Non-Revenue Water (NRW) Reduction Master Plan Knowledge Sharing Workshop

FARA Experience-Amman Jordan Water Company-Miyahuna

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Comprehensive NRW Reduction in Distribution Zone 27 (Tareq) - Amman

Background:
- The National Water Strategy (2016-2025) recognizes that NRW is a pivotal issue for Jordan and has the goals of reducing NRW to 25% nationally by 2025, and within that leakage reduced to below 15%.
- USAID’s Non-Revenue Water Project is targeting similar reductions in 22 DZs in Amman, Zarqa, Madaba and Aqaba.
- These projects are not just about asset replacement but involve comprehensive NRW reduction approaches, Leak detection and Repair, Pressure Management, Bulk and Residential Water Meter Replacement, SCADA, Loggers, and Tool and Equipment.

Challenges:
- The intermittent water supply, which damages distribution system components, prevents the use of leak detection equipment and limits the usefulness of water pressure control equipment;
- Deteriorated assets (there is essentially no maintenance budget for the major network assets);
- Excessive water pressures in some areas;
- Difficulty in hydraulically isolating zones and districts;
- Inaccuracies in GIS and CIS systems, creating difficulty in NRW measurement and implementing remediation programs;
Comprehensive NRW Reduction in Distribution Zone 27 (Tareq) - Amman

Scope:
- District isolation, bulk meter rehabilitation and corrections to the GIS and CIS;
- Rehabilitation works, disconnection of redundant mains, replacement of galvanized and steel pipes and disconnection of illegal connections;
- Leak detection and repair;
- Pressure control;
- Replacement of mechanical meters with ultrasonic meters in test districts 27 A-2, A-3.

Results:
- Average pressure reduced from 140m to 52m;
- In test district 27 A-2, NRW was reduced from 47% to 5%;
- In test district 27 A-3, NRW was reduced from 27% to 8%;
- In test district 27 D, NRW was reduced from 45% to 18%;
- NRW for DZ 27 as a whole was reduced to 11%.

Total cost USD 4.2 million, payback period 3-4 years.
Comprehensive NRW Reduction in Distribution Zone 27 (Tareq) – Foundation Tasks

**Foundation Tasks:**

- These tasks are essential to create NRW baseline to monitor the reduction of NRW for each proposed activity and overall NRW reduction
  - Hydraulic analysis
  - Restructuring of distribution zone and districts
  - Bulk meters verification and replacement whenever required
  - Adjusting zones boundaries, creating new districts and districts isolation;

**Design Criteria:**

- New district metered areas DMAs were created according to Miyahuna design criteria focusing on elevation difference, practicality and feasibility
- Total number of customers
- Number of feeders: one or two metered sources of water feeding the district
Hydraulic Analysis:

- Examine the actual performance and adequacy of the water network
- Based on the results of the hydraulic model, the districts borders were revised to achieve the best hydraulic performance with a minimum cost.
- As a result of the redistricting, the number of DZ-27 districts increased from 4 to 8

Existing Conditions:

Proposed Conditions:
Comprehensive NRW Reduction in Distribution Zone 27 (Tareq) – Water Network Rehabilitation

- **Tertiary Network and House Connection Rehabilitation**: 32,878 meters total
  - 200 mm DI: 317 meters,
  - 150 mm DI: 1,124 meters
  - 100 mm DI: 1,467 meters
  - 32 mm PE: 3,544 meters
  - 180 mm PE: 5,376 meters
  - 125 mm PE: 20,945 meters
  - 63 mm PE: 3,649 meters
  - 25 mm PE: 5,028 meters

- **Financial Analysis**
  - The capital cost of the NRW reduction activities that took place in DZ-27 is about 4 Million USD
  - The NRW reduction activities in DZ-27 reduce the NRW from 47% to reach 11.3%
  - The annual water supply in DZ-27 is about 3.8 MCM after FARA works completion.
  - The total amount of annual water saved = 1.36 MCM.
  - Total amount of cash saved = 1.76 Million USD per year based on the average selling price of cubic meter.
  - The payback period = 2.3 years
Comprehensive NRW Reduction in Distribution Zone 27 (Tareq) – Leak Detection and Repair

**Leak Detection**

- Miyahuna launched a comprehensive leak detection campaign to locate and maintain the invisible leaks in DZ27.
- NRW department located about 500 invisible and visible leaks during the implementation of project works utilizing the mobile workshop units.
NRW Reduction in DZ 27 A-2 (Ultrasonic Meters)

- Residential Water Meter Replacement
  - Replaced Class B meters with US meters in DZ 27 A-2 (1,600 customers) and A3 (120 customers).
  - After isolation and water meter replacement NRW dropped from 47% to 28% was due to the more accurate US meters and replacement of totally failed meters.
  - Keeping the meter fleet in working order is a management task not a technology choice.
NRW Reduction in DZ 27 (NRW Quantification)

Flow Balance Results

- Miyahuna and MESC team selected DZ-27 A2 to be the test district. This district was subjected to several flow balance tests (FB) to measure the marginal impact of each NRW reduction activity such as replacement of mechanical meters with ultrasonic meter, water network rehabilitation and leak detection.
- Miyahuna decided to measure NRW reduction in other DMAs in DZ-27 such as DZ 27-A3 and DZ-27 D.
- In addition, Miyahuna carried out a customer survey and a water flow balance for the Whole DZ-27. The activity was labour-intensive and required the assistance and coordination between all of Miyahuna directorates (NRW, CS, Technical, Operations and GIS).
- The NRW reduction from 47% to 5% was an excellent result, and beyond expectations given that over 90% of the customer meters in DZ 27 are still Class B. It had not been thought possible to achieve an NRW level this low in Jordan.
# DZ 27 A-2 Flow Balances

<table>
<thead>
<tr>
<th>Date</th>
<th>Post isolation, Class B meters</th>
<th>US Meters</th>
<th>Fixed large leak</th>
<th>Fixed large leak</th>
<th>Fixed large leak</th>
<th>Repeat</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/1-8/16</td>
<td></td>
<td>5/31-6/7/16</td>
<td>9/30-10/10/16</td>
<td>10/10-19/16</td>
<td>11/20-27/16</td>
<td>01-08/04/18</td>
</tr>
<tr>
<td>Customer Meters Read</td>
<td>1499</td>
<td>1605</td>
<td>1871</td>
<td>1877</td>
<td>1873</td>
<td>1963</td>
</tr>
<tr>
<td>Supplied volume, m3</td>
<td>6720</td>
<td>5882</td>
<td>11870</td>
<td>11700</td>
<td>9246</td>
<td>10939</td>
</tr>
<tr>
<td>Metered consumption, m3</td>
<td>3464</td>
<td>4233</td>
<td>9675</td>
<td>10001</td>
<td>8776</td>
<td>10140</td>
</tr>
<tr>
<td>NRW, m3</td>
<td>3256</td>
<td>1648</td>
<td>2195</td>
<td>1699</td>
<td>470</td>
<td>799</td>
</tr>
<tr>
<td>NRW, %</td>
<td>47</td>
<td>25</td>
<td>18</td>
<td>15</td>
<td>5</td>
<td>7</td>
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</tbody>
</table>
DZ 27 A-2 NRW Results

NRW %

- Isolation, Hydraulic upgrade, Class B Meters
- US Meters
- Network Rehabilitation
- Leak Detection and Repair

DZ27 A2 NRW%
### DZ 27 A-3 Flow Balances

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks</td>
<td>Portable bulk meter</td>
<td>Installed a bulk meter - baseline</td>
<td>Leak repaired</td>
<td>PRV, inlet 12 bar outlet 5.5 bar</td>
<td>Inlet 12 bar outlet 8 bar</td>
<td>Repeat</td>
<td>Repeat</td>
<td>US meters</td>
<td>Leak repair</td>
<td>Repeat</td>
<td>Repeat</td>
</tr>
<tr>
<td>Customers</td>
<td>111</td>
<td>114</td>
<td>114</td>
<td>116</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Water Supplied</td>
<td>353</td>
<td>368</td>
<td>386</td>
<td>378</td>
<td>474</td>
<td>487</td>
<td>413</td>
<td>647</td>
<td>421</td>
<td>452</td>
<td>386</td>
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<tr>
<td>Water Consumed</td>
<td>240</td>
<td>267</td>
<td>311</td>
<td>293</td>
<td>367</td>
<td>398</td>
<td>323</td>
<td>483</td>
<td>401</td>
<td>409</td>
<td>354</td>
</tr>
<tr>
<td>NRW%</td>
<td>32</td>
<td>27</td>
<td>20</td>
<td>22</td>
<td>23</td>
<td>18</td>
<td>22</td>
<td>25</td>
<td>5</td>
<td>10</td>
<td>8</td>
</tr>
</tbody>
</table>
DZ 27 A-3 NRW Results

![Graph showing NRW% vs. different interventions]

- **Isolation, Hydraulic upgrade, Class B Meters**
- **US Meters**
- **Network Restructuring, Leak Detection and Repair**
# DZ 27 D Flow Balances

<table>
<thead>
<tr>
<th>DZ 27 D</th>
<th>FB 1</th>
<th>FB 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post isolation, Class B meters</td>
<td>Network rehabilitation, leak detection and repair</td>
</tr>
<tr>
<td>Date</td>
<td>10/8-16/2017</td>
<td>11/21-28/2017</td>
</tr>
<tr>
<td>Customer Meters Read</td>
<td>2657</td>
<td>2706</td>
</tr>
<tr>
<td>Supplied volume, m³</td>
<td>14460</td>
<td>10215</td>
</tr>
<tr>
<td>Metered consumption, m³</td>
<td>7882</td>
<td>8422</td>
</tr>
<tr>
<td>NRW, m³</td>
<td>6577</td>
<td>1793</td>
</tr>
<tr>
<td>NRW %</td>
<td>45</td>
<td>18</td>
</tr>
</tbody>
</table>
DZ 27 D NRW Results

NRW %

Post Isolation, Class B Meters    Network Restructuring, Leak Detection and Repair
<table>
<thead>
<tr>
<th>Districts</th>
<th># of Customer</th>
<th>Avg. Cons</th>
<th>Water Supply (m³)</th>
<th>Water Consumption (m³)</th>
<th>NRW (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DZ -27 A1</td>
<td>10,586</td>
<td>2.78</td>
<td>32,088</td>
<td>29,462</td>
<td>8.2%</td>
</tr>
<tr>
<td>DZ- 27 A2</td>
<td>1,966</td>
<td>2.78</td>
<td>7,812</td>
<td>7,333</td>
<td>5%</td>
</tr>
<tr>
<td>DZ- 27 A3</td>
<td>134</td>
<td>2.29</td>
<td>337</td>
<td>305</td>
<td>9.6%</td>
</tr>
<tr>
<td>DZ- 27 B</td>
<td>72</td>
<td>4.25</td>
<td>347</td>
<td>302</td>
<td>12.9%</td>
</tr>
<tr>
<td>DZ- 27 D</td>
<td>2,764</td>
<td>2.65</td>
<td>10,327</td>
<td>9,139</td>
<td>11.5%</td>
</tr>
<tr>
<td>DZ -27 E1</td>
<td>2,555</td>
<td>2.479</td>
<td>6,920</td>
<td>6,321</td>
<td>8.7%</td>
</tr>
<tr>
<td>DZ- 27 E2</td>
<td>4,616</td>
<td>2.7</td>
<td>15,842</td>
<td>12,509</td>
<td>21.0%</td>
</tr>
<tr>
<td>DZ- 27</td>
<td>22,693</td>
<td>2.9</td>
<td>73,673</td>
<td>65,371</td>
<td>11.3%</td>
</tr>
</tbody>
</table>
Conclusion

- NRW can be reduced under intermittent supply to less than the 25% national target;
- Hydraulic improvements offer the greatest NRW reduction and cost/benefit ratio;
- Carry out additional residential water replacement programs to further reduce commercial NRW.
- Payback on the investment was satisfactory at 2-3 years.