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Water Loss Specialist Group
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The effect of controlled pressure adjustment on consumer water demand

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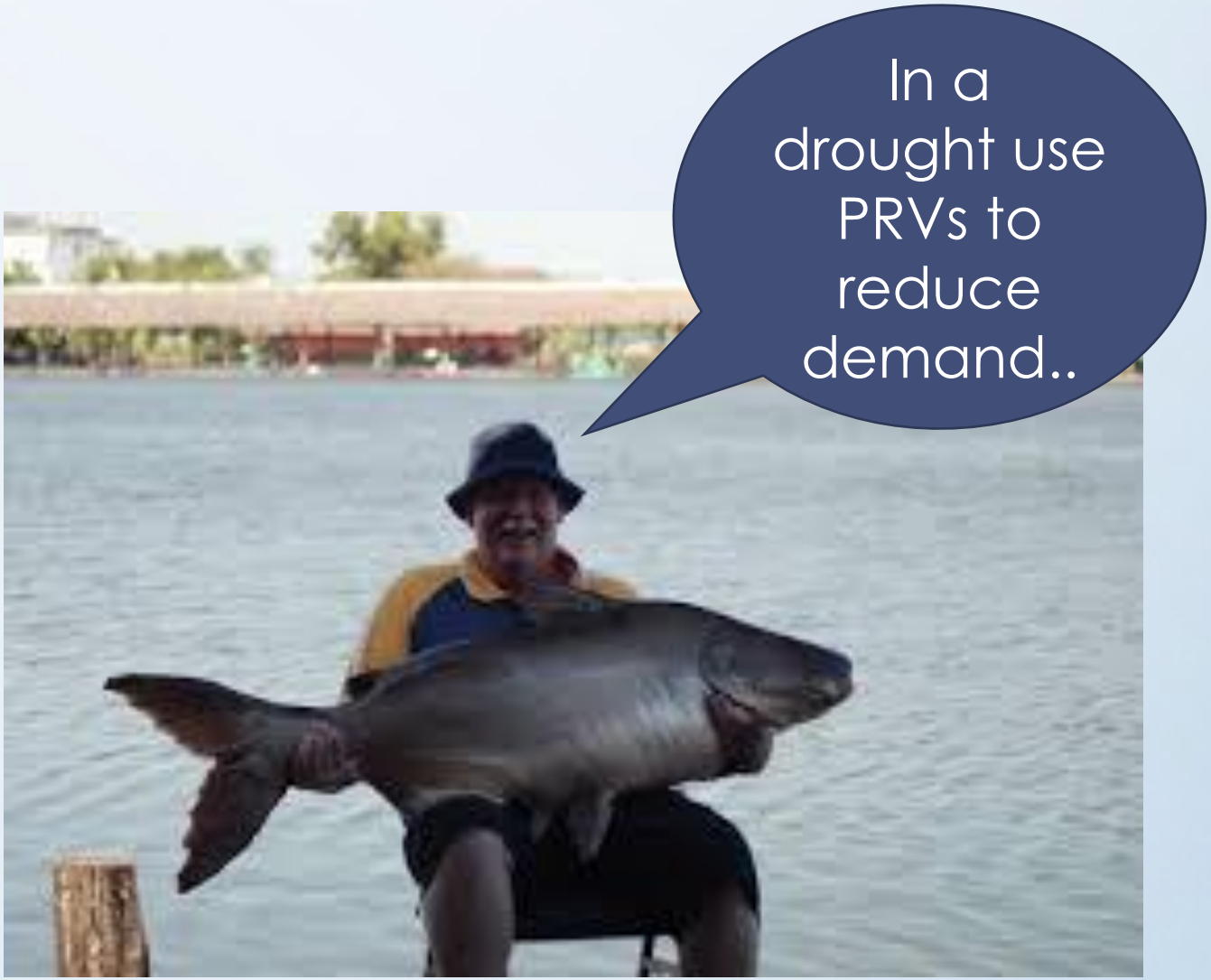
Zednet wrp


In a drought use PRVs to reduce demand..

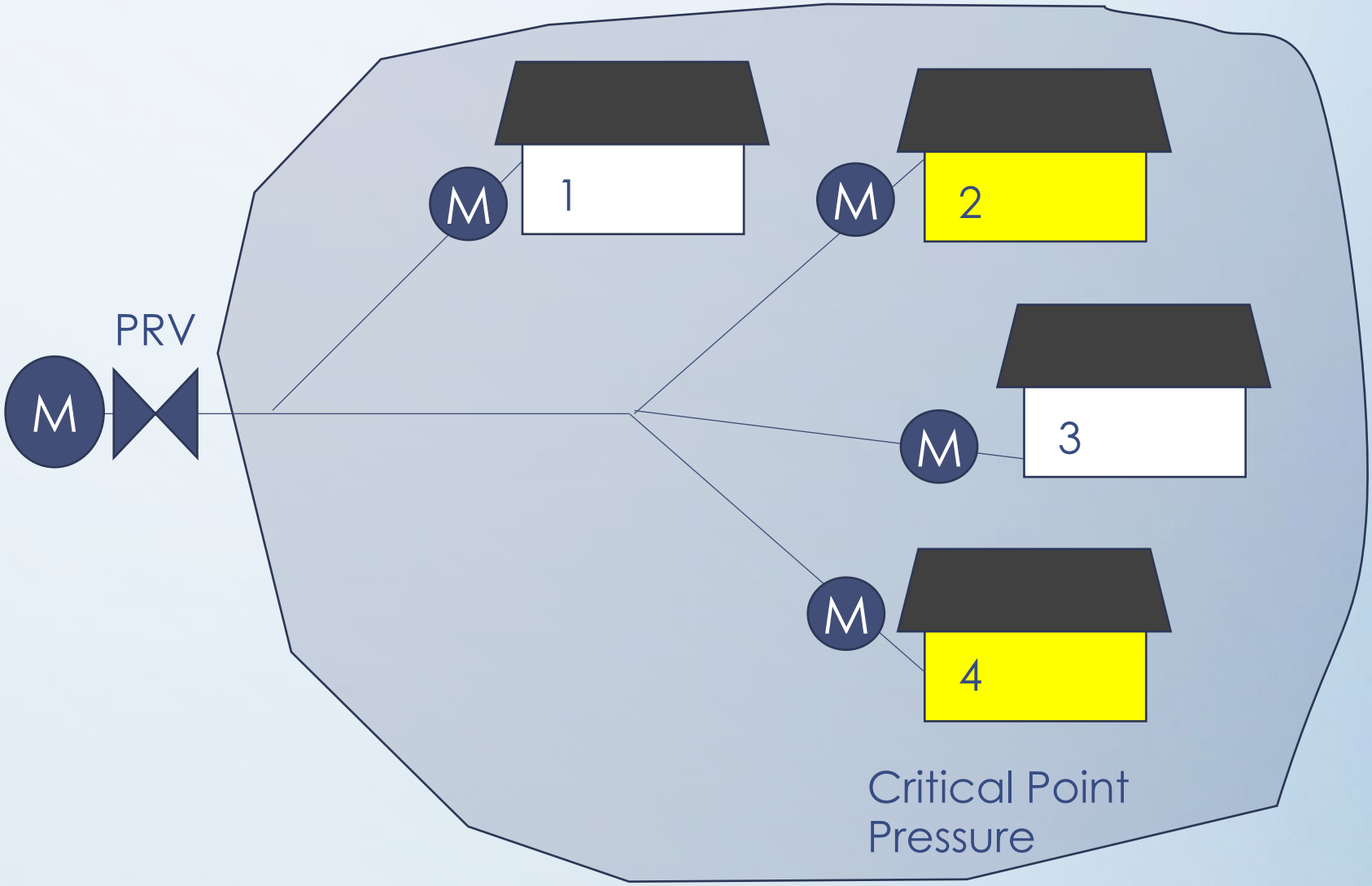
Background and Problem Statement

- Pressure management = reduction in leakage.
- What will the impact be on consumer demand if the pressure is changed?

Methodology

- Three DMAs were identified in the City of Tshwane.
- Data recording equipment was installed to record flow and pressure data for the three DMAs and 76 individual consumers.
- Pressure step changes were implemented and the recorded data was analysed by establishing the pressure-demand relationships.

Data logging at DMA and household level



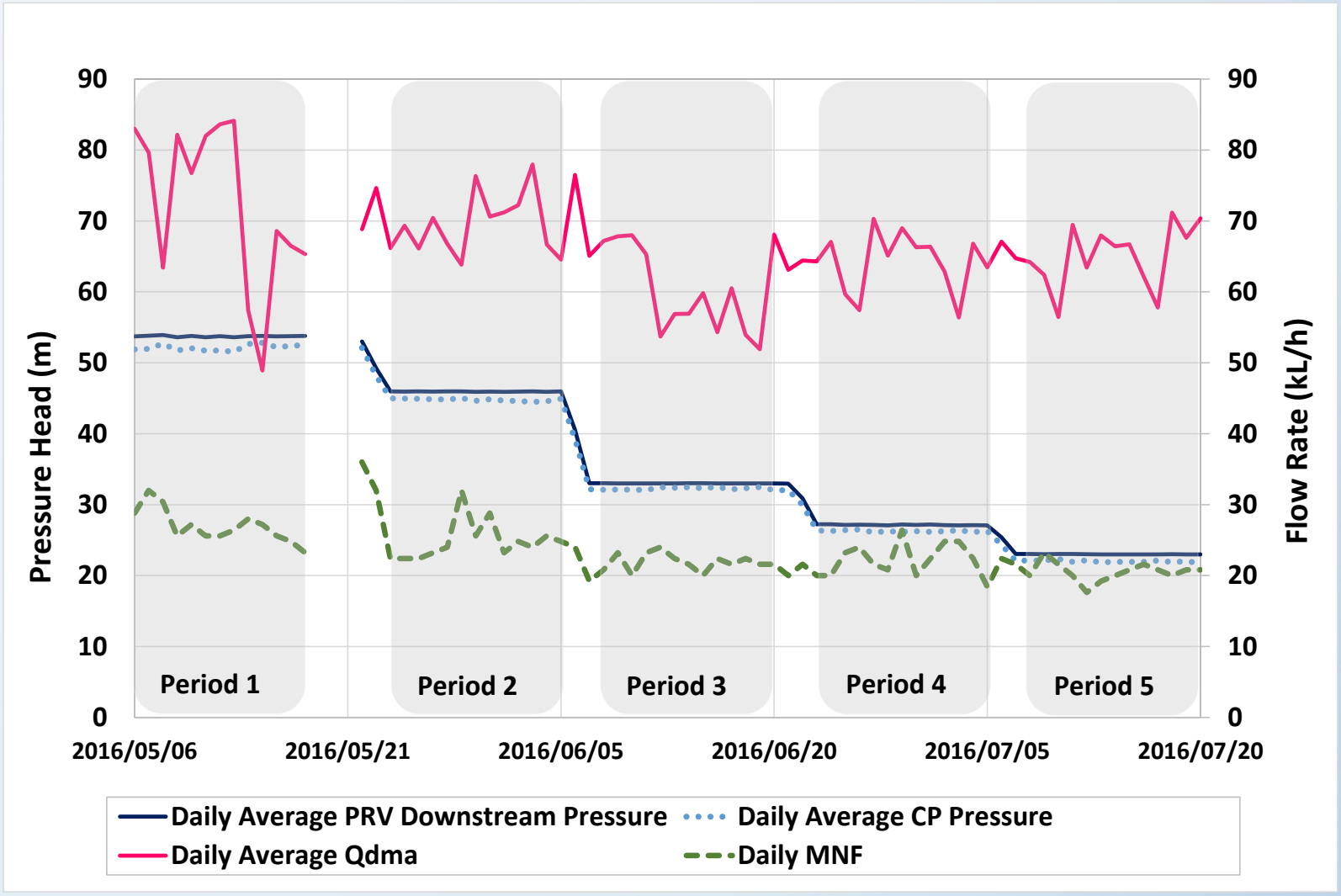
Logger Installations

DMA Characteristics

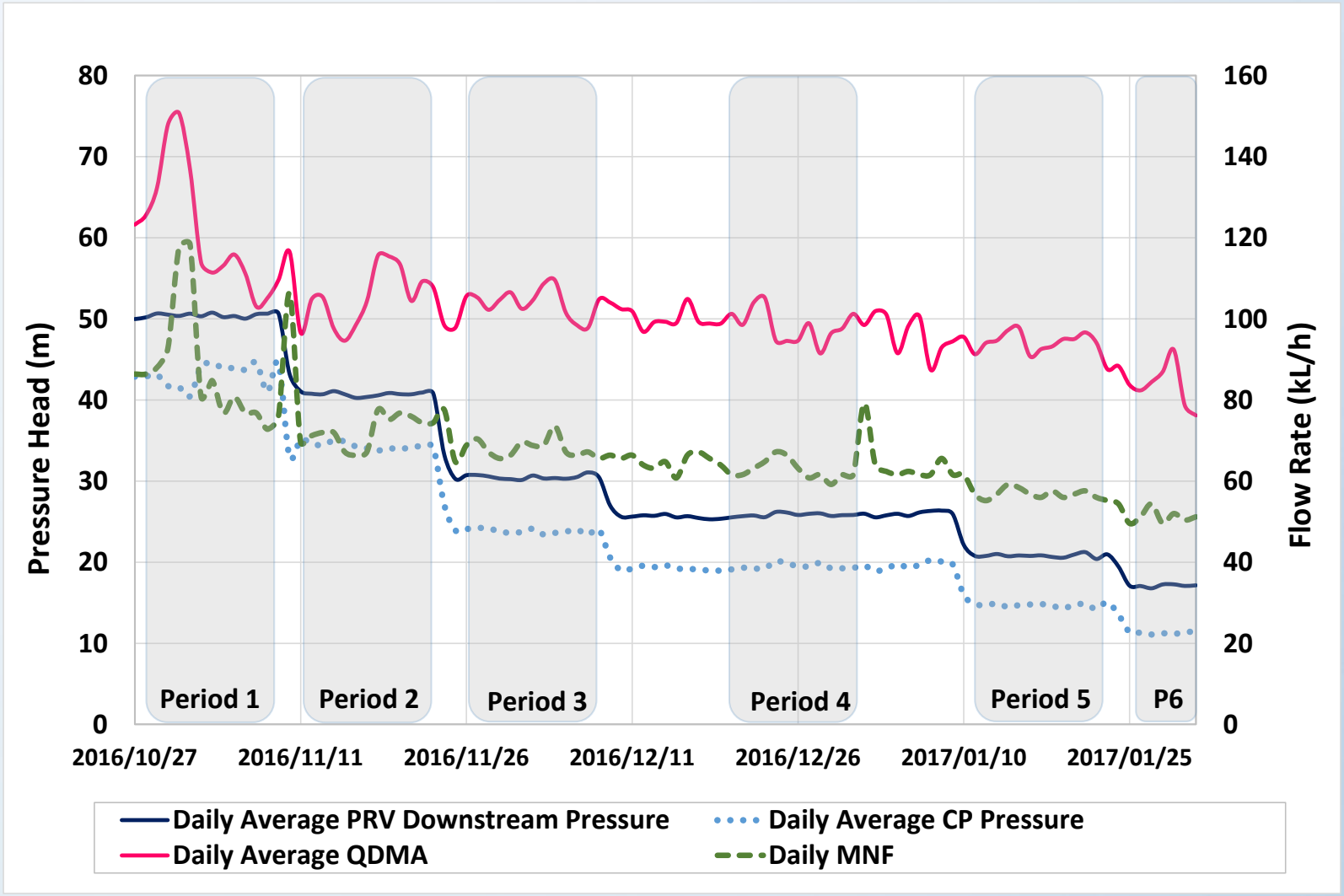
Description	DMA1	DMA2	DMA3
Average income of consumers	Medium to high	Low	Medium
Total stands	1201	4683	923
Residential % stands	94%	98%	95%
Total length of water pipes (km)	±24	±45	±18

Garden irrigation expected

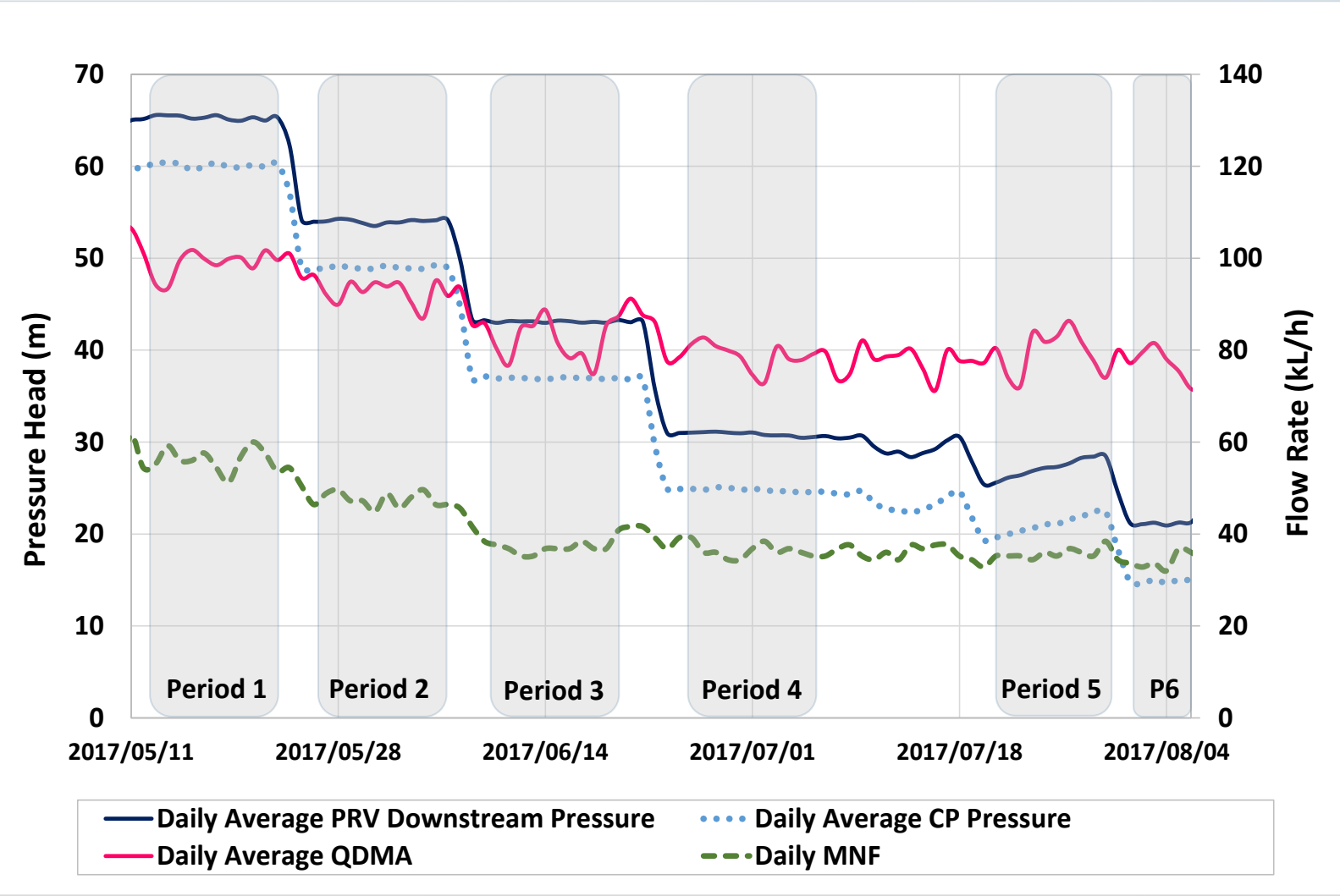
DMA1: Time series pressure and flow profile



DMA2: Time series pressure and flow profile

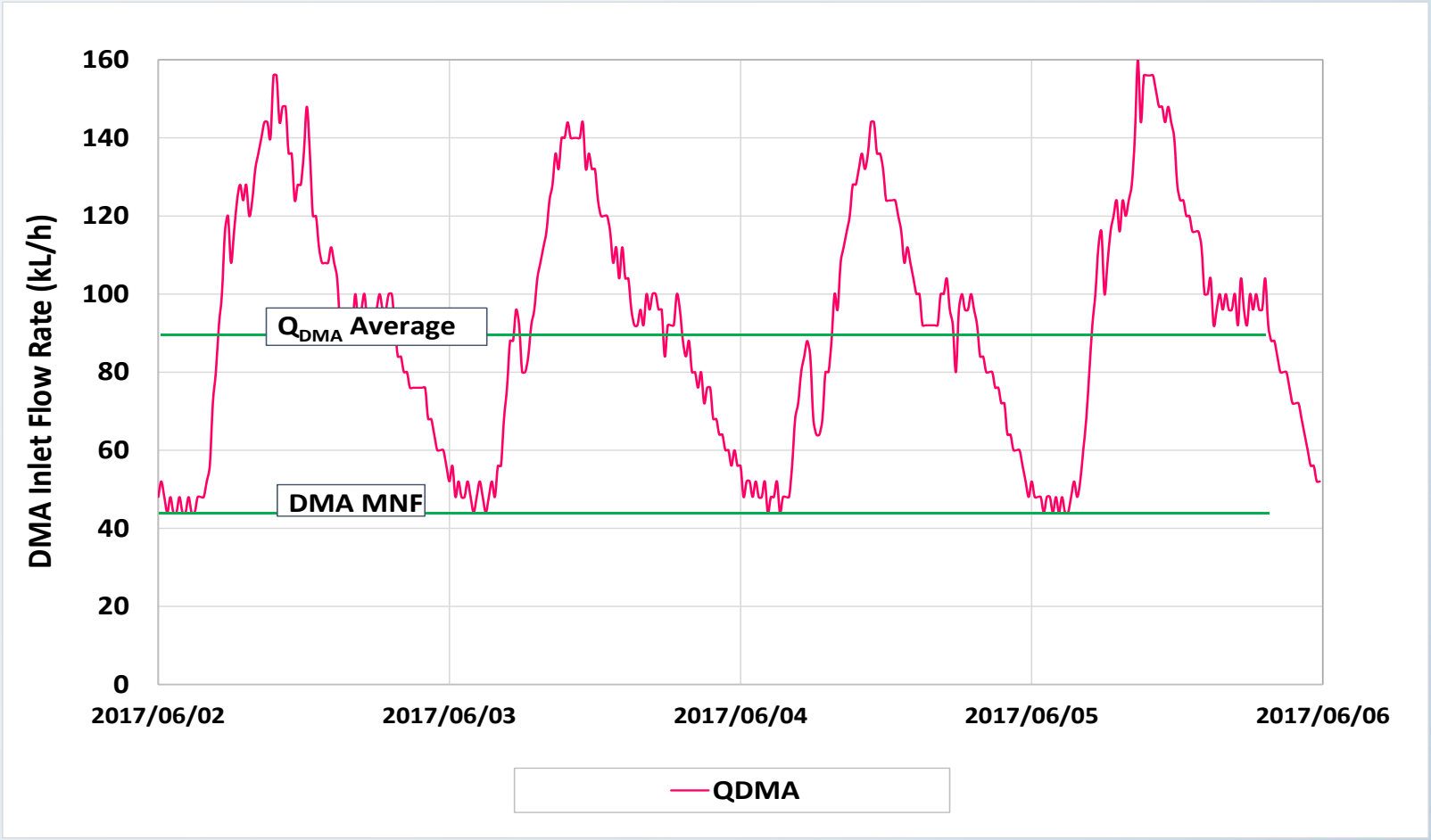


DMA 3: Time series pressure and flow profile



Demand component (Q_{dem})

$$Q_{dem} = (Average\ Q_{DMA} - Average\ MNF) + Legitimate\ Night\ Usage$$



Theoretical Pressure-Demand Relationship

$Q_{dem} = C\ h^{\beta}$ (Van Zyl & Clayton 2007)

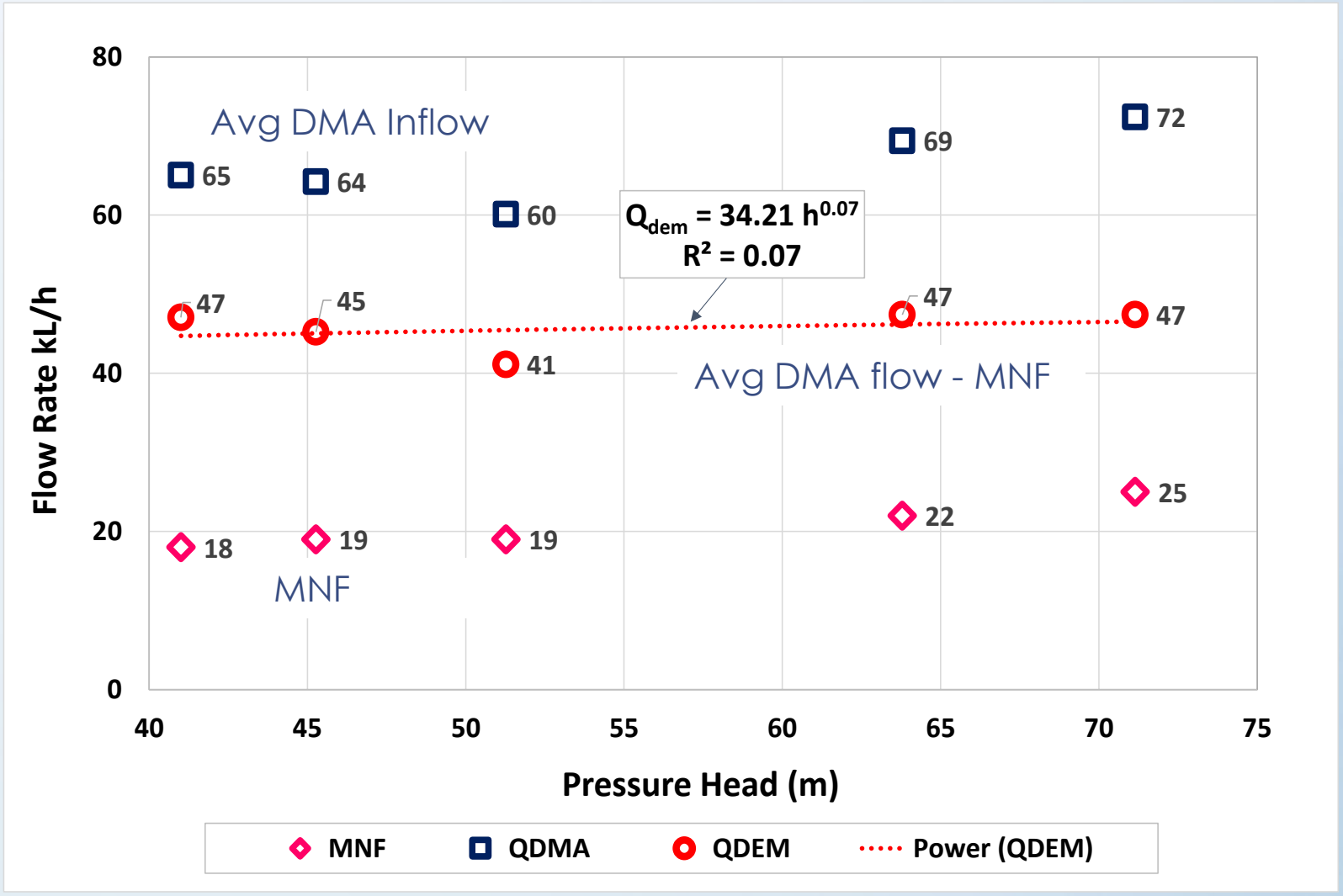
Q_{dem} = consumer water demand

C = constant coefficient

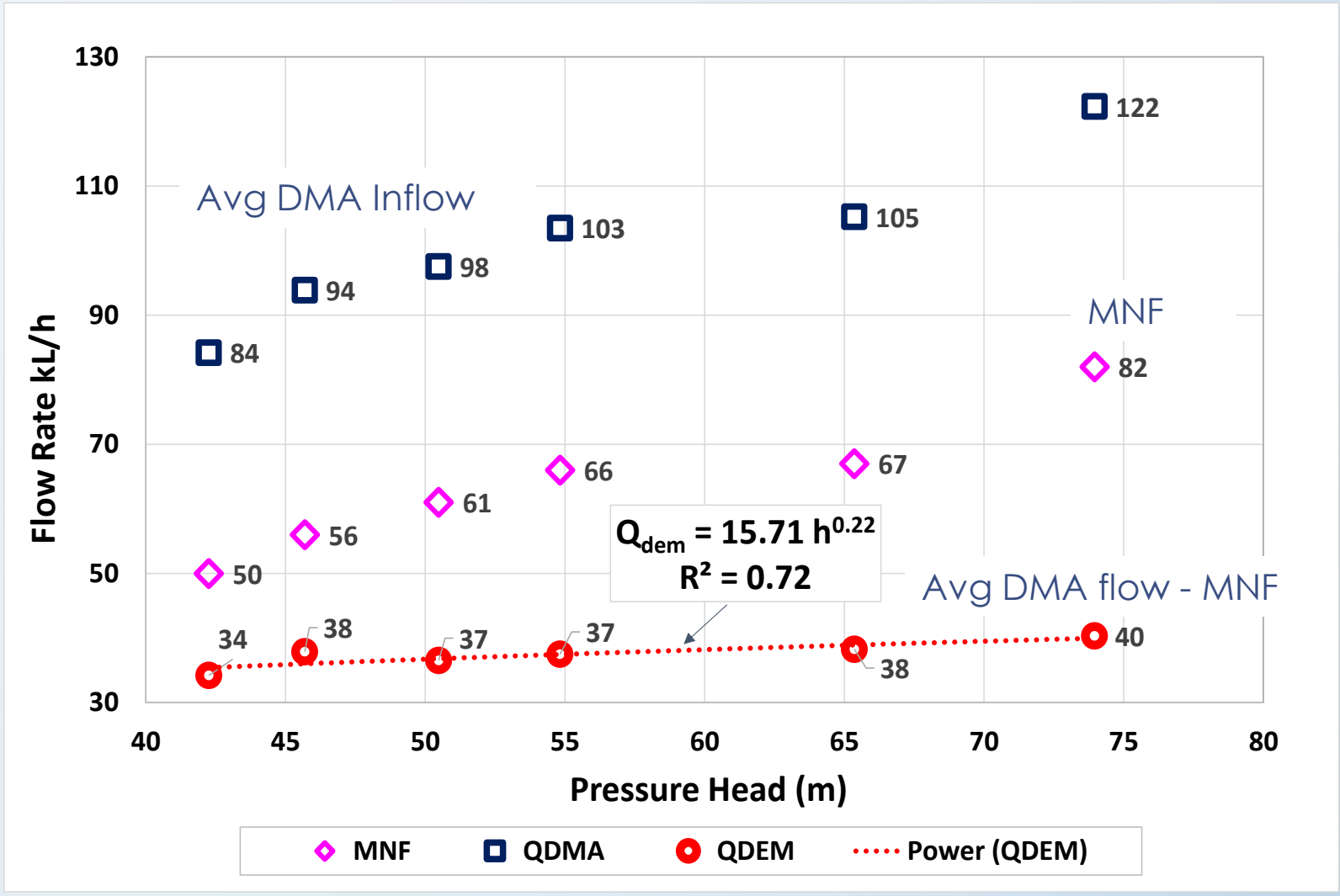
h = pressure head

β = elasticity of demand to pressure. Sensitivity of one (dependent) variable to changes in another (independent) variable

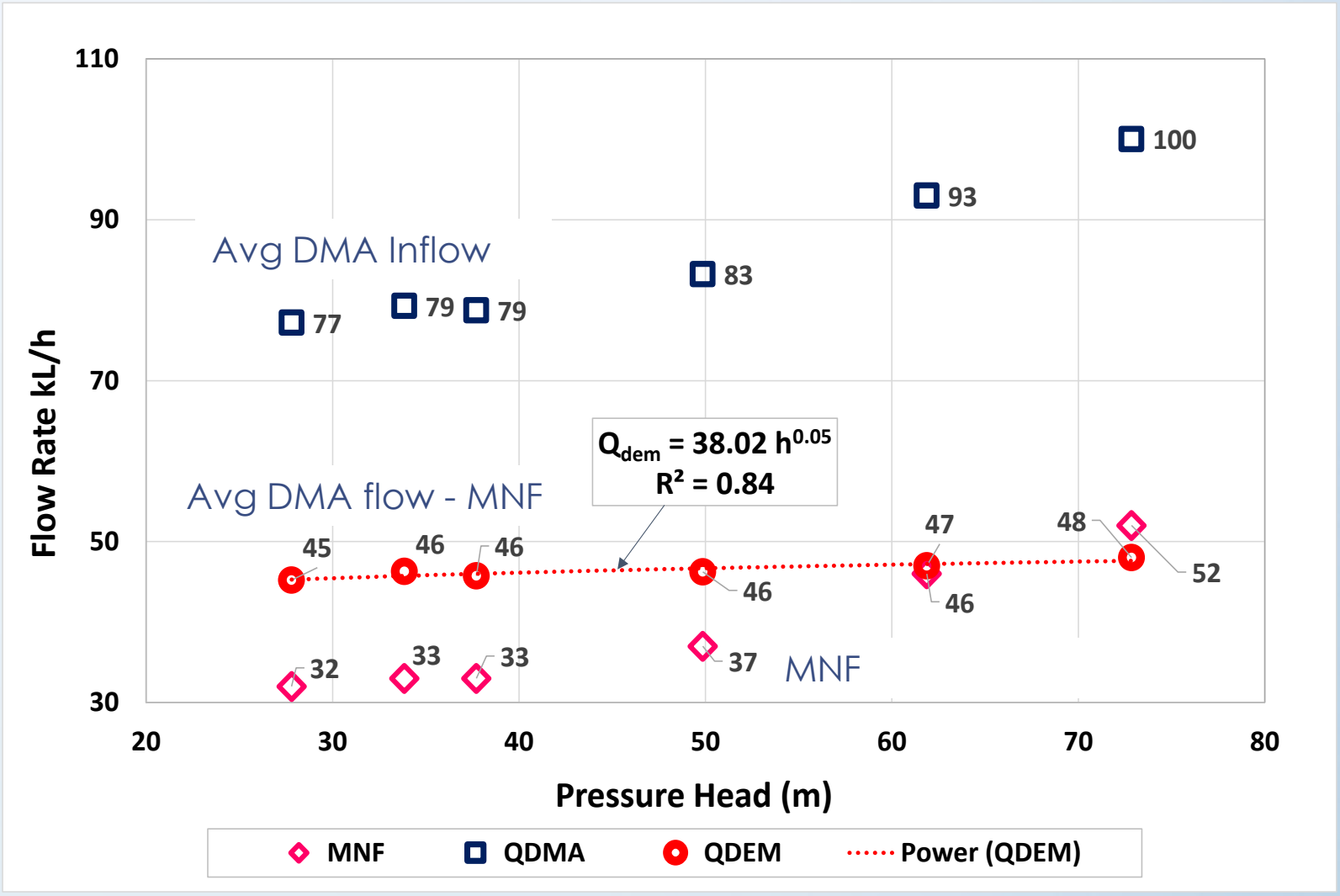
DMA 1: Tot Inflow, MNF and Demand versus pressure head



DMA 2: Tot Inflow, MNF and Demand versus pressure head



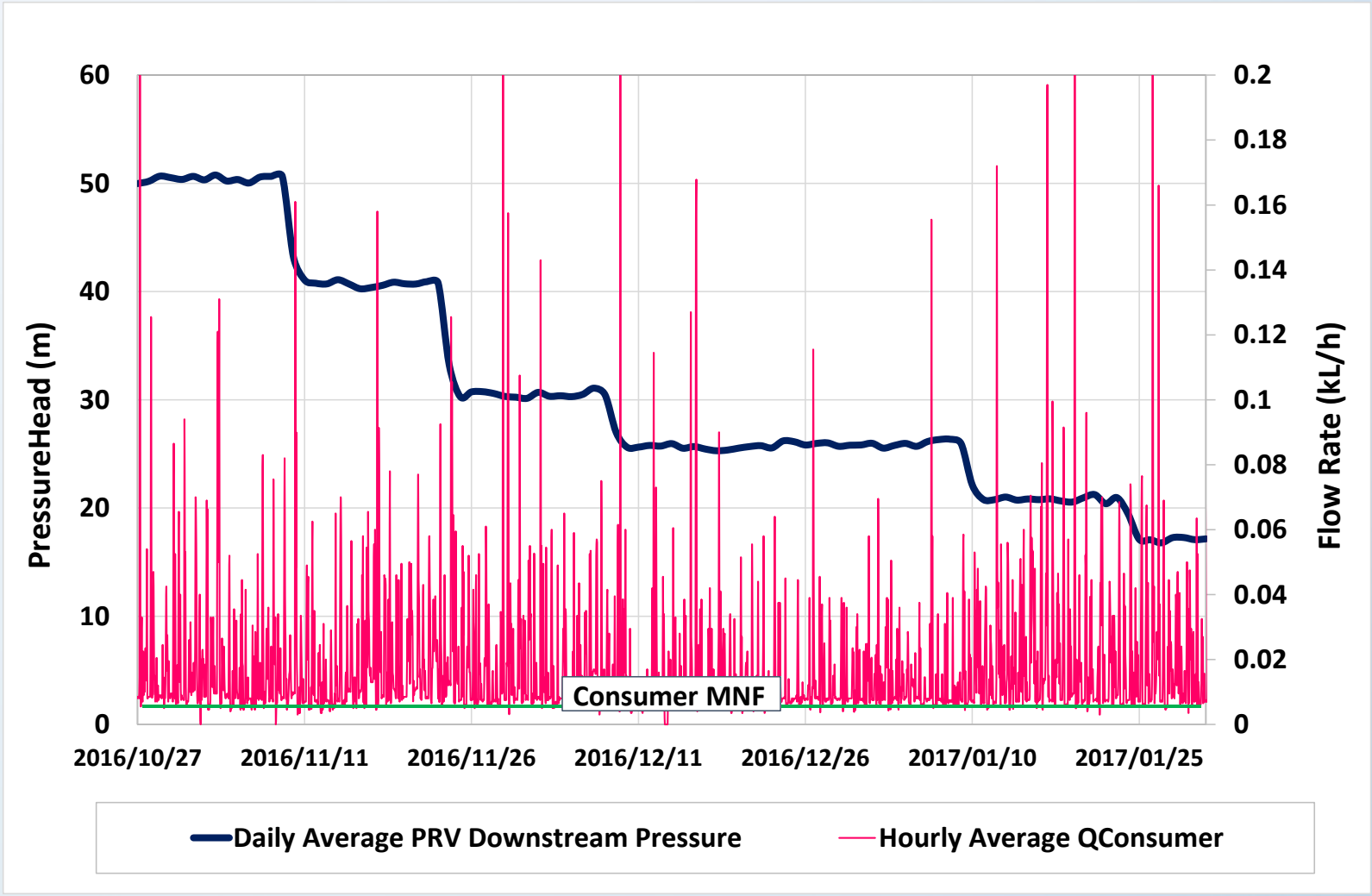
DMA 3: Tot Inflow, MNF and Demand versus pressure head



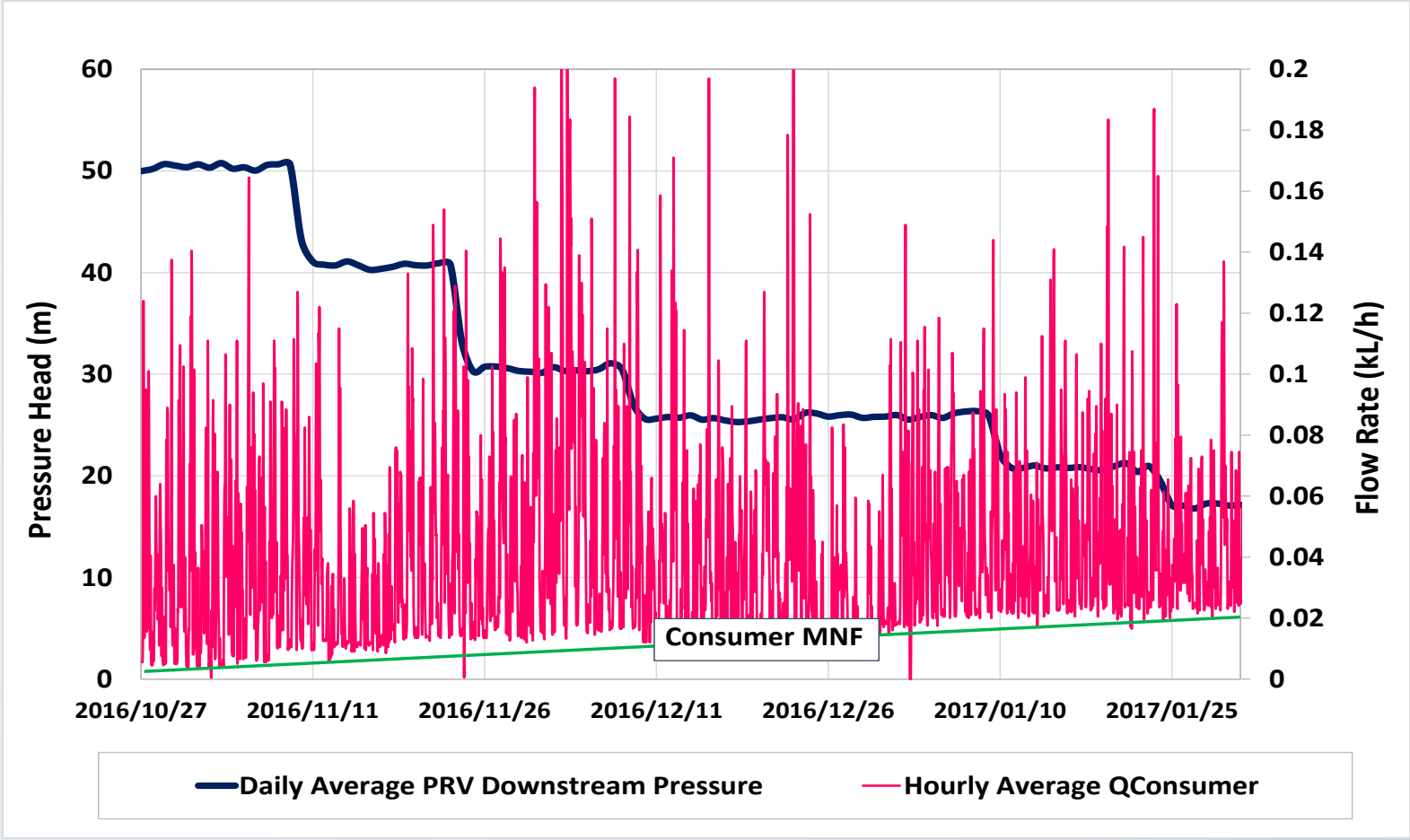
Consumer Logging and Consumer Minimum Night Flow (MNF)

Consumers per MNF category (L/h)				
DMA	None or Low MNF ≤ 5	Medium 5 < MNF < 15	High MNF ≥ 15	**Total**
DMA 1	8	5	3	**16**
DMA 2	20	5	3	**28**
DMA 3	19	4	5	**28**
Total	**47**	**14**	**11**	**72**

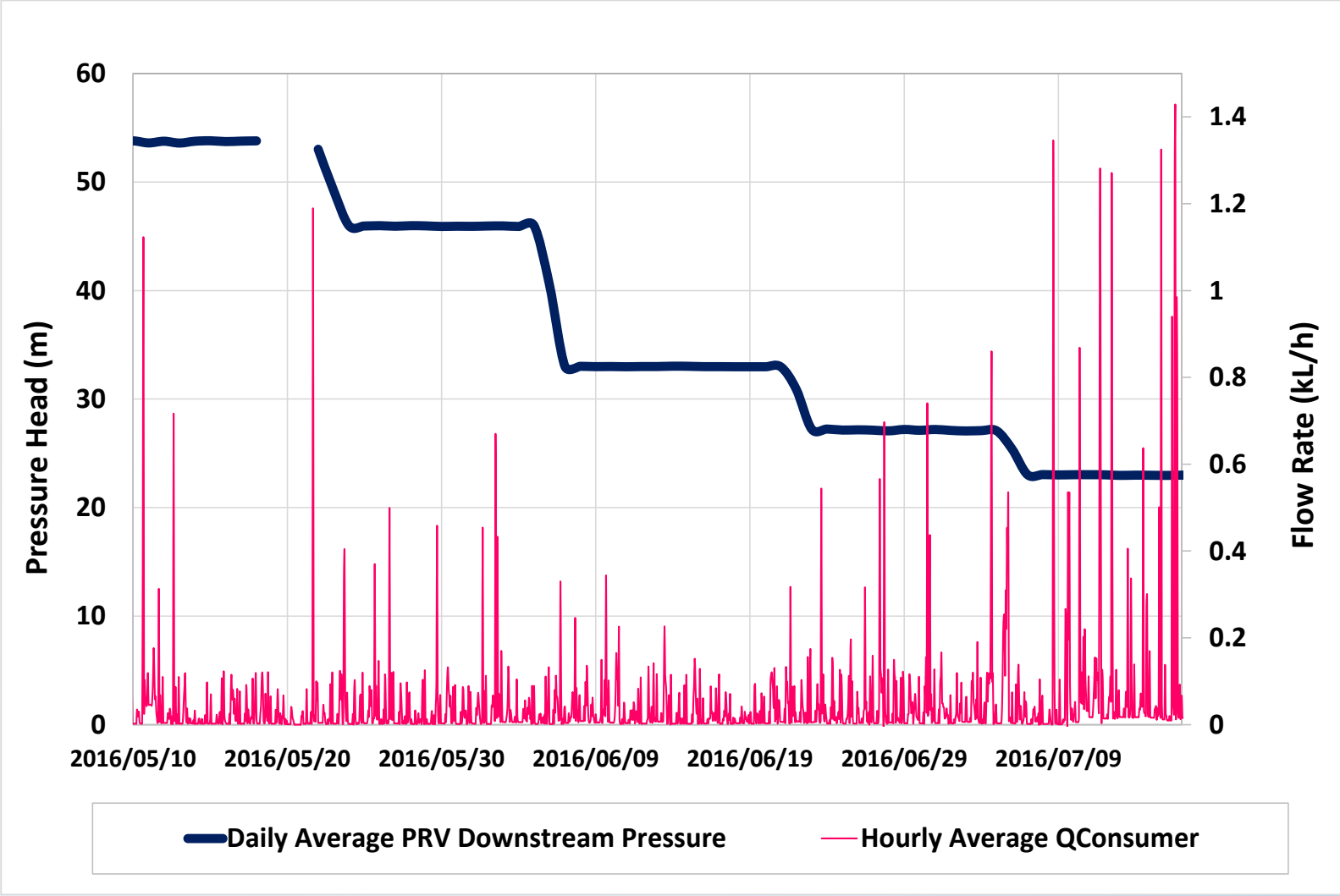
Constant Consumer MNF with reduced pressure



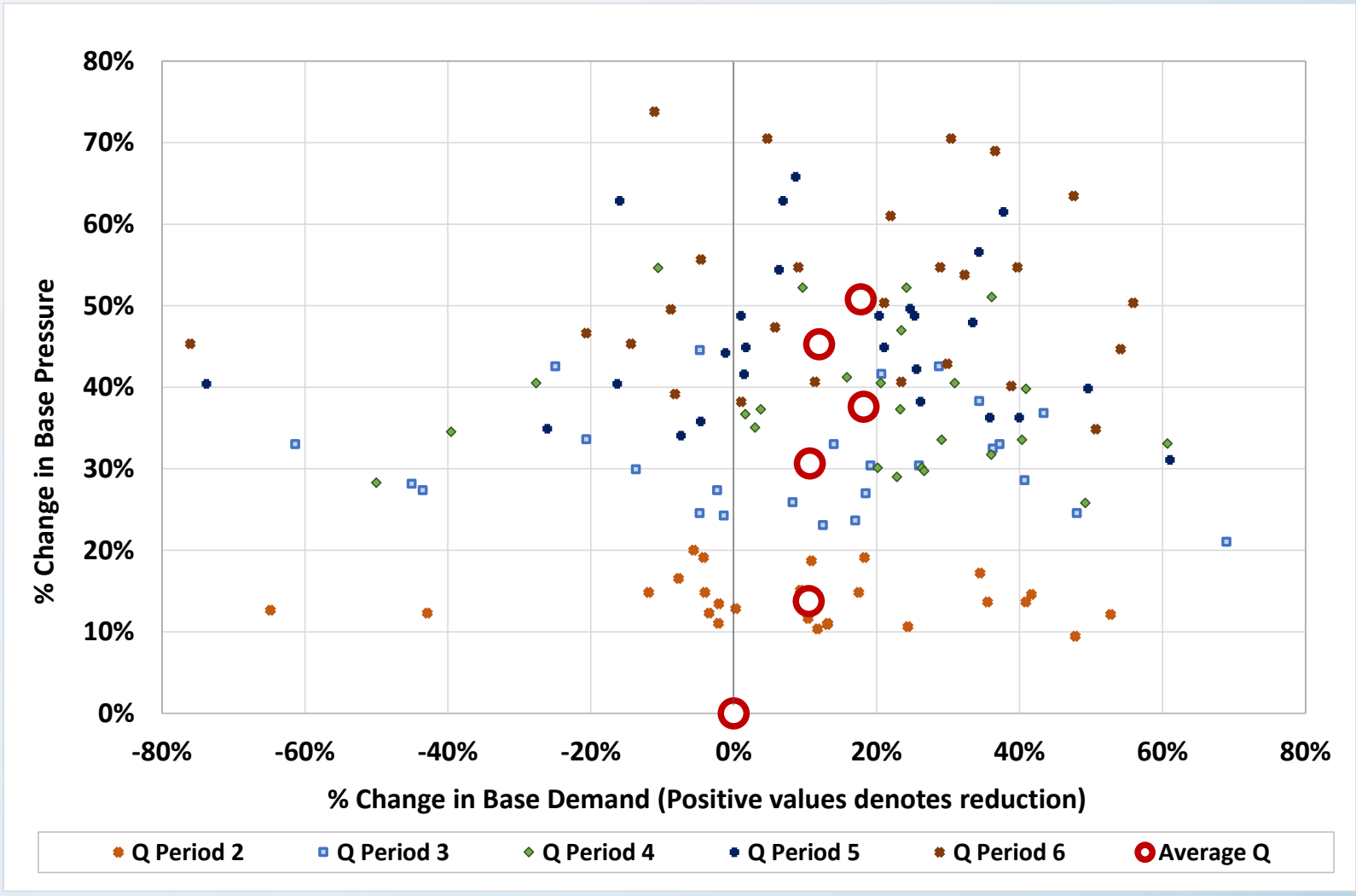
Increased Consumer MNF with Decreased Pressure



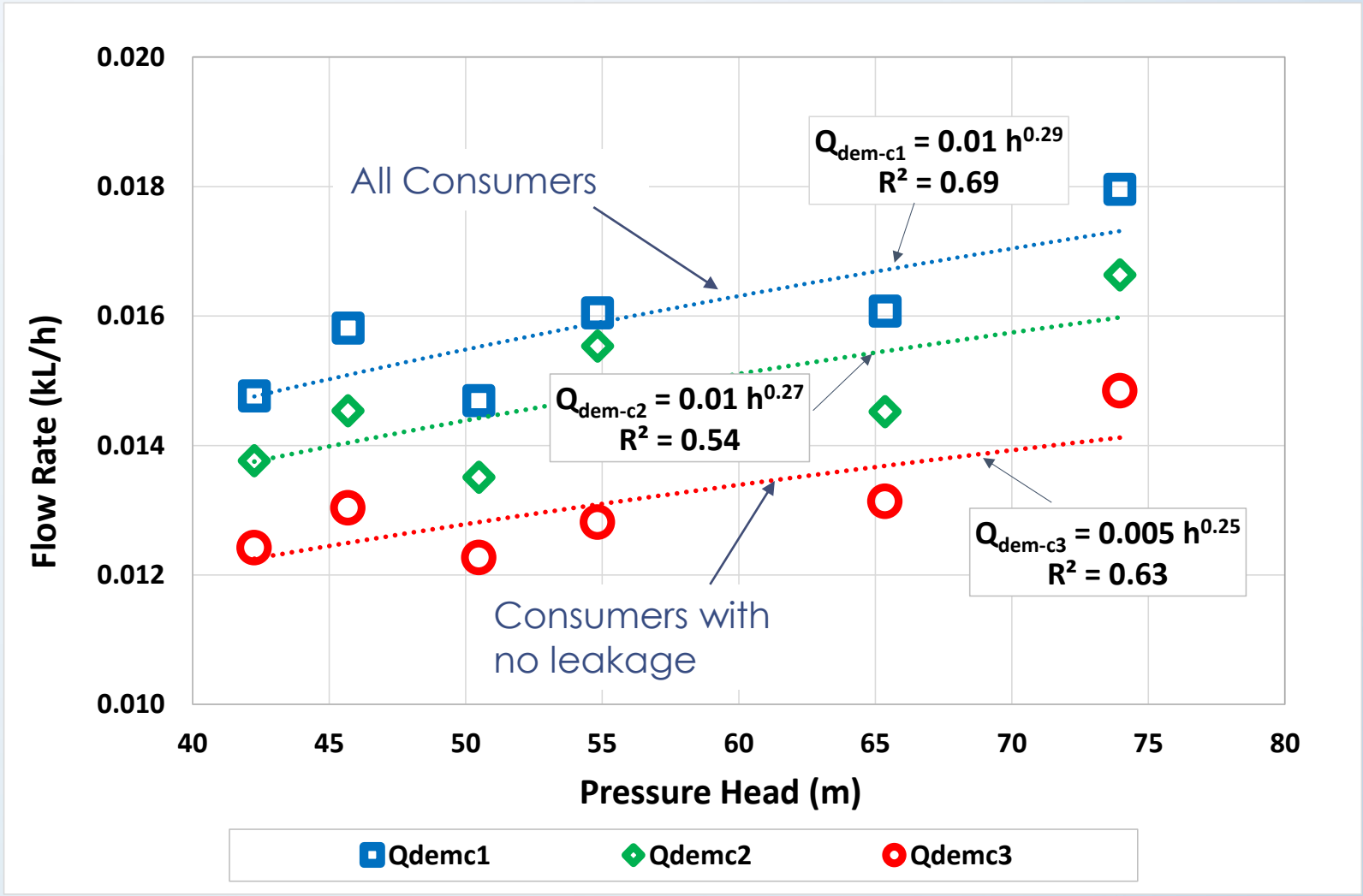
Unpredictable Consumer Demand Pattern



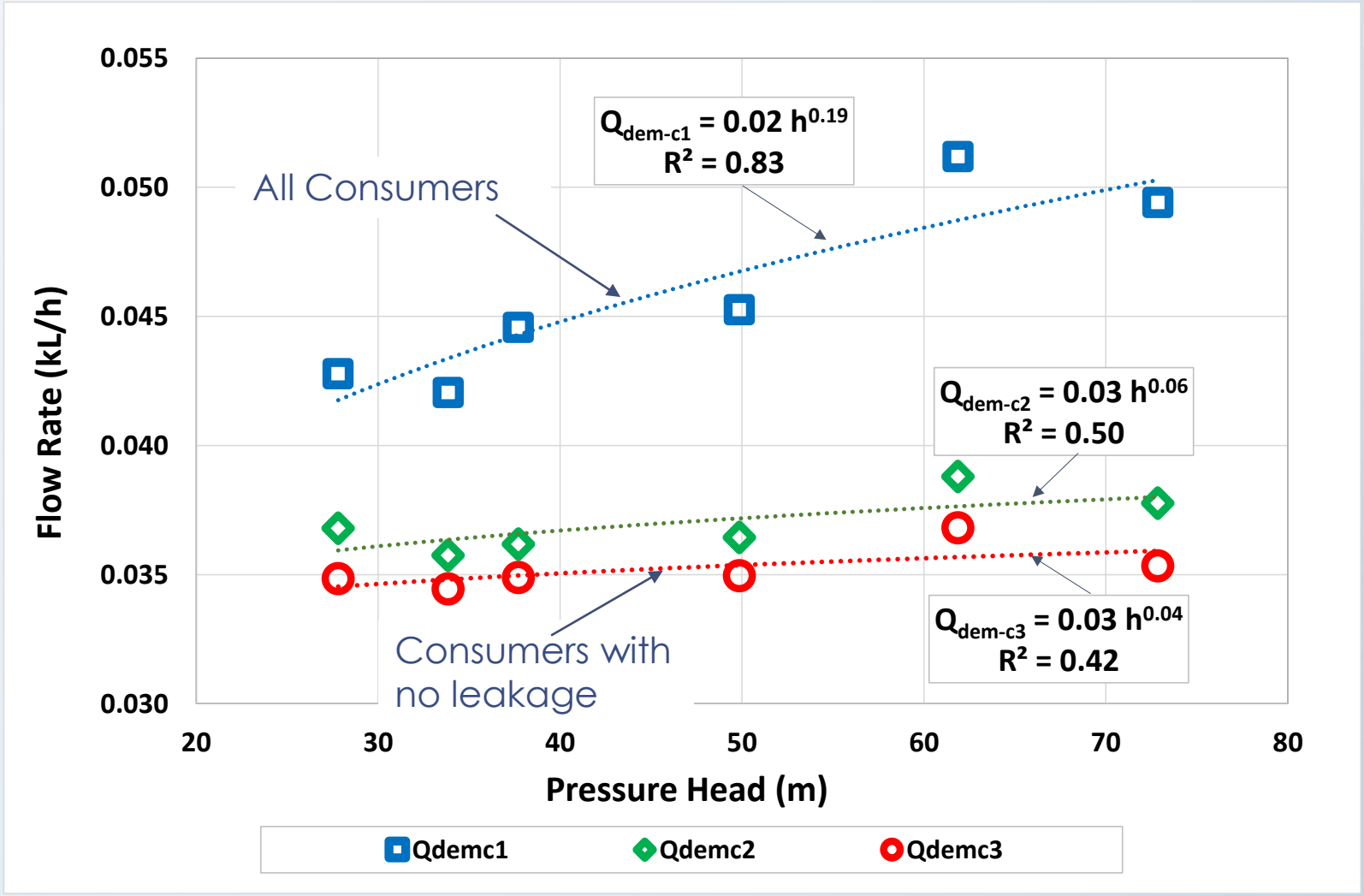
DMA2 Change in pressure versus change in consumer demand



DMA 2: Consumer demand versus pressure head



DMA 3: Consumer demand versus pressure head



Household plumbing PRVs

- Where household plumbing PRVs were expected the impact of elasticity of demand to pressure was lower (the impact of pressure change on demand was lower).
- In medium / high income DMAs most houses expected to have hot water geysers with plumbing PRVs. In some houses the hot and cold water systems can be regulated by a plumbing PRV.
- In the low cost DMA it appeared that many houses don't have hot water geysers and it was assumed that those houses don't have plumbing PRVs.

Elasticity Of Demand To Pressure

Elasticity of demand to pressure (β)				
	DMA Data	Individual Consumer Data		
		All Consumers	Exclude Consumer High Leakage	Exclude All Consumer with Leakage
DMA1	0.07	0.13	0.23	0.26
DMA2	0.22	0.29	0.27	0.25
DMA3	0.05	0.19	0.06	0.04

Conclusion

- Reduced pressure should on average result in reduced water demand. For individual consumers the pressure-demand relationship can however vary significantly.
- The elasticity of demand to pressure for the DMAs investigated was lower than anticipated:

  ≈0.15 to ≈0.30 (on-site leakage included)

  ≈0.05 to ≈0.25 (on-site leakage excluded)

  (Elasticity 0.25 means decrease by 2.5% for 10% reduction in pressure)
- Two significant factors were identified which could influence the elasticity of demand to pressure
  - On-site leakage
  - Household plumbing PRVs

Questions

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