Consequences of Intermittent Supply on Water Distribution Networks

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BACK to BASICS for a more SECURE FUTURE

An NRW Management Workshop
15th to 16th February 2018
Tsogo Sun Elangeni Hotel, Durban

Session 5.1: Intermittent Water Supply Consequences
Allan Lambert, Mark Shepherd
Intermittent Supply Experiences:
Allan Lambert

• Jordan 1995-97
• Brazil 1997-2002
• Bosnia-Herzegovina 1997
• Saudi Arabia 1998
• Cyprus 2008-9
• Mexico 2016-18
• LEAKSSuite Library
Jordan: World Bank, 1995-7

• Large city, intermittent pumped supplies, properties with roof tanks
• Surprised to find that mains burst frequencies were many (30?) times the rate for similar pressure in a continuous supply system (UK)
• This did not seem to be considered unusual by the Jordanian Utility
  • but in 1995, almost no published international work on pressure: burst frequency relationships existed
• This made me think that probably most Utilities come to believe:
  • that their repair frequencies (whatever they happen to be) are ‘normal’
  • and can only be dealt with by replacing infrastructure
• Utilities did not seem to consider that their system design or management might be the cause or partial cause of the high burst frequencies
Brazil

• Brazil: São Paulo 1997-2004
  • intermittent supply, properties with roof tanks, supplied >95% of time
  • resulted in rota cuts (rodizio) over regional systems to share restrictions
  • very high burst frequencies on mains and services, intensive leak detection

• Julian Thornton recommended move to pressure management would reduce leak flow rates sufficiently to achieve continuous supply
  • Gpress software predicted benefits were achieved in 10 pilot areas
  • around 1200 PRVs were installed over 4 years, 24/7 supply achieved
  • Targeted service connection replacement also greatly reduced leakage
  • SABESP became expert in managing system pressures to manage leakage
  • and during the 3 year 2013-15 drought, rodizio was avoided by extreme pressure management at critical points without completely shutting off supplies
Sarajevo, 1997

- Project to restore supplies in Sarajevo soon after the end of the wars in the Western Balkans
- The city had been heavily shelled, and was being supplied by intermittent pumping to properties without any storage after the Zone reservoir
- With no pressure transient control, and frequent valve operations, leak detection contracts found large backlog of leaks which were being repaired
  - but transients caused further frequent repeat leaks and no progress was being made
- Leak detection and repair ineffective without pressure management
- The leakage target was set only in % of terms, which was illogical as any leakage saved would be used to pressurise the system for longer
- the primary target for intermittent supply should be to achieve 24/7 supply, even if it means operating at lower pressure than normal
Saudi Arabia, 1998

• Large city, intermittent supplies, properties with ground tanks
• Properties supplied for around 2 days in 7 (approximately)
• Utility proud of low % NRW (around 4% of SIV from memory)
  • due to long periods without pressurised water mains!
  • but ILI performance (when system pressurised) was Class D (ILI > 8)
• Active leakage control was extremely labour intensive
  • Utility could only search for leaks when the mains are pressurised
  • So small sections of system (2 streets at a time) were pressurised with water from small tanks on vehicles, to permit checks for leaks
Lemesos, Cyprus, 2002-12

• Utility with roof storage tanks in properties
• From 2002 to 2007, real losses were reduced from 138 to 92 lit/conn/day, and ILI from 2.7 to 2.0, with continuous supply – an excellent performance
  • using IWA approach with pressure-managed small single entry point DMAs
  • AZNP reduced by 32% from 52.5 to 35.8 metres
  • reported bursts reduced by 45% on mains and 40% on service connections
• But in 2008/09 drought, all of Cyprus had to operate intermittent supply
  • mains breaks trebled, service connection breaks doubled during period of IS
  • minimum night flow increased by more than annual volume of water saved
  • unable to get back to pre-drought leakage levels even 3 years after the event
• This Case Study documenting the problems and consequences of IWS is freely available at https://www.leakssuitelibrary.com/wp-content/uploads/2019/08/Bambos-EU-Ref-Doc-Case-Study-update.pdf
Mexico, 2016-18

- Large city, intermittent supplies, properties with roof tanks
- Properties supplied for around 70% of time, average pressure < 30m
- High burst frequencies for mains, and very high for services
- Utility proposed DMAs and leak detection to reduce leakage
- Following Dec 2016 Masterclass, decided to use pressure managed zones as foundation strategy to achieve continuous 24/7 supply
- New techniques developed for tracking leakage from AZP pressures
- Implementation started: steady progress to date, a work in progress
Masterclass on IWS with international experts, UK, Nov 2016
IWA Specialist Group on IWS

• Up to end of 2017, IWS was a topic included in the IWA Water Loss Specialist Group

• In February 2017, it’s importance as a key topic was recognised by setting up a separate IWA IWS Specialist Group

• IWS Specialist Group is chaired by Bambos Charalambous (Cyprus)
  • Sessions on IWS at the IWA Water Efficient Conference, Bath, July 2017
  • 1st IWA IWS Conference in Kampala, Uganda in April 2019

• LEAKSSuite Library recommends all those with an interest in IWS to contact the IWA IWS Specialist Group, htolba1@outlook.com
The vicious cycle of iws: Source: Charalambous

1. Growth in demand / Reduced supply / High Leakage
2. Low supply pressures / Unable to supply 24/7
3. Intermittent Water Supply
4. Unable to rectify the situation / Increased leakage
5. Increased leakage and O&M costs / Reduced revenue

Increased leakage and O&M costs / Reduced revenue

Intermittent Water Supply
What have I learnt about Intermittent Supply?

• Severe consequences when 24/7 supply system adopts intermittent supply
  • Multiple pressure transients from valving operations and system recharge
• Very damaging to distribution system infrastructure
  • mains and services repair frequencies both increase significantly
• Intermittent Supply influences ability to carry out leak detection
  • Visible leaks cease to run, no noise from unreported leaks
  • Minimum night flows increase, volume savings less than simple calculation suggests
• Medium term effects (Lemesosos paper)
  • Higher leakage from damaged infrastructure for several years afterwards
  • Significant additional leak detection costs
• Absence of pressure management means no control during recovery
• 1st objective: to get back to 24/7 supply, at lower pressure if necessary
  • plus pressure management and service pipe replacements to regain control
LEAKSSuite Library Intermittent Water Supply

• Dec 2016 Masterclass: Managing NRW : Roof Storage Tanks & Intermittent Supply

• Attendees supported setting up a LEAKSSuite Info-hub on IWS and contributed the papers and presentations below

• These are now located at https://www.leakssuitelibrary.com/intermittent-water-supply-iws/

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Intermittent Supply Experiences:
Mark Shepherd

- Recent drought in South Africa
- Durban
- iLembe
Is Our Drought Affecting Us?

Taps turn off tonight
Water restrictions hit central, south Durban

WATER SHEDDING!
Residents on brink of facing severe cuts

Pray for rain, public urged
Technical Impacts of Drought

Technical impacts of drought are ways that water infrastructure is affected:

- Intermittent water supply – positive and negative pressures, increased bursts
- Negative impacts on water quality
- Inefficient system operation
- Damage to pumps, motors and control valves
- Non-operational PRV’s
- Damage to consumer meters
- Increased vandalism and abuse
- Increased billing to consumers – increased customer complaints, increased credits
Impact of Intermittent Water Supply: eThekwini

- Pressure surges
- High burst frequency
- Higher SIV
Impact of Intermittent Water Supply on Burst Frequency: eThekwini

- Hazelmere system watershedding
- Umgeni system watershedding
Impact of Intermittent Water Supply on Burst Frequency: Ethekwini

Monthly Burst Events for Mains (July 2006-Aug 2017)

Monthly Burst Events for Service Connections (July 2006-Aug 2017)
Impact of Intermittent Water Supply on Burst Frequency: eThekwini

Annual Mains Breaks

Total Number of Mains Breaks

Annual Service Connection Breaks

Total Number of Service Connection Breaks

Mains BFI

Service Connection BFI
Impact of Intermittent Water Supply on Burst Frequency:

Start of intermittent supply

End of intermittent supply

iLembe District Municipality
Monthly Volumes and Connections July 2011 to June 2017

- System Input Volume (kl/month)
- Billed Authorised Consumption (kl/month)
- Total Number of Connections
- 6 per. Mov. Avg. (System Input Volume (kl/month))
- 6 per. Mov. Avg. (Billed Authorised Consumption (kl/month))
Lessons Learned from Intermittent Water Supply

• Pressure management offers opportunities to avoid intermittent supply by reduction of excess pressures, leak flow rates, bursts on mains and services, and some components of consumption

• Burst frequency will increase as a result of moving onto intermittent water supply. In our experience, service connection bursts have increased more than mains bursts

• Intermittent water supply – recovery plans to full pressurized supply are just as important as plans going onto intermittent supply in the first place

• The need for sufficient, functioning air valves in reticulation network cannot be overstated – this will protect infrastructure, including consumer meters, from both negative and positive pressures

• Damage to consumer meters is a reality, which will affect billing. Meter maintenance/replacement programs need to be implemented once full pressure supply has been restored