Impact of Water Losses on Pressure and Energy in MWA Trunk Main Network, Thailand

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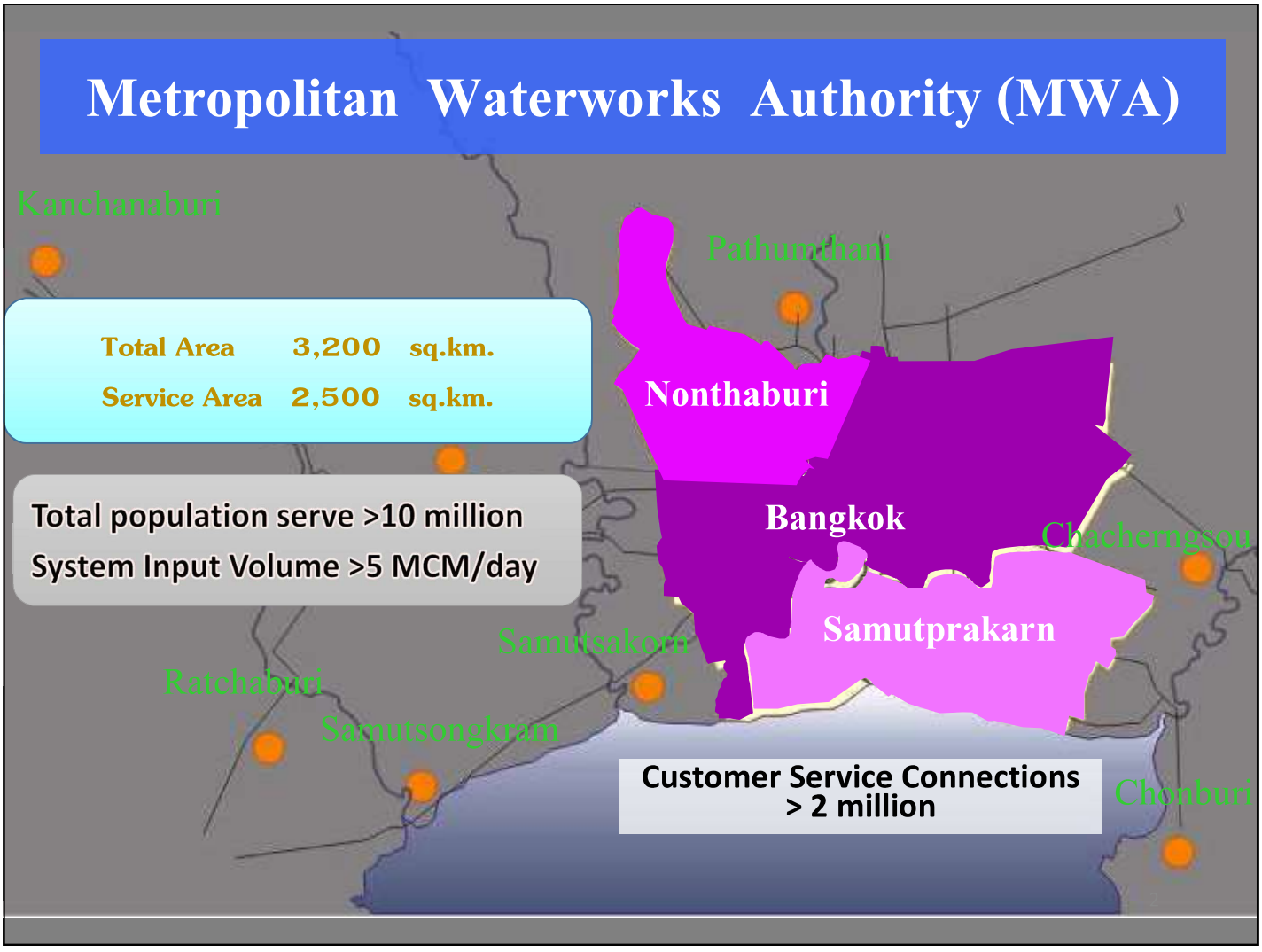
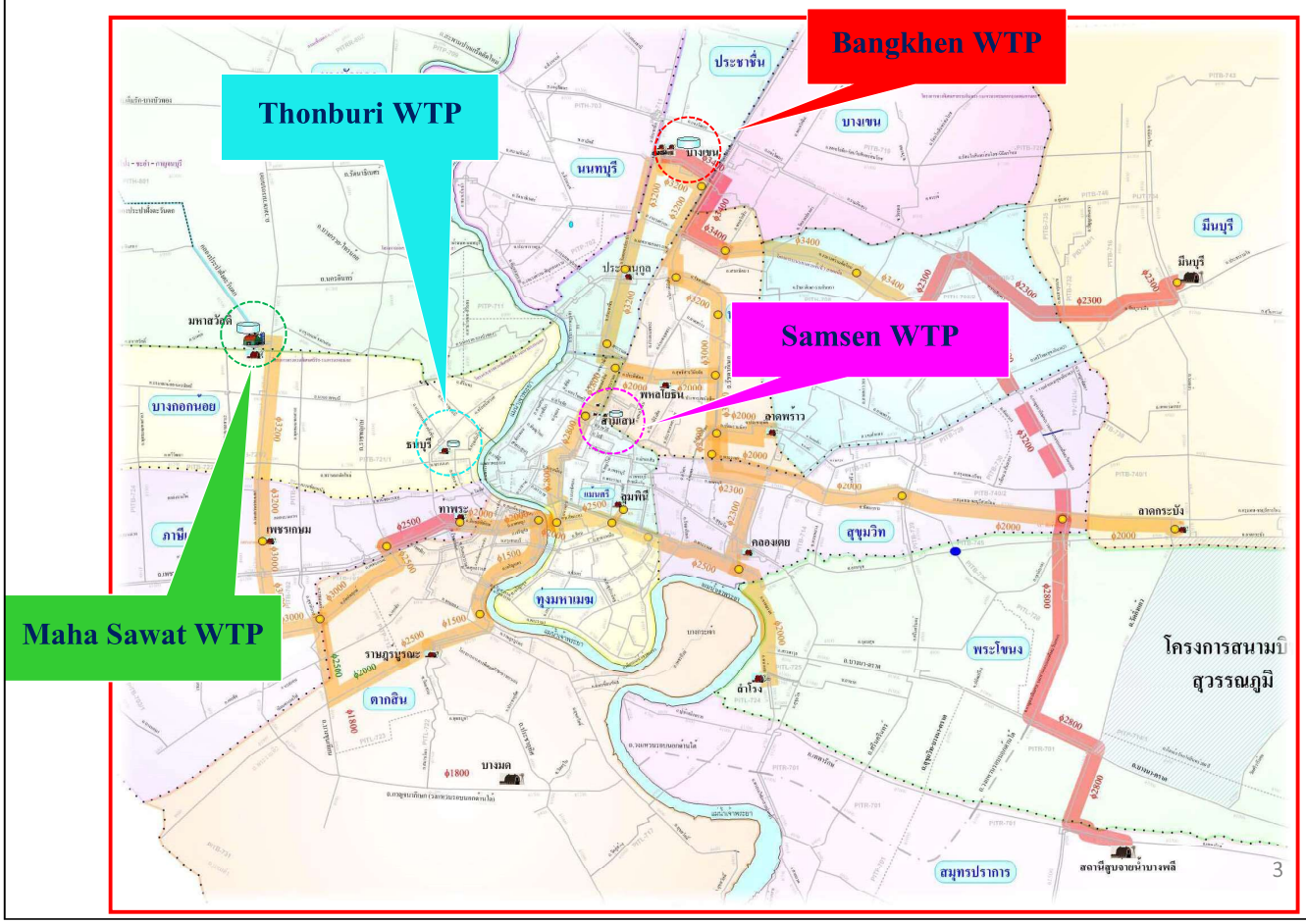
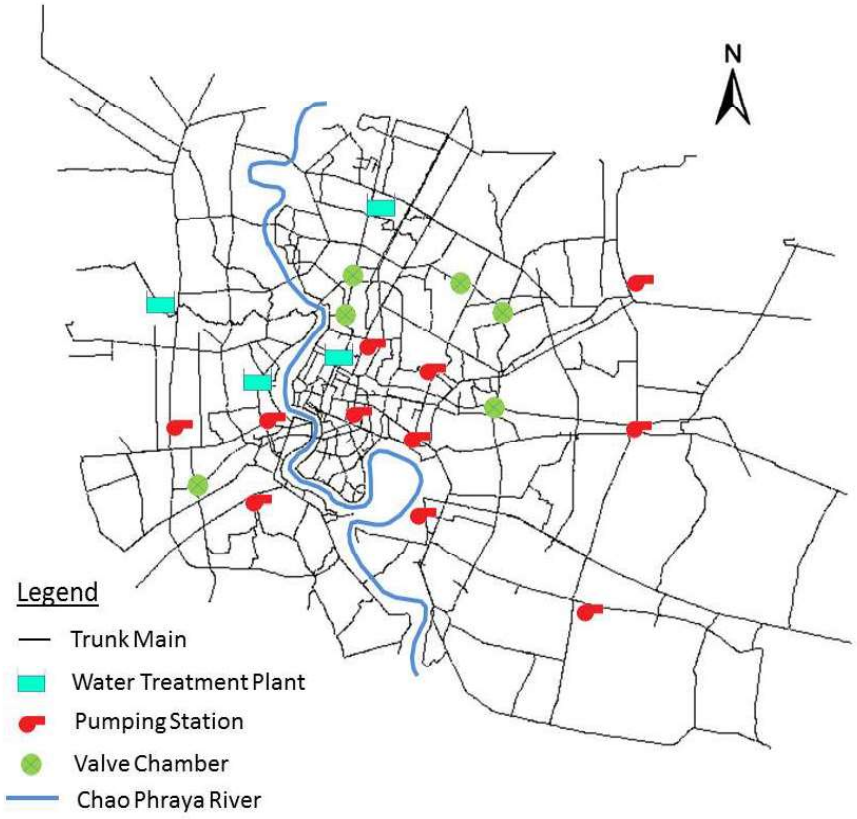


4 Water Treatment Plants (WTP) with 191-km transmission system



Trunk Main Network



- D = 500-1,800 mm
- 1,700 km
- 4 WTPs
- 11 distribution pumping stations
- 6 valve chambers

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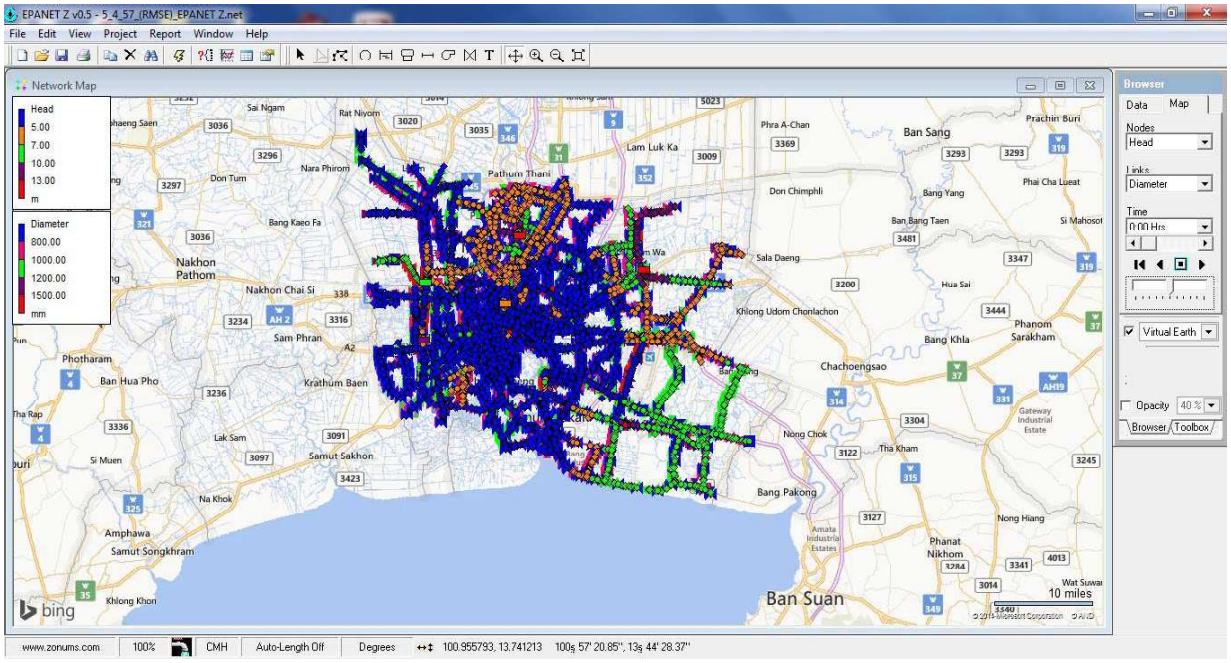
Simulation by EPANET software

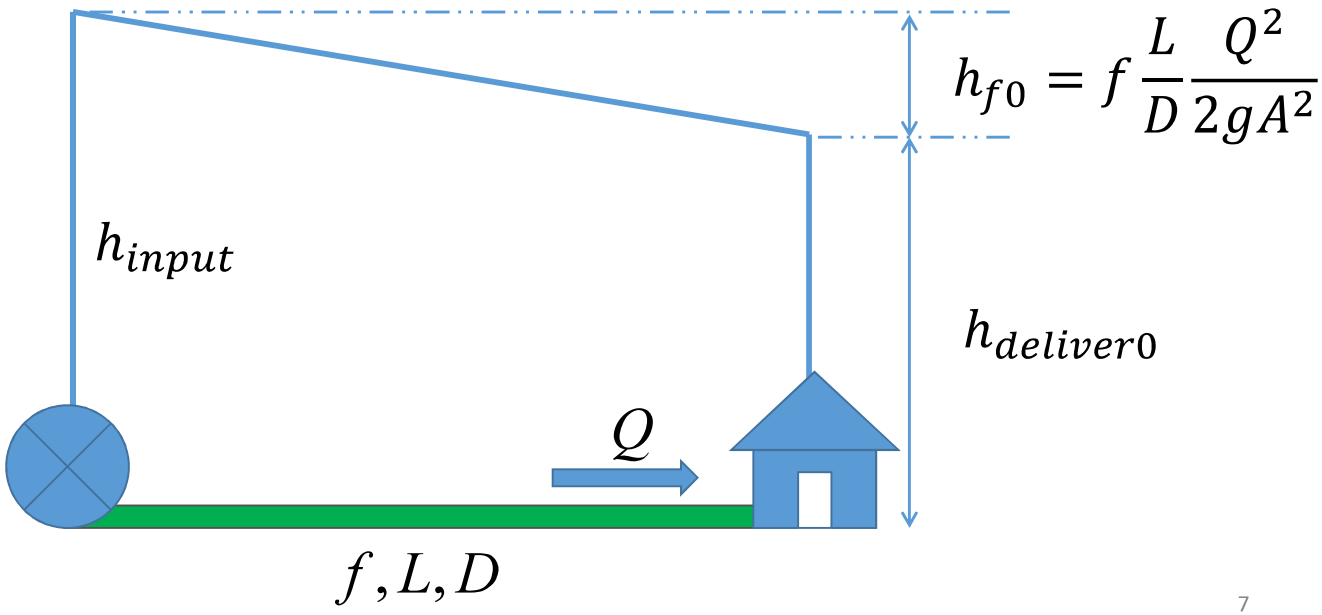


Energy Balance Concept

No water loss (%WL = 0)

$$E_{input} = E_{deliver} + E_{friction}$$

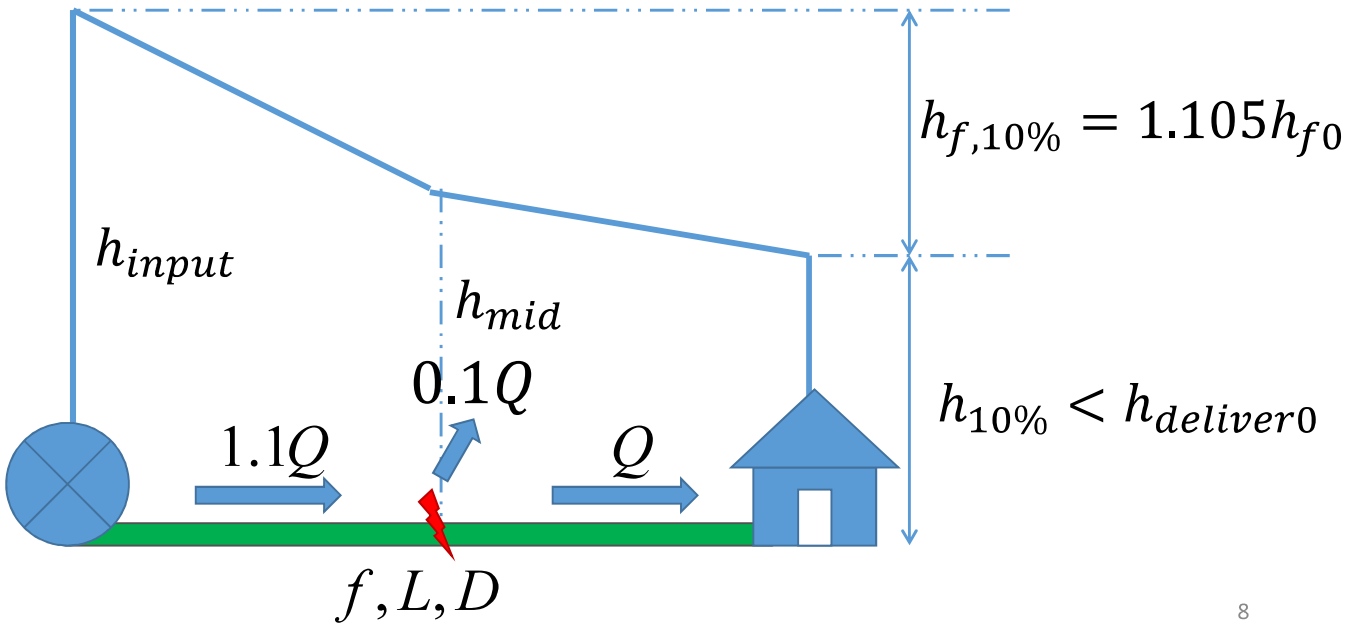
$$\rho g Q h_{input} = \rho g Q h_{deliver} + \rho g Q h_{f0}$$



%WL = 10% with a leak

$$E_{input} = E_{deliver} + E_{friction} + E_{leak}$$

$$1.1\rho g Q h_{input} = \rho g Q h_{10\%} + \sum \rho g Q h_f + 0.1\rho g Q h_{mid}$$



Energy Balance Metric for MWA Trunk main network

E_{Input} Input energy	E_{Output} Output energy	$E_{U,DM}$ Energy delivered to DMs
		$E_{L,DM}$ Outgoing energy through water loss in DMAs
		$E_{L,T}$ Outgoing energy through water loss on trunk mains
	$E_{Dissipated}$ Dissipated energy	$E_{F,DM}$ Friction at the DM feed lines
		$E_{F,T}$ Friction on the trunk mains
		$E_{F,V}$ Friction at throttled valves

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25.8% water losses in March 2013

Unit: MWatt-hr/day (%)

E_{Input} Input energy 277 (100%)	E_{Output} Output energy 148 (53.4%)	$E_{U,DM}$ Energy delivered to DMs 107 (38.6%)
		$E_{L,DM}$ Outgoing energy through water loss in DMAs 31 (11.2%)
		$E_{L,T}$ Outgoing energy through water loss on trunk mains 10 (3.6%)
	$E_{Dissipated}$ Dissipated energy 129 (46.6%)	$E_{F,DM}$ Friction at the DM feed lines 52 (18.8%)
		$E_{F,T}$ Friction on the trunk mains 64 (23.1%)
		$E_{F,V}$ Friction at throttled valves 13 (4.7%)

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MWA Targets in 2021

- To reduce %WL to 19% and
- raise the average pressure to 10.8 m.

Scenario

Leakage is pressure-driven flow and the main component of water losses. Thus,

$$Q_{leak} = C_L P^{N_1}$$

Scenario	Scenario Explanation	Throttling valves	Water loss parameters
0	Base model from March 2013	Yes	C_L
1	Remove all throttled valves	No	C_L
2	1st step of leak reduction	No	$0.8*C_L$
3	2nd step of leak reduction	No	$0.6*C_L$
4	3rd step of leak reduction	No	$0.4*C_L$

Results

Scenario	Volume of water losses, WL (MCM/day)	Percentage of water loses, %WL (%)	Average Pressure (m)	Range of Pressure (m)	Input Energy, E_{input} (MW-hr/day)
0	1.422	27.45	8.66	4.25 - 10.70	270
1	1.526	28.89	9.24	4.40 - 11.73	289
2	1.295	25.63	9.74	4.55 - 12.49	277
3	1.036	21.61 **19%**	10.33 **10.7 m**	4.72 - 13.39	264
4	0.741	16.48	11.02	4.92 - 14.49	249

Thus, if the MWA could reduce %WL to 19% as its target, the pressure would raise to 10.7 m very close to the target (10.8 m) by itself.

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Conclusion

- If MWA removes all throttled valves and can find and fix leaks and reduce %WL to 19% as its target, the pressure will raise to its pressure target (10.8 m) without increasing its pressure at the sources.
- MWA will save water of 0.434 MCM/day.
- MWA will save electricity around 23 MW-h/day (excluding production & transmission).
- The electricity reduction is worth ~30 mil.Baht/year (900,000 USD/year).

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Thank you

0% water losses

Unit: MWatt-hr/day (%)

<table>
<tr><td rowspan="4">E_{Input}
Input energy
207 (100%)</td><td rowspan="2">E_{Output}
Output energy
137 (66.2%)</td><td>$E_{U,DM}$
Energy delivered to DMs
137 (66.2%)</td></tr>
<tr><td>$E_{L,DM}$
Outgoing energy through water loss in DMAs
0 (0%)</td></tr>
<tr><td rowspan="2">$E_{Dissipated}$
Dissipated energy
70 (33.8%)</td><td>$E_{L,T}$
Outgoing energy through water loss on trunk mains
0 (0%)</td></tr>
<tr><td>$E_{F,DM}$
Friction at the DM feed lines
25 (12.1%)</td></tr>
<tr><td rowspan="2"></td><td>$E_{F,T}$
Friction on the trunk mains
37 (17.9%)</td></tr>
<tr><td>$E_{F,V}$
Friction at throttled valves
8 (3.8%)</td></tr>
</table>