1. Water Conservation

1.1. Current Rates of Water Consumption

There are mainly two water sources that supply our campus:

- KFUPM's brackish deep groundwater aquifers, with a TDS of 4,000 to 5,000ppm (raw water), total production 29,426 **m^3** 16hr/day
- Al Aziziah/ Al Khobar desalinated water, with a TDS of 700 to 1,100ppm (sweet water), with total supply of around **2,500m^3** per day

The water supplied from the Al Aziziah Desalination Plant is directly connected to the KFUPM's water distribution network. This water is mainly used for showering purposes in faculty/staff housings.

Meanwhile, the raw water supplied from KFUPM's deep wells need to be treated before being distributed to the pipe network due to high level of TDS. There are five Reverse Osmosis (RO) units being operated in the university. Basically the RO unit is used to lower the TDS level of the input water. The water produced through the RO unit will have TDS level of: 200 to 250 ppm.

The schematic process and distribution of the deep wells is as follow:

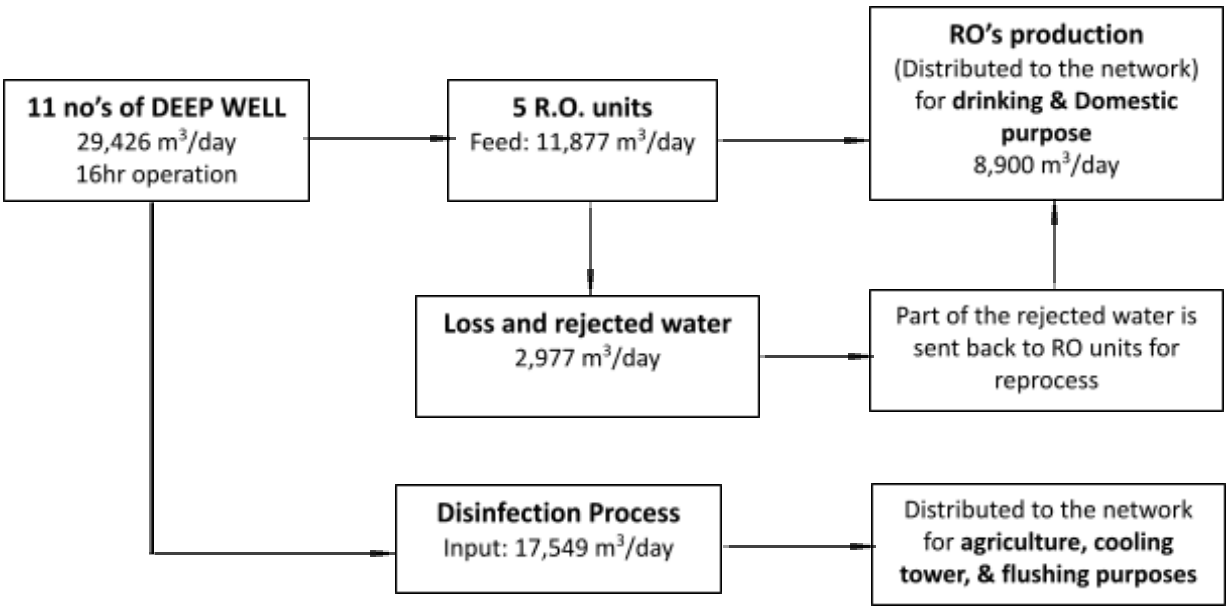
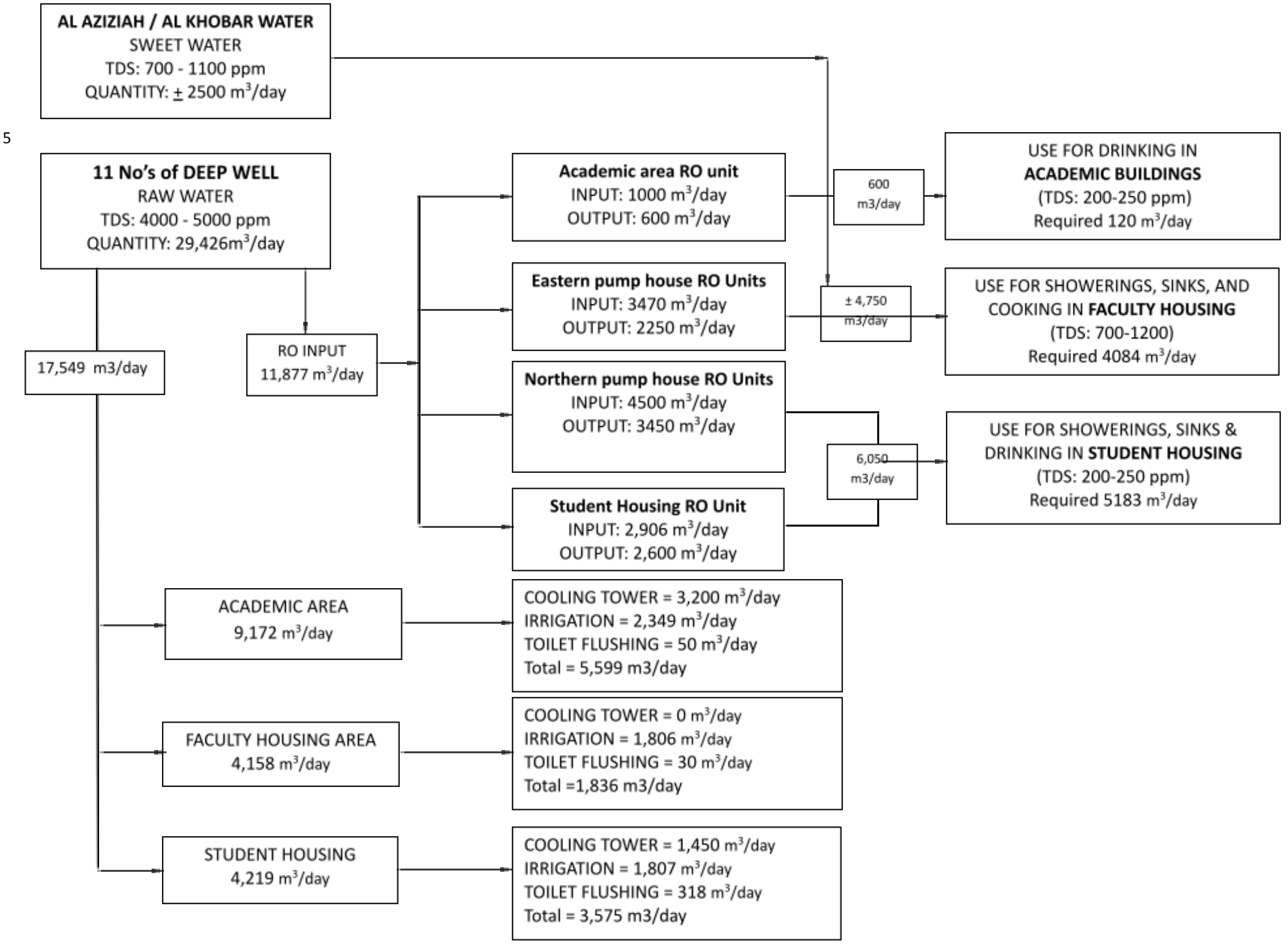


Figure 10: The schematic process and distribution of KFUPM's deep wells


AL AZIZIAH / AL KHOBAR WATER
SWEET WATER
TDS: 700 - 1100 ppm
QUANTITY: ± 2500 m3/day
11 No's of DEEP WELL
RAW WATER
TDS: 4000 - 5000 ppm
QUANTITY: 29,426m3/day
17,549 m3/day
RO INPUT
11,877 m3/day
Academic area RO unit
INPUT: 1000 m3/day
OUTPUT: 600 m3/day
Eastern pump house RO Units
INPUT: 3470 m3/day
OUTPUT: 2250 m3/day
Northern pump house RO Units
INPUT: 4500 m3/day
OUTPUT: 3450 m3/day
Student Housing RO Unit
INPUT: 2,906 m3/day
OUTPUT: 2,600 m3/day
600 m3/day
± 4,750 m3/day
6,050 m3/day
USE FOR DRINKING IN ACADEMIC BUILDINGS
(TDS: 200-250 ppm)
Required 120 m3/day
USE FOR SHOWERINGS, SINKS, AND COOKING IN FACULTY HOUSING
(TDS: 700-1200)
Required 4084 m3/day
USE FOR SHOWERINGS, SINKS & DRINKING IN STUDENT HOUSING
(TDS: 200-250 ppm)
Required 5183 m3/day
ACADEMIC AREA
9,172 m3/day
COOLING TOWER = 3,200 m3/day
IRRIGATION = 2,349 m3/day
TOILET FLUSHING = 50 m3/day
Total = 5,599 m3/day
FACULTY HOUSING AREA
4,158 m3/day
COOLING TOWER = 0 m3/day
IRRIGATION = 1,806 m3/day
TOILET FLUSHING = 30 m3/day
Total =1,836 m3/day
STUDENT HOUSING
4,219 m3/day
COOLING TOWER = 1,450 m3/day
IRRIGATION = 1,807 m3/day
TOILET FLUSHING = 318 m3/day
Total = 3,575 m3/day

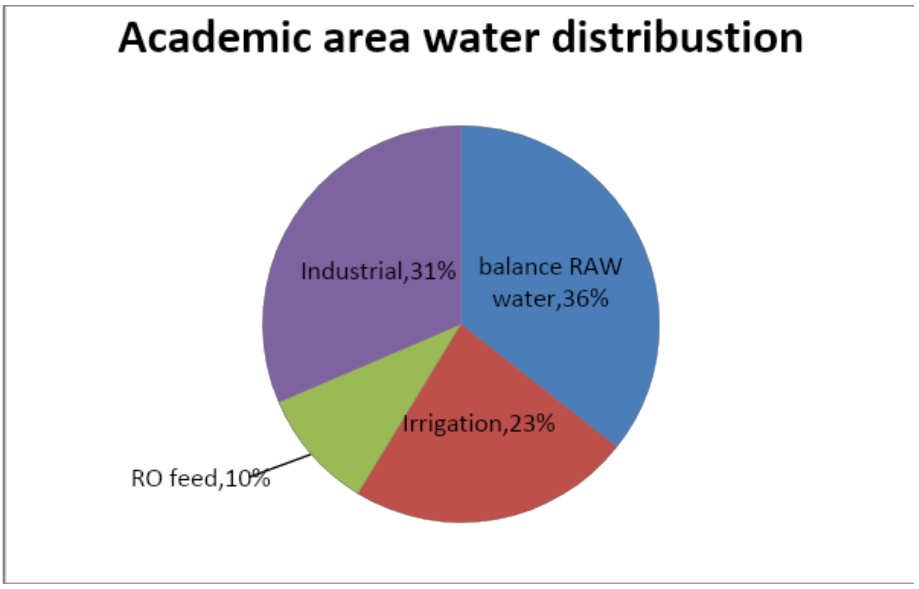
KFUPM Water distribution is mainly divided into 3 zones

1. **Academic area**
2. **Faculty Housing area**
3. **Student housing area**

Academic Area

1. Academic area

- Academic area raw water source from deep well num 1, 2, 9 & 12 each 2,543 m^3/16hr total production 10,172 m^3/day.
- Raw water divided into 4 categories in the academic area
    - RO Feed
    - Industrial
    - Irrigation
    - Flushing
- Based on Maintenance report water distribution for Academic area
    - RO Feed = 1,000 m^3/day Produced water = 600 m^3/day
    - Industrial = 3,200 m^3/day
    - Irrigation & Flushing = 5,972 m^3/day
    - Total = 10,172 m^3/day
- Based on Projects Department Design calculation
    - Sweet water required for academic area = 200 out of 600 m^3/day
    - Industrial water required for Academic area = 3,200 m^3/day
    - Irrigation water required for academic area = 2,349 out of 5,972 m^3/day
- Conclusion
    - We have enough source of sweet and raw water for academic area
    - Recommended to install digital water meter in the pump house to measure the actual usage.
    - Industrial water used by raw water from deep well, quality of water (TDS 3500-5000 ppm) is not suitable to use cooling tower and boilers. Currently we are using raw water by this we are consuming 3,200 m^3/day and damaging life cycle cost of the equipments.
    - Projects Department recommends using treated water (TDS 500-1000 ppm) for industrial purpose to increasing the efficiency and life cycle cost of the equipments.
    - Recommended to use automatic blow down system for existing cooling tower by this we can reduce the industrial water consumption 30 – 40 %
    - Separate the water tanks and water network for industrial water to avoid shortage for cooling tower make up water during summer season.


Academic area water distribustion
Industrial,31%
balance RAW water,36%
Irrigation,23%
RO feed,10%

Faculty/Staff Housing area

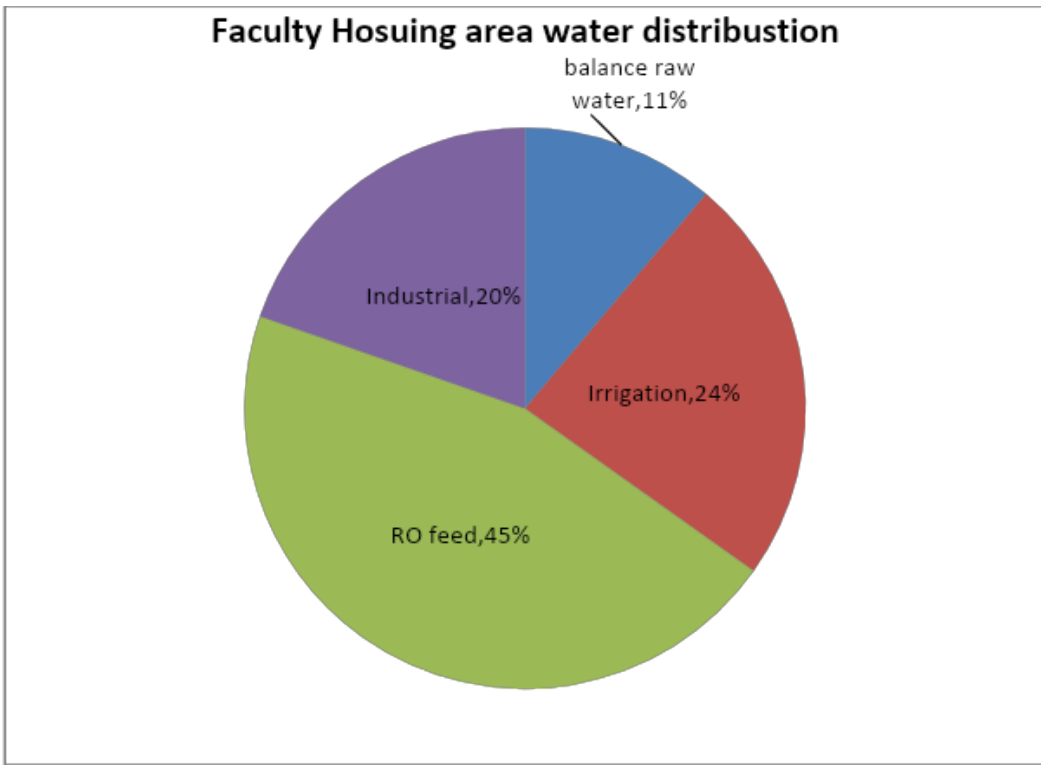
(Eastern Pump House)

2. Faculty/Staff Housing area (Eastern Pump House)

- Faculty/staff housing area raw water source from deep well num 5, 6 & 10 each 2,543 m^3/16hr total production is 7,629 m^3/day.

- Raw water divided into 4 categories in the Faculty/Staff housing area
    - RO Feed
    - Industrial
    - Irrigation
    - Flushing
- Based on Maintenance Department report
    - RO Feed = 3,471 m^3/day Produced water = 2,250 m^3/day
    - Industrial = 1,500 m^3/day
    - Irrigation & Flushing = 2,658 m^3/day
    - Total = 7,629 m^3/day
    - Khobar Municipality = ± 2,500 m^3/day TDS 700- 1200 ppm

- Based on Projects Department Design calculation
    - Sweet water required for Faculty housing area = **4,084 out of 2,250** m^3/day
    - Industrial water required for Faculty housing area = 1,500 m^3/day
    - Irrigation water required for Faculty housing area = 1,806 out of 2,658 m^3/day
- Conclusion
    - Shortages of sweet water 1,834 m^3/day managed by Khobar municipality water during winter season, in the summer season no water supply from Khobar municipality.
    - Eastern new pump house has 2 RO units it can produce 3000 m^3/day sweet water, Currently 1 RO unit is operating and it is producing 1,500 m^3/day. We could not run another RO Unit because existing sewer system can't carry the reject water if we run 2 RO units at the same time.
    - If we upgrade the existing sewer network it can be operated 2 RO units to get sufficient sweet water for the faculty housing area


Faculty Hosuing area water distribustion
balance raw water,11%
Industrial,20%
Irrigation,24%
RO feed,45%

Student Housing area

(Northern pump house)

3. Student Housing area (Northern pump house)

- Student housing area water source from north pump house area deep well num 7, 8 & 11 total production of raw water 8,719 m^3/16hr/day.
- New SCADA pump house inside the student housing area deep well num 13 production of raw water is 2,906 m^3/16hr
- Raw water divided into 4 categories in the Student housing area
    - RO Feed
    - Industrial
    - Irrigation
    - Flushing
- Based on Maintenance Department report for north pump house
    - RO Feed = 4,500 m^3/day Produced water = 3,450 m^3/day
    - Industrial = 1,450 m^3/day
    - Irrigation & Flushing = 2,769 m^3/day
    - Total = 8,719 m^3/day
- New SCADA pump house from student housing area
    - RO feed = 2,906 m^3/day Produced water = 2,600 m^3/day
- Based on Projects Department calculation
    - Sweet water required for Student housing area = 4,834 out of 6,050 m^3/day
    - Industrial water required for Student housing area = 1,450 m^3/day
    - Irrigation water required for Student housing area = 1,805 out of 2,769 m^3/day
- Conclusion
    - Sweet water calculation consider current development of student housing Phase 5 B
    - Sweet water used as Domestic & Drinking purpose for student housing area
    - Currently sweet water for student housing area supplied from northern pump house and SCADA pump house.
    - New SCADA pump house have 3 Primary RO units and 3 Secondary RO units it can produce 4,800 m^3/day, it can independently cover required sweet water supply for all student housing areas. Currently it is producing 2,600 m^3/day because shortage of raw water from the Deep well, no secondary source of deep well. We recommend making a new deep well near building

40 and supporting SCADA RO plant to maintain Sweet supply for student housing area.