)	Madeline Rose (CU)	Maria Gravini (CU)
Julia Lee (CU)	Mira Yengera (CU)	Catherine Papa (DU)	Bryce Outten (DU)
Bea Hardacre (DU)	Taryn Long (DU)	Emerson Cortazar (DU)	Chloe Lowman (DU)

Other Contributors

Grace Lo			

Team Ambassadors

Talia August
talia.august@gmail.com

Anya Dias-Hawkins
anyadiashawkins@gmail.com

Emily Hallock
emily.r.hallock@gmail.com

Faculty Advisor

Hadas Ritz
hr32@cornell.edu

David Schaad
david.schaad@duke.edu

Design Engineer in Charge

Louis Woofenden
louiswoof@gmail.com

Design Engineer in Charge Shadow

Susan McGrattan
sjmcgrattan@gmail.com

WASH Corps Members

Ousmane Insa
ousmane.insa@jacobs.com

Eric Lowder
eric.lowder@gmail.com

Mark Taylor
mtaylor@westlandresources.com

WASH FEIC

Abdalrahman Msharqah
AbdAlrahman.Msharqah@jacobs.com

Concept Definition Report Checklist

The contents of this checklist must be completed before the team will receive Notice to Proceed. The team and its reviewers should ensure that this checklist is complete before submission to Engineers in Action for review. By signing and dating below, reviewers give their professional word that the checklist is complete and accurate.

- ☐ Proof of report review by technical mentors, ambassadors, DEICs, and faculty advisor
- ☐ General report content and quality
- ☐ Concept Plan with infrastructure size and values shown (pdf, google earth, or dwg acceptable).

Proof of Review

The contents of this report and all appendices must be proofed for errors, omissions, efficiency, and strong writing before it is submitted to Engineers in Action for Review. By signing and dating below, reviewers give their professional word that they have proofed the report and appendices in their entirety and have found them satisfactory for submission to Engineers in Action and use in a real-world engineering design-build project in the developing world. Reviewers should not sign until they feel the report and appendices meet their standards. If the report does not meet EIA's standards, the team will be assessed a $500 "poor performance fine" as outlined in more detail in the Bridge Binder. Failure to secure the required reviews and accompanying signatures will also result in the poor performance fine.

The objective of this review system is to hold students accountable to doing excellent work and educate them on the level of performance that is required and expected of them when working on real-world engineering projects. Thank you for participating in this educational process.

Signature Page

Team Ambassador (required):
By signing below, I certify that I reviewed the following according to the above requirements:

- ☐ Report and appendix content and quality (required)
- ☐ Preliminary design and associated calculations (recommended)

Name (printed): ____

Signature: ____

Date: ____

WASH Corps (at least one WASH Corps reviewer required):
By signing below, I certify that I reviewed the following according to the above requirements:

- ☐ Report and appendix content and quality (required)
- ☐ Preliminary design and associated calculations (required)

Name (printed): ____

Signature: ____

Date: ____

Design Engineer in Charge (required):
By signing below, I certify that I reviewed the following according to the above requirements:

- ☐ Report and appendix content and quality (recommended)
- ☐ Preliminary design and associated calculations (required)

Name (printed): ____

Signature: ____

Date: ____

Faculty Adviser (recommended):
By signing below, I certify that I reviewed the following according to the above requirements:

☐ Report and appendix content and quality (recommended)
☐ Preliminary design and associated calculations (recommended)

Name (printed): ____

Signature: ____

Date: ____

Table of Contents

1. Introduction

This Concept Definition Report will serve as a master plan study for the water system design serving the Herefords Primary School in the Kingdom of Eswatini.

1.1 Project Development and Justification

The water system will serve the Herefords Primary School in the Mayiwane inkhundla (municipality) of the Hhohho region. There are 274 students, 16 staff members, and 11 teacher dwellings at the school.

The current water system in the Herefords Primary School was built in 1954 and uses water from a mountain spring offsite from the school. The current source for the water system is unreliable because it dries up and often requires offsite repairs. The school is also competing with other water users such as agriculture sectors, and the water is contaminated with 85 coliforms most probably number (MPN) per 100 mL and 13 Escherichia coli MPN per 100mL. The new water system will provide reliable and clean water.

1.2 Project Location

The Herefords Primary School is located in the Mayiwane inkhundla of the Hhohho region and serves the Herefords community in the Kingdom of Eswatini (refer to Figure 3). Most of the land surrounding the site appears to be very hilly, with steep terraces on the school grounds. Most of the vegetation consists of patches of short grass that can be easily removed during excavation with some mature trees that could pose a hindrance to excavation.

2.0 Engineering Criteria

This section summarizes the engineering criteria that drives the design of the project and is generally determined by local code, standards, design manuals, best practices, or regulations.

2.1 Demand Criteria

The following demand criteria steer the design of this project:
- Average Day Demand (ADD)
- Peak Day Demand (PDD)
- Peak Hour Demand (PHD)
- Maximum Instantaneous Demand (MID)

Table 1. Demand Criteria from WASH Manual

Average daily water usage per person	15 lpds*
Average daily water usage per teacher dwelling unit	500 lpddu*
Peak Day Factor	1.0

Peak Hour Factor	4.0
Design Period	20 year
Annual Growth Rate	3%
Growth Factor	1.81
Tapstands	1 per 100 students
Service Connections	1 per teacher dwelling unit

*lpds = liters per day per student, lpddu = liters per day per dwelling unit

2.2 Supply Criteria

Borehole capacity should meet or exceed one day's worth of PDD (which is equal to ADD), using run time determined by solar parameters.

2.3 Storage Criteria

Storage capacity should meet or exceed the greater of two days' worth of ADD, or 20,000 L of storage. Minimal cloud cover data was provided; however, online weather data indicates that the highest cloud coverage is about 54% during the rainy season. We believe that more storage or backup power supplies are not needed for this case. However, EIA field staff are investigating the possibility of using a backup power supply to increase water availability from the well, but this will be confirmed for RC2. The water retention time must be at or below seven days. If the retention time exceeds this criteria, then water quality issues associated with stagnation must be considered. A plan will be developed to address periods of reduced system usage, such as school holidays.

2.4 Distribution Criteria

Table 2. Distribution Criteria from WASH Manual

Design flow	Peak flow from all standpipes discharging (MID) and static (ie. zero) flow
Max pressure at fixtures	50 m
Min pressure throughout system	10 m (5 m in extreme situations with DEIC permission)
Recommended maximum pipe velocity	1.0 m/s (Rural Water Supply Branch uses 1.5 m/s)
Recommended maximum pipe headloss	1 m loss / 100 m pipe
Minimum pipe size	32 mm**
Pipe class	Class 9

Pipe cover	600 mm generally (900 under cultivated land)
Standing discharge rate	8 L/min at 10 meters water head
Isolating valves	Install one valve for each branch of pipe
Service connections	Connections made to house connections will be made with HDPE pipe where possible. Above ground pipes to be galvanized steel pipes.
Road crossings: Major roads Road subject to goods vehicles General***	 Pipes laid through culverts Concrete sleeve pipe with 900 mm cover Use of steel pipes only where instructed

*RWSB = Rural Water Supply Branch.
**Service connections may be 25 mm, but transmission lines should not be reduced below 32 mm
***Since the WASH site is a school campus, only small motor vehicles will be entering and exiting the school grounds during the beginning and the end of the school day. In this case, a PVC sleeve pipe will be used for the HDPE pipes since there is a low frequency of the traffic.

3.0 System Planning and Calcs

This section summarizes the calculations used to size the water system based on the beneficiary population and engineering criteria of Section 2. All calculations for the design are completed in the Design Spreadsheet.

3.1 Service Population

The system will serve both students and teachers at the school, with approximately 290 total beneficiaries. The system will provide students and teachers with clean drinking water and hand sanitation during the school day, and will likely be used for cooking and washing dishes at student mealtimes. There are also several teacher dwellings on site, meaning teachers may utilize the system throughout the week for daily activities. Details of the beneficiary population are provided in Table 3 below.

Table 3. Population Information from Site Information Packet

Students	274
Teachers & Staff	16
Teacher Dwellings	11
Total Beneficiaries	290

3.2 Demand Calculations

Demand calculations were generally performed in accordance with the criteria specified in Section 2.1. However, due to low well yield at this site, the teacher dwellings will not be serviced via stub connections, but rather with a new communal tapstand located centrally. Teachers will be encouraged to use the old system for non-potable water needs, such as laundry and flushing toilets. They will be advised to use the new tap and system for potable water needs, such as drinking, cooking, and cleaning. It is anticipated that the teacher dwellings will use the new system for potable water needs, so a reduced demand of 100 L per dwelling unit per day was allocated to each teacher dwelling. This is the maximum amount that can be allocated to the teacher dwellings without exceeding the well capacity.

To ensure a conservative estimate, ADD was calculated with the assumption that students will be on site seven days per week. However, since the school follows a five-day school week, there will typically be lower water usage over the weekend. This allows the available pump output that would go towards student use during the weekdays to be reallocated to storage or additional teacher use. The average student demand over two days was calculated at almost 15,000 L, which, if spread across the week, would provide approximately another 100 L per day per teacher dwelling (after adjusting for the growth factor), or it could be used for weekend activities. Therefore, any water not used by students over the weekend will help offset the impact of the reduced teacher demand allocation.

The limited well yield and reduced demand have been discussed with the teachers by EIA staff on the initial site visit. The demands calculated for this project allow for the maximum utilization of the system while maintaining a minimum required well yield below the available well yield (see Section 3.3 for further details).

Additionally, while the demand criteria requires one fixture per 100 students, the proposed total number of fixtures in the system is seven. All six existing taps will be serviced by the new system, and a new tapstand will be constructed in a location central to the teacher dwelling area. This will reduce confusion amongst the students between potable and non-potable sources, and will ensure the teachers have convenient access to potable water.

Table 4 below summarizes the calculations relevant to system demands.

Table 4. System Demands

Demand Type	Equation	Value
$ADD_{initial}$	(# people) × (avg daily water usage per person) + (# teacher dwellings) × (avg daily water usage per dwelling)	5450 lpd*
ADD	$ADD_{initial}$ × Growth Factor	9840 lpd
PHD	ADD × Peak Hour Factor	27.3 lpm*
Number of Fixtures	Based on concept plan	7
MID (After concept plan)	(# fixtures) × (flowrate per fixture)	56 lpm

*lpd = liters per day, lpm = liters per minute

3.3 Supply Calculations

Supply at this site is limited by the available well yield, which is estimated at 18.6 lpm based on a pump test performed by Manzi Drilling on the 19th of December, 2022. The full test data are provided in Section 6.4. To ensure the well is being fully utilized, the ADD was adjusted to ensure a Minimum Required Well Yield that is only just satisfied by the Available Well Yield. These values will be revisited in the Design Report during pump sizing, with the continued goal of maximizing water production given the hydraulic constraints. There are a range of solutions to increase supply, including having additional run-time from grid power, confirming well-development quality, and determining if redevelopment may increase yield. Table 5 below summarizes the supply calculations for this project.

Table 5. Supply Calculations

Parameter	Equation	Value
PDD	See Section 3.2	9840 lpd
Solar Pump Runtime	See Section 5.2	9 hrs/day
Minimum Required Well Yield	$\frac{ADD}{Solar\ Pump\ Runtime} \times \frac{1\ hour}{60\ min}$	18.2 lpm
Available Well Yield	Based on pump tests	18.6 lpm

3.4 Storage Calculations

For this project, 5,000 L tanks will be used, as they are the most cost-effective, locally available option. Initial storage calculations were performed using the criteria detailed in Section 2.3. These calculations gave a two-day ADD of 19,690 L, and therefore a required storage capacity of 20,000 L. However, due to low well yield (approximately 10,000 lpd), the number of tanks was increased to improve reliability. A total of five tanks were decided to reduce the chance of outages, giving an overall storage capacity of 25,000 L. The storage calculations are summarized in Table 6 below. Storage calculations will be revisited during Review Call 2, once the pump sizing has been performed and an hourly analysis of usage versus production will be conducted to understand typical storage levels throughout the week.

Table 6. Storage Requirements

Parameter	Equation	Value
ADD	See Section 3.2	9840 lpd
Two days ADD	ADD × 2	19690 L
Minimum Storage	From storage criteria	20000 L
Required Storage	Greater of two day ADD or minimum storage	20000 L
Daily Use by Students	(# students) × (avg daily water usage per person)	7420 L

	× (growth factor)	
Tank Size	Chosen based on local availability and cost	5000 L
Number of Tanks	Chosen based on minimum storage and reliability	5 tanks
Planned Storage	Tank Size × Number of Tanks (5,000 L Tank Capacity × 5 Tanks)	25000 L
Average Retention Time	$\frac{Required\ Storage}{ADD}$	2.54 days

4.0 Concept Plan and Proposed Facilities

Figure 1 shows an overview map of the project site and proposed facilities. The following sections provide specifications about the supply, storage, fixtures, and pipe layout.

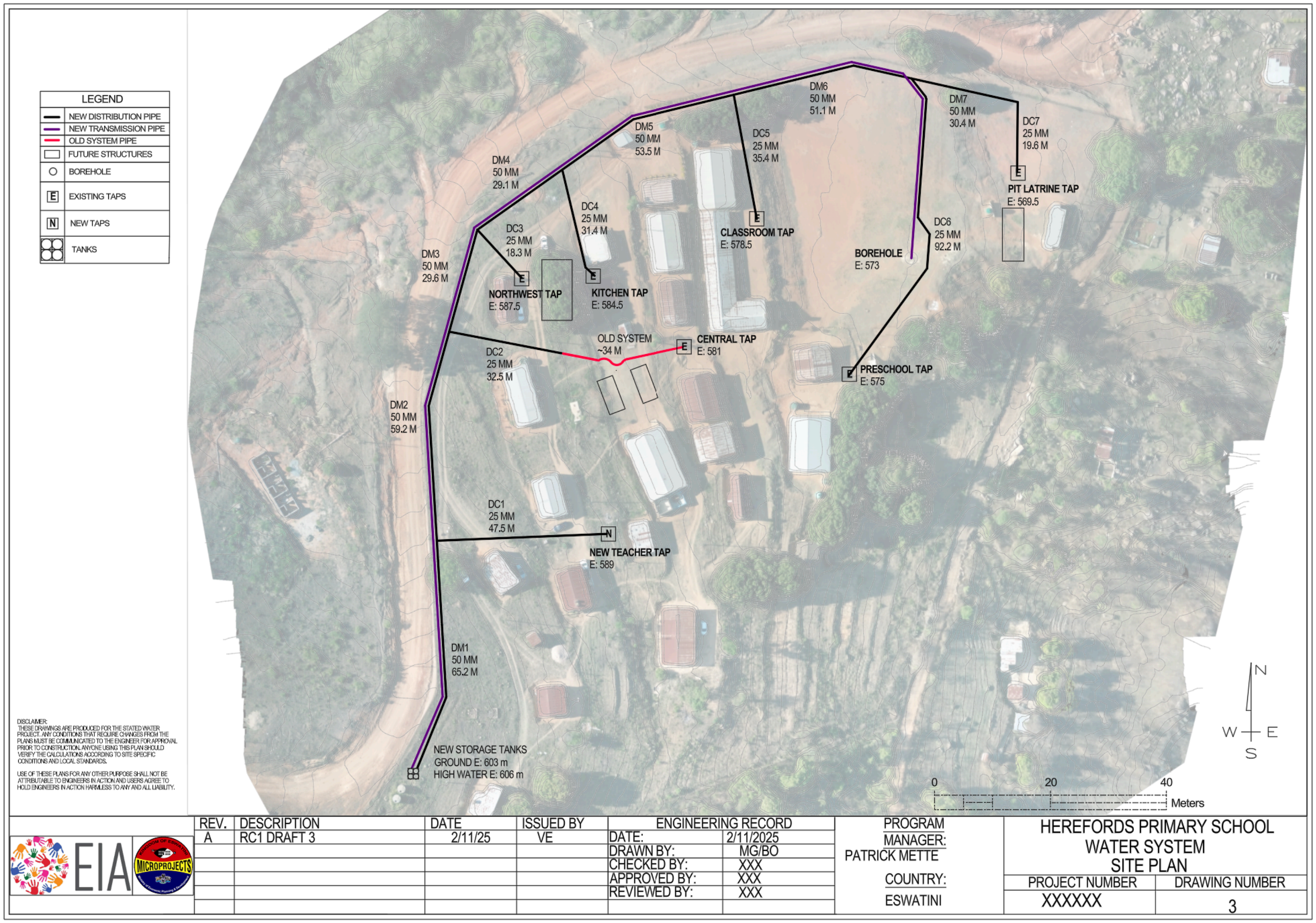


Figure 1. Proposed Design

*The DC2 connection to the Central tap will have a tie over to the old system to prevent difficult excavations. We have approximated a location for the tie over; however, this is subject to change once the existing pipe layout is confirmed.

4.1 Proposed Supply

The water supply for this project is an existing borehole, which is located at 25°54'29.64"S and 31°27'35.51"E. Based on the six hour borehole test data (Section 6.4), this is a low yield well, and hydraulic constraints will be limiting for this project. The system has a Minimum Required Well Yield of 18.2 lpm, which was intentionally calculated to be just below the Available Well Yield of 18.6 lpm. The pump that is being used to draw water from the borehole will be solar powered, with a solar array and attached pump control units located adjacent to the well. There will be an enclosure placed around the pump to protect from weathering, the design will be included in RC2. A specific pump lpm will be chosen after solar design is done. A water-powered chlorine pump with volumetric proportioning will be used for disinfection, and will be attached to the manifold.

4.2 Proposed Storage

An ADD for a total of two days is equivalent to 19,680 L, which is almost equal to the minimum storage requirement of 20,000 L. However, as discussed in Section 3.4, additional storage capacity could allow excess water produced over the weekend to be used at the teacher dwellings throughout the week. As a result, the proposed solution is to use five 5,000 L storage tanks. The 5,000 L tanks will be used instead of the 10,000 L tanks due to the cheaper cost of the smaller tanks. The new storage tanks will be located north of the existing storage tanks with latitude 25°54'34.12"S and longitude 31°27'30.28"E. The new storage tanks will be constructed on a relatively flat area at an elevation of 603 m (the tanks will be constructed on concrete bases that will all be level with each other to ensure that the bottom and top elevation for each tank will be the same).

4.3 Tapstands

There are seven proposed tapstands on site, which can be seen in the proposed design in Figure 1. All taps other than the New Teacher tap are existing and currently connected to the old system. The tapstands are located as follows and are ordered from the tanks to lowest elevation:

- The **New Teacher tap** is located in between a few of the teacher dwellings in the most concentrated part of the teacher dwelling locations.
- The **Northwest tap** is located east of the northernmost teacher dwelling.
- The **Kitchen tap** is located on the south end of the kitchen building.
- The **Central tap** is located in the center of the classroom building layout, and lies between two smaller classrooms.
- The **Classroom tap** is located to the eastern side of the largest classroom building.
- The **Preschool tap** is located to the eastern side of the preschool building.
- The **Latrine tap** is located northwest of the pit latrine building.

4.4 Distribution System and Pipelines

The transmission pipeline runs between the borehole and tanks, hugging the northern and western fence line. The transmission pipe is anticipated to be a 32 mm diameter pipe, 340.7 m in length. There is one main distribution line that will run parallel to the transmission line and service seven fixtures via connections. The connection pipes will be with a diameter of 25 mm. The pipeline consists of the following sections in Table 7 based on locations shown in Figure 1:

Table 7. Pipe Sections

Pipe	Outer Diameter (mm)	Length (m)	Start	End
DM 1	50	65.2	Tanks	DC1
DM 2	50	59.2	DM1	DC2
DM 3	50	29.6	DM2	DC3
DM 4	50	29.1	DM3	DC4
DM 5	50	53.5	DM4	DC5
DM 6	50	51.1	DM5	DC6
DM 7	50	30.4	DM6	DC7
DC 1	25	47.5	DM1	New Teacher Tap
DC 2	25	32.5	DM2	Connection to old system leading to Central Tap
DC 3	25	18.3	DM3	Northwest Tap
DC 4	25	31.4	DM4	Kitchen Tap
DC 5	25	35.4	DM5	Classroom Tap
DC 6	25	92.2	DM6	Preschool Tap
DC 7	25	19.6	DM7	Pit Latrine Tap

4.5 Static and Dynamic Pressures

All elevations in Table 8 are relative to each other. Elevations were provided by EIA Eswatini field staff in a CAD file based on a topographic survey they performed. The elevation of the bottom of the tank is 603 m. The tank itself will be three meters tall and a concrete base will serve as the foundation. The elevation of the highest water point is 606 m. We are assuming the tanks will be at a minimum storage level (603 m in elevation) for pressure calculations. Table 8 shows the static and dynamic pressure at different taps:

Table 8. Static and Dynamic Pressures by Tapstand

Tap	Relative Tap Elevation (m)	Static Pressure (m)	Dynamic Pressure (m)	Pipe length (m)
New teacher tap	589	14	11.6	112.7
Kitchen tap	584.5	18.5	14.7	214.5
Classroom tap	578.5	24.5	20.4	272
Latrine tap	569.5	33.5	29.6	337.7
Central tap	581	22	18.9	156.9
Preschool tap	575	28	22.7	379.9
Northwest tap	587.5	15.5	12.2	172.3

5.0 Other Civil Design Considerations

This section summarizes other considerations influencing the design, including water quality, solar, land ownership, materials acquisitions, conflicts and crossings, stream crossings, and soil conditions.

5.1 Water Quality

Table 9. Water Quality Data

Parameter	Standard (mg/L)	Measured value
Primary Standards		
Total Coliform	Non-Detectable in 100 mL (ND)	261 (per 100 mL)
E. Coli	ND	ND
Nitrate (NO_3) as N (mg/L)	10	1.6
Nitrite (NO_2) as N (mg/L)	3	<0.02
Fluoride (mg/L)	4.0 (EPA MCL) 2.0 (EPA Secondary Standard)	0.09
Secondary Standards*		
Chloride (mg/L)	250	13.9

Iron (mg/L)	0.3	0.06
Manganese (mg/L)	0.5	0.05
PH	6.5 - 8.5	6.2 (at 25℃)
Turbidity (NTU)	5	2.7
Hardness as $CaCO_3$ (mg/L)	500	29

*Some of the secondary measurements have not been provided including color, totally dissolved solids, taste & odor, temperature, and alkalinity as $CaCO_3$.

Given the positive test for coliforms, disinfection is required. We will be using only chlorine disinfection given that this is groundwater, not surface water, and there is no presence of E. Coli. Chlorine disinfection will be more feasible for the community to maintain.

Table 10. Disinfection Requirements

ADD	9840 lpd
Target Bleach Dosage	1 ppm
Average Day Bleach (3.5%) Dosage	0.281 L
Storage Volume for Two Week Supply of Bleach	41.34 L
Maximum Well Flow Rate	20 lpm
Maximum Bleach Dosing Rate	0.0006 lpm (0.82 lpd)

5.2 Solar

The proposed location is in close proximity to the borehole (exact location is TBD), and it will be fenced around to avoid disruption. The chosen location will avoid structures or vegetation that would cause shade issues. Since it is still the early stages of the design process, the Grundfos sizing tool was used to make a rough estimate of 9 hours of useful sunlight. The sizing was completed on a proposed pipe design with the shortest day of the year in June. The useful hours of sunlight, and thus the minimum required well yield, is subject to change with future iterations of the design.

5.3 Land Ownership

The water system construction will pose minor impacts on the environment because the grounds have been previously cleared for the school. The pipe placement will avoid trees and other natural elements to mitigate the disturbance to the environment during the excavation and construction process. The water system will be constructed on school property, thereby not requiring additional land use permissions. Some sections of the system, specifically the Classroom, Preschool, and Central Taps, are located in heavy student traffic areas. Disruptions to the school day will be minimized however possible and safety measures will be in place to allow children to access their designated classes using other routes. The only concern is that construction will proceed during regular school hours, so children's safety on site is of utmost priority.

5.4 Material Acquisition

A full list of materials will be provided in the Design Report, and will be updated in the Construction and Safety Report if necessary. Materials will be chosen from supplies available at local vendors, and may be delivered by the vendors or purchased and brought to site by in-country EIA staff. There are six existing taps on the site, and our plan is to install one new tap. All well site materials will be provided by the contractor team. Tanks will be delivered to site by the manufacturers.

5.5 Conflicts and Crossings

There are existing water lines that will be left untouched so as to not cut off the school's water supply over the duration of construction. At certain points, our new system would tie into the existing water lines for convenience. The existing system is primarily made of HDPE materials, with an unknown age and mix of components from various repairs. The entire water system will be constructed and tested before switching over the systems at the tap stands. In addition, there is one road adjacent to the western side of the site that passes by the teacher dwellings. The proposed layout has one conflict at the entrance of the school that will require a PVC pipe sleeve for the distribution and transmission lines that pass through there. This section would likely be constructed, filled, and compacted in the span of one day to avoid safety hazards. Another conflict will be the pipes laid between the classrooms. A section of the pipe system will be buried with soil compacted on top in quick succession to recover access to the classrooms and maintain safety on site.

5.5.1 Stream Crossings

There is no stream/drainage crossing.

5.6 Soil Conditions

Soil information has not been provided. In-country staff penetrated the soil approximately ¼ to ½ inches by thumb with a sustained effort, indicating fine soil with a stiff to very stiff consistency.

6.0 Appendix

6.1 Maps

Community: HEREFORDS Region: HHOHHO GPS Coordinates: S 25°54'29.5"
District: MAYIWANE Country: KINGDOM OF ESWATINI E 31°27'35.5"

Figure 2. Aerial Map of Water System Location with Existing Features from Google Earth Pro

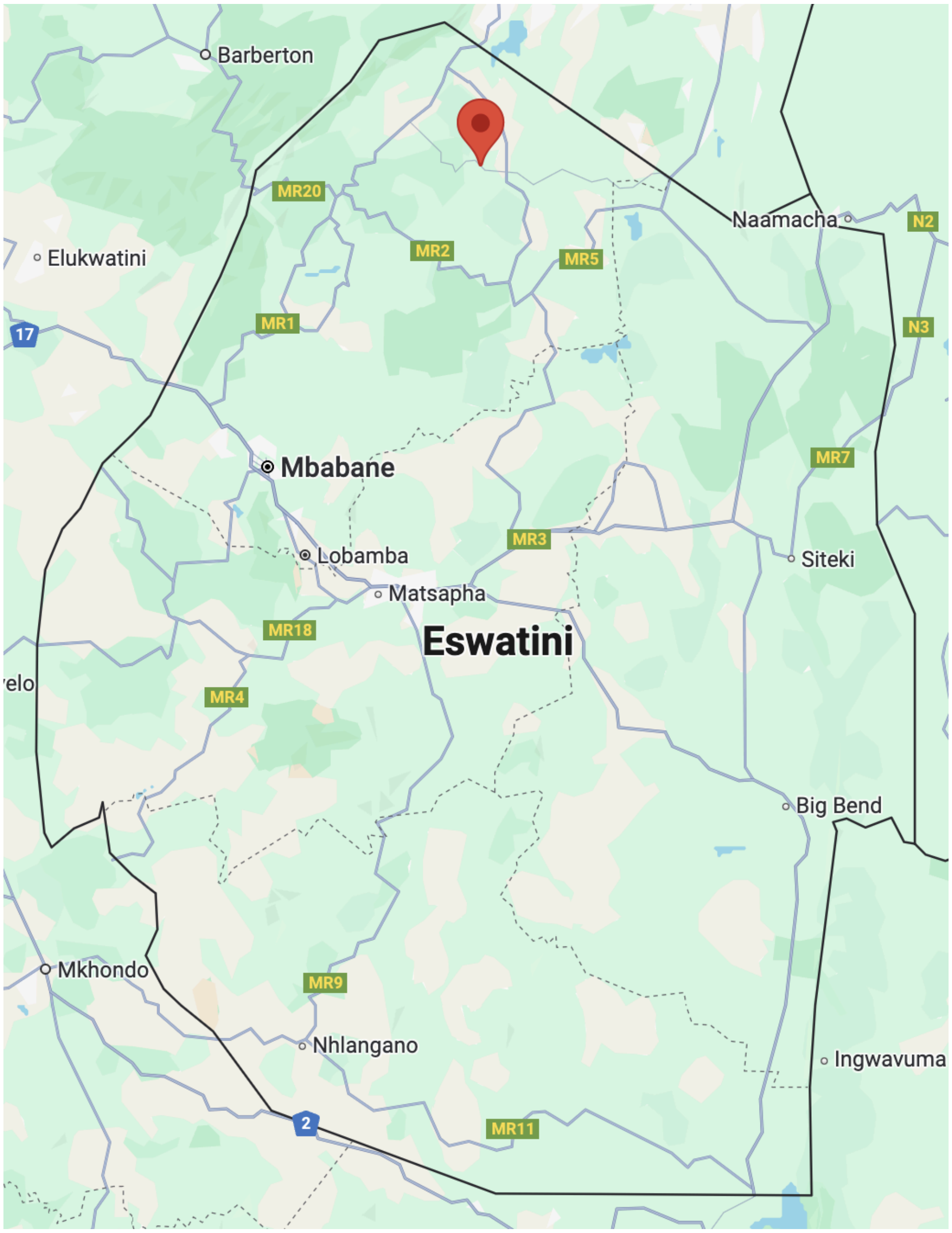


Figure 3. Map of Eswatini with Water System Location from Google 2024[1]

[1] Google Maps Image from January 15th, 2025
https://maps.app.goo.gl/rcfYtBofJqLQdHxC7

6.2 Media

No notable discrepancies were found between the site photos and the topographic survey.

6.2.1 Well Site

6.2.2 Tank Site

Existing Tank Site and Surroundings

6.2.3 Structures to be Served

Latrines

Classrooms

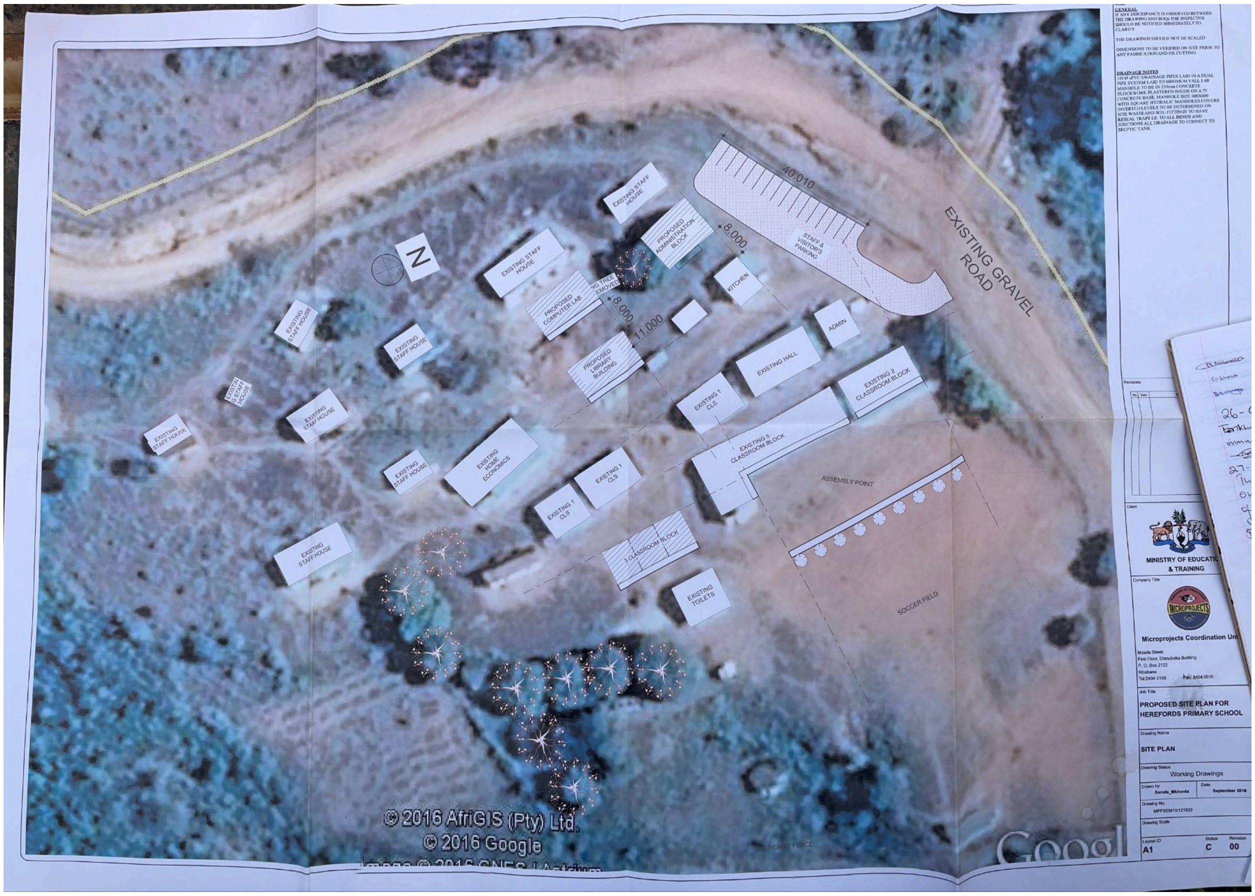
Teacher Housing

Kitchen

6.2.4 Crossings

Crossings

6.3 Site Map



Note: The latrine is labeled incorrectly and is south of the soccer field. The labeled building is actually the Grade 0 classroom. The staff and visitor parking lot is a proposed area.

6.4 Borehole Data

6.4.1 Drilling Report

MANZI DRILLING

BOREHOLES, PUMPS, TANKS, TANK STANDS, EXPLORATION ETC

Po Box 2738
Manzini
Swaziland

Tel / Fax: 518 7775
Cell: 7618 8400 / 7622 0200
Email: info@manzidrilling.co.sz

No 299 of 2004

BOREHOLE REPORT

DATE: 30 / 11 / 2022

CLIENT: Microprojects

SITE: Hereford Primary School

CO-ORDINATES: S 25° 54'29.9"
E 031° 27'35.6"

ACTION: New Borehole

DEPTH OF BOREHOLE: 130m

WATER STRIKES: +/- 50m +/-84m

CASING: 37m X 177mm X 4mm Plain Steel Casing
83.6m X 145mm Plain PVC Casing
46.4m X 145mm Perforated PVC Casing

STATIC WATER LEVEL: 21,62m

YIELD: +/- 1,000 L/h (0.27 L/sec)

HAMMER SIZE: 161mm

PLEASE NOTE:

The above mentioned yield has been determined with a blow test.
A blow test involves high pressure air being blown into the borehole for a certain time, whilst measuring the volume of the water against time (L / Hr)

The accurate yield of a borehole can only be determined by means of an aquifer test (pump testing). These tests involve installing a test pump and pumping the borehole for a period of time at a given rate (yield) whilst monitoring the draw down (lowering of water level in the borehole as a result of abstraction).

6.4.2 Borehole Pump Test Results

MANZI DRILLING

BOREHOLES, PUMPS, TANKS, TANK STANDS, EXPLORATION ETC

VAT NO: 100 191 718

Po Box 2738
Manzini
Swaziland

Tel / Fax: 2518 7775
Cell SWD: 76188400, 76220200
E-mail: info@manzidrilling.co.sz

No 299 of 2004

Pump Test Date: 19 / 12 / 2022

Customer: Microprojects

Site: Hereford Primary School

<u>BOREHOLE TEST RESULTS:</u>

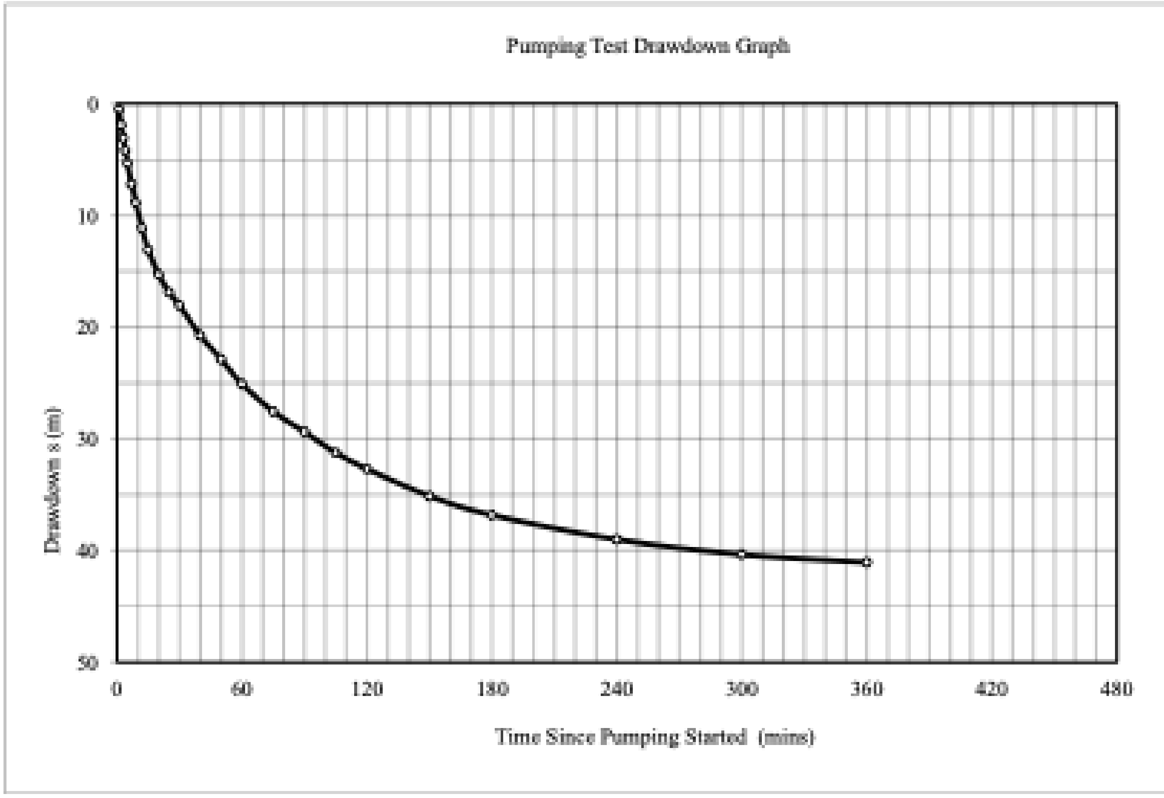
Static Water Level:	21.62m
Borehole Depth:	130.70m
Pump Depth:	100.00m
Test Duration:	360 min
Total Draw Down:	41.05m
Pump Rate:	1,115 ℓ/h (0,31 ℓ / sec) @ 62.67m
Recovery:	90 min upto 23.55m

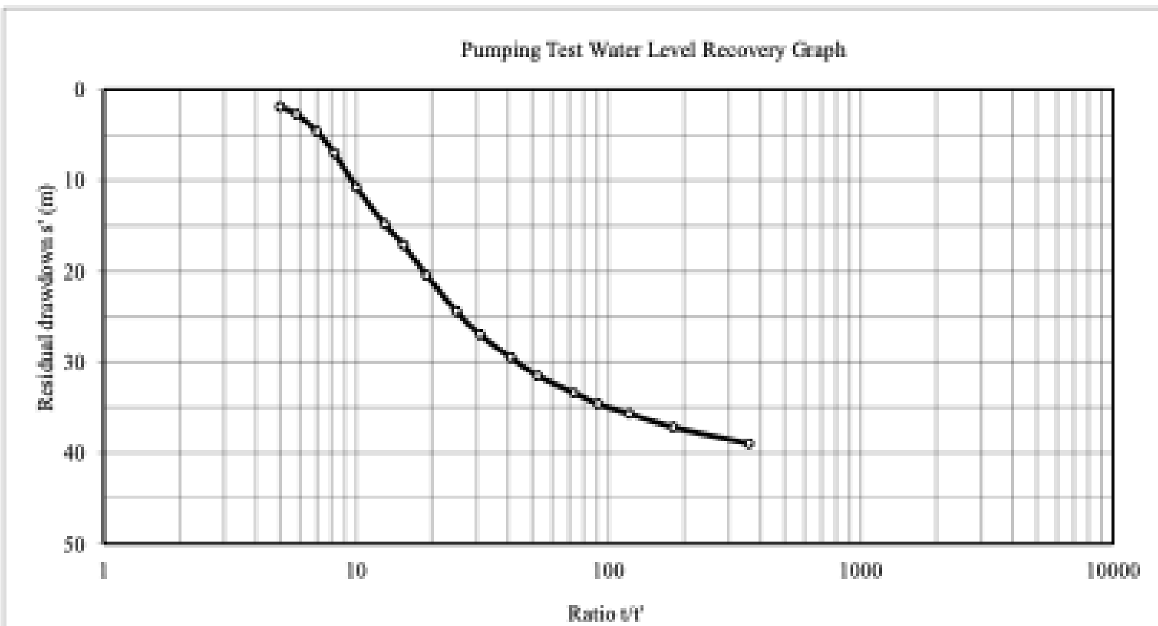
<u>PLEASE NOTE:</u>

Full detailed Pump Test results available, if required. As this is only a summary of the Pump Test done.

DRAWDOWN					RECOVERY				
Time	Time (mins)	Water Level (m)	Drawdown (m)	Pumping Rate (l/sec)	Time	Time (mins)	Ratio t/t'	Water Level (m)	Resid. draw down s' (m)
1m	1	22.10	0.48	0.44	1m	1	361.00	60.60	38.98
2m	2	23.50	1.88	0.44	2m	2	181.00	58.80	37.18
3m	3	24.70	3.08	0.44	3m	3	121.00	57.30	35.68
4m	4	25.80	4.18	0.44	4m	4	91.00	56.25	34.63
5m	5	26.93	5.31	0.43	5m	5	73.00	55.00	33.38
7m	7	28.80	7.18	0.42	7m	7	52.43	53.12	31.50
9m	9	30.46	8.84	0.41	9m	9	41.00	51.12	29.50
12m	12	32.73	11.11	0.40	12m	12	31.00	48.60	26.98
15m	15	34.70	13.08	0.40	15m	15	25.00	46.05	24.43
20m	20	36.90	15.28	0.39	20m	20	19.00	42.05	20.43
25m	25	38.49	16.87	0.39	25m	25	15.40	38.75	17.13
30m	30	39.66	18.04	0.39	30m	30	13.00	36.45	14.83
40m	40	42.36	20.74	0.38	40m	40	10.00	32.35	10.73
50m	50	44.50	22.88	0.36	50m	50	8.20	28.63	7.01
1h	60	46.70	25.08	0.36	1h	60	7.00	26.25	4.63
1h15m	75	49.17	27.55	0.35	1h15m	75	5.80	24.35	2.73
1h30m	90	50.99	29.37	0.35	1h30m	90	5.00	23.55	1.93
1h45m	105	52.85	31.23	0.35	1h45m	105			
2h	120	54.30	32.68	0.34	2h	120			
2h30m	150	56.73	35.11	0.34	2h30m	150			
3h	180	58.44	36.82	0.32	3h	180			
4h	240	60.62	39.00	0.31	4h	240			
5h	300	61.97	40.35	0.31	5h	300			
6h	360	62.67	41.05	0.31	6h	360			
7h	420				7h	420			
8h	480				8h	480			
9h	540				9h	540			
10h	600				10h	600			
11h	660								
12h	720								
13h	780								
14h	840								RECOVERY
15h	900								
16h	960								
17h	1020								
18h	1080								
19h	1140								
20h	1200								
21h	1260								
22h	1320								
23h	1380								
24h	1440								
		Switch off pump and record recovery							

MANZI DRILLING P.O. BOX 2738 Manzini Tel / Fax; 2518 7775 email: info@manzidrilling.co.sz	BOREHOLE PUMPING TEST			
	HEREFORD PRIMARY SCHOOL			
	Borehole Depth: 130m		Static Water Level: 21.62m	Pump Depth:100m
		Date Of Test: 19 / 12 / 2022	**FIGURE: 1**	





MANZI DRILLING P.O. BOX 2738 Manzini Tel / Fax; 2518 7775 email: info@manzidrilling.co.s	BOREHOLE PUMPING TEST		
	HEREFORD PRIMARY SCHOOL		
	Borehole Depth: 130m	Static Water Level: 21.62m	Pump Depth:100m
		Date Of Test: 19 / 12 / 2022	**FIGURE: 2**

6.4.3 Borehole Water Quality Test Results

SADCAS
SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
TEST-5 0026

SADCAS
SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
TEST-1 0010

Eswatini Water Services Corporation

EWSC Laboratory Services
P.O. Box 20, Mbabane, Buntfu Road, Mountain View, Geo Position: S26°20.131',E31°08.977'
Telephone:(+268) 2404-3218/2404-0051, Facsimile: (+268) 2404-3218/2404-1136

Test Report 8498

Manzi Drilling
P. O. Box 2738
Manzini
Tel: 25187775

Date Received: December 20, 2022

Date Analysed: December 20 – 23, 2022

Lab. Ref.: 8498

Client Reference	Our Reference	Description	Sample condition	Sampled by
Microprojects Herefords Primary	20221220030C	Potable	Comply	Client

Lab. Ref.: 8498

Parameter	Method	Microprojects Herefords Primary
pH at 25°C	AMC 08	6.2
Conductivity (µS/cm) at 25°C	AMC 11	154
*Fluoride (mg/L)	AMC 22	0.09
Nitrate (mg/L)	AMC 15	1.6
*Nitrite (mg/L)	AMC 20	<0.02
Sulphate (mg/L)	AMC 17	<0.03
*Chloride (mg/L)	AMC 19	13.9
Turbidity (NTU)	AMC 09	2.7
Total Alkalinity (mg/L)	AMC 06	49
*Total Hardness (mg/L $CaCO_3$)	AMC 13	29
*Calcium (Ca) (mg/L)	AMC 10	15.58
*Iron (Fe) (mg/L)	AMC 10	0.06
*Magnesium (Mg) (mg/L)	AMC 10	4.32
*Manganese (Mn) (mg/L)	AMC 10	0.05
*Potassium (K) (mg/L)	AMC 10	2.39
*Sodium (Na) (mg/L)	AMC 10	17.45

*Tests marked with an asterisk (*) are not SADCAS accredited

Technical Signatory

Name: Mthobisi S. Kunene

Signature & Date: Kunene 30/12/2022

Page 1 of 3

Confidential

SADCAS SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
TEST-5 0026

SADCAS SOUTHERN AFRICAN DEVELOPMENT COMMUNITY
TEST-1 0010

Eswatini Water Services Corporation

EWSC Laboratory Services
P.O. Box 20, Mbabane, Buntfu Road, Mountain View, Geo Position: S26°20.131',E31°08.977'
Telephone:(+268) 2404-3218/2404-0051, Facsimile: (+268) 2404-3218/2404-1136

Test Report 8498

Manzi Drilling
P. O. Box 2738
Manzini
Tel: 25187775

Date Received: December 20, 2022

Date Analysed: December 20, 2022

Lab. Ref.: 8498

Client Reference	Our Reference	Description	Sample condition	Sampled by
Microprojects Herefords Primary	20221220030M	Potable	Comply	Client

Lab. Ref.: 8498

Parameter	Method	Microprojects Herefords Primary
Total coliform MPN / 100mL	AMM 06	261
Escherichia coli MPN / 100mL	AMM 06	Not detected

***Tests marked with an asterisk (*) are not SADCAS accredited**
Not detected <1 MPN/ 100mL

Technical Signatory

Name: Nompumelelo T. Vilakati

Signature & Date: NTVilakati 30/12/2022

TEST-5 0026

TEST-1 0010

EWSC Laboratory Services
P.O. Box 20, Mbabane, Buntfu Road, Mountain View, Geo Position: S26°20.131',E31°08.977'
Telephone:(+268) 2404-3218/2404-0051, Facsimile: (+268) 2404-3218/2404-1136

Test Report 8498

Manzi Drilling
P. O. Box 2738
Manzini
Tel: 25187775

Date Received: December 20, 2022

Lab. Ref.: 8498

Quality Assurance Manager

Name: Mangaliso M. Mavuso

Signature & Date: p.p. 30/12/2022

Disclaimer

This report relates to the sample(s) tested by Eswatini Water Services Corporation Laboratory. The Eswatini Water Services Corporation (EWSC) Laboratory does not accept responsibility for any matters arising from the further use of these results. This certificate/report shall not be reproduced, except in full, without the written approval of the Managing Director. This report is confidential and only intended for the use of the individual or entity to which it is addressed. Opinions and interpretations are not accredited. Uncertainty values will be available on request. Internal Reference F010-1, Effective 19/08/2022.

End of Test Report **Date of Issue: 30/12/2022**

6.4.4 Existing Water System Quality Test Results

Eswatini Water Services Corporation

SADCAS SOUTHERN AFRICAN DEVELOPMENT COMMUNITY ACCREDITATION SERVICE

TEST-5 0026

SADCAS SOUTHERN AFRICAN DEVELOPMENT COMMUNITY ACCREDITATION SERVICE

TEST-1 0010

EWSC Laboratory Services

P. O. Box 20 Mbabane, H100. Buntfu Lane, Mountain View, Mbabane.
Geo Position: S26°20.131', E31°08.977' Telephone: (+268) 2416 9500

Test Report 9597

Engineers in Action
6th Floor Dlanubeka Building
Mbabane
Tel: 78130980

Date Received: November 20, 2024

Date Analysed: November 20, 2024

Lab. Ref.: 9597

Client Reference	Our Reference	Description	Sample condition	Sampled by
Herefords Primary	20241120044M	Potable	Comply	Client
Ndlalambi Primary	20241120045M	Potable	Comply	Client

Lab. Ref.: 9597

Parameter	Method	Herefords Primary	Ndlalambi Primary
Total coliform MPN / 100mL	AMM 06	85	14
Escherichia coli MPN / 100mL	AMM 06	13	4

***Tests marked with an asterisk (*) are not SADCAS accredited**
Not detected: <1 MPN / 100mL

Existing water system sample. Tested from tapstand

Technical Signatory

Name: Nompumelelo T. Vilakati

Signature & Date: Vilakati 29/11/2024

TEST-5 0026

TEST-1 0010

EWSC Laboratory Services

P. O. Box 20 Mbabane, H100. Buntfu Lane, Mountain View, Mbabane.
Geo Position: S26º20.131', E31º08.977' Telephone: (+268) 2416 9500

Test Report 9597

Engineers in Action
6th Floor Dlanubeka Building
Mbabane
Tel: 78130980

Date Received: November 20, 2024

Lab. Ref.: 9597

Senior Manager – Water Quality

Name: Mangaliso M. Mavuso

Signature & Date: p.p. 29/11/2024

Disclaimer

This report relates to the sample(s) tested by Eswatini Water Services Corporation Laboratory. The Eswatini Water Services Corporation (EWSC) Laboratory does not accept responsibility for any matters arising from the further use of these results. This certificate/report shall not be reproduced, except in full, without the written approval of the Managing Director. This report is confidential and only intended for the use of the individual or entity to which it is addressed. Opinions and interpretations are not accredited. Uncertainty values will be available on request.
Internal Reference F010-1, Effective 01/06/2024.

End of Test Report **Date of Issue: 29/11/2024**