Operation and Maintenance Manual Water Supply
Azraq Refugee Camp - Jordan

Draft
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Abbreviations

AZRC  Azraq Refugee Camp
AZBH  Azraq Refugee Camp Borehole
BH    Borehole
WSSO  Water Supply System Operator
PPE   Personal Protective Equipment
SOP   Standard Operating Procedures
SCADA Supervisory Control and Data Acquisition
Icd   liters per capita per day (daily water consumption per person)
E.C   Electrical Conductivity
NTU   Nephelometric Turbidity Unit
TDS   Total Dissolved Solids
TSS   Total Suspended Solids
E.Coli Escherichia coli
T.Coli Total Coliforms
MPN   Most Probable Number
CFU   Coliform Forming Units
FRC   Free Residual Chlorine
PPM   Parts per Million
GOJ   Government of Jordan
JS    Jordanian Standard
MoH   Ministry of Health
MoWI  Ministry of Water and Irrigation
WAJ   Water Authority Jordan
O&M   Operation and Maintenance
WHO   World Health Organization
1 Objective

This O & M Manual Water Supply Azraq Refugee Camp is the core document that defines the needs, requirement, processes, elements and timelines to assure a proper and sustainable running of Azraq Water Supply System – independent of who is the Water Supply Operator and applicable to all/any Water Supply Operators in Azraq Refugee Camp. Its purpose is to define the needs, requirements, processes, elements, timelines and activities for proper, reliable and sustainable operation and maintenance for the Water Supply System of Azraq Refugee Camp.

Any aspects regarding Water Quality are defined in the separate Water Safety Plan Azraq Refugee Camp and are not treated/included here, unless and only as required in relation to O&M of Azraq Water Supply System.

The Azraq Refugee Camp Water Supply System Operator (Operator) is responsible for adoption, implementation, monitoring and compliance with this O&M Manual for Water Supply in Azraq Refugee Camp, to be in line with all relevant National Standards and Regulations for Drinking Water in Jordan as well as for the Water Operation Reporting to UNICEF.

This manual will propose standard procedures common for all water supply systems according to the Jordanian Water Authority (WAJ) rules and regulations, but also highlight special conditions, problems and strategies according to the specific background of Azraq Refugee Camp and the Humanitarian nature/origin and its different driving forces and considerations.

2 Content and Main Elements Summary

This O&M Manual for Water Supply in Azraq Refugee Camp is based on the Water Strategy of Azraq Refugee Camp (existing ? to be defined ?, year ?) and on the Azraq Refugee Camp Overall Strategy and Planning, if and as existing, known and defined in January 2019 (by the Government of Jordan and UNHCR – responsible for the overall Camp Management).

The following elements and information can be found (none exhaustive list) in this Manual:

- Minimum Organisational Structure for the Water Supply System Operator
- Staffing plans including staff capacity requirements and job descriptions
- Permits and Regulations
- Water Supply Infrastructure and Equipment in Azraq Refugee Camp
- Tools and Spare Parts
- Water Supply Operation including goals/targets, activities, schedules, activities, etc.
- Preventive/regular maintenance Water Supply System
- Emergency Operation (or in the separate Water Contingency Plan Azraq Refugee Camp ?)
- Reporting
- Monitoring and Evaluation including performance indicators
- Training Requirements
The elaboration of this O&M Manual for Water Supply in Azraq Refugee Camp is based on:

- Camp layout (January 2019)
- Water Supply System – boreholes and network (January 2019)
- Technical drawings of the water supply network (January 2016)
- Hydraulic Models of Azraq Refugee Camp Water Supply Network (February 2016)
- Borehole reports (drilling and pumping tests) of existing boreholes
- Actual Pump specifications and settings (April 2019)
- Documentation for equipment, such as pumps, valves, flowmeters etc.
- Documentation for the operation and process control (SCADA)
- Population/Users: Actual Camp Occupation and Maximum Camp Design Capacity
- Locations, state and use of institutions and services (January 2019)
- Site visits on the ground by UNICEF WASH Section and Azraq Camp Water Supply Systems Operator

3 System Description

3.1 Water Supply System Summary

Maximum Camp Design Capacity: 55’000 persons in 10’608 shelters
Current Camp Population: 38’000 persons in xxxx shelters
Average Daily Water Production: 1’820 m3/day (2018)
Minimum and Maximum Daily Water Production: 1’354 to 2’138 m3/day (2018)
Water sources/origin: 2 boreholes of the camp (only for the camp)
Current pumping schedule: flexible hours, not regularised yet, as per water operator’s team work choice on the ground.

Borehole information:

<table>
<thead>
<tr>
<th>Borehole</th>
<th>Borehole diameter(s) [inch]</th>
<th>Casing Internal diameter(s) [inch]</th>
<th>Borehole Depth [m]</th>
<th>Screen depth(s) [m]</th>
</tr>
</thead>
</table>
| Borehole 2 | 24” (0 – 20m)  
17.5” (20 – 200m)  
12.25” (200 – 485m) | 20” (0 – 20m)  
14” (20 – 200.50m)  
10.75” (196.40 – 485.00m) | 485.00 | Screens: starting at 213.60 – 461.40m |
### Storage locations:

<table>
<thead>
<tr>
<th>Storage Location</th>
<th>Location</th>
<th>Water storage capacity [m³]</th>
<th>Supply to:</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>J4</td>
<td>Next to borehole 3 and village 3</td>
<td>1’440</td>
<td>Village 2</td>
<td>16 Oxfam T95 tanks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Village 3</td>
<td>(the 2 chlorination units for J4 are located at borehole 3, Chamber AZBH_3_2).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sameh Mall</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Visitors Area</td>
<td></td>
</tr>
<tr>
<td>J8</td>
<td>Next to village 6</td>
<td>1’440</td>
<td>Village 5</td>
<td>16 Oxfam T95 tanks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Village 6</td>
<td>2 chlorination units (automatic dosing pump)</td>
</tr>
<tr>
<td>J2</td>
<td>At Borehole 2</td>
<td>720</td>
<td>Only usable for the tanker filling station</td>
<td>8 Oxfam T95 tanks</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 chlorination unit (automatic dosing pump)</td>
</tr>
</tbody>
</table>
Designed/Target daily water provision: 35 lcp (litres per capita per day)

Current water supply schedule:

### Summer
(from ... to ...)

<table>
<thead>
<tr>
<th>Village</th>
<th>Supply Time 1</th>
<th>Supply Time 2</th>
<th>From Storage</th>
<th>Total time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village 2</td>
<td>7.00 – 9.00</td>
<td>14.00 – 16.00</td>
<td>J4</td>
<td>4h</td>
</tr>
<tr>
<td>Village 3</td>
<td>9.00 – 11.00</td>
<td>16.00 – 18.00</td>
<td>J4</td>
<td>4h</td>
</tr>
<tr>
<td>Village 5</td>
<td>7.00 – 9.00</td>
<td>14.00 – 16.00</td>
<td>J8</td>
<td>4h</td>
</tr>
<tr>
<td>Village 6</td>
<td>9.00 – 11.00</td>
<td>16.00 – 18.00</td>
<td>J8</td>
<td>4h</td>
</tr>
</tbody>
</table>

### Winter
(from ... to ...)

<table>
<thead>
<tr>
<th>Village</th>
<th>Supply Time 1</th>
<th>Supply Time 2</th>
<th>From Storage</th>
<th>Total time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village 2</td>
<td>7.00 – 9.00</td>
<td>14.00 – 16.00</td>
<td>J4</td>
<td>4h</td>
</tr>
<tr>
<td>Village 3</td>
<td>7.00 – 9.00</td>
<td>14.00 – 16.00</td>
<td>J4</td>
<td>4h</td>
</tr>
<tr>
<td>Village 5</td>
<td>7.00 – 9.00</td>
<td>14.00 – 16.00</td>
<td>J8</td>
<td>4h</td>
</tr>
<tr>
<td>Village 6</td>
<td>7.00 – 9.00</td>
<td>14.00 – 16.00</td>
<td>J8</td>
<td>4h</td>
</tr>
</tbody>
</table>

**Remarks on the water supply schedules:**

- The water operator is on the ground at village level during the supply hours – and checks if the needs have been covered or not. Therefore, the times are sometimes a bit longer or shorter – than the standard ones indicated.
- Distribution schedule is only partly flexible – as water production from the 2 boreholes is limited and water is blended before distribution (due to higher, but still acceptable TDS concentrations (as per JS 286:2015) from borehole 3; this is mainly done because of complaints from consumers and to increase the water taste (quality) provided to consumers.

**Water Quality (details see Water Quality Safety Plan Azraq Refugee Camp):**

At borehole 2 (AZBH_2):

- Rapid sand filtration
- By the operator: Hourly monitoring of turbidity (NTU), and daily monitoring for pH, FRC, and E.C. (for TDS by calculation) and Ammonium (not done yet); Monthly testing of TDS (by gravimetric method) by the operator (not done yet)
• By an external certified laboratory (Yarmouk) for the operator: Monthly testing of: E. coli and Total coliforms + list of standard physical and chemical parameters (details see Water Quality Safety Plan Azraq Refugee Camp).
• By monitoring body (MoH) through external certified laboratory (RSS): Every 6 months, testing of: E. coli and Total coliforms + comprehensive list of all physical, chemical and radiological parameters.

At borehole 3 (AZBH_3):
• Aeration tower for H2S elimination
• Rapid sand filtration
• Chlorination by automatic dosing pumps
• By the operator: Hourly monitoring of turbidity (NTU) and daily monitoring for pH, FRC, and E.C. (for TDS by calculation) and Ammonium (not done yet); Monthly testing of TDS (by gravimetric method) by the operator (not done yet)
• By an external certified laboratory (Yarmouk) for the operator: Monthly testing of: E. coli and Total coliforms + list of standard physical and chemical parameters (details see Water Quality Safety Plan Azraq Refugee Camp).
• By monitoring body (MoH) through external certified laboratory (RSS): Every 6 months, testing of: E. coli and Total coliforms + comprehensive list of all physical, chemical and radiological parameters.

At water storage station J4 (next to AZBH_3):
• No water treatment, as all done directly at borehole 3.
• FRC levels monitoring at T95 storage tanks and outlet level on a daily basis
• Turbidity monitoring on a daily basis

At water storage station J8 (next to Village 6):
• Chlorination by automatic dosing pumps solar powered (no network connection existing, but possible as network next to it close)
• FRC levels monitoring at T95 storage tanks and outlet level on a daily basis
• Turbidity monitoring on a daily basis

At water distribution network level:
• Water quality monitoring frequencies, monitoring parameters and monitoring locations, please refer to/see in the Water Quality Safety Plan Azraq Refugee Camp.
• So far, the water operator does only FRC and E.C testing on a daily basis with a certain amount of random samples at tapstands and chambers. Plan to do FRC, E.C, pH and turbidity analysis on a daily basis at strategic tapstand locations (see Water Quality Safety Plan Azraq Refugee Camp) plus monthly sampling for total coliforms and E. coli at network level – which is not done until now.
At household/consumer level:

- Water quality monitoring frequencies, monitoring parameters and monitoring locations, please refer to/see in the Water Quality Safety Plan Azraq Refugee Camp.
- To include this here? Done actually by who? To be done by who (to be clear for the Water Quality Safety Plan Azraq Refugee Camp and this O&M Manual Azraq Refugee Camp).

All water quality monitoring and testing in Azraq Refugee Camp is according to Jordanian Drinking Water Standards JS 286/2015 and WHO Guidelines.

3.2 General Camp Information

Azraq Refugee Camp is located around 70km East of Amman city in Zarqa Governorate. Azraq Camp is accessible directly from the Highway Nr. 30 leading to Azraq Town and further to the Syrian and Saudi Arabian border crossings in the East of Jordan.

The camp has been established in April 2014. The camp has been designed for up to 55’000 persons with 10’608 shelters, whereas currently in since 2018 the number of Syrian Refugees in the camp remains stable around approximately 38’000 persons.

The camp is open, except village 5 where inhabitants there are not allowed to go outside village 5 of Azraq Refugee Camp. For all the others, they can leave the camp as they want, but have to register when going out and when coming back. All materials and goods entering and exiting the camp are strictly monitored and regulated by Jordanian security forces and police, and permits for all gods as well as external persons working in the camp as well as for visitors are required to be arranged and approved in advance.

Azraq Camp is divided currently in 4 villages – village 2, village 3, village 5 and village 6 – as well as some separate service areas – Base Camp, Reception Center, Visitors Center, SARD and police operations center and central supermarket.

At villages’ level, further subdivision system is blocks, plots and then shelters. A summary of these sub-divisions, as well as population figures at village level are shown in the table here beyond:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Village 2</td>
<td>17</td>
<td>205</td>
<td>2428</td>
<td>7700</td>
</tr>
<tr>
<td>Village 3</td>
<td>19</td>
<td>223</td>
<td>2619</td>
<td>10050</td>
</tr>
<tr>
<td>Village 5</td>
<td>20</td>
<td>273</td>
<td>3276</td>
<td>10300</td>
</tr>
<tr>
<td>Village 6</td>
<td>15</td>
<td>199</td>
<td>2285</td>
<td>8700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4</strong></td>
<td><strong>900</strong></td>
<td><strong>10608</strong></td>
<td><strong>36750</strong></td>
</tr>
</tbody>
</table>
For the water supply in Azraq Refugee Camp, the division into villages is relevant, and the lowest level to which the water supply network can be regulated for operation (see Section 3.3.).

Conceptual Map of Azraq Refugee Camp

3.3 Water Supply Network Layout and Information

In this Section, we explain the existing water supply network of Azraq Refugee Camp, with all its elements, but without going into details of each element or component of the water supply system – this will be done and can be found in Chapter 4.

In Azraq Refugee Camp, there exist 3 boreholes. Only 2 boreholes can be used, as water from borehole 1 (AZBH_1) doesn’t fulfil the water quality requirements even by near for several parameters that could only with a lot of efforts be brought to standards (Radiation levels and very high conductivity above 4’000 µs/cm as well as Mollybdenum). Therefore, borehole 1 has actually never been used and is not operational. Currently and in the near future, only 2 boreholes are available for operating Azraq Refugee Camp water supply network currently. So far, no additional boreholes are planned in or for Azraq Refugee Camp water supply network.

Even though there is a municipal water supply line (from AWSA wellfield North of Azraq town to Zarqa Town and Governorate) a connection for Azraq Refugee Camp was never authorized or even looked into from the Government of Jordan and its relevant ministries (including MoWI and WAJ). This is not going to change in the future.
Water from the 2 boreholes are pumped to two storage locations – J4 station located at borehole 3, and J8 station located next to village 6. From this two storage locations, the water is distributed by gravity over a ring main pipeline around the camp to the 4 villages and the service areas. The village level distribution systems are connected to the ring main pipeline the following:

- For village 2: two connection lines; chamber J2 and chamber Ext V2
- For village 3: one connection line; chamber J4
- For village 5: three connection lines; chamber J6, chamber J5.1 and J5.2
- For village 6: two connection lines; chamber J7 and chamber J8

The locations of the boreholes, the storage locations, the ring main pipeline and the connection chambers to the village levels are shown in the map beyond here.

**Water Supply Network Azraq Refugee Camp – Main Level:**

From each of the chambers on the ring main pipeline, a distribution line continues at village level, with further branching to cover the whole area of the village. The distribution lines at village level lead then to several public tapstands, where refugees collect their water. There are no household connections in Azraq Refugee Camp for the water supply.

The following maps show the distribution networks and tapstands for each of the villages.
Water Supply Network Azraq Refugee Camp – Village 2:

Water Supply Network Azraq Refugee Camp – Village 3:
Water Supply Network Azraq Refugee Camp – Village 5:

Water Supply Network Azraq Refugee Camp – Village 6:
Households are supposed to collect water from a nearby tapstand. Due to cultural reasons and being used to have running water in their places of origin, many have connected illegally plastic houses to bring water from the public tap into their homes directly. This is not only a problem/issue for equity of water access, but as well of concern/risk for water quality – with potential contamination between collection point and household storage which is either a fixed improvised water tank or mobile containers.

The conceptual situation of this at block and plot levels, is shown in the figure beyond here:

**Conceptual System of the Water Supply at Block / Plot Level in Azraq Refugee Camp**

Details about diameters of pipes, tapstand numbering etc. are found in the technical drawings in the respective project folder on Unicef W:/ drive, and as Annex to this manual as relevant.

### 3.4 Water Supply Network System Composition

The water supply network of Azraq Refugee Camp consists of the following components mainly (for more details see Annex and project document folder on Unicef Jordan W:/ share drive).

- **Water Resources:** Water is produced at 2 boreholes inside Azraq Camp and only used for Azraq Camp. Each borehole is equipped with a submersible pump that lifts water through the main rain ring pipeline to 2 storage locations J4 and J8. Each borehole can feed each of the storage locations separately, or simultaneously. At both boreholes, there exist a rapid sand filtration unit. In addition to that, at borehole 3 water goes through an aeration tower for H₂S elimination and is chlorinated by 2 automatic chlorine
dosing pumps, before sent to storage location J4 and J8. At borehole 2, no chlorination is done.

- **Storage**: Two separate storage locations exist in Azraq Refugee Camp. At each location, 16 Oxfam Water Storage Tanks are installed, operational and used. Both locations have a capacity of 1’440 m³ (around 90m³ usable of the T95 Oxfam tank – between outlet and inlet levels). Storage Location J4 is feeding village 2 and village 3, as well as the camp central supermarket, the reception area and SARD base. Storage location J8 is feeding village 5 and village 6 mainly. Base Camp, Reception Area and the camp Hospital are at the far point of the ring main pipeline, and therefore can and are fed by both storage locations (depending on available flow rates and pressures situations in the overall system). Storage location J8 is equipped with 2 automatic chlorination dosing pumps – used to chlorinate water arriving from borehole 2.

At borehole 2, there is an additional storage location with 8 Oxfam Water Storage tanks installed with a capacity of 720 m³ (around 90m³ usable of the T95 Oxfam tank – between outlet and inlet levels) which serve the tanker filling station – which is normally no longer used. There is no possibility currently to pump water from this storage location to the ring main pipeline or any of the villages, as no pump available/installed and no network connection to the ring main pipeline. We call this storage location J2 (situated at Borehole 2).

- **Main ring pipeline**: A main ring pipeline goes all around Azraq Refugee Camp, and with connection to both boreholes. It is used on one hand for pumping water from the boreholes to the storage locations, as well as for the distribution to the villages by gravity. Though, the eastern part of the ring main pipeline is exclusively used for the pumping from the boreholes to the 2 storage locations, and can be isolated by gate-valves from the western part, which is mainly used for the distribution of water to villages and service areas by gravity. The ring main pipeline is HDPE, has a length of 13km and diameters from 180 and 250mm in different sections.

- **Village level flow control chambers**: Village level flow control chambers are connected to the ring main pipeline to regulate and control water distribution to villages and service areas. All village level supply lines are connected to one of these flow control chambers. Each flow control chamber is equipped with a manual gate-valve, a flow meter and a tap for water sampling or/and air release if and as needed. The villages are supplied through the following flow control chambers:
  - Village 2: Chamber V2 ; Chamber Ext_V2
  - Village 3: Chamber V3
  - Village 5: Chamber V5_6; Chamber V5_51; Chamber V5_52
  - Village 6: Chamber V6_7; Chamber V6_8

Village level flow meters reading are collected every day before and after each rotation to know the quantities of water provided to each village (since March 2019).

- **Village level distribution lines**: The distribution system at village level is different in each village. Some do have a separation into several individual lines after the village level flow...
chamber – such as for village 2, whereas for other villages only one line departs from the village level flow control chamber, and then further branches out, without any further flow regulation chambers inside the villages – such as village 3. Parts of the village level distribution lines are sometimes single lines with end points, sometimes ring pipelines (see detailed maps at village levels in the Annex and the project folder on Unicef shared drive W:/). The same applies to service areas level distribution lines.

- **Public tapstands:** All public tapstands are supplied by the village level distribution lines. There are no household level water connections in Azraq Refugee Camp. Though, some refugees connect flexible plastic water houses (green garden houses) to public tapstands to bring water to their self-made storage tanks and tap or mobile storage containers in their homes (which is illegal basically as well as a risk for water quality, but tolerated and difficult to control/enforce). In Azraq Refugee camp, there are the following number of public tapstands per village:
  
  - Village 2: 71 public tapstands
  - Village 3: 82 public tapstands
  - Village 5: 88 public tapstands
  - Village 6: 59 public tapstands
  - Total Azraq Camp: 300 tapstands

Each public tapstand is equipped with 4 taps (nozzles), and with a simple concrete platform with simple surface drainage (no gravel packs for spill over and runoff infiltration) leading to natural ground/drainage channels. Each tapstand can be isolated and cut off from the village level distribution lines by a manually operated gate-valve at tapstand level. No all tapstands are currently used, as not all areas in the camp are actually occupied by refugees and some shelters empty and not used.

At service area and centres level, such as schools, makanis, health facilities, and NGO/institutions compounds, tapstands within buildings as well as, the village level distribution lines are connected to water tanks, which are feeding then tapstands and toilet flushing of the compounds and buildings in separate sub-networks.
Systemic flow chart of Azraq Water Supply Network System:

The main components of the water supply system, as well as the main flow control gate valves are shown in this systemic flow chart for Azraq Camp Water Supply Network.

4 Operation of the Water Supply System

4.1 Water production times and schedules requirements

The goal of the operation of Azraq Refugee Camp Water Supply System is to provide sufficient safe drinking water for all refugees and services in the camp every day. The minimum target value is to assure provision of 35 liters per person per day (35 lcpd). This means a minimum water production of 1’330 m3/day for 38’000 persons.

In 2018, the average daily water production in Azraq Camp was 1’820 m3/day – with a minimum of 1’354 m3/day to a maximum of 2’138 m3/day. This means that in average 49 lcpd were produced in 2018. From this, consumption for WASH outs, backwashing of sand-filters, consumption of institutions, service areas and working personnel in the camp, as well as water losses in the network still need to be deducted.

Based on the average borehole production rates in 2018, with 72.1 m3/h for borehole 2 and 43.2 m3/h for borehole 3, this means that both boreholes need to be operated for at least 11.5 hours per day to assure the minimum water production of 1’330 m3/day. In order to reach the average production of 2018, the minimum operation time of both boreholes in Azraq Refugee Camp needs to be 15.8 hours per day.
Operation times required for water production at Azraq Refugee Camp at average production rates of boreholes

<table>
<thead>
<tr>
<th></th>
<th>For 38'000 persons at 35 lcd (Absolute Minimum)</th>
<th>For 38'000 persons at 49 lcd (Average 2018 – including losses, institutions, etc.)</th>
<th>For 38'000 persons at maximum demand in 2018</th>
<th>For 55'000 persons (camp maximum capacity) at 35 lcd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borehole 2</td>
<td>11.5 h / day</td>
<td>15.8 h / day</td>
<td>18.6 h / day</td>
<td>16.7 h / day</td>
</tr>
<tr>
<td>Borehole 3</td>
<td>11.5 h / day</td>
<td>15.8 h / day</td>
<td>18.6 h / day</td>
<td>16.7 h / day</td>
</tr>
</tbody>
</table>

Both pumps / boreholes need to run for **at least 12 hours per day**, to assure production of the minimum water quantity required in Azraq Refugee Camp. At peak demand in summer, both boreholes need to be run for up to 18 hours per day.

In 2018, water was pumped from borehole 2 in average 16.3 hours per day, and from borehole 3 in average 10.8 hours per day. If possible, it is reasonable to maximize the pumping time at borehole 2, as the hourly production rate is 40% higher than at borehole 3 and as the static water level remains much more stable with a decrease of 1.40m in 2018 compared to 4.50 (3 times as much) in borehole 3.

Though, in terms of efficiency, one m3 of water produced from borehole 2 consumed in average 0.361 lt of fuel, whereas for borehole 3 one m3 of water produced required only 0.293 lt of fuel – which is 20% less.

As water quality in borehole 3 is just within national standards for Total Dissolved Solids (TDS), water from borehole 3 is blended with water from borehole 2 to reduce TDS content level before distribution. As refugees have complained in the past about a smell and taste level of the water provided.

That blending requires therefore a harmonized pumping schedule between borehole 2 and borehole 3, which is generally the following:

1<sup>st</sup> step: pump from borehole 2 and borehole 3 to water storage station J8 station in the morning for minimum 3 hours. Often, pumping time is around 4 hours.

2<sup>nd</sup> step: pump from borehole 2 and borehole 3 to water storage station J4 during mid-day for minimum 5 hours. Often, pumping time is around 7 hours.

3<sup>rd</sup> step: pump from borehole 2 and boreholes 3 again to water storage station J8 in the after-noon to evening for minimum 4 hours. Often, pumping time is around 5 hours.
Therefore, both boreholes are pumping to the same water storage location simultaneously at the same time. This is not only required due to blending, but as well the ring main pipeline of the camp would allow to pump water from borehole 3 to storage location J4 and from borehole 2 to storage location J8 at the same time, but not the other way round. Though, it is possible, from any borehole to pump to any storage location – if only one borehole is operated – which sometimes happens in the morning for a bit, and again at the end of the day for a bit.

The timetables indicated are based on the operation as carried out in 2018. For the Maximum Timetable, it would be possible to start 1 to 2 hours earlier with pumping, in order to avoid spillover pumping time to the next morning early hours.

Pumping timetable during Ramadan is special – and different, as mainly going on during night.

### 4.2 Personnel and Material Requirements for Operation and Maintenance

In order to assure proper operation of Azraq Refugee Camp Water Supply System, the following minimum staffing is required as follows and for the following tasks:

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Staff</th>
<th>Number of Staff</th>
<th>Main tasks / work</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZBH_2</td>
<td>Borehole Operator</td>
<td>2</td>
<td>Daily verification and operation of generators, submersible pump, surface pumps and sand filtration unit; water quality monitoring; water quantity and quality daily reporting in available</td>
</tr>
</tbody>
</table>
log; reporting on generator usage, fuel consumption, operation hours, and generator routine checks

<table>
<thead>
<tr>
<th>Location</th>
<th>Role</th>
<th>Shift</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZBH_3</td>
<td>Borehole Operator</td>
<td>2</td>
<td>Daily verification and operation of generators, submersible pump, surface pumps, aeration tower, sand filtration unit and chlorine dosing pump; water quality monitoring; water quantity and quality daily reporting in available log; reporting on generator usage, fuel consumption, operation hours, and generator routine checks; daily reporting on automatic chlorination</td>
</tr>
<tr>
<td>Storage Location J4</td>
<td>Water Operator</td>
<td>2</td>
<td>Daily verification and operation of T95 tanks, surface mounted pump and flow-meters; water quality monitoring; water quantity and quality daily reporting in available log; periodic/regular T95 tank cleaning and small maintenance works. Open and closing of gate valve for village 2 and village 3 water supply including flow-meter readings before and after each shift.</td>
</tr>
<tr>
<td>Storage Location J8</td>
<td>Water Operator</td>
<td>2</td>
<td>Daily verification and operation of T95 tanks, surface mounted pump and flow-meters; water quality monitoring; water quantity and quality daily reporting in available log; periodic/regular T95 tank cleaning and small maintenance works. Open and closing of gate valve for village 5 and village 6 water supply including flow-meter readings before and after each shift.</td>
</tr>
<tr>
<td>Water Network at village levels</td>
<td>Water Operator and Water Team Responsible</td>
<td>1</td>
<td>Checking water supply operation at village levels at start, during and end of the shifts; plus check if and where repair/maintenance needed at tapstands and how tapstands are used. Supporting of the other locations and teams as needed. Check and assure that all flow-meter readings, generator hour readings, water quantity and quality testing and daily reporting/data logging is done.</td>
</tr>
</tbody>
</table>
Monthly water operation reporting and data analysis from boreholes and network.
Assures and manages basic spare parts of/for Azraq Refugee Camp Water Supply System – including spare pumps, motors, generators, gate valves, flow-meters, raising pipes, main pipe parts, air- and fuel filters, etc. small materials and day to day tools and equipment used and consumables.

<table>
<thead>
<tr>
<th>All 4 locations</th>
<th>Night Guards (or additional 3rd shift, when no water production and no water supply).</th>
<th>4</th>
</tr>
</thead>
</table>

Guarding the boreholes and storage locations at night and assure no vandalism, breaking or/and stealing of assets, and no water quality sabotage nor water quantity stealing.

It is to understand, that the above mentioned personnel will be working in 2 day shifts – meaning 1 person per location per shift. Except the Water Team Responsible Person, who will only do 1 shift per day – as per need and as required to assure smooth water supply operation in Azraq Refugee Camp. And, the water operator is responsible to assure that a 2nd person is capable of replace/support the Water Team Responsible Person during its holidays, sick-days, and for support for specific work/emergency situations. The 2 shifts have to be adjusted to assure all water production and water distribution of Azraq Refugee Camp 7 days a week and 365 days a year. And, the water operator has to assure that he has additional staff capacity that can be deployed in case of emergencies, breakdowns, maintenance, sickness of regular staff, etc. Standby staff has to be familiar with the tasks delegated to – for specific as well as for regular operation as required.

Working shifts should be usually 8 hours per day. But, borehole and water operator shifts have to be put to assure that all water production and water supply of Azraq Refugee Camp is happening. Therefore, sometimes shift hours might be required to be more than 8 hours per shift – but should not be the regular situation.

With 2 day-shifts at all stations, the water production and water supply can be covered. In order to assure protection of the assets and equipment, the water operator has to assure night guard at all 4 stations/locations – requiring additional 4 guards for 1 usually night shift during which no water production nor water supply is happening. These night guards don’t have to be water operators.

In addition to the regular water operation staff (including night guards) required for Azraq Refugee Camp Water Supply, the water operator needs to assure the following stand-by
staff for specific tasks and situations. These staff capacities can be available within the water operator company directly, or through external contracting/mobilization by the water operator and within his budget/costs and operational responsibility and within short time notices in order to assure minimum down-times of water supply network of Azraq Refugee Camp. And, the capacity to respond to any other needs that might occur.

<table>
<thead>
<tr>
<th>Type of Staff</th>
<th>Expected competences and work/tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogeologist / Borehole specialist</td>
<td>Available in case of problems with the boreholes and submersible pumps.</td>
</tr>
<tr>
<td></td>
<td>Analysis and check of monthly borehole logging data; tend analysis, in depth analysis and early detection of borehole issues/problems.</td>
</tr>
<tr>
<td></td>
<td>Available and in charge of planning and supervising all borehole rehabilitation or/drilling activities.</td>
</tr>
<tr>
<td></td>
<td>Capable of doing CCTV for boreholes and their analysis/interpretation as well as hydrogeological investigations (Geophysical, etc.)</td>
</tr>
<tr>
<td>Electrician / Pump mechanic / Generator Specialist</td>
<td>Assuring all preventive and regular maintenance as per maintenance manual requirements from manufacturers for all generators, pumps, water treatment units, control panels, etc.</td>
</tr>
<tr>
<td></td>
<td>Assuring all emergency and unforeseen maintenance and repairs of generators, pumps, water treatment units, control panels at pump and storage location facilities, etc.</td>
</tr>
<tr>
<td></td>
<td>Available and in charge of planning and supervising all electrical and mechanical works.</td>
</tr>
<tr>
<td>Plumbers / Welders</td>
<td>Assuring all maintenance, repair and construction work of the pipelines, storage tanks and operational facilities.</td>
</tr>
<tr>
<td></td>
<td>Having functional welding equipment and all plumbing tools to be able to repair/change pipelines and water storage tanks and tapstands.</td>
</tr>
<tr>
<td>Water Engineer (Environmental or/and Civil Engineer)</td>
<td>Assuring verification, reporting and analysis for all water quality testing done by the water operator as per the water safety plan Azraq Refugee Camp.</td>
</tr>
<tr>
<td></td>
<td>Being able to identify actions required in case water quality problems or water supply network issues (pressure, damages, extensions, etc.), supervise all works, companies and actors and assure the lead of the water supply team of the water operator of Azraq Refugee Camp for regular operation, maintenance and all construction/expansion activities.</td>
</tr>
</tbody>
</table>
Plans and supervises the regular/periodic cleaning and disinfection of the water tanks at the storage locations, as well as any disinfection works for household water storage tanks – if/as asked by UNICEF.

4.3 Operation Boreholes

Operation of the 2 boreholes of Azraq Refugee Camp is indicated here. The explanations and indications given here refer to the regular operation mode. Emergency operation mode and considerations, are explained in chapter xxxx.

_Borehole 2 (AZBH_2) and equipment at borehole 2:_

Borehole 2 is located about 2km east of village 6 and village 3 (GPS coordinates: 36.624178 / 31.901361). AZBH_2 has the following characteristics:

<table>
<thead>
<tr>
<th><strong>Borehole 2 (AZBH_2)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Realisation:</td>
</tr>
<tr>
<td>Location and Altitude:</td>
</tr>
<tr>
<td>Borehole depth:</td>
</tr>
<tr>
<td>Borehole diameter(s):</td>
</tr>
<tr>
<td>Casing diameters(s):</td>
</tr>
<tr>
<td>Screens</td>
</tr>
<tr>
<td>Borehole bottom</td>
</tr>
<tr>
<td>Borehole capacity</td>
</tr>
<tr>
<td>Static Water Level</td>
</tr>
<tr>
<td>Dynamic Water Level</td>
</tr>
<tr>
<td>Minimum Drawdown</td>
</tr>
<tr>
<td>Maximum Drawdown</td>
</tr>
</tbody>
</table>

_Equipment of AZBH_2:_

| **Raising pipe** | GI pipe 4”, 6m length units |
| **Submersible Pump** | Lowara Z855 (8inch diameter; 50 Hz); Pump capacity range: 120 – 1’300 l/min; maximum pump head is 520m; variable speed control. |
### Submersible Pump Dates
- Date of purchase
- Date of installation
- Last check/repair

### Submersible Pump Setting
- 210.00m (oral information SG on the 24.01.2019 -> to be verified/checked)

### Submersible Pump Motor
- Brand ?
- Model ?
- kW rating
- Number of phases
- Voltage, Hz, etc.
- Franklin 75 kW, 8inch; 3 phase; 50Hz; Maximum starts per hour: 10

### Submersible Pump Motor Dates
- Date of purchase
- Date of installation
- Last check/repair

### Average production rate
- 72.1 m3/h (2018)

### Average production time
- 978 Minutes per day = 16h and 18 minutes (2018)

### Average water production
- 1’175 m3/day (2018)

### Borehole monitoring probe
- Brand, Type, Parameters monitored
  - Senator Plus, Temperature, Pressure, Water Level, E.C.

### Borehole monitoring probe depth setting
- Depth ? (and Date at which the depth information is from)

---

In addition to the borehole and the pump, there is a rapid sand filtration unit present at borehole 2. The rapid sand filtration unit is only used and can only be used for water pumped to the storage tanks at the tank filling station. **But not for the water pumped from BH2 to the ring main pipeline and J4 and J8 storage locations.**

### Rapid Sand Filtration Unit

<table>
<thead>
<tr>
<th>Installation Date:</th>
<th>......</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand and Type:</td>
<td>......</td>
</tr>
<tr>
<td>Maximum treatment flow capacity:</td>
<td>70 m3/h</td>
</tr>
<tr>
<td>Maximum turbidity treatment capacity:</td>
<td>...... NTU</td>
</tr>
</tbody>
</table>
Maximum TDS treatment capacity: ⋯⋯ mg/l

Target value design treatment outlet NTU: ⋯⋯ NTU

Target value design treatment outlet TDS: ⋯⋯ mg/l

The sand filtration unit is operated by pressure directly from the submersible pump in BH2. And, the filtration unit can only be used for water pumped to the storage tanks at BH2 (J2 storage location), and not for any water pumped into the ring main pipeline going to J4 and J8 storage locations.

For the backwash of the sand filtration unit, there are 2 small pumps available. Details and operation see in the separate SOP Sand Filtration Unit at AZBH_2.

*Photos Sand-Filtration Unit at BH_2:*

Sand filtration Unit at AZBH_2: blue tank; operated by pressure from submersible pump in BH_2.
The rapid sand filtration unit is filled with a 3 layer aggregate medium – made out of silicate sand as layer 1, aggregates up to 1 cm diameter of crushed turf rock and bigger crushed stones between 3 to 5 cm diameters.

The details of pumps, connections, valves, operation of the sand filtration unit at AZBH_2 are indicated in the specific SOP Sand filtration Unit AZBH_2 – separately from this document.

Borehole 2 equipment is powered by generator – as no grid connection was allowed to be established. The national grid is passing next to the camp, so a connection would be possible, if given permission from the relevant ministry and the grid operator (which so far has not been given).

There are two big generators present at borehole 2 to power the submersible pump, which are used by alternation – meaning generator 1 one day, then generator 2 the next day, then again generator 1, and so on.

In addition to this, there is a smaller service generator to be used outside pump operating hours for the office and staff accommodation caravans at BH2.

The characteristics of the generators at Borehole 2 are indicated here:

<table>
<thead>
<tr>
<th>Generator 1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Number:</td>
</tr>
<tr>
<td>Installation Date:</td>
</tr>
<tr>
<td>Brand and Type:</td>
</tr>
<tr>
<td>Power Rating (kVA)</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Number of Phases</td>
</tr>
<tr>
<td>Motor information</td>
</tr>
<tr>
<td>Alternator information</td>
</tr>
<tr>
<td>Control Panel Information</td>
</tr>
<tr>
<td>Fuel Tank Information</td>
</tr>
</tbody>
</table>

**Generator 2:**

| Asset Number | ..... |
| Installation Date | ..... |
| Brand and Type | Cumins... |
| Power Rating (kVA) | 220 kVA |
| Number of Phases | ....... |
| Motor information | ....... |
| Alternator information | ..... |
| Control Panel Information | ..... |
| Fuel Tank Information | Integrated fuel tank, but used currently supplied from the separate 7’000 lt fuel tank. |

**Generator 3:**

| Asset Number | ..... |
| Installation Date | ..... |
| Brand and Type | Perkins... |
| Power Rating (kVA) | 55 kVA |
| Number of Phases | ....... |
| Motor information | ....... |
Both generators are supplied by an external fuel tank. Here beyond the characteristics of the fuel tanks and the fuel supply system is explained.

**Fuel Tanks:**

| Asset Number(s): | ..... |
| Installation Date: | ..... |
| Brand(s) and Type(s): | ..... |
| Materials of the tanks: | Horizontal cylindrical steel tank |
| Capacities of the tank(s): | 7’000 lt |
| Information on the fuel connections to the Generators: | All three generators present are connected and supplied from this tank with individual fuel connection pipes. |
Schematic site layout of Borehole 2 (AZBH_2):

Photo of J2: T95 storage tanks feeding the tanker filling station at AZBH_2. No connection/pumping possible from or to the ring main pipeline.
Azraq Borehole 2 (AZBH_2) operation:

Azraq Borehole 2 is equipped with a submersible pump (details given before). The submersible pump is powered by one of the 2 generators at a time available and in use at AZBH_2.

From the borehole water can be pumped to 4 locations, by opening/closing respective gate-valves:

1) To storage location J4 at AZBH_3 via the ring-main pipeline – and the chamber in the valley
2) To storage location J8 next to village 6 via the ring main pipeline – and the chamber in the valley
3) To the sand-filtration unit at AZBH_2, and then to the storage location of the tanker filling station at AZBH_2 (J2)
4) Directly to the storage location of the tanker filling station at AZBH_2 (J2)
5) Pumping to the Wash-out at AZBH_2 (Cleanout)

The valley chamber (VACB) is the one on the ring-main pipeline that allows to choose/direct if water from BH_2 is pumped to storage location J4 (at AZBH_3) or to storage location J8 (next to village 6). Currently, in this camber in the valley (VACB) – all gate valves are open, and none are operated in usual operation mode chosen by the current operator. The flow to storage locations J4 and J8 are controlled by closing the respective gate valve at the entry of either of the stations, in order to supply the other one.
But, the VACB gives the possibility, to close gate valves there to choose/block the line to storage locations J4 and J8, depending on which one wants to be supplied and when. But, this needs that one person physically goes there to operate the gate valves at each time, as the gate valves are not connected to a remote controlled operation system (SCADA for example).

Beyond here, the layout plan and gate valve configuration at AZBH_2 and at V CAB as well as storage location J4 and J8 are given, for each of the 4 situations/pumping destinations to be served/pumped water to.

1) Pumping from AZBH_2 to storage location J4 (at AZBH_3):

![Diagram showing the process of pumping from AZBH_2 to storage location J4](image_url)
2) Pumping from AZBH_2 to storage location J8 (next to village 6):

3) Pumping from AZBH_2 to the sand filtration unit at AZBH_2:
4) Pumping from AZBH_2 to storage tanks T95 at AZBH2 (called storage location J2):

4) Pumping AZBH_2 to Storage J2 Tanker Filling Station (at AZBH_2)

At AZBH_2:
1. Gate-valve open
2. Gate-valve open
3. Gate-valve closed

At AZBH_2:
4. Gate-valve open
5. Gate-valve closed
6. Gate-valve closed

5) Pumping from AZBH_2 to Wash-out (Cleanout) at AZBH2:

5) Pumping AZBH_2 to Washout (at AZBH_2)

At AZBH_2:
1. Gate-valve open
2. Gate-valve open
3. Gate-valve closed

At AZBH_2:
4. Gate-valve closed
5. Gate-valve open
6. Gate-valve closed

At borehole 2, the following steps are required to put into operation and run the submersible pump at AZBH_2:

1. Check fuel availability and fuel line connection to the generators
2. Select which of the big generators (Generator 1 or Generator 2) to be used for the day. Alternate use of both generators – Generator 1 day 1, Generator 2 day 2, Generator 1 day 3, Generator 2 day, and to continue like this.
3. Put all the gate-valves into position for the wash-out/clean out – as per scenario 5 indicated above.
4. Check if the selected generator seems ok and functional.
5. Write down the operation hour reading of the generator into the generator/borehole log book at AZBH_2 for the respective generator. As well as level of fuel use/fuel available.
6. Switch on the generator (as per the detailed generator switch-on protocol of the respective generator).
7. Take the reading at the flow-meter of AZBH_2 – and write it down in the daily borehole monitoring logs for water production.
8. Once the generator up and running stable – after having passed at least the minimum start-up time of the generator (as per the generator operation manual) and until operational parameters at the control board of the generator are normal and stable, the submersible pump can be switched on (as per the pump operation manual).
9. Observe for around 5 minutes the pump control board and values – for flow rates and other information showed – to check if all within acceptable range and stable/stabilizing. If all values within acceptable ranges and no problems indicated/seen, pumping to continue. If doubts and values not stabilizing, continue to observe for further time, until values stabilize, or until pump shuts down by own protection mechanisms. **Do not switch off the pump unless really big concerns** – as number of restarts of the pump per time are limited and can cause damage to the pump.
10. After pump running stable, check on values for the water quality parameters measured by the senator-probe at their indication panels in the service building next to AZBH_2. And, take water sample at the sampling tap at AZBH_2 and do the relevant tests for additional parameters- such as turbidity (NTU), ammonium (N-NH4), and pH. Once all parameters ok as required for drinking water, continue with next step (step Nr. 9). Write down all parameters tested for with time and testing results in the borehole log of AZBH_2.
11. Change all the gate-valves into the required position – as per the destination location where you want to pump the water to (see scenarios 1 to 4 explained above). And, inform the respective team at storage location J4 or J8, that you will be starting to pump water their way (so they’re aware and can check on the flow arriving in terms of quantities and qualities).
12. Write down time when you started pumping with indication to what destination, into the AZBH_2 logbook and water production templates.
13. During pumping, every hour, write down water quality parameters E.C, pH, temperature in the borehole/water production log book of AZBH_2. Take samples and analyse turbidity each hour and write down the testing time and results in the borehole/water production log book of AZBH_2 as well.
14. Write down flow-meter reading each time, a change in the gate-valve setting is done, and indicate to which direction water is pumped now, and the end of pumping to the location set/served before.

15. Once the required quantities pumped for the day, switch off the pump (as per the pump operation manual procedure). And, read flow-meter and write into the logbook together with the time of pumping end.

16. Switch off the generator used (as per the generator operation manual switch-off procedure), once the pump has been switched off and stopped. Write down operation switch off time of the generator, operation hours and fuel use into the generator and borehole log book of AZBH_2.

17. Before any restart of the pump, respect the minimum rest time required for the pump as per the pump operation manual. Otherwise, you will damage the pump/pump motor.

Any other operations/instructions for borehole 2 activities? Make SOP for sand filtration unit and SOP for water tanker filling station separately in separate documents. For generator start up and switch-off, as well as for submersible pump start and switch-off, see user manuals/procedure done by contractor – and see if user manual ok, or if need to make a laminated card that will be put at the generators and at the pump.

**Borehole 3 (AZBH_3) and equipment at borehole 3:**

Borehole 3 is located next to village 3 (GPS coordinates: 36.603258 / 31.907018). AZBH_3 has the following characteristics:

<table>
<thead>
<tr>
<th>Borehole 3 (AZBH_3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realisation</td>
</tr>
<tr>
<td>Location and Altitude</td>
</tr>
<tr>
<td>Borehole depth</td>
</tr>
<tr>
<td>Borehole diameter(s)</td>
</tr>
<tr>
<td>Casing diameters(s)</td>
</tr>
<tr>
<td>Screens</td>
</tr>
<tr>
<td>Borehole bottom</td>
</tr>
</tbody>
</table>
| Borehole capacity                            | 105 m³/h (Pumping Test at construction, April 2014) xxxxxxx
Static Water Level | 167.15m (31.12.2018)
Minimum Drawdown | 22.20m (2018)
Maximum Drawdown | 38.00m (2018)

**Equipment of AZBH_3:**

| Raising pipe | GI pipe 4”; 6m length; 42 pieces = 252m |
| Submersible Pump | Since 02.04.2019: Lowara Z855-17/75 kW (8 inch diameter; 50 Hz); Pump capacity range: 10 (500m) – 80 (200m); maximum pump head is 500m; variable speed control. Before: Grundfoss SP95-17 (8inch diameter; 50 Hz); Pump capacity range: 10 (at 360m) – 100 m3/h (at 200m); maximum pump head is 360m; variable speed control. |
| Submersible Pump Dates | Installation on the 02.04.2019; Used pump from Rhukban |
| Submersible Pump Setting | 252.00m (42 main raising pipes 6m each = 252m) |
| Submersible Pump Motor | Now: Franklin 75kW rewindable (Model Nr. 2636145311 – DOL; 304; PE2/PA windings) 3 phase; 50Hz at 380-415 V (and 60Hz at 460 V); Maximum starts per hour: 10; VFD approved (30 to 50 Hz resp. 30 to 60 Hz (at 460V)). Before: Franklin 75kW (Model Nr. 2396047043); 3 phase; 50 Hz; Maximum starts per hour: 10; VFD approved. |
| Submersible Pump Motor Dates | New motor installed on the 02.04.2019; not used before |
| Average production rate | 43.2 m3/h (2018) |
| Average production time | 918 Minutes per day = 15h and 18 minutes (2018) |
| Average water production | 645 m3/day (2018) |
| Borehole monitoring probe | **Brand, Type, Parameters monitored** Senators Plus, Temperature, Pressure, Water Level, E.C. |
Borehole monitoring probe depth setting | Set at 252m (02.04.2019).

In addition to the borehole and the pump, there is an automatic chlorination unit, an aeration tower for H2S elimination and oxygenation as well as a rapid sand filtration and chlorination unit present at borehole 3. The H2S elimination and oxygenation is required as TSS levels are high and just within standards but perceived unpleasant by consumers. Therefore, all water from AZBH_3 is blended with water from AZBH_2 before being distributed.

The chlorination unit available and operational at AZBH_3 is located in the service building in the chlorination room. It is composed of 2 automatic chlorine dosing pumps with each supplied by a liquid chlorine solution barrel.

The chlorine injection point is located in the chamber AZBH_3.1 and allows chlorination of water coming from BH_3 as well as from BH_2 going to storage location J4. (Layout of the chamber and pipe connections with chlorine injection point see below).

Location and layout of the chlorine injection chamber at AZBH_3:

Two automatic chlorination dosing pumps (blue):

- **Type, model, capacity**

- **White case on the wall:**

  **Reading of the free chlorine concentration in the water after mixing (where is it measured?)**

---

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The aeration tower for H2S elimination and oxygenation run and used at AZBH_3 is run by a separate generator (Perkins Leroy-Somer, 200 kVA) and has the following characteristics:

<table>
<thead>
<tr>
<th><strong>Aeration Tower</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Installation Date:</strong></td>
</tr>
<tr>
<td><strong>Brand and Type:</strong></td>
</tr>
<tr>
<td><strong>Capacity cleaned water tank:</strong></td>
</tr>
<tr>
<td><strong>Maximum treatment flow capacity:</strong></td>
</tr>
<tr>
<td><strong>Treatment procedure description:</strong></td>
</tr>
<tr>
<td><strong>Maximum H2S treatment capacity:</strong></td>
</tr>
<tr>
<td><strong>Target value design treatment outlet H2S:</strong></td>
</tr>
<tr>
<td><strong>Target value design treatment outlet ???:</strong></td>
</tr>
</tbody>
</table>
The rapid sand filtration unit is run and used for all water produced at AZBH_3.

<table>
<thead>
<tr>
<th><strong>Rapid Sand Filtration Unit</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Date:</td>
</tr>
<tr>
<td>Brand and Type:</td>
</tr>
<tr>
<td>Maximum treatment flow capacity:</td>
</tr>
<tr>
<td>Filtration rate:</td>
</tr>
<tr>
<td>Maximum working pressure:</td>
</tr>
<tr>
<td>Filter information:</td>
</tr>
<tr>
<td>Filter equipment:</td>
</tr>
<tr>
<td>Backwash rate:</td>
</tr>
<tr>
<td>Maximum turbidity treatment capacity:</td>
</tr>
<tr>
<td>Maximum TDS treatment capacity:</td>
</tr>
<tr>
<td>Target value design treatment outlet NTU:</td>
</tr>
<tr>
<td>Target value design treatment outlet TDS:</td>
</tr>
</tbody>
</table>

The sand filtration unit is powered by a surface mounted pump (Ebara 3LM/I50 – 7.5 kW, centrifugal surface mounted, 24 – 72 m3/h). For the backwash of the sand filtration unit, there is 1 surface mounted pump available (Ebara 3LM/I80 – 11 kW, centrifugal surface mounted, 78 – 204 m3/h). Details and operation see in the separate SOP Sand Filtration Unit at AZBH_3.
Photos Sand-Filtration Unit at AZBH_3:

The rapid sand filtration unit is filled with a 3 layer aggregate medium – made out of silicate sand as layer 1, aggregates up to 1cm diameter of crushed turf rock and bigger crushed stones between 3 to 5 cm diameters.

Sand filtration Unit at AZBH_3: layer composition
The details of pumps, connections, valves, operation of the sand filtration unit at AZBH_3 are indicated in the specific SOP Sand filtration Unit AZBH_3 – separately from this document.

Borehole 3 equipment is powered by generator – as no grid connection was allowed to be established. The national grid is passing next to the camp, so a connection would be possible, if given permission from the relevant ministry and the grid operator (which so far has not been given).

There are two big generators present at borehole 2 to power the submersible pump, which are used by alternation – meaning generator 1 one day, then generator 2 the next day, then again generator 1, and so on.

A third big generator (200 kVA) is present and used to run the aeration tower for H2S elimination and oxygenation.

In addition to this, there is a smaller service generator to be used outside pump operating hours for the office/service building at BH3.

The characteristics of the generators at Borehole 3 are indicated here:

<table>
<thead>
<tr>
<th>Generator 1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Number:</td>
</tr>
<tr>
<td>Installation Date:</td>
</tr>
<tr>
<td>Brand and Type:</td>
</tr>
<tr>
<td>Power Rating (kVA):</td>
</tr>
<tr>
<td>Number of Phases:</td>
</tr>
<tr>
<td>Motor information:</td>
</tr>
<tr>
<td>Alternator information:</td>
</tr>
<tr>
<td>Control Panel Information:</td>
</tr>
<tr>
<td>Fuel Tank Information:</td>
</tr>
</tbody>
</table>
### Generator 2:

| Asset Number: | ..... |
| Installation Date: | ..... |
| Brand and Type: | Perkins... |
| Power Rating (kVA): | 250 kVA |
| Number of Phases: | ..... |
| Motor information: | ..... |
| Alternator information: | ..... |
| Control Panel Information: | ..... |
| Fuel Tank Information: | Integrated fuel tank, but used currently supplied from the separate 2’000 lt fuel tanks. |

### Generator 3:

| Asset Number: | ..... |
| Installation Date: | ..... |
| Brand and Type: | Perkins... with Leroy-Somer Alternator |
| Power Rating (kVA): | 200 kVA |
| Number of Phases: | 3 Phases; 380 – 415 V; 50Hz |
| Motor information: | Perkins 1106A-70TAG-4 (water cooled) |
| Alternator information: | Leroy-Somer LSA 46.3 S3 |
| Control Panel Information: | ..... |
| Fuel Tank Information: | Integrated fuel tank, but used currently supplied from the separate 2’000 lt fuel tank. |
### Generator 4:

<table>
<thead>
<tr>
<th><strong>Asset Number:</strong></th>
<th>.....</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Installation Date:</strong></td>
<td>.....</td>
</tr>
<tr>
<td><strong>Brand and Type:</strong></td>
<td>Hyundai...</td>
</tr>
<tr>
<td><strong>Power Rating (kVA):</strong></td>
<td>16 kVA</td>
</tr>
<tr>
<td><strong>Number of Phases:</strong></td>
<td>.....</td>
</tr>
<tr>
<td><strong>Motor information:</strong></td>
<td>.....</td>
</tr>
<tr>
<td><strong>Alternator information:</strong></td>
<td>.....</td>
</tr>
<tr>
<td><strong>Control Panel Information:</strong></td>
<td>.....</td>
</tr>
<tr>
<td><strong>Fuel Tank Information:</strong></td>
<td>Integrated fuel tank, but used currently supplied from the separate 2’000 lt fuel tank.</td>
</tr>
</tbody>
</table>

Photo of generators and fuel tanks at AZBH_3
These 3 generators are supplied by the 3 external fuel tanks. Here beyond the characteristics of the fuel tanks and the fuel supply system is explained.

**Fuel Tanks:**

<table>
<thead>
<tr>
<th>Asset Number(s):</th>
<th>.....</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation Date:</td>
<td>.....</td>
</tr>
<tr>
<td>Brand(s) and Type(s):</td>
<td>.....</td>
</tr>
<tr>
<td>Materials of the tanks:</td>
<td>4 horizontal rectangular steel tanks each 2’000 lt (3 at the generators location, 1 next to the sand-filtration unit / aeration tower for the generator used to run the aeration tower.</td>
</tr>
<tr>
<td>Capacities of the tank(s):</td>
<td>4 x 2’000 lt</td>
</tr>
<tr>
<td>Information on the fuel connections to the Generators:</td>
<td>All four generators present are connected and supplied from this tanks with individual fuel connection pipes.</td>
</tr>
</tbody>
</table>

**Schematic table of Borehole 3 (AZBH_3) site layout:**
Photo of Azraq Borehole 3: operation building (left), borehole with Wash-Out pipe (right) and pipe to aeration tower/network (front)

Photo of Water Treatment System AZBH_3: aeration tower (H2S elimination) (left), sand filtration unit (blue, middle) and small clean water storage tanks (white, right)
**Borehole 3 (AZBH_3) operation:**

Azraq Borehole 3 is equipped with a submersible pump (details given before). The submersible pump is powered by one of the 2 big generators at a time available and in use at AZBH_3.

From the borehole water can be pumped to 4 locations, by opening/closing respective gate-valves:

1) To storage location J4 at AZBH_3
2) To storage location J8 next to village 6 via the ring main pipeline
3) To the aeration tower and sand-filtration unit at AZBH_3, and then to the storage location J4 or J8 (option 1 or/and 2)
4) Pumping to the Wash-out at AZBH_3 (Cleanout)
5) Pumping without passing through the aeration tower and sand filter unit to J4 or/and J8

Beyond here, the layout plan and gate valve configuration at AZBH_3 are given for each of the 5 situations/pumping destinations to be served/pumped water to.

1) Pumping from AZBH_3 to storage location J4 (at AZBH_3):

![Diagram of the pumping system](image-url)
2) Pumping from AZBH_3 to storage location J8 (next to village 6):

3) Pumping from AZBH_3 to the aeration tower and sand filtration unit at AZBH_3:
4) Pumping from AZBH_3 to the Wash-Out (Cleanout):

4) Pumping AZBH_3 to the Wash-Out (Cleanout)

5) Pumping from AZBH_3 without passing through the aeration tower and sand filter unit to J4 or/and J8

5) Pumping AZBH_3 to J4 or J8 – without passing through the aeration tower and sand filtration unit
At borehole 3, the following steps are required to put into operation and run the submersible pump at AZBH_3:

1. Check fuel availability and fuel line connection to the generators
2. Select which of the big generators (Generator 1 or Generator 2) to be used for the day. Alternate use of both generators – Generator 1 day 1, Generator 2 day 2, Generator 1 day 3, Generator 2 day, and to continue like this.
3. Put all the gate-valves into position for the wash-out/clean out – as per scenario 4 indicated above.
4. Check if the selected generator seems ok and functional.
5. Write down the operation hour reading of the generator into the generator/borehole log book at AZBH_3 for the respective generator. As well as level of fuel use/fuel available.
6. Switch on the generator (as per the detailed generator switch-on protocol of the respective generator).
7. Take the reading at the flow-meter of AZBH_3 – and write it down in the daily borehole monitoring logs for water production.
8. Check the automatic chlorination units that liquid chlorine is available, that connections are ok and chlorine dosing pumps ready to be switched on.
9. Once the generator up and running stable – after having passed at least the minimum start-up time of the generator (as per the generator operation manual) and until operational parameters at the control board of the generator are normal and stable, the submersible pump can be switched on (as per the pump operation manual).
10. Observe for around 5 minutes the pump control board and values – for flow rates and other information showed – to check if all within acceptable range and stable/stabilizing. If all values within acceptable ranges and no problems indicated/seen, pumping to continue. If doubts and values not stabilizing, continue to observe for further time, until values stabilize, or until pump shuts down by own protection mechanisms. **Do not switch off the pump unless really big concerns** – as number of restarts of the pump per time are limited and can cause damage to the pump.
11. After pump running stable, check on values for the water quality parameters measured by the senator-probe at their indication panels in the control room of the service building of AZBH_3. And, take water sample at the sampling tap at AZBH_3 and do the relevant tests for additional parameters such as turbidity (NTU), ammonium (N-NH4), and pH. Once all parameters ok as required for drinking water, continue with next step (step Nr. 11). Write down all parameters tested for with time and testing results in the borehole log of AZBH_3.
12. Change all the gate-valves into the required position – as per the destination location where you want to pump the water to (see scenarios 1 to 5 explained above). And, inform the respective team at storage location J4 or J8, that you
will be starting to pump water their way (so they’re aware and can check on the flow arriving in terms of quantities and qualities).

13. Write down time when you started pumping with indication to what destination, into the AZBH_3 logbook and water production templates.

14. Switch on the automatic chlorine dosing pump that you’re using this day (alternative use of the 2 automatic chlorine dosing pumps one day 1, next day the other one, etc.)

15. When using the aeration tower and sand filtration unit – which is the usual operation – you have to follow the following steps beyond here to put these units in operation:
   a. Write down in the generator 3 log book (the one for the aeration tower) the reading of the operation hours as well as the time of starting the generator. Check fuel availability in the fuel tank and fuel connection line status. Start the generator as per the generator handbook procedure.
   b. Only switch on the aeration tower unit, if the water flow from the borehole is stable and sufficient. If this is the case, switch off the aeration tower unit.
   c. Switch on the small pump after the aeration tower to start feeding the sand filtration units.
   d. Once there is sufficient water in the white PE tanks after the sand filtration unit, switch on the small surface mounted pumps after these tanks, to pump the water to J4 or/and J8 station – as per the destination needed.

16. During pumping, every hour, write down water quality parameters E.C, pH, temperature in the borehole/water production log book of AZBH_3. Take samples and analyse turbidity each hour and write down the testing time and results in the borehole/water production log book of AZBH_3 as well. And, check on the operation of the automatic chlorination dosing pumps and the reading of the free residual chlorine level indicated in the chlorination room white box on the wall. Should always be within 0.5 to 1.0 mg/l under normal operation conditions. If value read outside this range, make manual FRC test to check/verify proper function of the equipment, and if value read confirmed, then adjust quantity of chlorine injected by the automatic dosing pumps until you reach/can read the required value (this will need time to adjust – so observe and give time for the system to react).

17. Write down flow-meter reading each time, a change in the gate-valve setting is done, and indicate to which direction water is pumped now, and the end of pumping to the location set/served before.

18. Once the required quantities pumped for the day, switch off the pump (as per the pump operation manual procedure). And, read flow-meter and write into the logbook together with the time of pumping end.

19. Switch off the automatic chlorine dosing pump.
20. Switch of the aeration tower (first the unit itself, then its generator), and then the sand filtration unit and its pumps. If the pumping for the day is finished, then the sand-filter backwash should be initiated and operated (as per the specific sand filtration unit SOP).

21. Switch off the generator used (as per the generator operation manual switch-off procedure), once the pump has been switched off and stopped. Write down operation switch off time of the generator, operation hours and fuel use into the generator and borehole log book of AZBH_3.

22. Before any restart of the pump, respect the minimum rest time required for the pump as per the pump operation manual. Otherwise, you will damage the pump/pump motor.

Any other operations/instructions for borehole 3 activities? Make SOP for aeration tower and SOP for sand filtration unit.

4.4 Operation Storage Locations

Operation of the 2 storage locations and the tanker filling station (and storage location at AZBH_2) of Azraq Refugee Camp is indicated here. The explanations and indications given here refer to the regular operation mode. Emergency operation mode and considerations, are explained in chapter xxxx.

Storage Location J4 (at AZBH_3):

The location of the storage Location J4 is indicated in the map beyond here:
Here beyond you find the schematic system layout for storage location J4:

Storage Location J4 is equipped with 16 Oxfam T95 tanks for drinking water storage. Each tank has a usable volume of about 90m³ (as outlet is some 30cm above ground). Each of the 16 T95 tanks can be supplied individually by open or closing the inlet gate valve of each tank. In addition to that, it can be chosen to supply each line of 4 T95 tanks separately.

Water supply from storage location J4 to the ring-main pipeline is done by using a surface mounted pump operated with applying a 2 bar pressure. All water coming to storage location J4 can be (and is) chlorinated using the automatic chlorination dosing pumps (at AZBH_3 chlorination room) with their injection point into the pipeline leading up to J4 station in Chamber AZBH_3_2. The outlet from J4 station can be closed by 2 gate-valves, and is equipped with an electromagnetic flow-meter on the outlet.

For the supply of water to the ring-main pipeline, each T95 tank outlet is equipped with an individual line and a set of 3 gate-valves and 1 sampling tap. Therefore it allows to take water samples at the sampling tap of each tank, as well as to have the possibility to connect a flexible or fixed pipe to each tank to divert water to other places/locations or possible tankers, if wished so. On the supply side 2 groups of each 8 tanks can be isolated in addition to that, if wished so for stepwise water supply or/and pressure regulation.

The inlet to Storage Location J4 is regulated at the Chamber AZBH_3_2 at borehole 3. In Chamber AZBH_3_1, the gate-valves have to be set up to either allow supply from borehole 2 or borehole 3 (or both at the same time, with some flow limitations, as there are no non return valves installed in that chamber. The inlet to storage location J4 can as well be linked directly to the outlet, bypassing all storage tanks to allow direct supply to the ring-main pipeline from borehole 2 or/and borehole 3.
The operator of storage location J4 has to be informed when supply to his location is started, so he can open/close the respective gate valves of the T95 tanks that he wants to be filled/used, in what order, up to what levels/quantities, etc. In addition to that, the operator takes FRC (free residual chlorine) samples at some T95 tanks to check FRC levels of water supplied to the storage location at each rotation. In addition to that, FRC levels are checked and reported on at outlet of J4 station before water reaches the ring-main pipeline at the J4 station outlet sampling point. The operator of storage location J4 has as well to assure that the automatic chlorination pumps located at AZBH_3 are switched-on, for all water coming to storage location J4 from borehole 2 and borehole 3.

Beyond here some photos from Storage Location J4:
Photos of storage location J4; left photo: individual inlet equipped with a gate-valve to each T95 storage tank; right photo: individual outlet from each T95 storage tank equipped with 3 gate-valves and one sampling tap.

Photos: Outlet Storage Location J4; left photo: surface mounted pump for J4 supply to ring-main pipeline distribution to village 2 and village 3 (operated at 2 bar), with gate-valves; right photo: flow meter and recording unit for J4 station outlet (before the pump on the left photo).
Storage Location J8 (next to village 6):

The location of the storage Location J8 is indicated in the map beyond here:

Here beyond you find the schematic system layout for storage location J8:

Storage Location J8 is equipped with 16 Oxfam T95 tanks for drinking water storage. Each tank has a usable volume of about 90m³ (as outlet is some 30cm above ground). Each of
the 16 T95 tanks can be supplied individually by open or closing the inlet gate valve of each tank. In addition to that, it can be chosen to supply each line of 4 T95 tanks separately.

Water supply from storage location J8 to the ring-main pipeline is done only by gravity.

For the supply of water to the ring-main pipeline, each T95 tank outlet is equipped with an individual line and a set of 3 gate-valves and 1 sampling tap. Therefore it allows to take water samples at the sampling tap of each tank, as well as to have the possibility to connect a flexible or fixed pipe to each tank to divert water to other places/locations or possible tankers, if wished so. On the supply side 2 groups of each 8 tanks can be isolated in addition to that, if wished so for stepwise water supply or/and pressure regulation.

The inlet to Storage Location J8 is regulated at the Gate valve control Chamber J8 Inlet (GVC-J8_Inlet) located at Storage Location J8. In the same chamber, there is a flow-meter measuring inflows into J8 station, as well as there is the injection of the chlorine from the automatic chlorine dosing pumps at J8 station. These automatic chlorine dosing pumps are powered by a solar panels and a small back-up generator, and are located in the chlorination room. The inlet can as well be linked directly to the outlet, bypassing all storage tanks to allow direct supply to the ring-main pipeline from borehole 2 or/and borehole 3.

The operator of storage location J8 has to be informed when supply to his location is started, so he can open/close the respective gate valves of the T95 tanks that he wants to be filled/used, in what order, up to what levels/quantities, etc. Secondly, he has to know when to switch on and switch off the automatic chlorination dosing pumps if water incoming is from borehole 2, as not chlorinated yet. If water comes from borehole 3, it is already chlorinated, and the operator doesn’t need to switch on the chlorination pumps. In addition to that, the operator takes FRC (free residual chlorine) samples at some T95 tanks to check FRC levels of water supplied to the storage location at each rotation. In addition to that, FRC levels are checked and reported on at outlet of J8 station before water reaches the ring-main pipeline at the sampling point.

Beyond here some photos from Storage Location J8:
Photos of storage location J8; upper photo: view on storage location J8; left photo: individual inlet equipped with a gate-valve to each T95 storage tank; right photo: individual outlet from each T95 storage tank equipped with 3 gate-valves and one sampling tap; bottom photo: outlet of storage location J8 with flow-meter, gate-valve and air suction point.
Photos of storage location J8: chlorination station with left: chlorination station building with solar panels, small generator and power grid line (not connected); right: automatic chlorine dosing pumps and liquid chlorine drums.

**Tanker filling station and storage location J2 (at AZBH_2):**

The location of the tanker filling station and storage Location J2 is indicated in the map beyond here:
Here beyond you find the schematic system layout for the tanker filling station and storage location J2:

Tanker Filling Station and Storage Location J2 is equipped with 6 Oxfam T95 tanks for drinking water storage (usable volume: 540 m³). Each tank has a usable volume of about 90 m³ (as outlet is some 30 cm above ground). Each of the 6 T95 tanks can be supplied individually by open or closing the inlet gate valve of each tank. Water to the tanker filling station can only be supplied from borehole.

Supply from borehole 3 possible -> enough pressure from the pumps there?

Water supply from storage location J2 to the tanker filling station is done first part by gravity, and then using surface mounted pumps. The tanker filling station is equipped with 2 filling lines with one line having 2 filling hoses, and 1 line having 3 filling hoses. Each filling line can be supplied independently, and is equipped with a gate-valve, a pump and a flow meter.

Water flowing form the storage location J2 to the tanker filling station is chlorinated by automatic chlorine dosing pumps. Yes ? no ? If yes, where is the chlorination point ? And, why chlorination not used/possible for water from BH_2 sent to J4?

The operator of storage location J2 and the tanker filling station has to be informed when supply to his location is started, so he can open/close the respective gate valves of the T95 tanks that he wants to be filled/used, in what order, up to what levels/quantities, etc.

For operating the tanker filling station, the operator has to check the two surface mounted pumps, put the gate-valves in positions for which tanker filling line(s) he want to use, and to check that the tanker filling hoses are closed (not to spill/loose water). Secondly, he has then to go and open the gate-valves from each T95 tank he wants water to flow to the tanker filling station pumps and to switch on and switch off the automatic chlorination dosing pumps as needed.
In addition to that, the operator takes FRC (free residual chlorine) samples from the tanker filling hoses when the tanker filling station is used.

Beyond here some photos from the Tanker Filling Station and Storage Location J2:
4.5 Operation of the Water Distribution Network

In this chapter, all activities linked to the operation of the water distribution part of Azraq Refugee Camp water supply system are explained. The explanations and indications given here refer to the regular operation mode. Emergency operation mode and considerations, are explained in chapter xxx.

To assure water supply to the 4 villages and all service areas of Azraq Refugee Camp, 11 gate-valve chambers are located on the ring-main pipeline. 8 of them are used to control water supply to the 4 villages, and 3 of them are used to control water supply to 5 service areas. Whereas the gate-valves in the chambers controlling water supply of the villages are only open during the distribution times, the gate-valves in the 3 chambers controlling water supply to service areas are generally open permanently, but still can be closed based on operational requirements. All gate-valves in the network of Azraq Refugee Camp are operated manually and no remote control system is installed/available.

Each of the chambers is equipped with a gate-valve as well as a flow-meter. Since March 2019, flow-meter readings are taken every time when gate-valves to villages are opened and closed. This allows to monitor and know, how much water has been distributed to which village and to which service area(s). All gate-valve chambers have a solid cover with a lock, so that access to them is only possible for the water operator of Azraq Refugee Camp.
Location of Gate-valve chambers:

Beyond here, there is the table with the information for each of the gate-valve chambers of the distribution network of Azraq Refugee Camp.

<table>
<thead>
<tr>
<th>Name</th>
<th>Function(s)</th>
<th>GPS Coordinates (E / N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber_BC</td>
<td>Connections of Base Camp line and Service Area line</td>
<td>36.567769 / 31.912424</td>
</tr>
<tr>
<td>Chamber_V2</td>
<td>Connection of main distribution line village 2; this main line is afterwards divided into 7 separate distribution lines (controlled each with a separate gate-valve in the Chamber V2_Distrib)</td>
<td>36.579490 / 31.915197</td>
</tr>
<tr>
<td>Chamber_V2_Ext</td>
<td>Connection of distribution line to extension area of village 2</td>
<td>36.583389 / 31.914978</td>
</tr>
<tr>
<td>Chamber_V3</td>
<td>Connection of main distribution line village 3</td>
<td>36.603388 / 31.907484</td>
</tr>
<tr>
<td>Chamber_VA</td>
<td>Connection of 3 lines: line to Visitors Area (VA), line to</td>
<td>36.589460 / 31.913754</td>
</tr>
<tr>
<td>Chamber Name</td>
<td>Description</td>
<td>Coordinates</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Chamber_SARD</td>
<td>Connection to line for SARD/Security</td>
<td>36.603757 / 31.907814</td>
</tr>
<tr>
<td>Chamber_V5_6</td>
<td>Connection of 1 distribution line village 5 for blocks 1 to 4, 5 to 10 and 13</td>
<td>36.575826 / 31.897646</td>
</tr>
<tr>
<td>Chamber_V5_51</td>
<td>Connection of 1 distribution line village 5 for blocks 5,11,14,16,18 (and parts of 6,12,15,17,19)</td>
<td>36.582863 / 31.892998</td>
</tr>
<tr>
<td>Chamber_V5_52</td>
<td>Connection of 1 distribution line village 5 for blocks 6,12,15,17,19 (and parts of 5,11,14,16,18)</td>
<td>36.580893 / 31.893299</td>
</tr>
<tr>
<td>Chamber_V6_7</td>
<td>Connection of 1 distribution line village 6 to blocks 1,2,4,5,7,8,10,11,13,14</td>
<td>36.586199 / 31.891350</td>
</tr>
<tr>
<td>Chamber_V6_8</td>
<td>Connection of 1 distribution line village 6 to blocks 3,6,9,12,15</td>
<td>36.588017 / 31.889639</td>
</tr>
</tbody>
</table>

Beyond here you see some photos of how the chambers look like:
Beyond the level of the chambers located on the ring-main pipeline and controlling the water supply into the villages, there are no further control or access gate-valves or possibilities to regulate the flows inside the village levels.

But, each tapstand has its own gate-valve on the distribution line, and can be opened and closed off as per the operational requirements and/or consumer demand or not. This gate-valves are located in the ground next to each tapstand, with no real gate-valve chamber.

All chambers and gate-valves are operated by the water supply operator of Azraq Refugee Camp.