



WSTA 13th Gulf Water Conference
Water in the GCC: Challenges and Innovative Solutions
Kuwait Institute for Scientific Research (KISR), State of Kuwait
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Reduction of the Technical Losses Component of the NRW in water Networks in Sultanate of Oman

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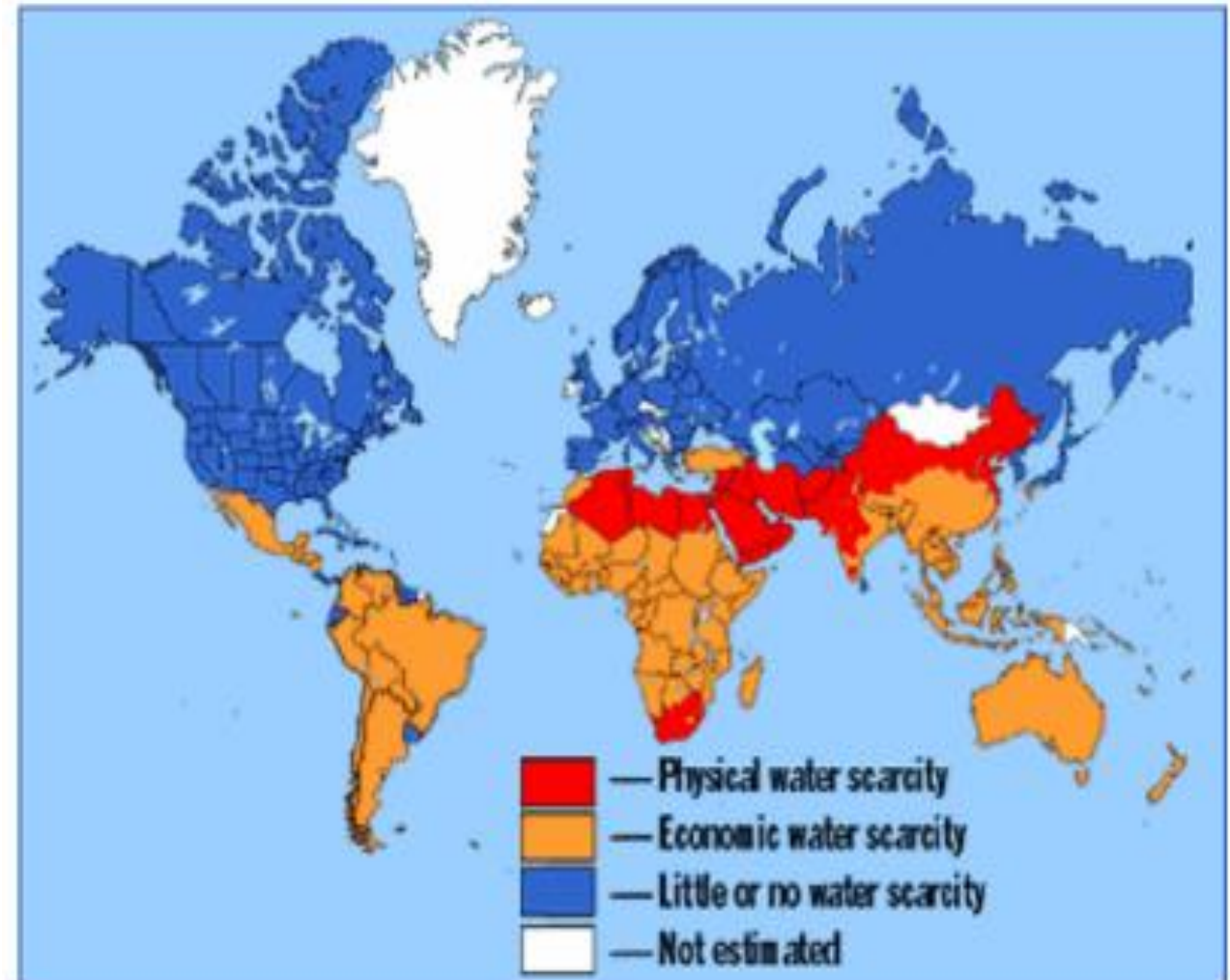


Water Scarcity

Non Revenue Water

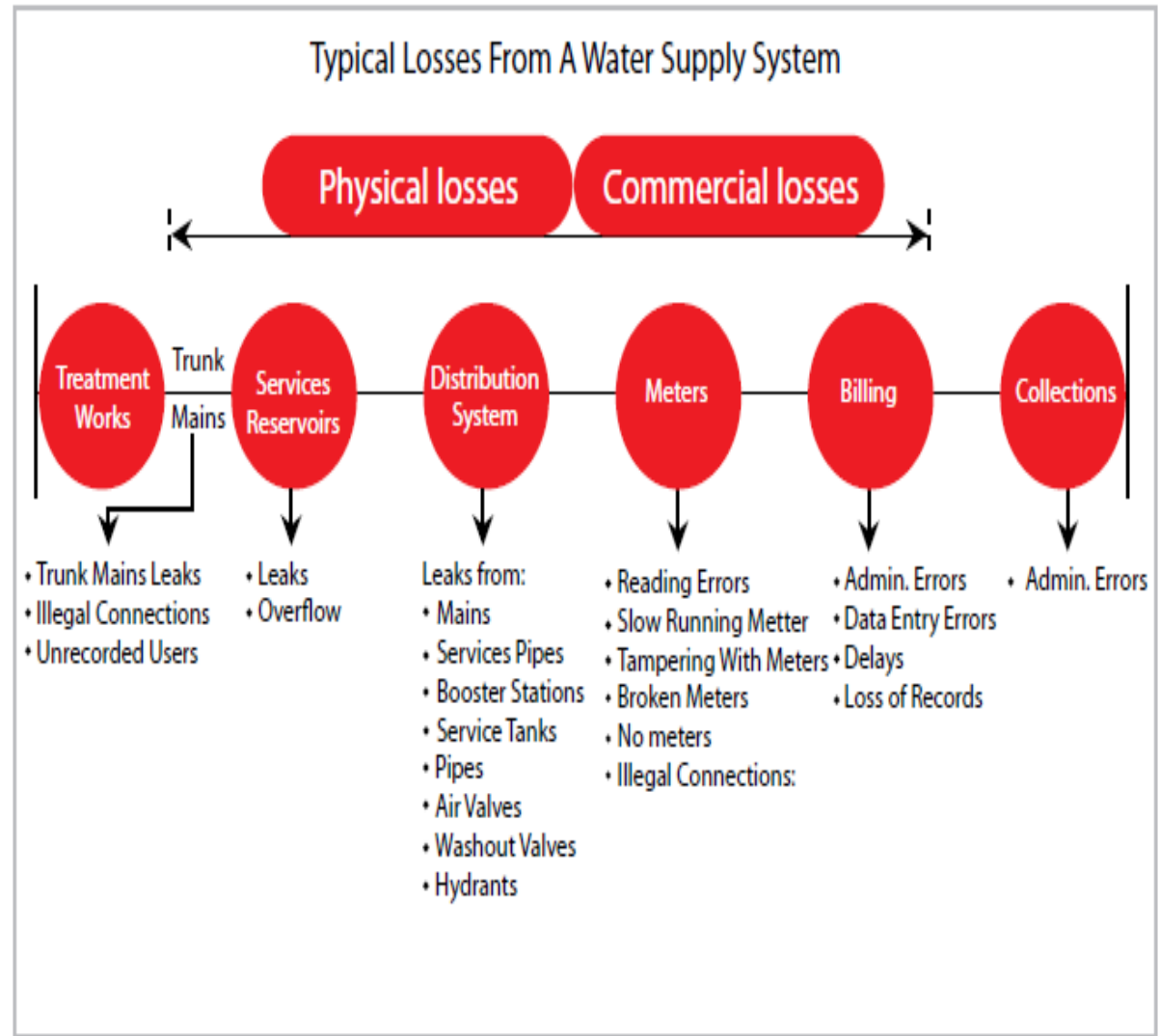
Water Supply System in
DIAM

Reduction of Technical
Losses



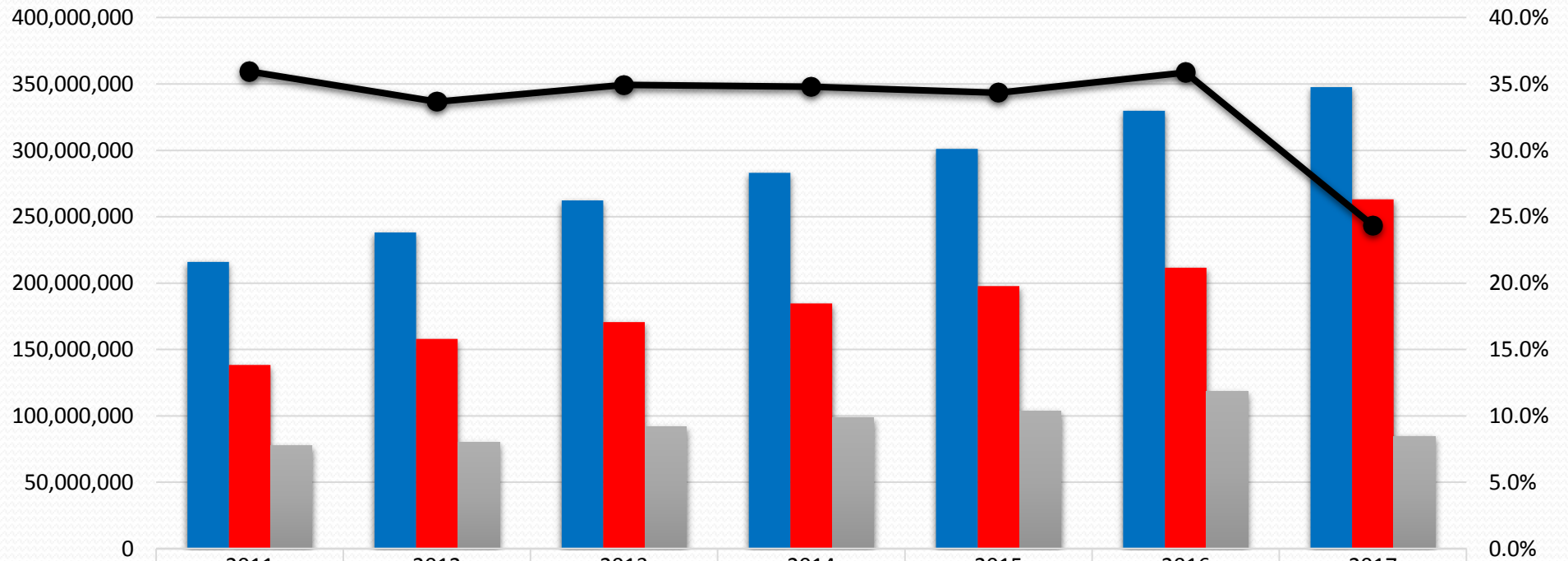
Non Revenue Water (Losses)

System input volume (treated water production)	Authorized Consumption	Billed Authorized Consumption	Billed metered	Revenue water (volume invoiced)	
		Unbilled Authorized Consumption	Billed unmetered	Unbilled metered	Unbilled non metered
			Unauthorized consumptions		
Water Losses	Apparent losses (commercial)	Meters inaccuracies	Losses on hydraulic facilities	Non Revenue Water (NRW)	
		Real losses (physical losses)	Losses on transmission & distribution mains		



Production , Consumption & NRW in DIAM

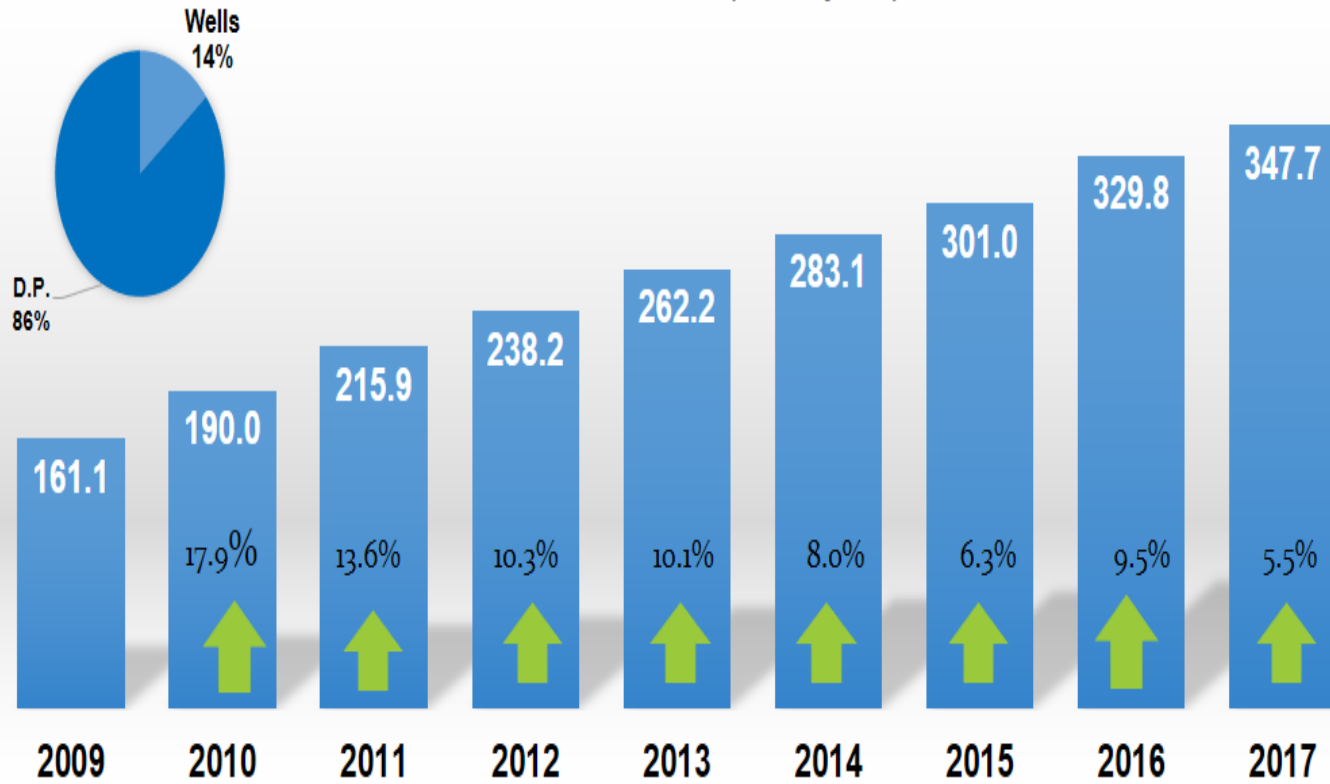
Production / Consumption / UFW (Unaccounted For Water)



	2011	2012	2013	2014	2015	2016	2017
Production	215,900,000	238,200,000	262,199,120	283,135,760	301,008,112	329,787,928	347,684,307
Accounted Consumption	138,290,000	158,010,000	170,609,120	184,625,760	197,668,112	211,522,119	263,051,772
UFW	77,610,000	80,190,000	91,590,000	98,510,000	103,340,000	118,265,809	84,632,536
UFW%	35.9%	33.7%	34.9%	34.8%	34.3%	35.86%	24.34%



Water Production (Mm3/year)



Reduction of Technical Losses



Total Saving in Technical Losses in 2018
8,029,976 m3/year

Water Supply System in DIAM

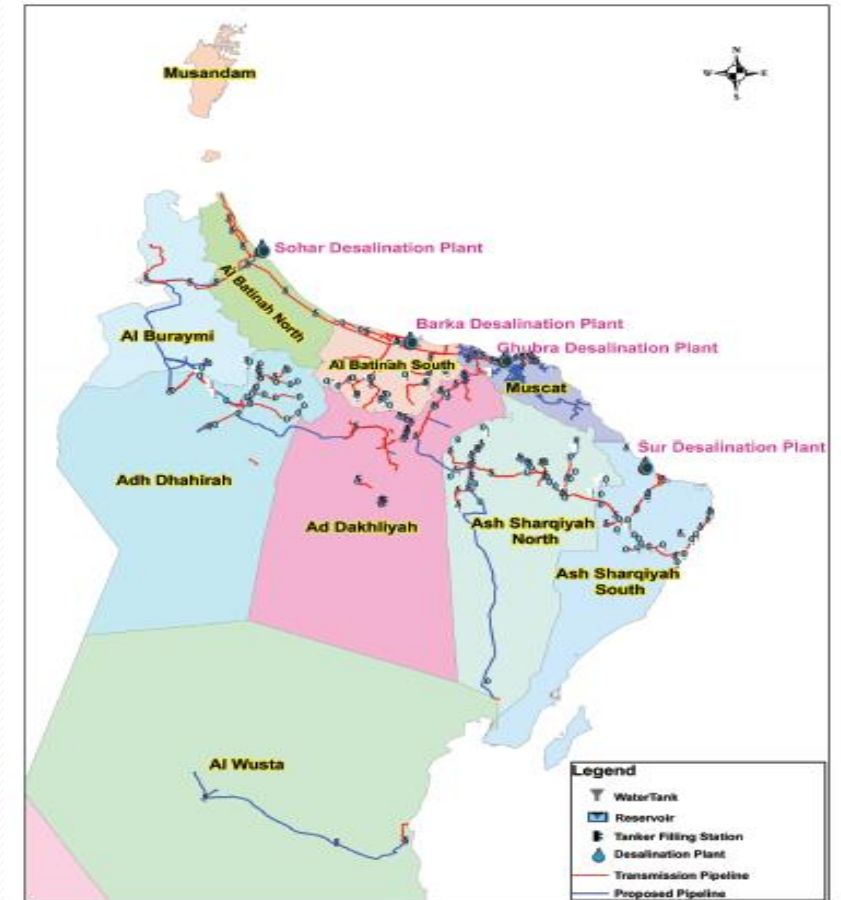
Monitoring of volumes from production sites up to customer premises is the basis for water balance and KPI calculations



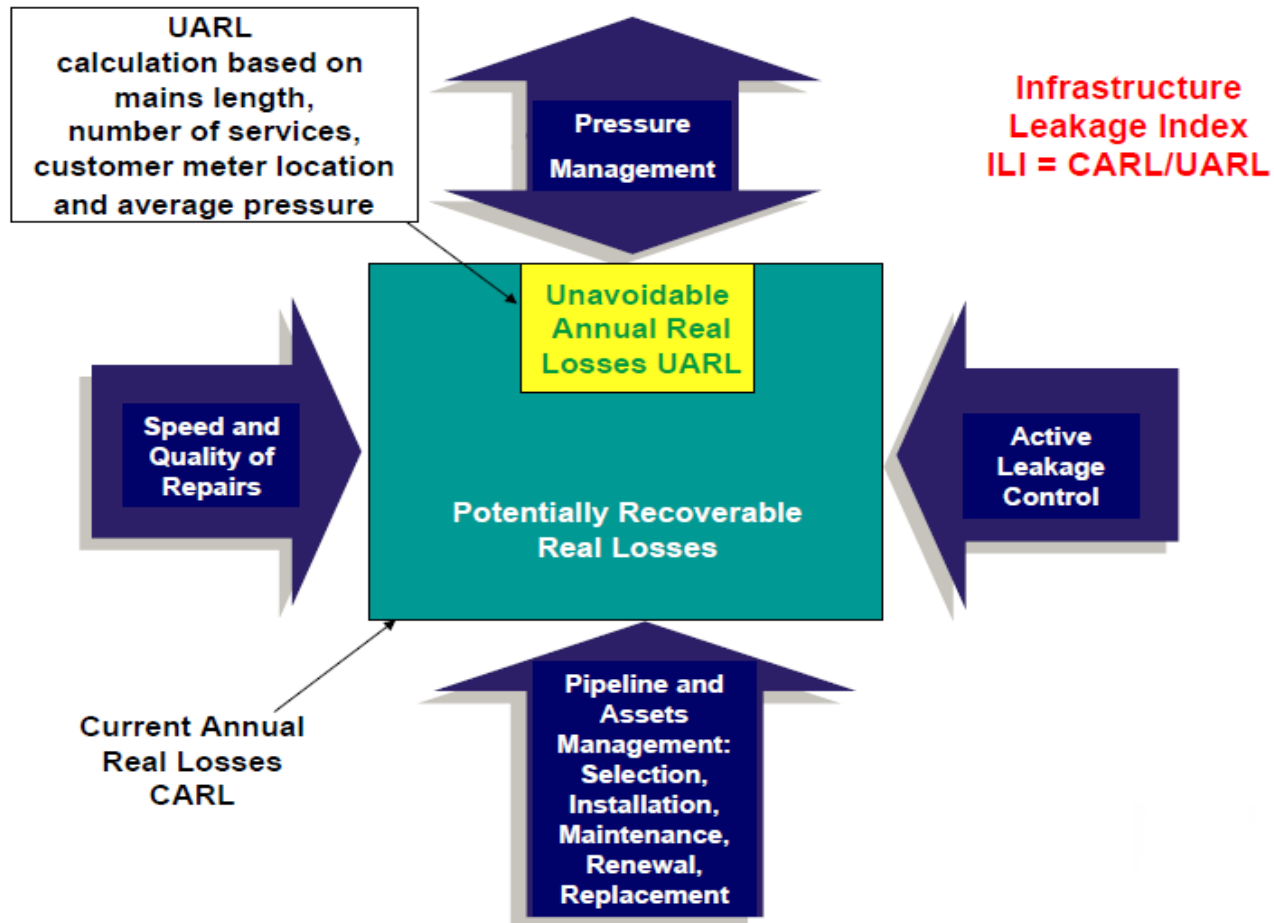
Total Networks length = 17,850 km

Total Operational assets = 2,434

Number of Customers = 500,000



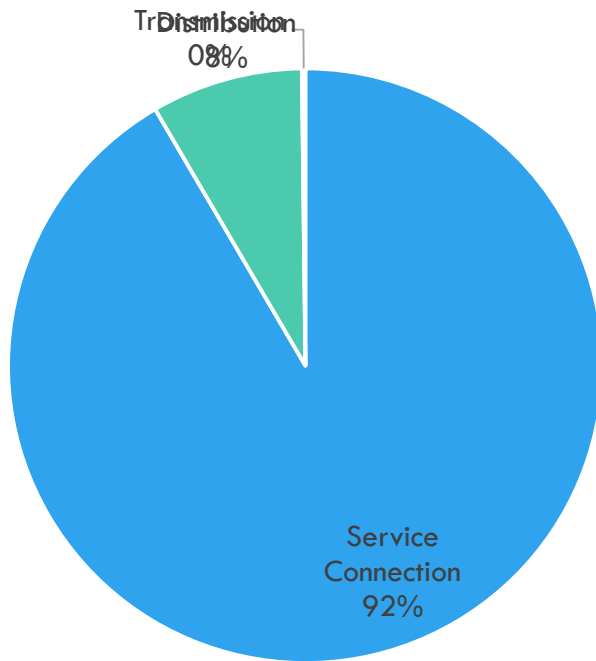
Efforts of Technical Losses Reduction



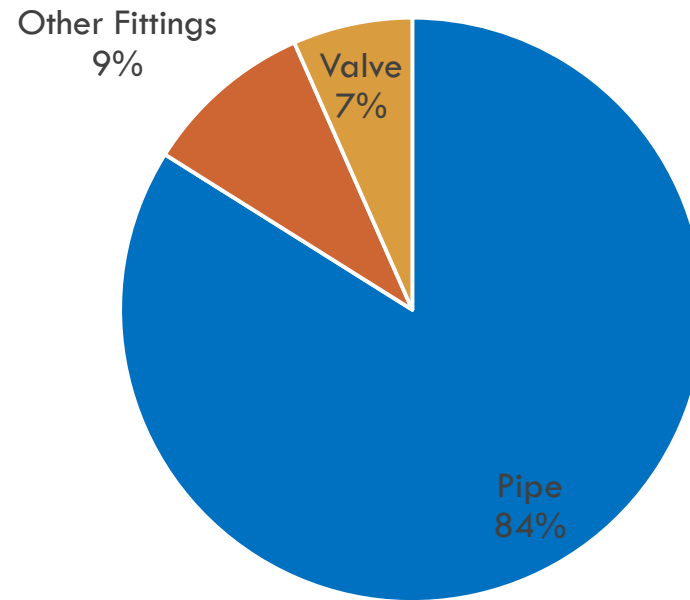
NRW Reduction Main PILLARS



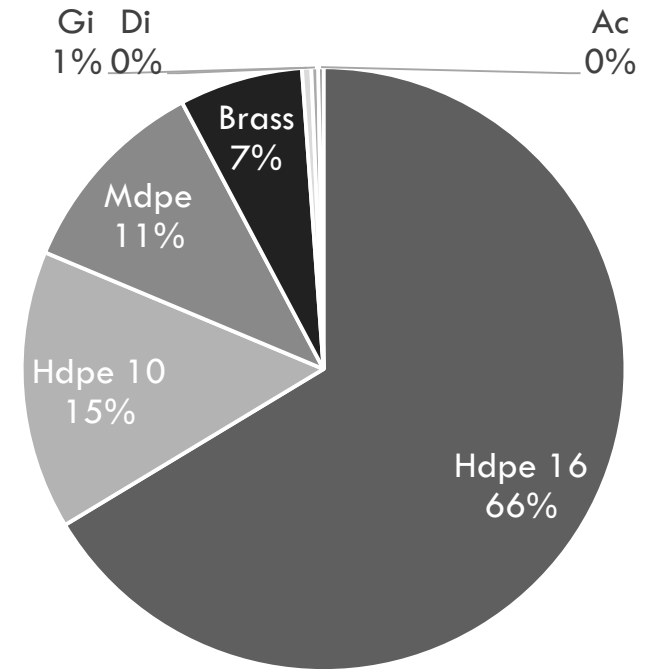
Leaks in the type of networks



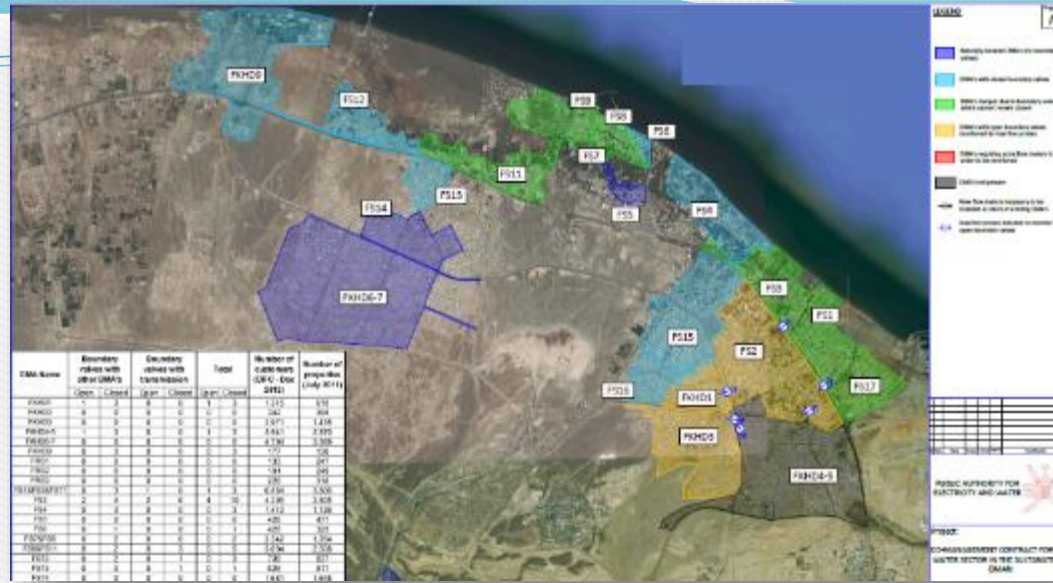
Leaks in the type of assets



Leaks in the type of pipe materials



Tools & Equipment



DMAs

Sr.	Tool & Equipment Name
1	Correlators
2	Ground Microphone
3	Listening sticks
4	Metal Detector
5	Plastic pipe Detector
6	Pressure Transducer
7	Pressure Gauge
8	Insertion prob flow meter
9	Clamp on flow meter
10	Noise loggers
11	Pressure Data loggers
12	Flow Data loggers
13	Helium gas detector
14	Softwares



12 Omani teams

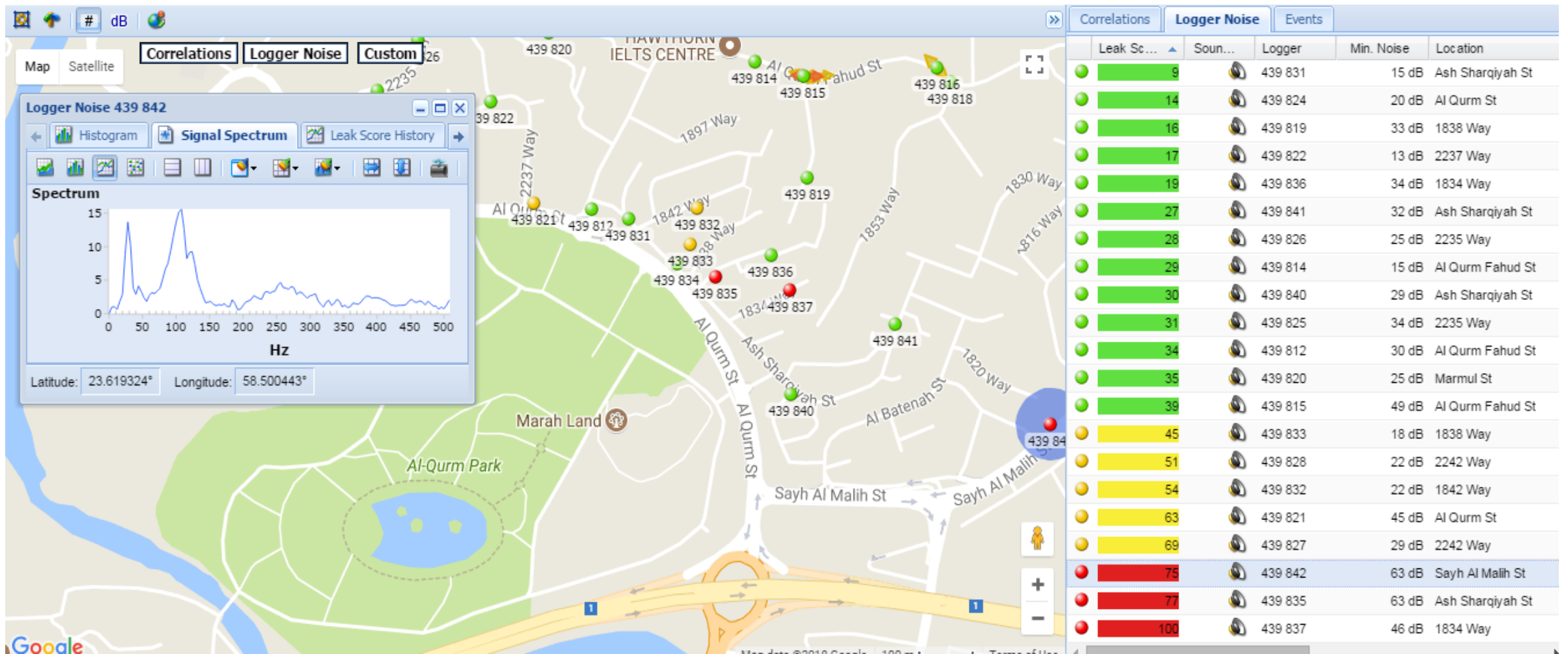


LD Field Tools



Softwares

Analyze sound levels and properties using sensors by connecting them to an electronic tracking system to identify leakage zones

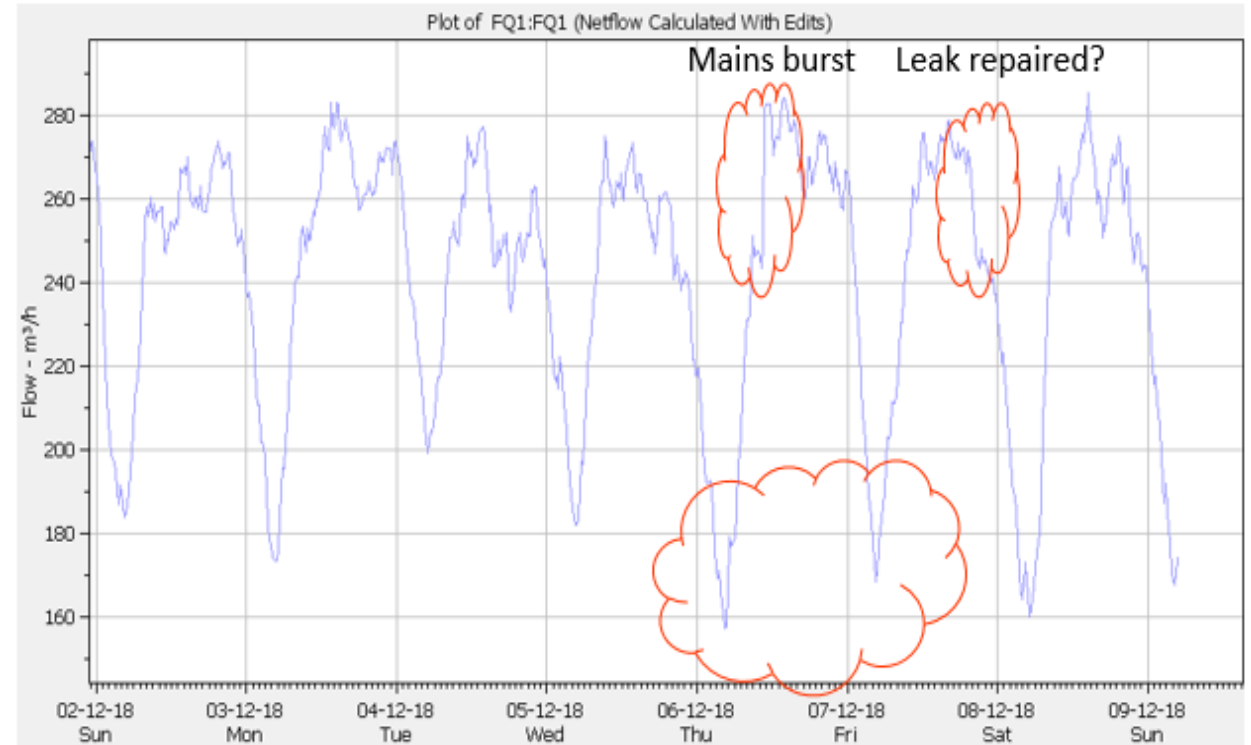
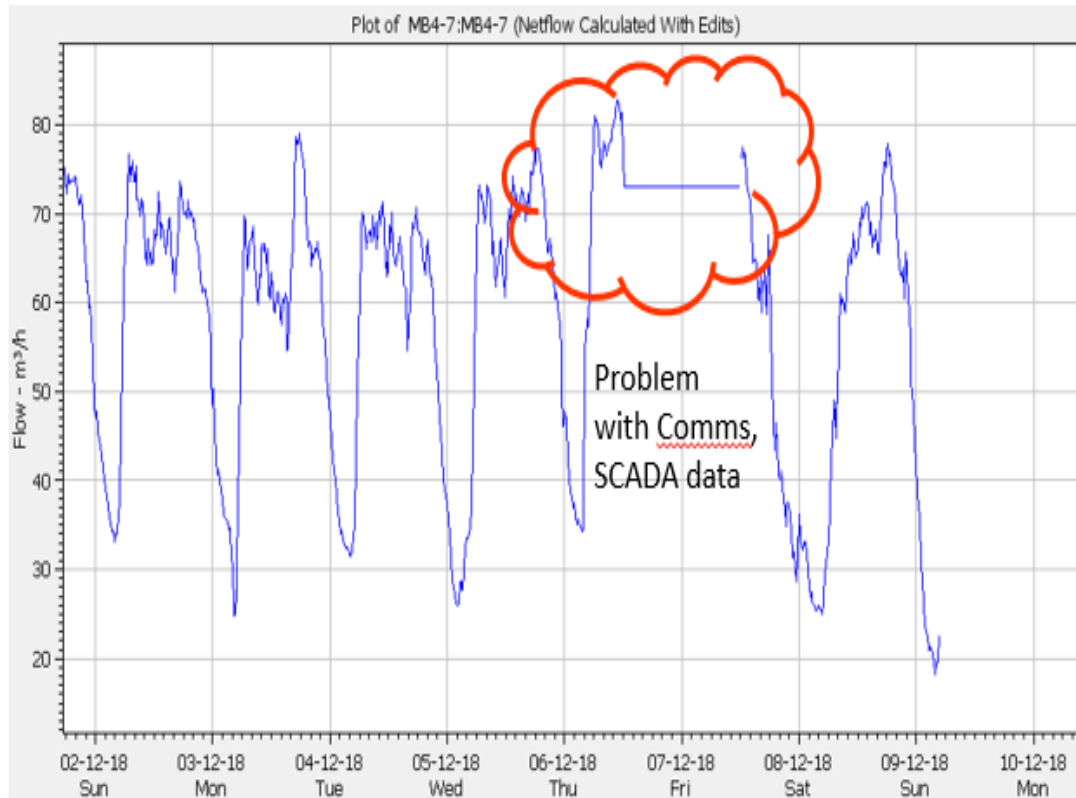


Analyzing Software

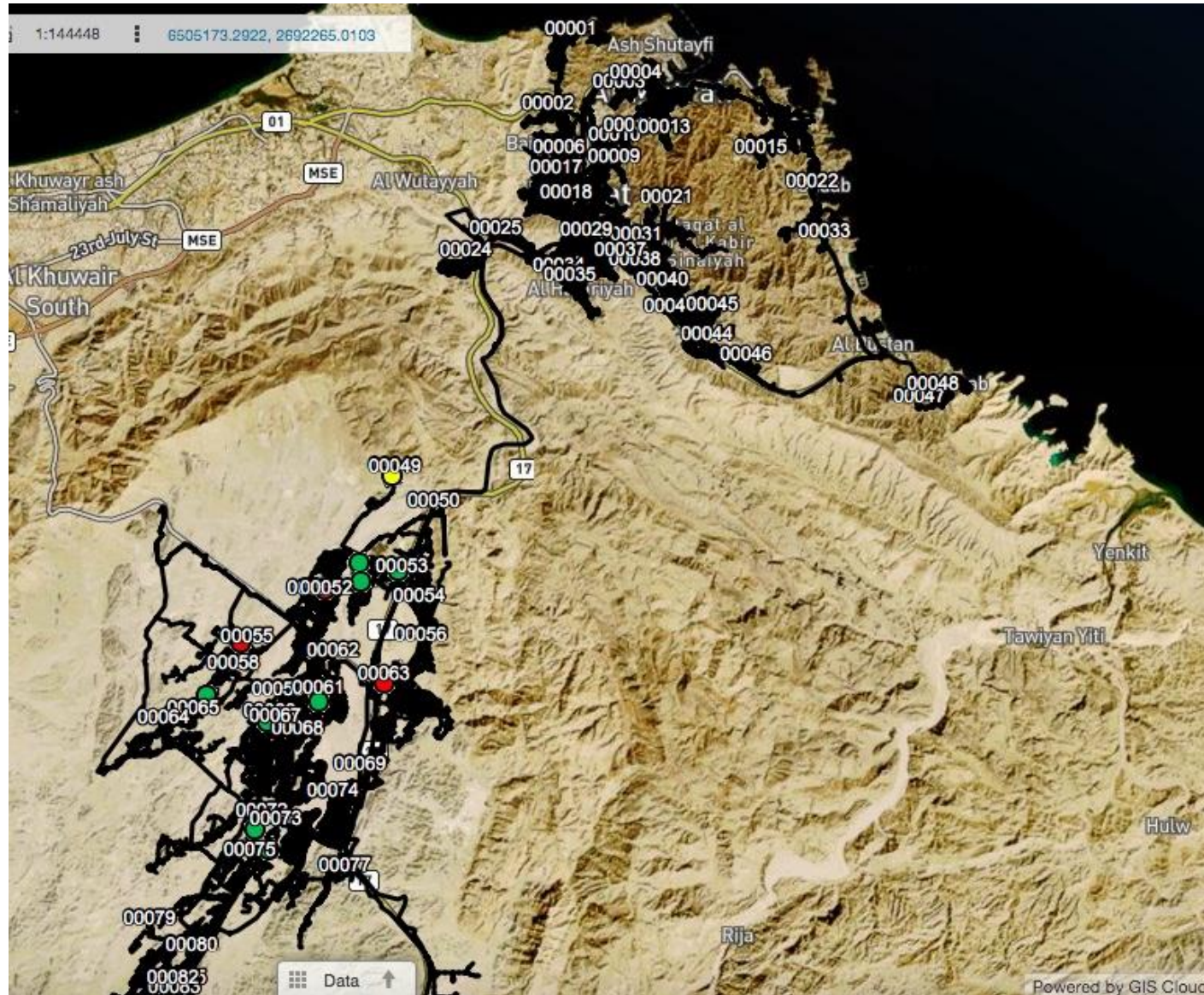
Show Min Hist Night Flow: Yes
 Exclude Trunk Main Area: Yes
 Exclude Dummy Area: Yes
 Net MNF Difference
 Calculated From: End Date and the Previous Date
 Order DMAs by: Net Min Night flow Difference
 Data Displaying: Two Columns
 Number of Decimal Places: 2

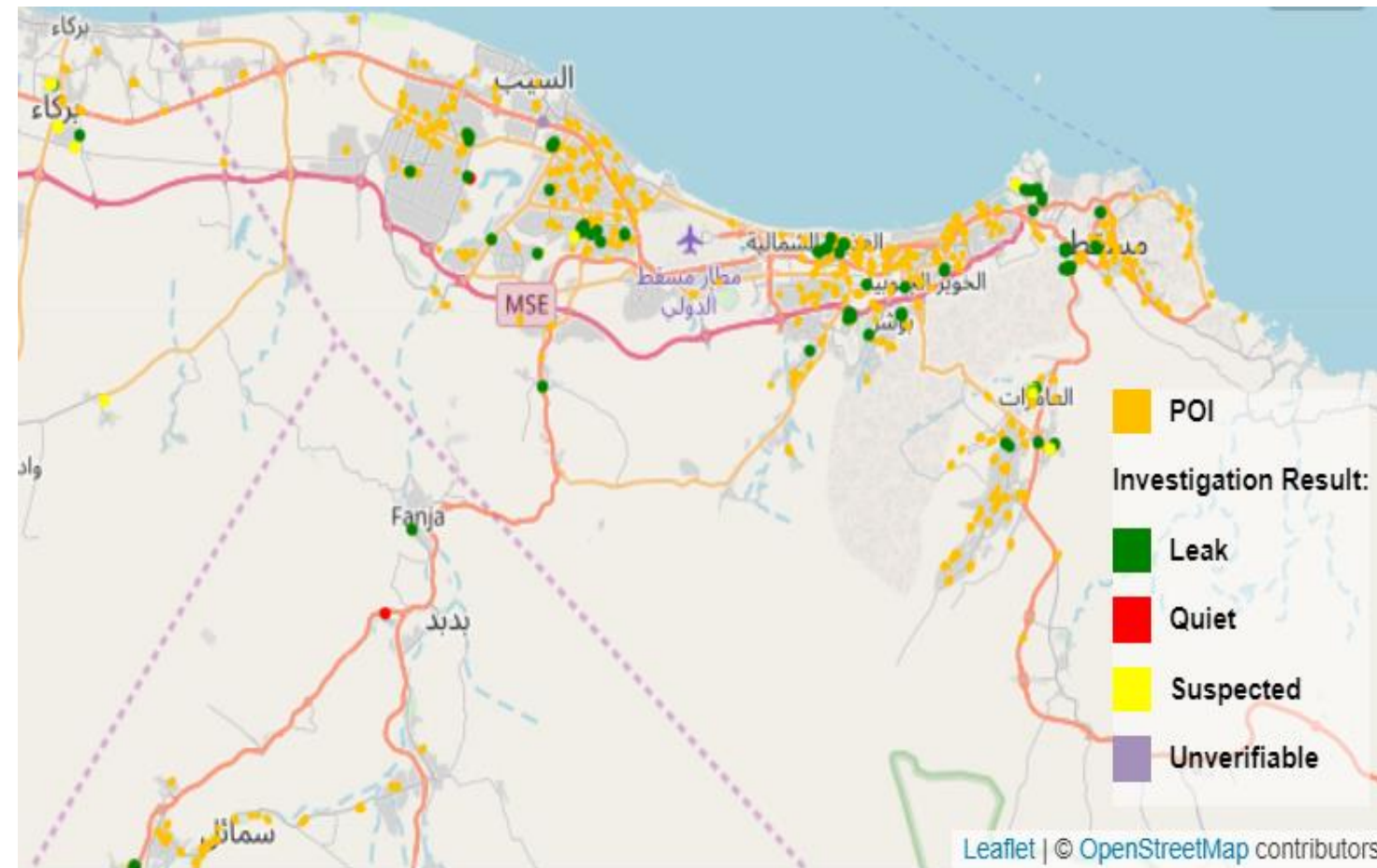
DMAs Reference	DMAs Name	Area Type	No of cont logged users	Exit Level (m³/h)	Minimum Achieved Nightline (m³/h)	06/12/2018		07/12/2018		Net Min Night Flow Difference 07/12/2018 - 06/12/2018 (m³/h)	Exit Level Difference 07/12/2018 (m³/h)	Minimum Achieved Nightline Difference 07/12/2018 (m³/h)
						Net Min Night Flow (m³/h)	Net Min Valid	Net Min Night Flow (m³/h)	Net Min Valid			
BAR3	BARXA3	DMA (Domestic and Industrial)	0	29.97	0.00	29.25	Yes	68.25	Yes	39.00	38.28	
MB4-7	MB4-7	DMA (Domestic and Industrial)	0	0.00	0.00	34.67	Yes	73.10	Yes	38.43		
KHUMAILLAH RESERVOIR	KHUMAILLAH RESERVOIR	DMA (Domestic and Industrial)	0	0.00	0.00	60.00	Yes	85.00	Yes	25.00		
FQ1	FQ1	DMA (Domestic and Industrial)	0	0.00	0.00	169.54	Yes	192.63	Yes	23.09		
FQ9	FQ9	DMA (Domestic and Industrial)	0	301.87	0.00	258.56	Yes	275.71	Yes	17.16	-26.15	
FRS1	FRS1	DMA (Domestic and Industrial)	0	59.01	0.00	210.24	Yes	226.81	Yes	16.57	167.81	
FSA1	FSA1	DMA (Domestic and Industrial)	0	0.00	0.00	195.04	Yes	210.13	Yes	15.10		
SUR1	Sur 1	DMA (Domestic and Industrial)	0	0.00	0.00	239.25	Yes	253.00	Yes	13.75		
FR4	FR4	DMA (Domestic and Industrial)	0	0.00	0.00	58.25	Yes	70.60	Yes	12.35		
FT3	FT3	DMA (Domestic and Industrial)	0	0.00	0.00	281.29	Yes	291.36	Yes	10.08		
FT1	FT1	DMA (Domestic and Industrial)	0	211.71	0.00	221.66	Yes	231.46	Yes	9.80	19.76	
FMS	FMS	DMA (Domestic and Industrial)	0	97.32	0.00	112.99	Yes	122.27	Yes	9.28	24.96	
DAR1	DARIZ	DMA (Domestic and Industrial)	0	14.50	0.00	31.06	Yes	38.50	Yes	7.44	24.00	
FS15	FS15	DMA (Domestic and Industrial)	0	360.98	0.00	192.94	Yes	200.12	Yes	7.18	-160.87	
FB4	FB4	DMA (Domestic and Industrial)	0	328.02	0.00	362.85	Yes	369.99	Yes	7.14	-41.97	
FR7	FR7	DMA (Domestic and Industrial)	0	15.50	0.00	36.87	Yes	43.76	Yes	6.89	28.26	
FS4	FS4	DMA (Domestic and Industrial)	0	0.00	0.00	29.15	Yes	35.49	Yes	6.34		

Analyzing Software



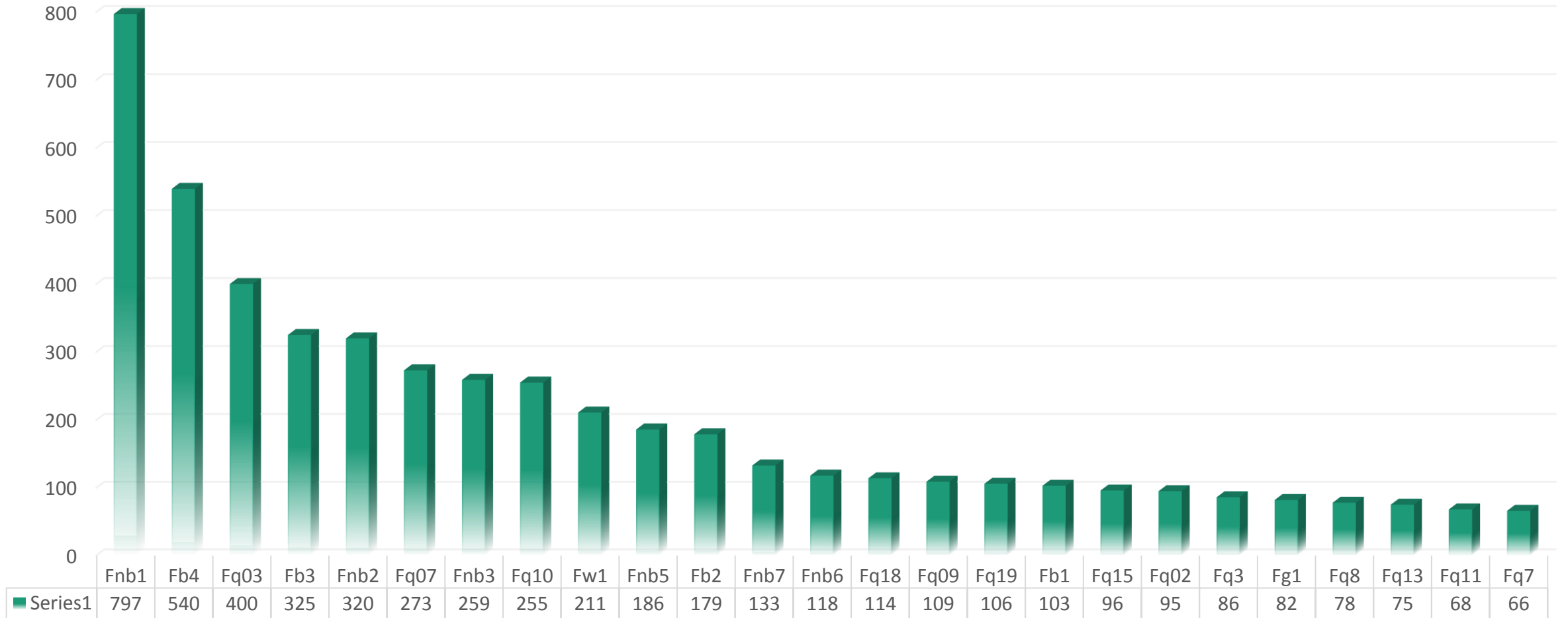
Satellite Leak Detection





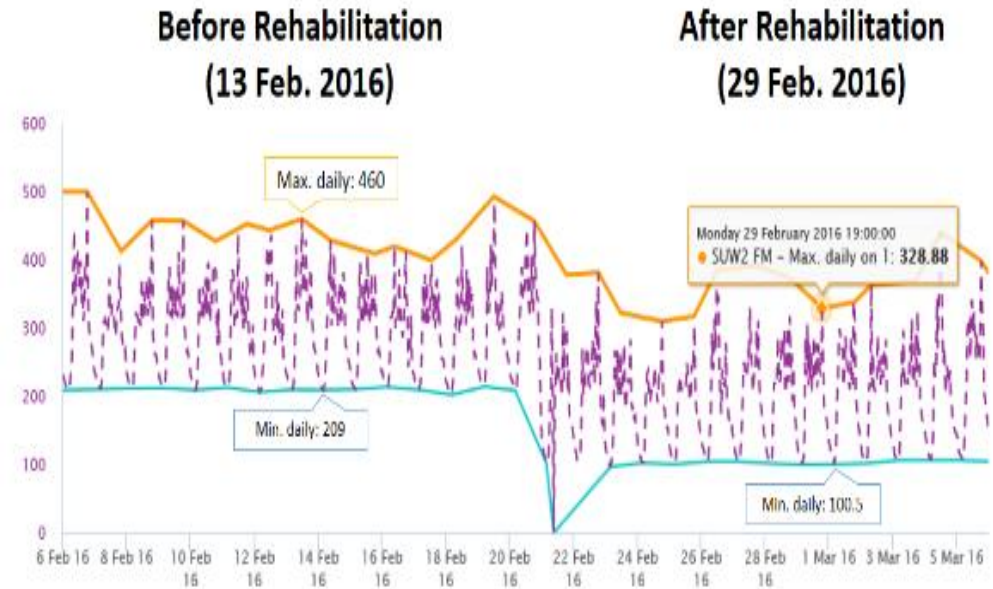
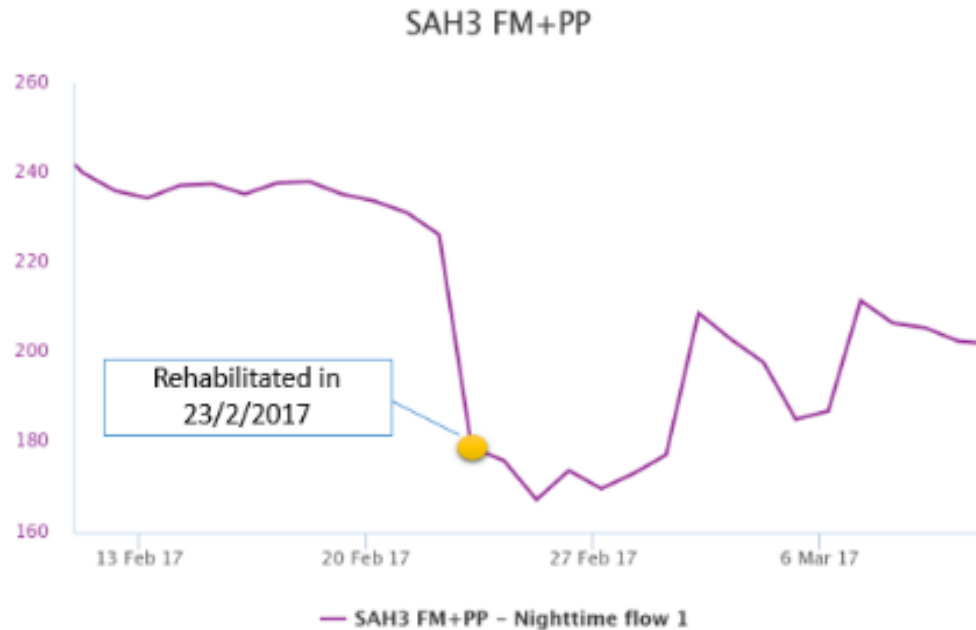
- Number of delivered findings: 635
- Locations Survey: 154 Completed
- Percentage Completed: 24%
- Total leaks found: 229
- 76% of surveyed areas had leaks
- 18% Suspected leaks
- 6% No leaks

Networks Rehabilitations



PIPES REHABILITATION

In all water networks the renew and rehabilitation is continuous process, because the pipes have operating life, after that it start deteriorating and breaks



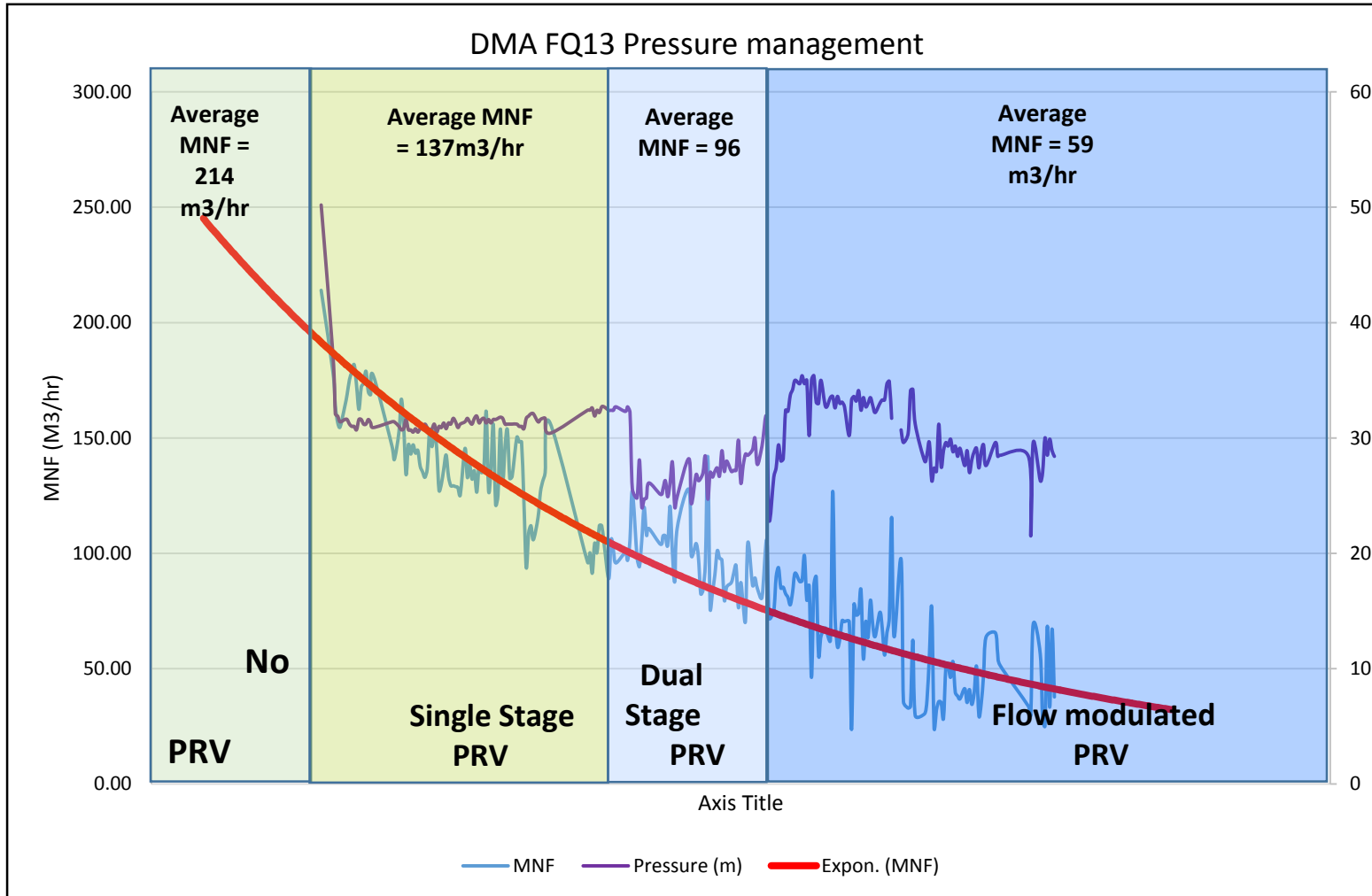
Networks Rehabilitations for 321 km in 2017

Pressure Management

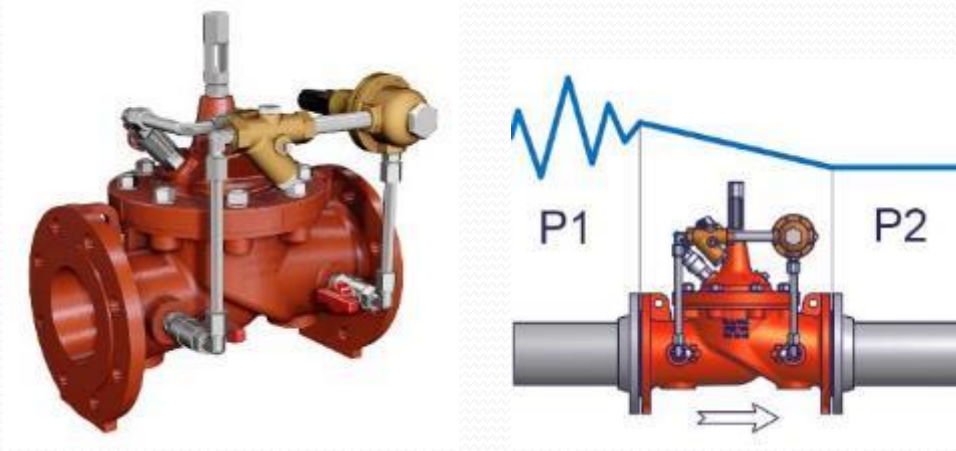


60 Pressure Reducing Valves Installed in 2017

Techniques of Pressure Management

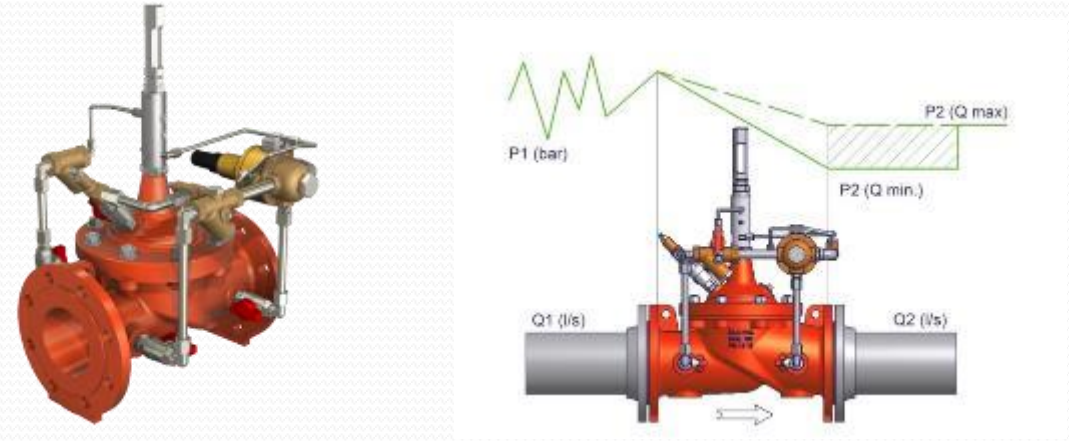


Single Stage PRV



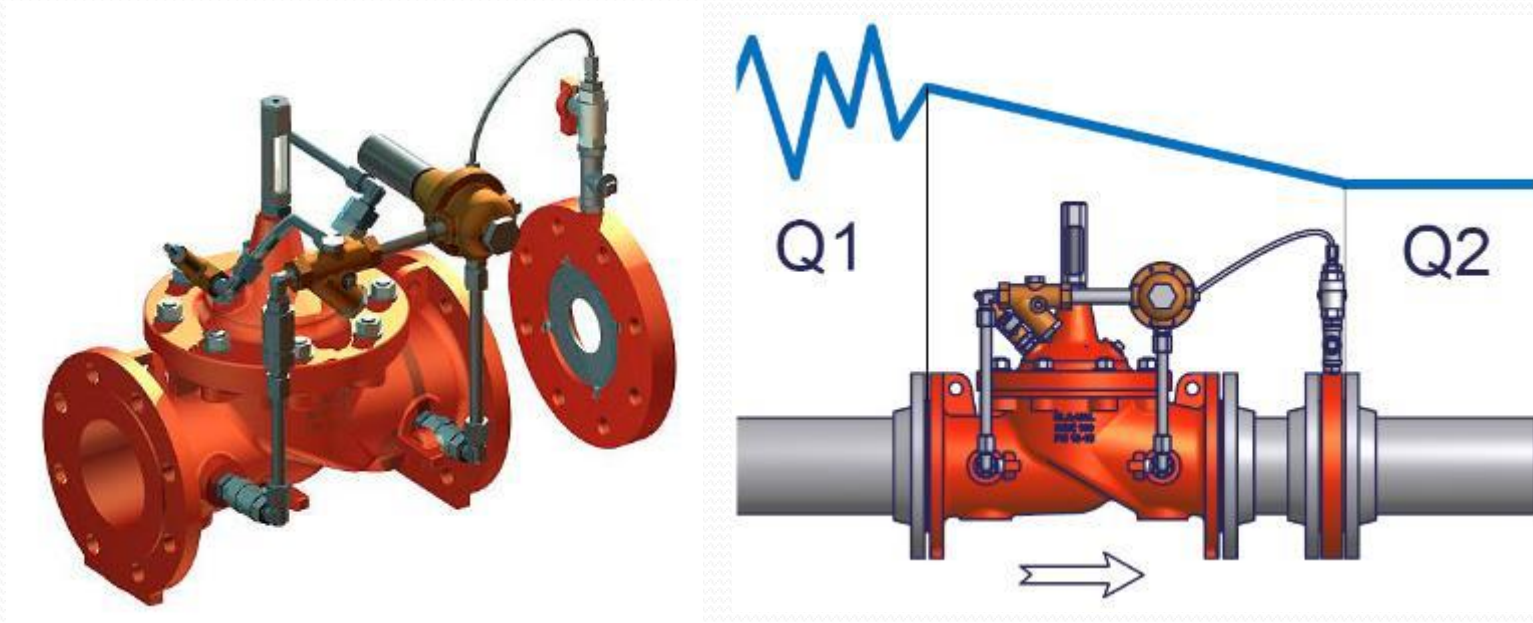
reduces a higher inlet pressure to a constant downstream pressure (Pressure Reducing Control) regardless of changing flow rate and/or varying inlet pressure.

Dual Stage PRV



Pressure Management Control Valve automatically adjusts the downstream pressure based upon demand changes in the system.

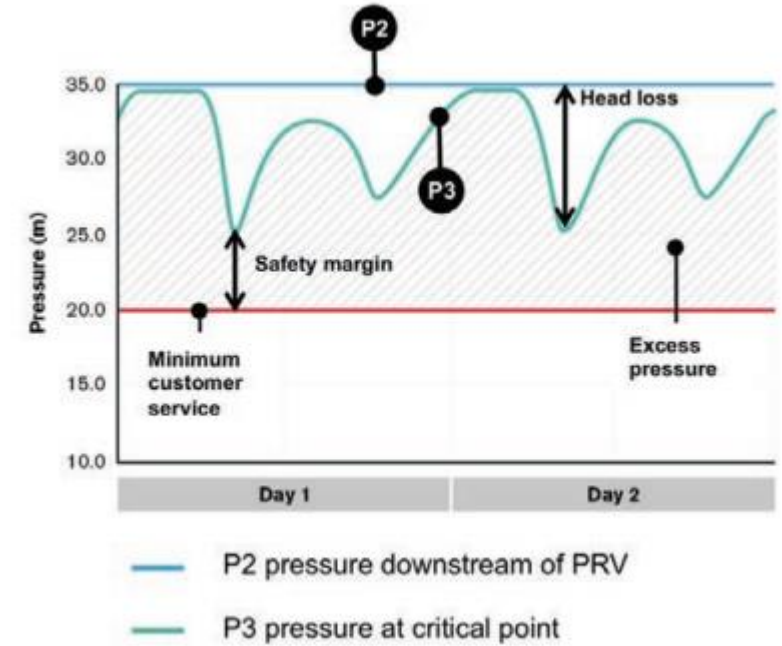
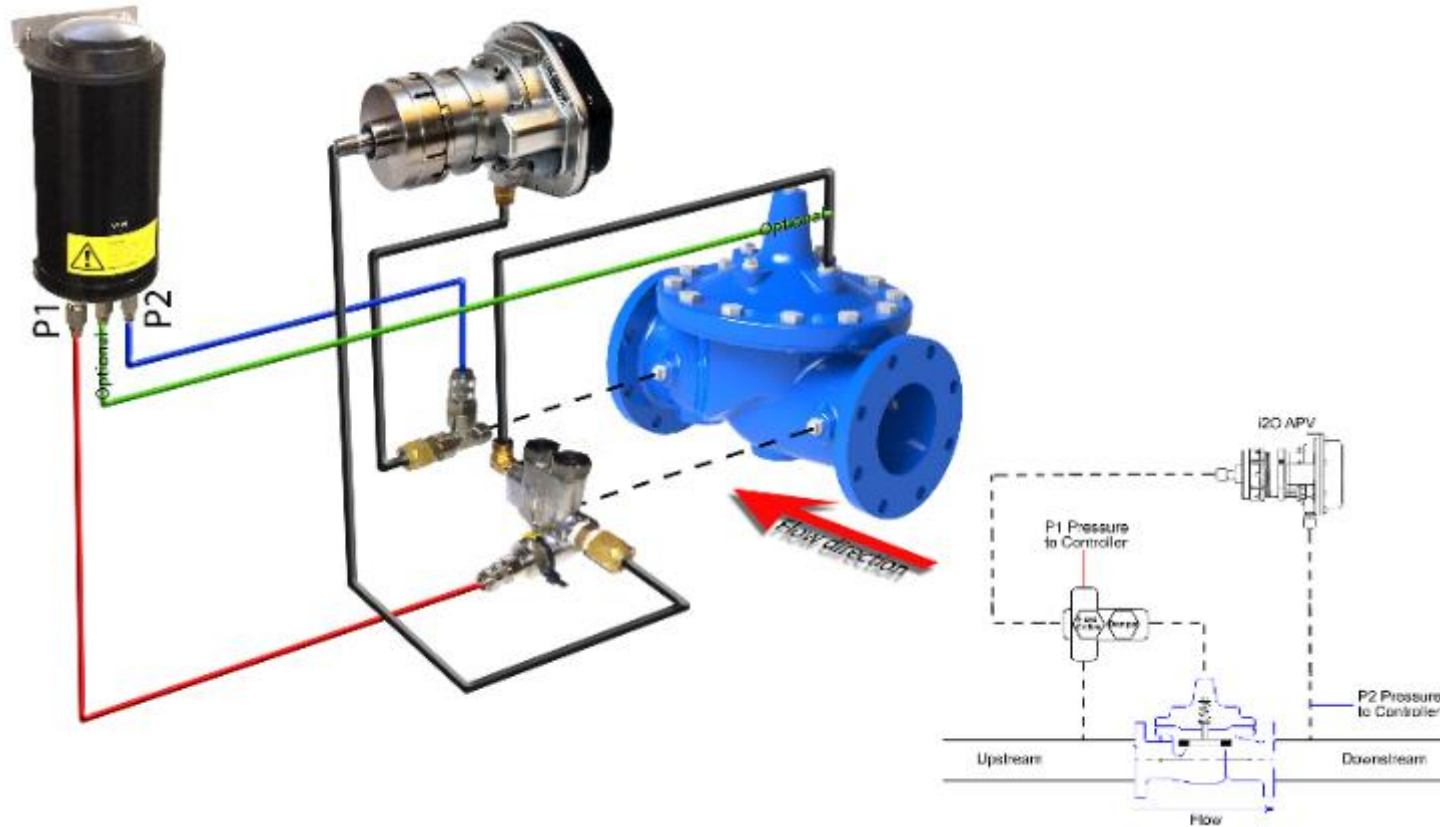
Flow Modulating PRV



This PRV is used to accurately limit excessive flow to a preselected maximum rate (Flow Control) regardless of changes in pressure and/or varying inlet flow.



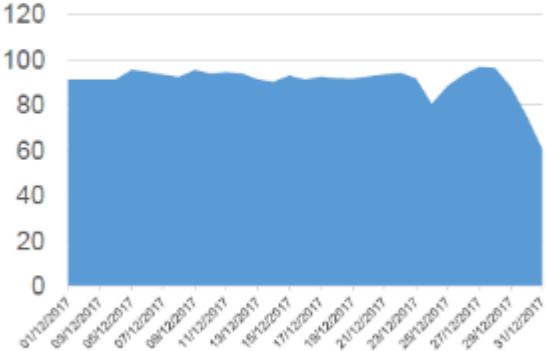
Critical Point PRV



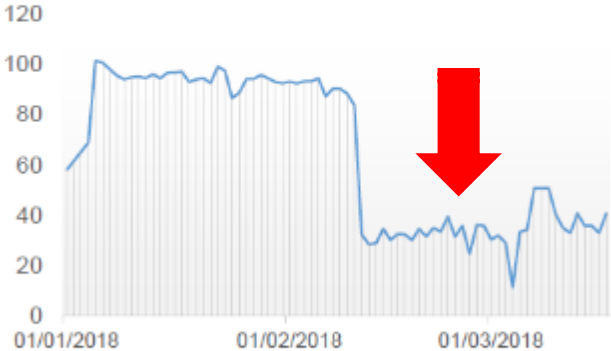
Pressure Management

FT # 7 - Al Amirat

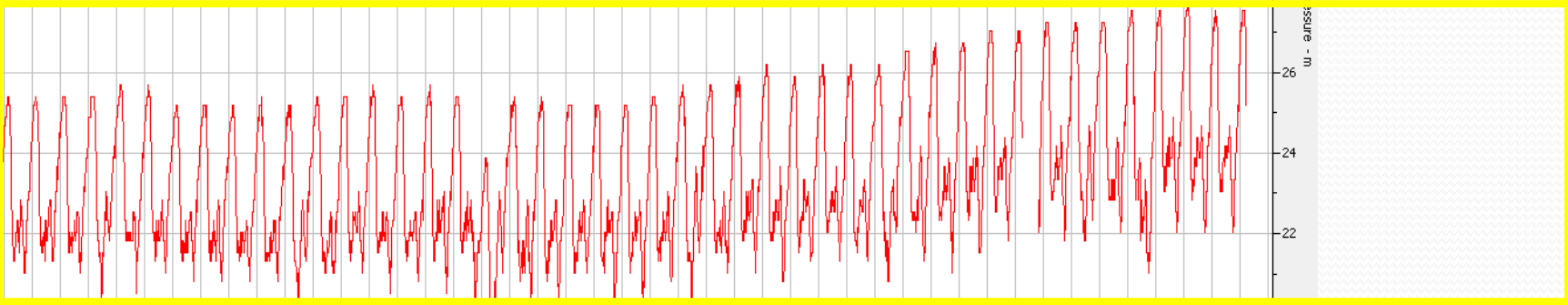
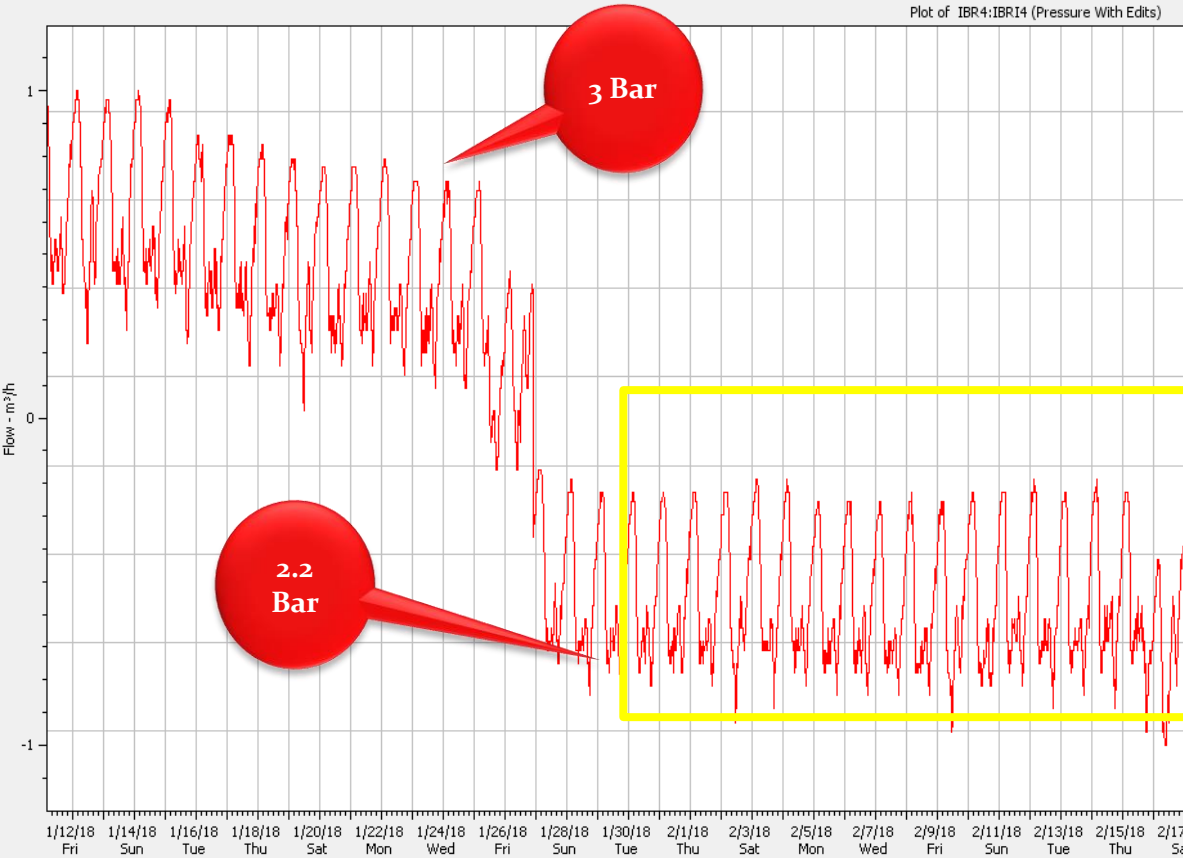
MNF IN FT#7 DECEMBER 2017



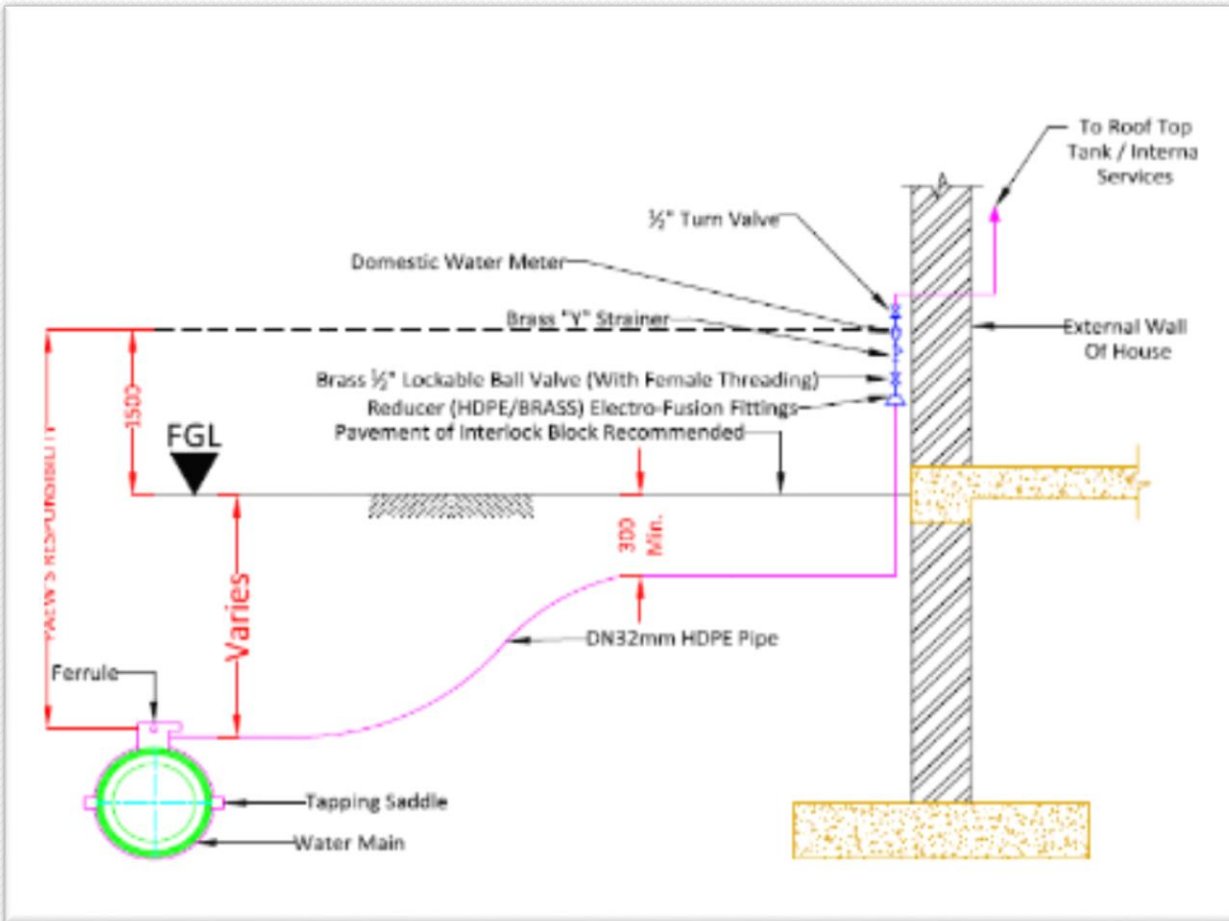
MNF IN FT#7 FEB 2018



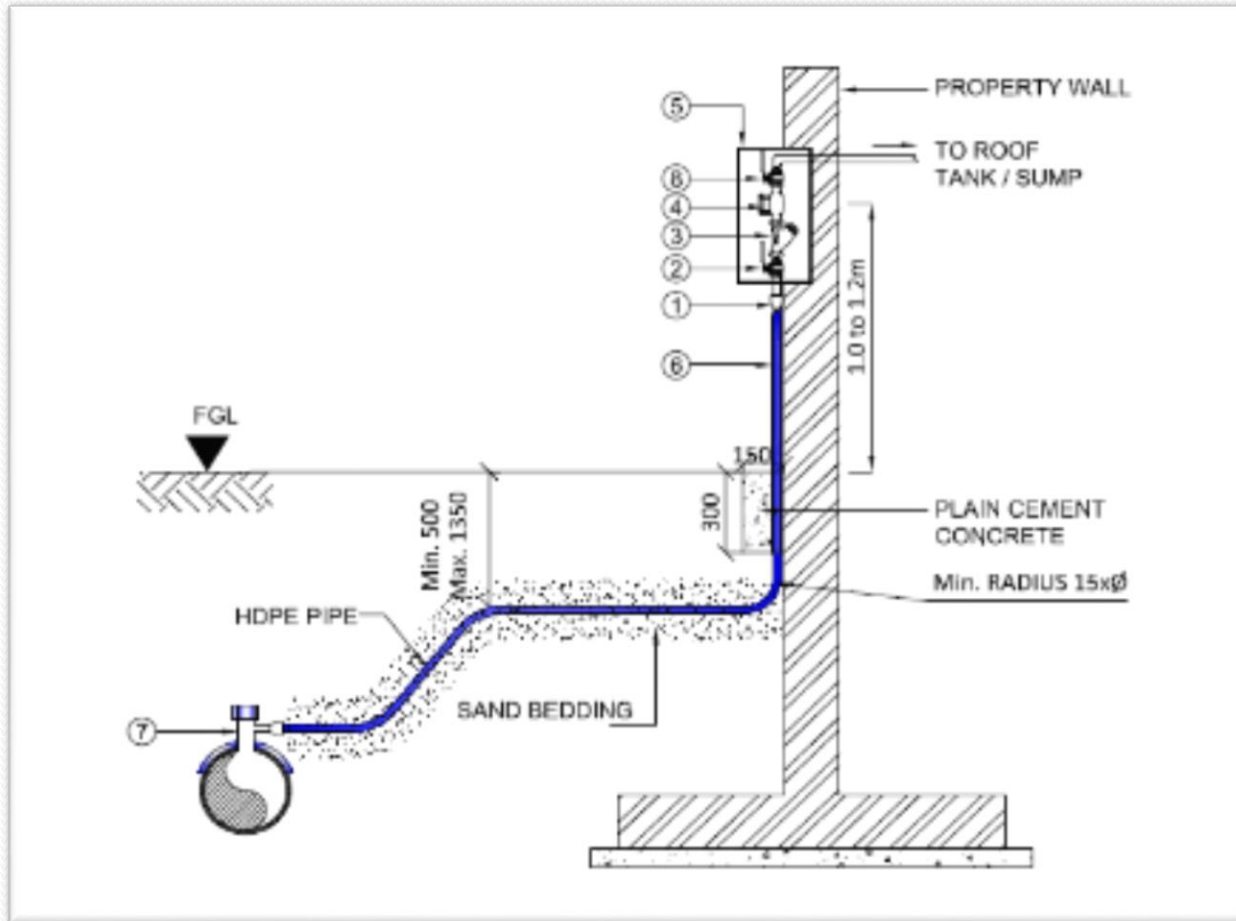
Saving around **46.78 m3/h**



INSTALLATION STANDARDS & QUALITY OF REPAIR

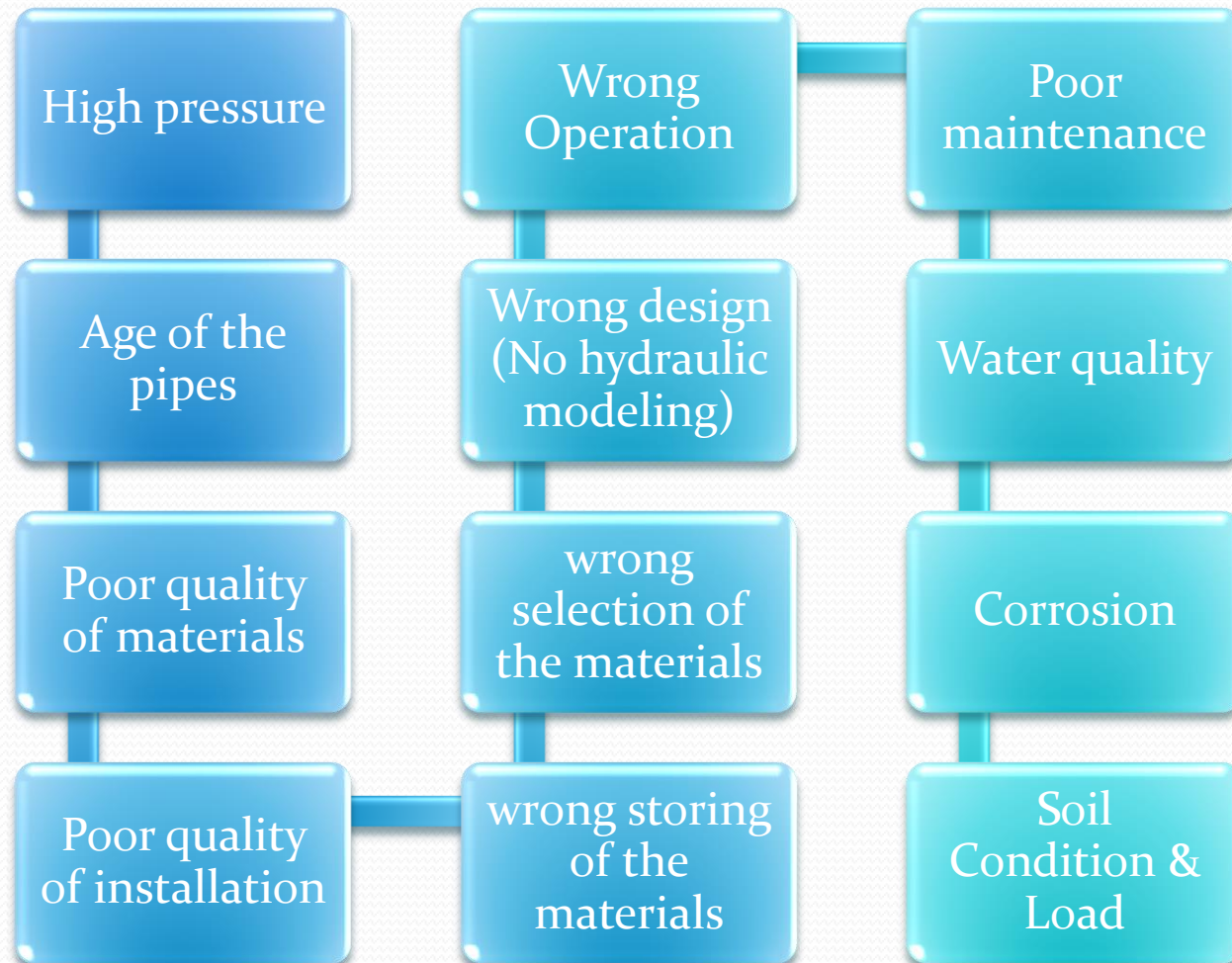


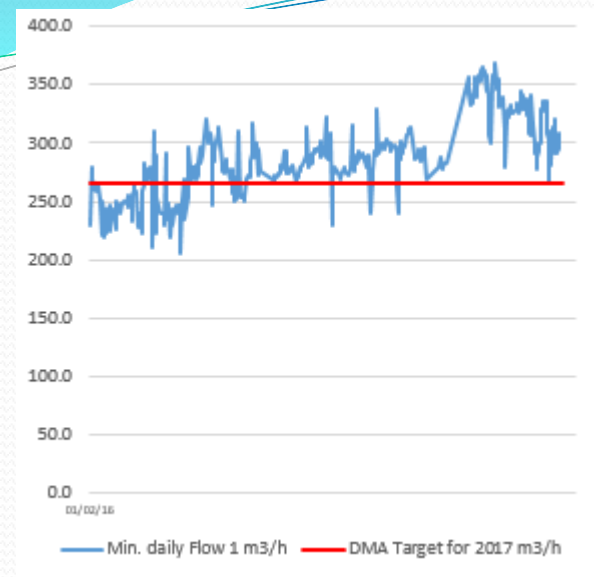
PAEW Typical house connection standard (old)



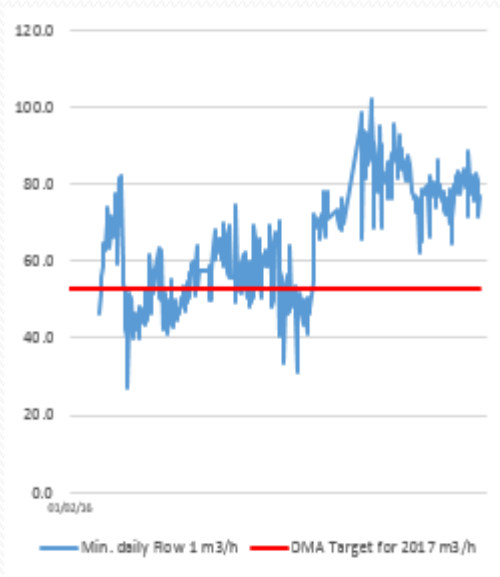
PAEW Typical house connection standard (New)

Main Reasons of Leaks in Water Networks

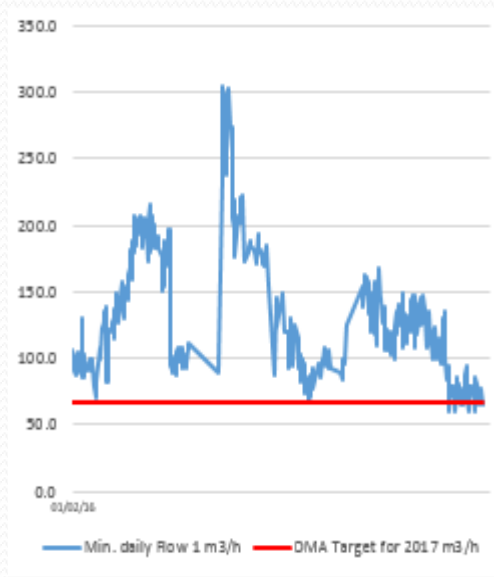




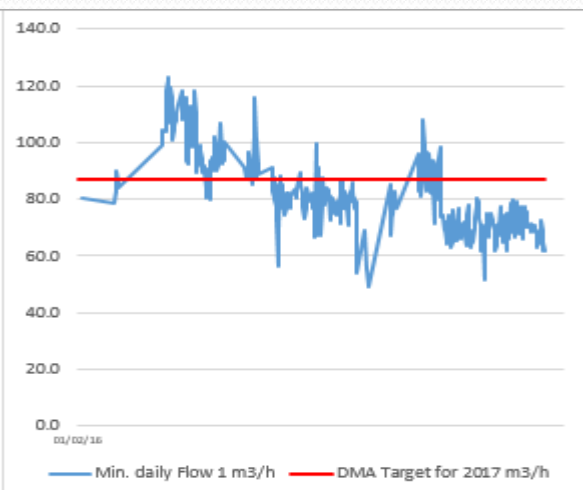
FNB1



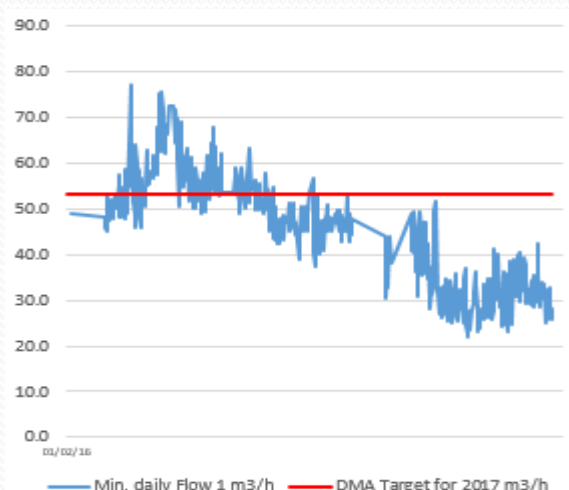
FNB6



FQ4



FQ18



FQ19



FB1 & FB2

**Minimum Night Flow
(MNF)
in
District Metering Areas
(DMA)**

Real Losses Savings in DMAs (2018)

GoV	DMA	N.O	MNF before (m3/hr)	MNF after (m3/hr)	MNF Saving (m3/hr)	MNF Saving (m3/day)	Annual saving (m3)	Installed Date	Method
Batinah South	Bar1		125.00	100.00	25.0	525	31,500		LD
	Bar2		150.00	125.00	25.0	525	47,250		LD
	Bar3		80.00	70.00	10.0	210	31,500		LD/PRV Adjustment
	Bar4		45.00	32.00	13.0	273	49,140		LD/PRV Adjustment
	Bar5		75.00	60.00	15.0	315	56,700		LD/PRV Adjustment
	Khafdi		20.00	10.00	10.0	210	18,900		LD
Batinah North	Saham 1		120.00	105.00	15.0	315	56,700		PRV ETIMER / Rehabilitation
	Saham 2		195.00	157.00	38.0	798	143,640		PRV ETIMER / Rehabilitation
	Saham 3		95.00	68.00	27.0	567	102,060		PRV ETIMER / Rehabilitation
	SUW1		200.00	140.00	60.0	1,260	37,800		PRV ETIMER
	SUW2		150.00	100.00	50.0	1,050	126,000		PRV ETIMER
	KHA3		82.00	70.00	12.0	252	22,680		LD
	KHA4						61,017		LD
Al-Dhahira	Liwa		300.00	250.00	50.0	1,050	31,500		PRV ETIMER
	Yan		132.00	100.00	32.0	672	100,800		LD
	Al Murtfaa 1	1	281	100	181	3,801	1,212,519	Feb-18	PRV
	Kawas 2	1							
	AL murtfaa 3	1							
Al Murtfaa 4	1								
Al-Sharqia South	Sur		240	220	20.0	420	75,600		Rehabilitation
	JBBH1		216	136	80.0	1,680	151,200		Rehabilitation
	ASH1		85.00	50.00	35.0	735	132,300		LD
	KAM1		85.00	65.00	20.0	420	75,600		LD
	JBBA2	1	169.0	168.0	1.0	21	3,297	27-Jun	PRV/Rehabilitation
	JBBA3	1	90.0	45.0	45.0	945	170,100	27-Jun	PRV/Rehabilitation
	JBBA4	2	68.00	53.00	40.0	840	151,200	26-Jun 25-Jun	PRV
Total		56	6740.18	4831.90	2,000.7	42,204	8,029,976		

SUMMARY OF INCREASING PERFORMANCE FACTORS

- 1 Improve Networks Designs
- 2 Improve installation standards & quality of repair
- 3 Pressure Management
- 4 Pipes Rehabilitation
- 5 Improve PPM & CM
- 6 Activate Leak Detections
- 7 Improve QMS, Reporting & Documentations

- 8 Improve Monitoring & controlling
- 9 Improve Analyzing methods
- 10 Introduce Key performance indicators
- 11 Using of new technologies
- 12 Increasing the technical skills
- 13 Improve Water Quality
- 14 Create Research Department