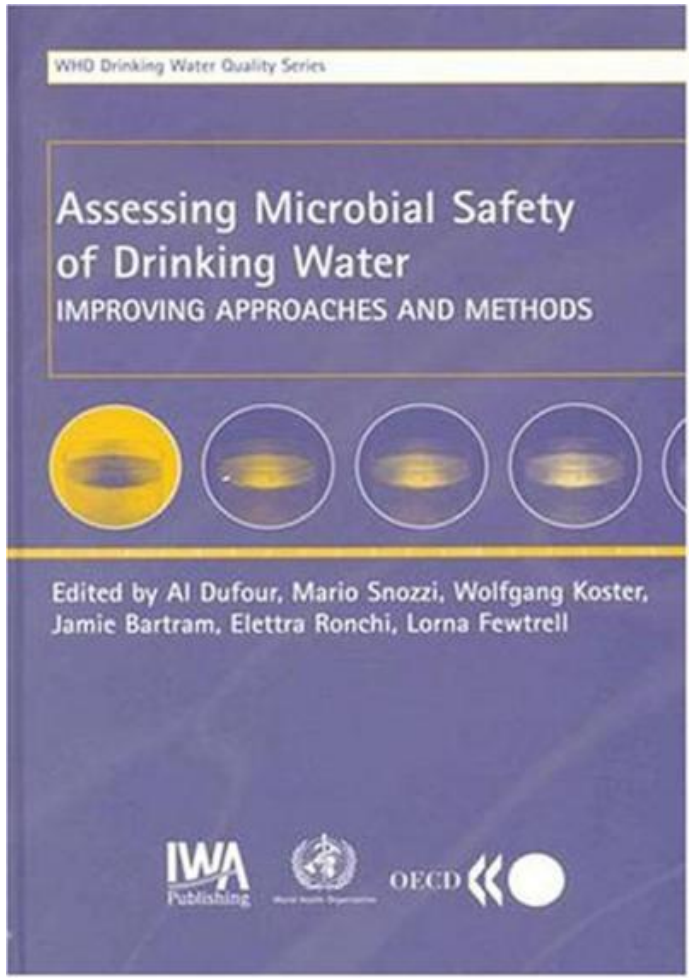
Where is water safety planning going globally? How can sanitation safety plans support WSPs?

JAMIE BARTRAM AND KAREN SETTY

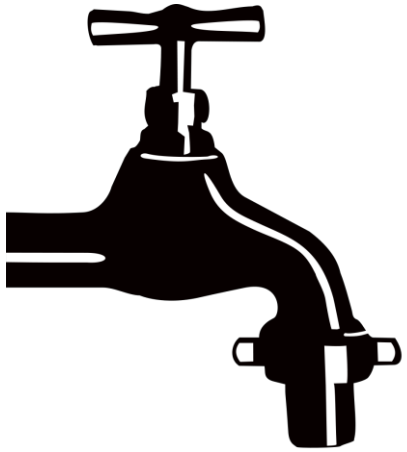
19TH SEPTEMBER 2017

Some history



1. Acenaphthene
2. Acrolein
3. Acrylonitrile
4. Benzene
5. Benzidine
6. Carbon tetrachloride
7. Chlorobenzene
8. 1,2,4-trichlorobenzene
9. Hexachlorobenzene
10. 1,2-dichloroethane
11. 1,1,1-trichloreothane
12. Hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. Chloroethane
17. (Removed)
18. Bis(2-chloroethyl) ether
19. 2-chloroethyl vinyl ethers
20. 2-chloronaphthalene
21. 2,4,6-trichlorophenol
22. Parachlorometa cresol
23. Chloroform
24. 2-chlorophenol
25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene
28. 3,3-dichlorobenzidine
29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. 2,4-dichlorophenol
32. 1,2-dichloropropane
33. 1,3-dichloropropylene
34. 2,4-dimethylphenol
35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
37. 1,2-diphenylhydrazine
38. Ethylbenzene
39. Fluoranthene
40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. Bis(2-chloroisopropyl) ether
43. Bis(2-chloroethoxy) methane
44. Methylene chloride
45. Methyl chloride
46. Methyl bromide
47. Bromoform
48. Dichlorobromomethane
49. (Removed)
50. (Removed)
51. Chlorodibromomethane
52. Hexachlorobutadiene
53. Hexachlorocyclopentadiene
54. Isophorone
55. Naphthalene
56. Nitrobenzene
57. 2-nitrophenol
58. 4-nitrophenol
59. 2,4-dinitrophenol
60. 4,6-dinitro-o-cresol
61. N-nitrosodimethylamine
62. N-nitrosodiphenylamine
63. N-nitrosodi-n-propylamine
64. Pentachlorophenol
65. Phenol
66. Bis(2-ethylhexyl) phthalate
67. Butyl benzyl phthalate
68. Di-N-Butyl Phthalate

1994: From detection to prevention



WHO *Guidelines* development 10 year journey

490 people, 90 countries, 50 consultative processes

Contributors and Collaborative Meetings

Why we need to review our approach

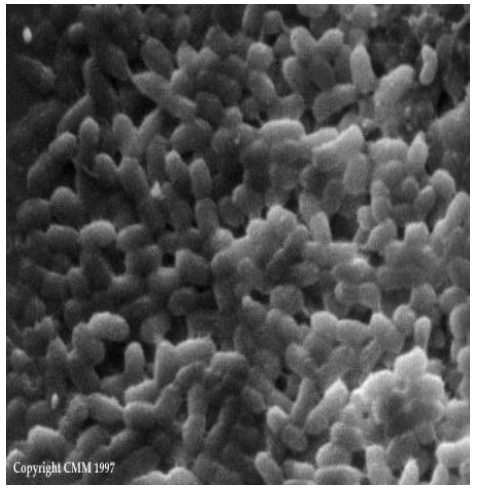
- In all countries waterborne illness still occurs
- Outbreaks show us that we cannot solely rely on water treatment and indicators
- End-point testing is too-little-too-late

NSW Heads of Water,2003

Disease still happening

USA (1989-1990)

- 26 waterborne disease outbreaks reported
- Causes:
  - inadequate water treatment 54%
  - untreated groundwater 23%
  - distribution deficiencies 12%
  - untreated surface water 8%



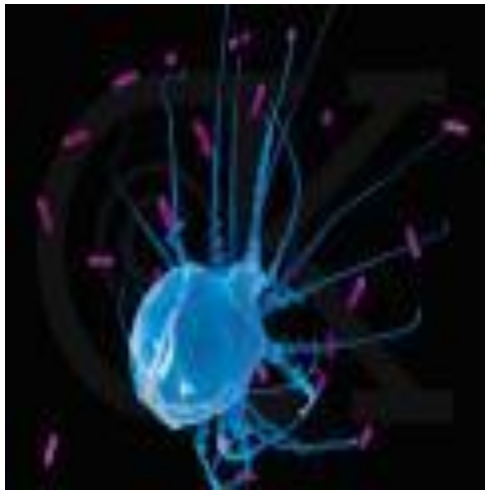
Treatment infallibility

- Milwaukee (1993) showed that sophisticated treatment not sufficient - event driven outbreak
- 403,000 individuals contracted cryptosporidiosis
- Treated water complied with all WHO guidelines (contained no *E. coli)*

NSW Heads of Water,2003

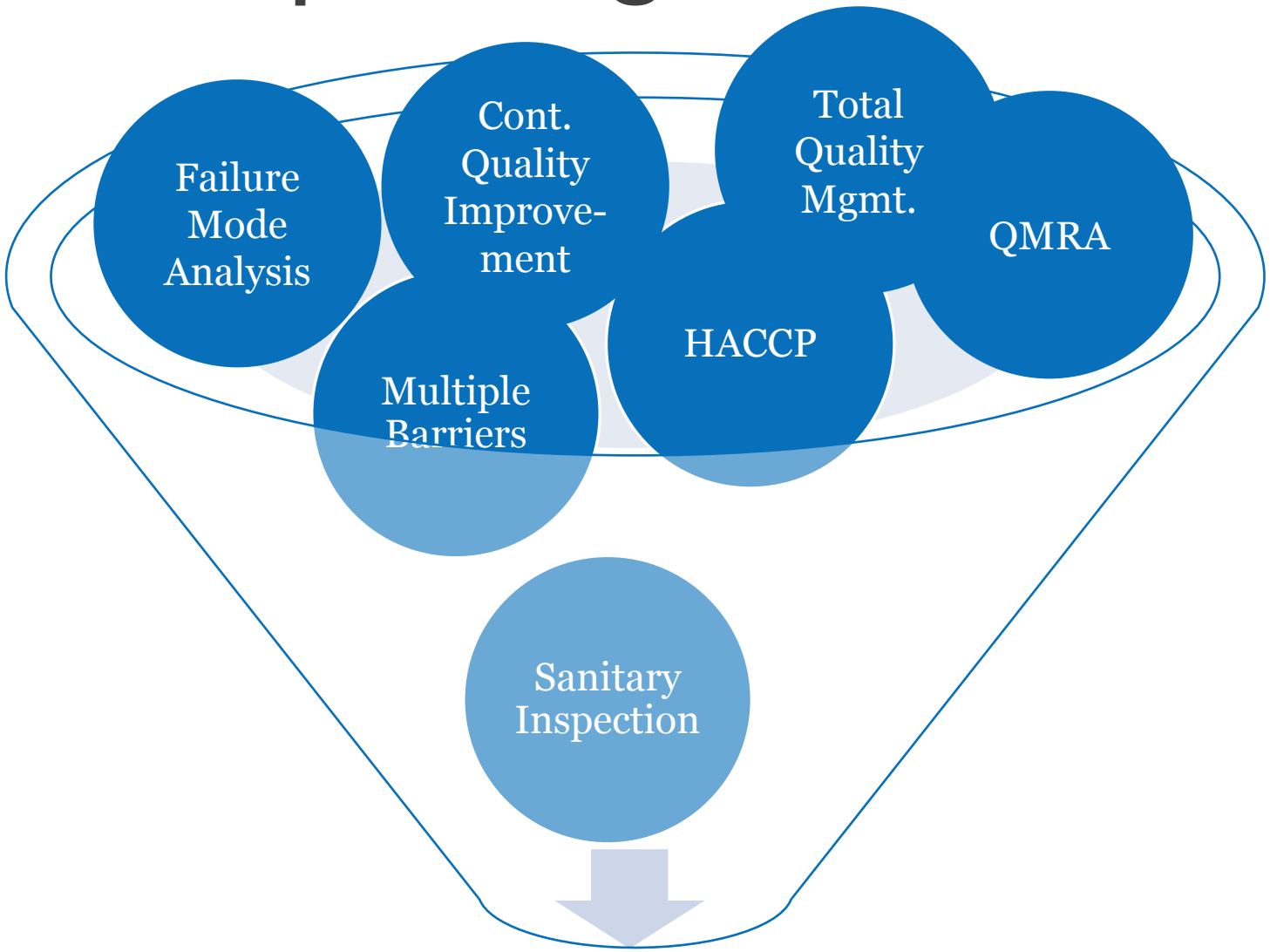
End-point testing (too little too late)

- Example Melbourne Water
- 14,000 samples in 2001 (100 mL samples)
- 1,000,000,000 L per day (1000 ML)
- Sample millionth of 1% of supply
- < 0.2 second snapshot per year



NSW Heads of Water,2003

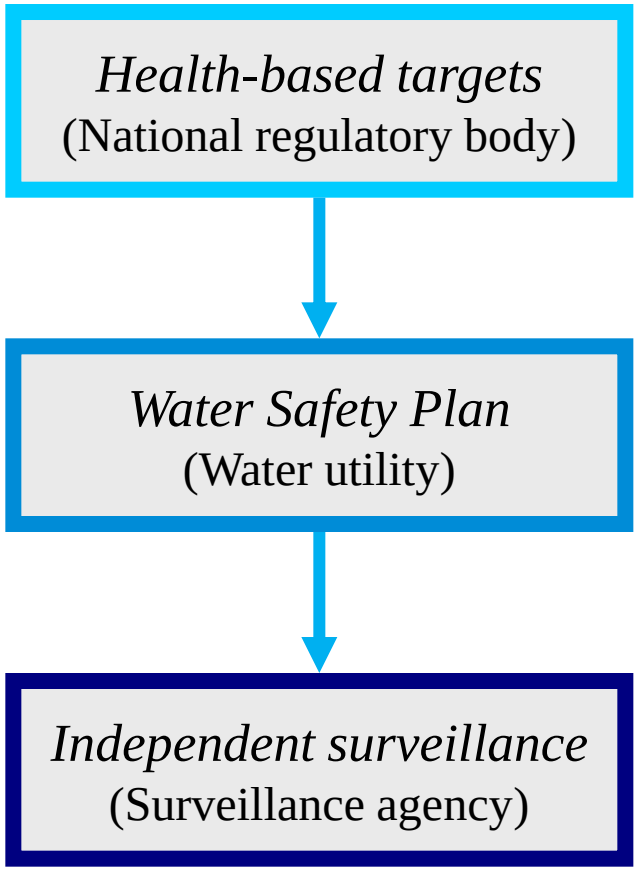
Conceptual ingredients



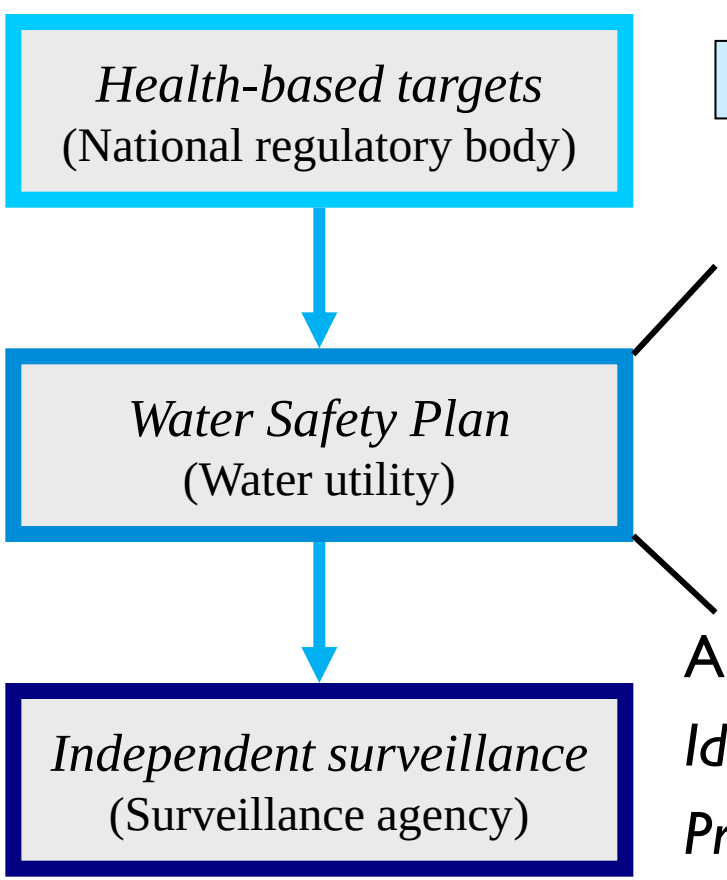
Framework for Safe Drinking-Water

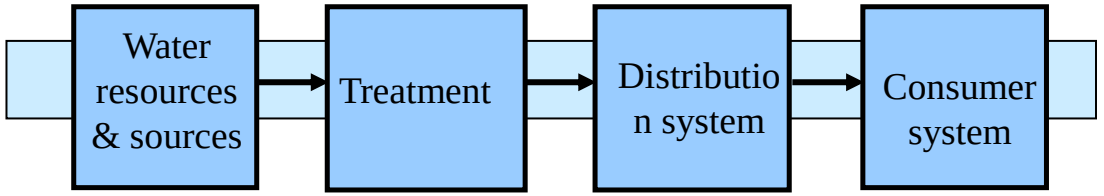
Water Safety Plans

WHO *Guidelines for Drinking Water Quality*, 2004
Framework for Safe Drinking Water



WHO *Guidelines for Drinking Water Quality*, 2004 Framework for Safe Drinking Water





A documented plan that:

Identifies risks from catchment to consumer

Prioritises risks

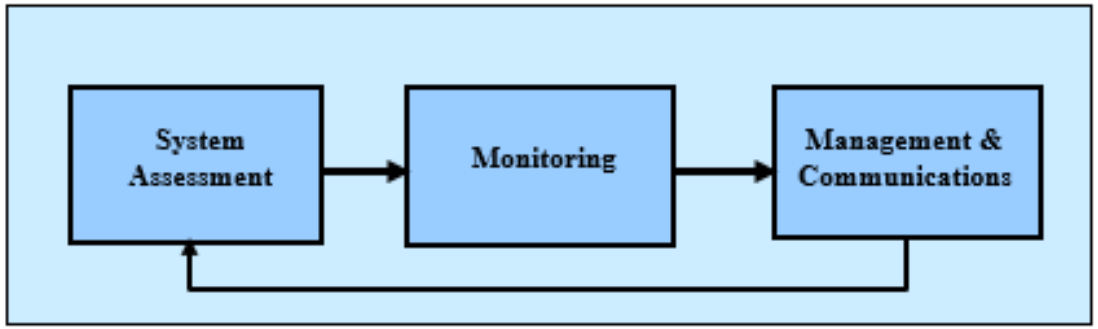
Mitigates risks through control measures

WHO *Guidelines for Drinking Water Quality*, 2004 Framework for Safe Drinking Water

Health-based targets
(National regulatory body)

Water Safety Plan
(Water utility)

Independent surveillance
(Surveillance agency)

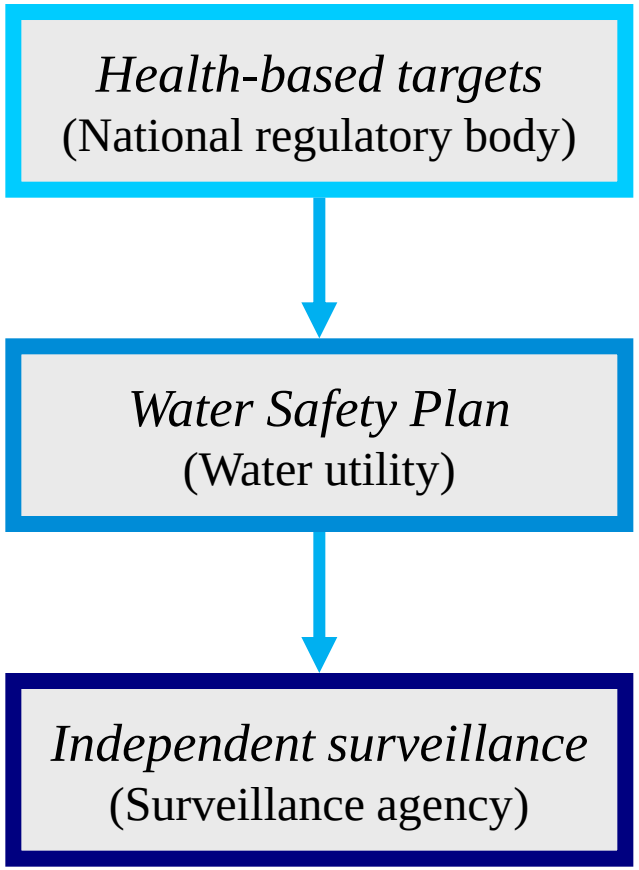


System Assessment: … can the water supply chain deliver safe water?

Monitoring: … of control measures of particular importance in securing water safety

Management and Communication: … actions to be undertaken from normal conditions to extreme events

WHO *Guidelines for Drinking Water Quality*, 2004
Framework for Safe Drinking Water

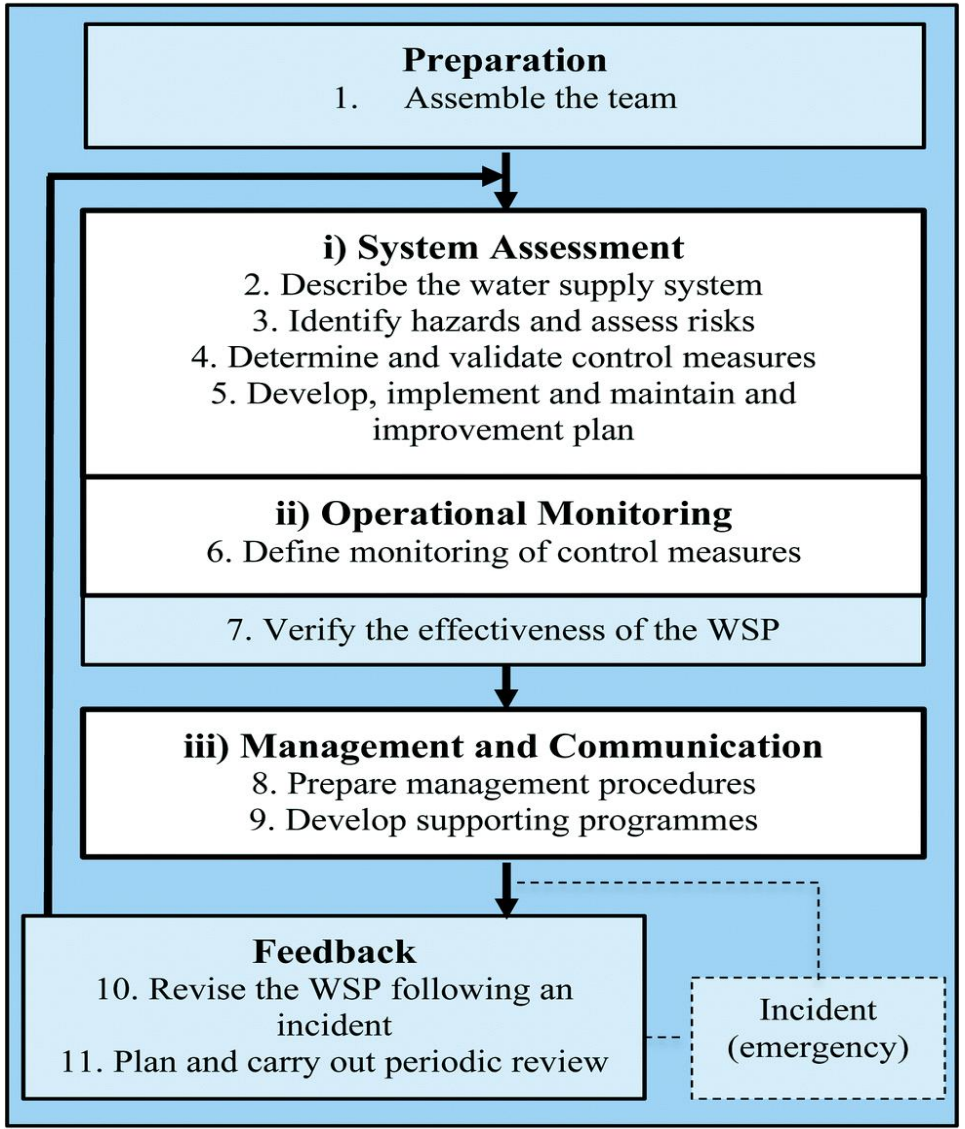


Water Safety Plans made … Simple

Water Safety Plans made …

Simple

In Practice



The Case for WSPs

Compared to end-point monitoring, WSPs:

1. Save utility money in the long-term
2. Better prevent waterborne disease
3. Work in resource limited settings
4. Are more sustainable (utility engagement in WSP development builds capacity)
5. Are internationally accepted
6. Demonstrate 'due diligence'

Does it work? (compliance)

Site	Parameter	Change post-intervention	Threshold value	Source
1	Total coliform	Increase in compliance	>0 MPN/100ml	EU and French quality limit
	Turbidity	Increase in compliance	>2 NTU	French quality reference for tap

Setty, et al. (2017). Water quality, compliance, and health outcomes among utilities implementing Water Safety Plans in France and Spain. *Int. J. Hyg. Environ. Health* 220: 513–530.

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3	Free chlorine (sensors)	Increase in compliance	<0.05 mg/l	WSP critical limit for chlorination

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3	Free chlorine (sensors)	Increase in compliance	<0.05 mg/l	WSP critical limit for chlorination
4	Bromate	Increase in compliance	>10 µg/l	EU and French quality limit
	Free chlorine (surface water plant only)	Increase in compliance	<0.2 mg/l *simplified	WSP operational limit (surface water plant)

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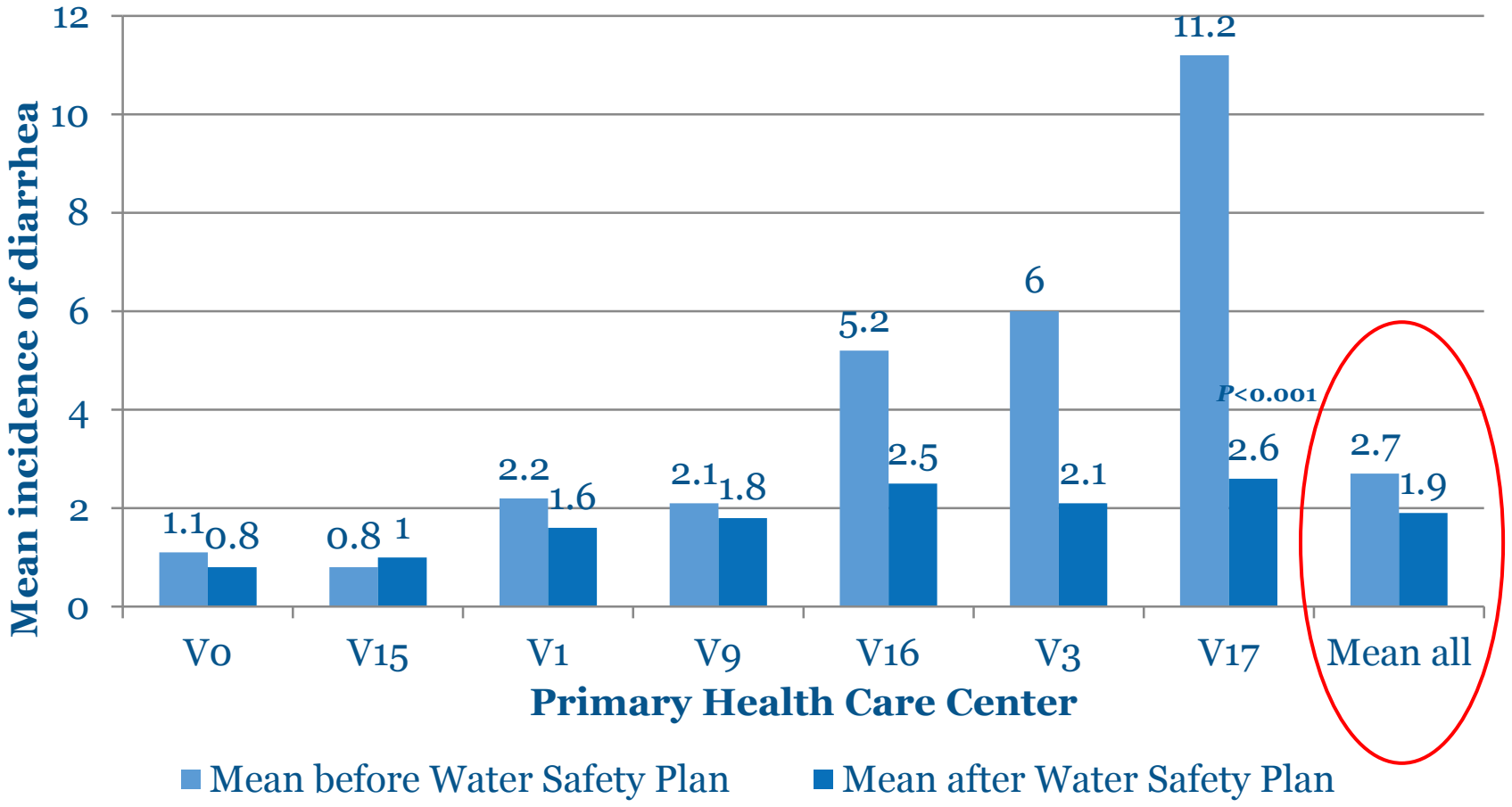
4	Bromate	Increase in compliance	>10 µg/l	EU and French quality limit
	Free chlorine (surface water plant only)	Increase in compliance	<0.2 mg/l *simplified	WSP operational limit (surface water plant)
5 (full)	Aluminum	Increase in compliance	>100 µg/l	Suez internal recommended practice
	THMs	Increase in compliance	≥50 µg/L	Suez recommendation for outlet of plant
		Increase in compliance	>100 µg/l	EU and Spanish quality limit for network
	Free chlorine (sensors)	Increase in compliance	<0.2 mg/l *simplified	Catalunya/WSP critical limit for chlorination
	Aluminum	Increase in compliance	>200 µg/L	EU and Spanish and regional quality limit
	Turbidity (sensors after sand filters)	Decrease in compliance	≥0.75 NTU	WSP operational limit
		Decrease in compliance	≥1 NTU *simplified	WSP critical limit
	Turbidity (sensors)	Increase in compliance	>0.5 NTU	Spanish quality reference for plant outlet
	Nickel	Increase in compliance	<550 mg I2/g	WSP operational level for granular activated carbon

Setty, et al. (2017). Water quality, compliance, and health outcomes among utilities implementing Water Safety Plans in France and Spain. *Int. J. Hyg. Environ. Health* 220: 513–530.

Incidence of diarrhea at 7 Primary Health Care Centers (per month per 1000 inhabitants)



Result: Mean incidence of diarrhea significantly higher before than after WSP at five out of seven PHCCs (at V0, V1, V16, V3 and V17)

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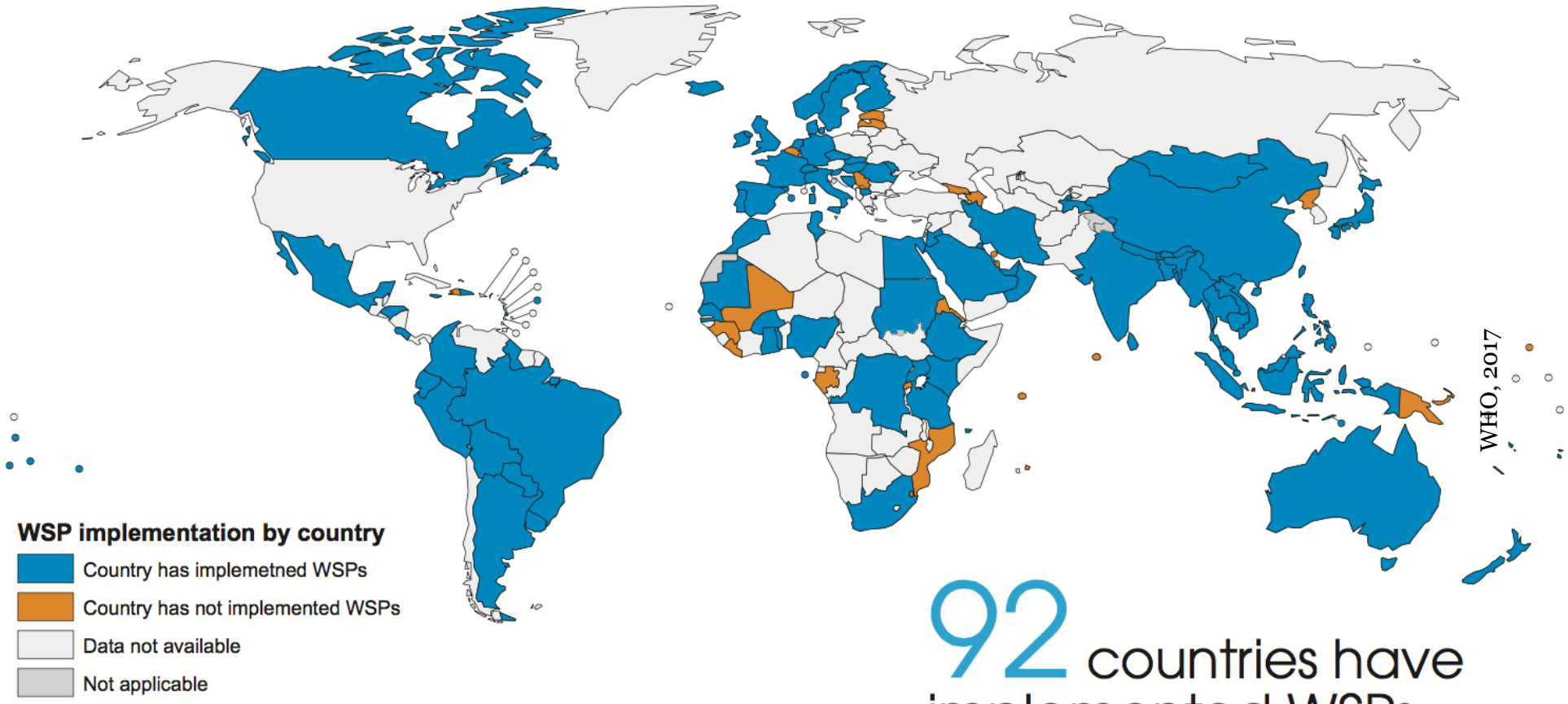
Gunnarsdóttir, et al. (2012). Benefits of water safety plans: microbiology, compliance, and public health. *Environ. Sci. Technol.* 46 (14), 7782–7789.

WSP uptake



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WHO. 2017. Global status report on water safety plans.

Making it work:

Pre-conditions → Getting started → Keeping up

Making it work:

Pre-conditions → Getting started → Keeping up

Risk: New programs can fail if guidance is (or has a reputation as) overly technical, vague, or difficult[1]

- Main WSP manual is undergoing updates based on user feedback[2]
- WHO has developed a number of more context-specific manuals (e.g., for small systems, surface water systems, auditing)
- Manuals are also a backed by crowd-sourced information on wsportal.org

"Make it easy for people to 'do the right thing'"

– WHO WSP Manual, 2009, pg 75

Making it work:

Pre-conditions → Getting started → Keeping up

External factors:

- Culture that values safe water[3]
- Trigger event/recognition of need
- Cooperation of government/oversight agencies[4,5]
- Peer support/local case studies[6]

Internal factors:

- Leaders/champions[7]
- Readiness (including resources)[8]
- Fidelity to the developers' intentions

Making it work:

Pre-conditions → Getting started → Keeping up

Alignment of local WSP goals with broader public health goals[9]

Understanding of WSP among staff[10]

Avoiding "tokenism"[7]

- Practice of making only a perfunctory or symbolic effort to do something

Frequent internal and external audits[10]

Attention to weak signals, wildcards, and near misses[11]

Havelock North?

Water Safety Plan

versus

Water Safety Planning

Framework for Safe Drinking-Water

WSP described the risks, but perhaps the heart of the program was not being followed:

- Lack of communication among four employee groups
- Risks not well-understood among employees
- Infrastructure not being maintained

Havelock North?

Water Safety Plan

versus

Water Safety Planning

Framework for Safe Drinking-Water

Legislation

- Health-based targets
- Clear assignment of responsibilities

Independent Surveillance?

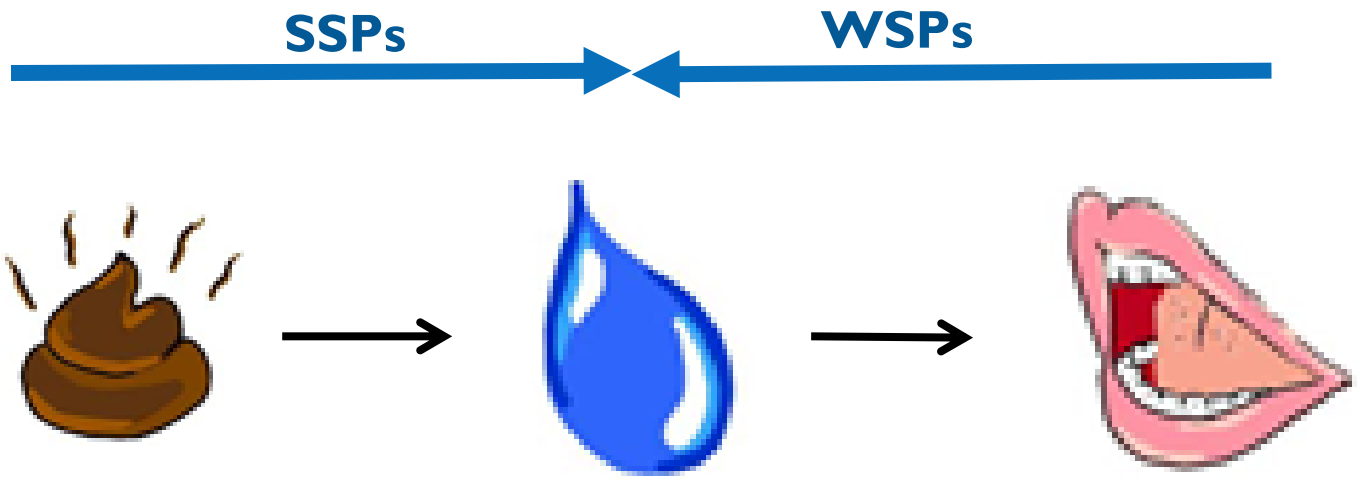
Sanitation Safety Plans

WSP-SSP co-dependency: Part
source water and part of SDG 6

Also Guidelines on:

Safe Recreational Water Environments

Safe Use of Wastewater in Agriculture and Aquaculture



Images: http://www.healthy-mind-body.com/humanitarian/vetiver_latrine.html

WSPs and SSPs

SSPs typically consider human waste management

- Great! All of shit cycle; But, also worry about animal waste, chemicals, etc.
- → Necessary but not sufficient

WSPs should consider diverse watershed activities that could affect source waters

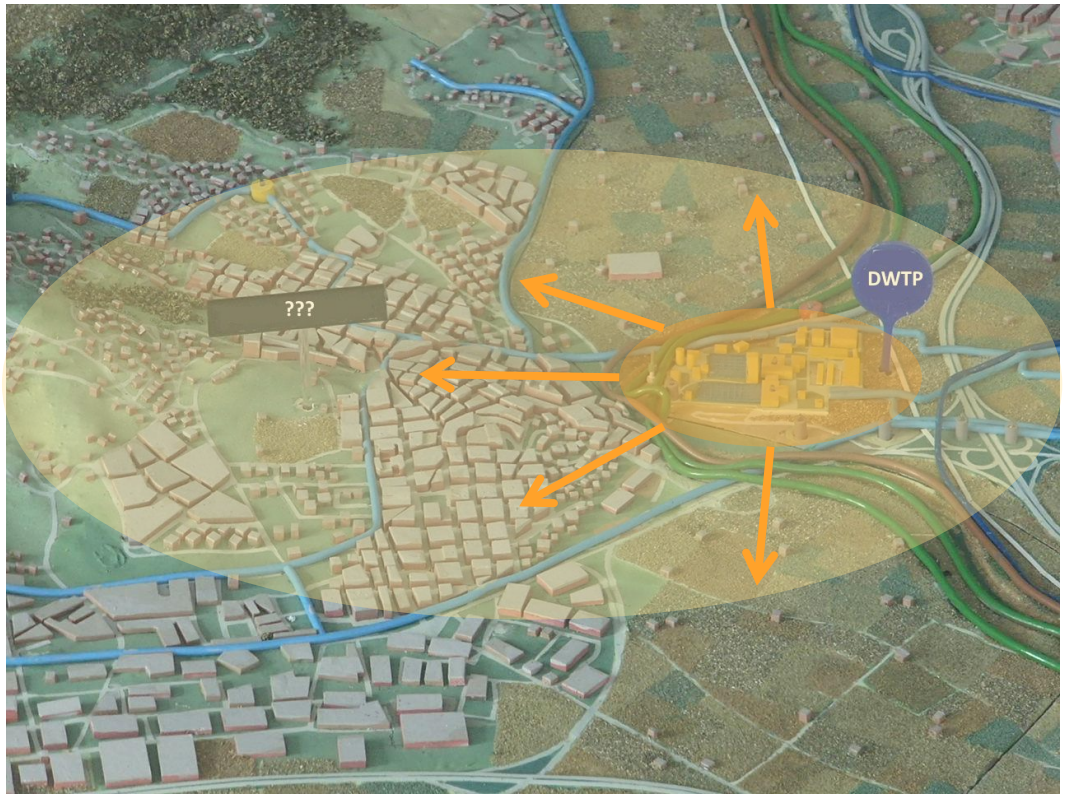


Image: K. Setty

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Thank You

Q&A

References (Making it Work)

1. Baum et al. 2015. An examination of the potential added value of water safety plans to the United States national drinking water legislation. *International Journal of Hygiene and Environmental Health* 218: 677–685.
2. Ojomo, E. 2017. Recommendations to improve the WSP manual. (J. Luh, *ed.*) UNC Water Institute. Chapel Hill, NC.
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10. Gunnarsdóttir, M.J., Gardarsson, S.M., & Bartram, J. (2012). Icelandic Experience with Water Safety Plans. *Water Science & Technology* 65(2): 277–288.
11. Takala, A. & Heino, O. (2017). Weak signals and wild cards in water and sanitation services – exploring an approach for water utilities. *Eur J Futures Res* 5:4.

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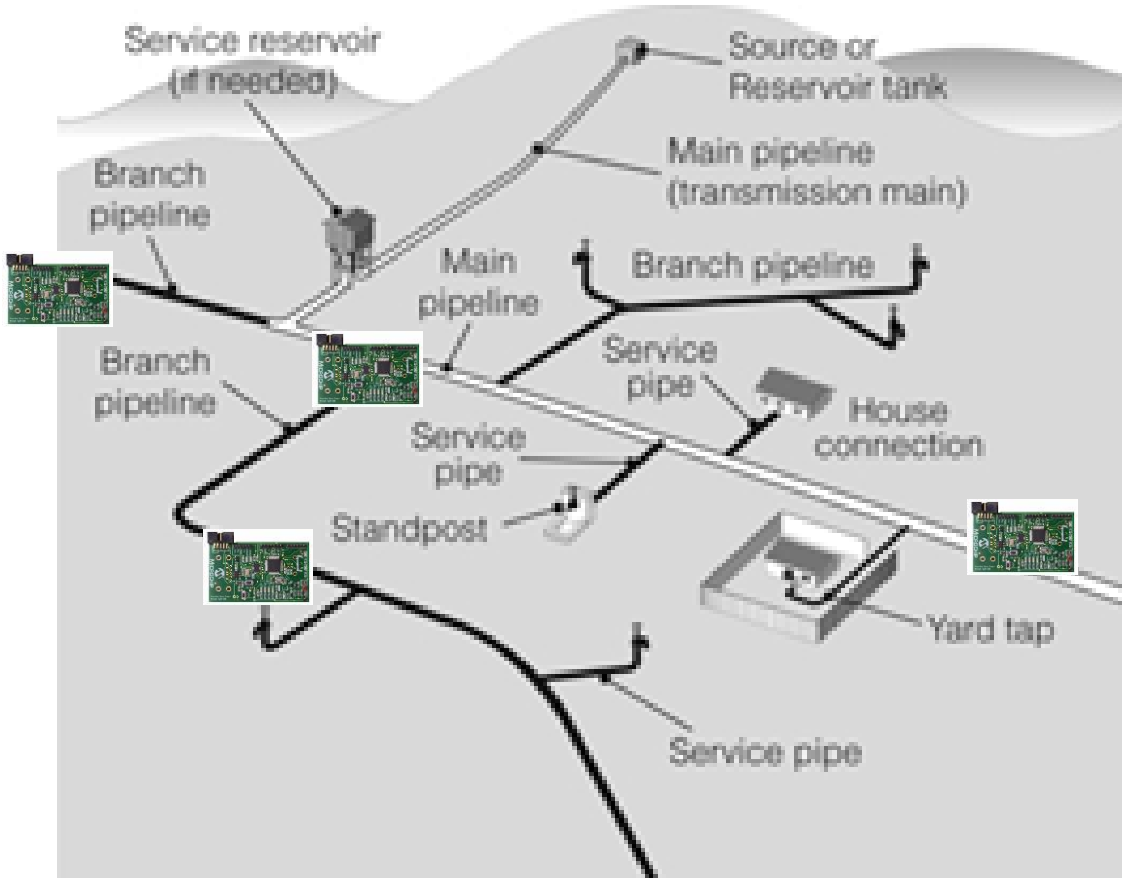
Extra Slides

Water Safety Plans, part of the 'Framework for Safe Drinking-Water", emerged from a ten-year WHO process that began in 1994. They turned around the then-dominant focus on ever faster and more specific testing and on treatment-focused actions to secure quality. They demanded re-engagement with understanding and tackling the potential sources of and barriers to contamination, rather than reliance on detecting it once it had occurred. In doing so they increased recognition of the need to intervene in catchment and in distribution as well as treatment to secure reliable water safety. For water suppliers, legislators and regulators they represented a fundamental change, which challenged established ways of working. Such radical change was accepted in large part because of a ten-year process of development that involved 490 people from 90 countries; and more than 50 expert and consultative meetings and processes. The result has been a rate of adoption of this approach that is arguably unprecedented for such a policy initiative. That process of adoption has provided opportunities to understand WSP processes and impacts. High quality studies in Iceland, France and Spain have documented beneficial impacts on water quality, compliance with internal and external standards and on health outcomes. The latter, from a high-income country with good infrastructure and high quality underlying resources is noteworthy. These opportunities have also provided insights into factors that support the successful implementation of Water Safety Plans ie what makes them work on-the-ground; and also on the factors associated with their uptake and adoption in policy and regulation.

Shift to Preventive Management



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HACCP vs. WSP

- Batch product
- Knock-out step
- Most steps under supplier's control

- Continual service
- Incremental pollution and elimination
- Most steps not under supplier's control

- Both developed to control infectious hazards
  - WSP included chemical consideration

Less-Developed Countries

- In rural applications, need simplified WSP process and community support[1]
- Often improves record keeping and service orientation[2]
- Cost-savings associated with focused monitoring, earlier problem identification, health improvements, reduced water loss and purchases[3]

Does It Work? (Health)

Table S4 Statistical summary of incidence of diarrhoea at eighteen PHCCs

PHCCs combined		No. month data	Mean*	Median*	Percentiles* 5th and 95th	Range*
Comparison one	All 7 PHCCs before WSP	358	2.74	1.60	0.30, 9.37	20.37
	All 7 PHCCS after WSP	638	1.88	1.37	0, 4.90	28.52
Comparison two	All 7 PHCCs without WSP	895	1.63	1.23	0, 5.16	16.78
	All 4 PHCCS with WSP	517	0.94	0.80	0.11, 2.25	4.29
Total 18 PHCCs		2408	1.71	1.16	0, 5.35	28.52

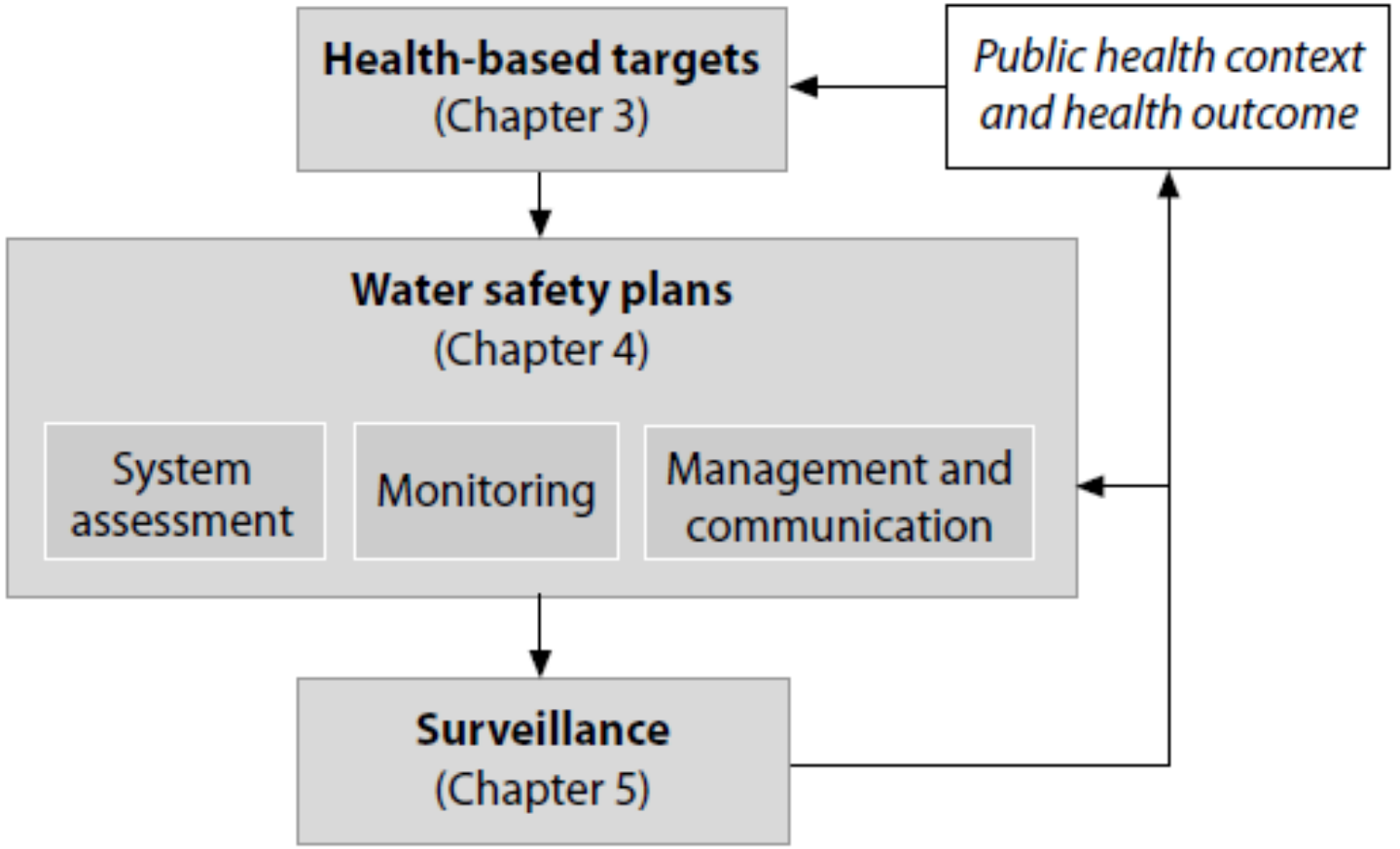
*Incidence of diarrhea per 1000 inhabitants per month

Found a 14% reduction in diarrheal incidence in Iceland

Gunnarsdottir et al., 2012

Developed Countries

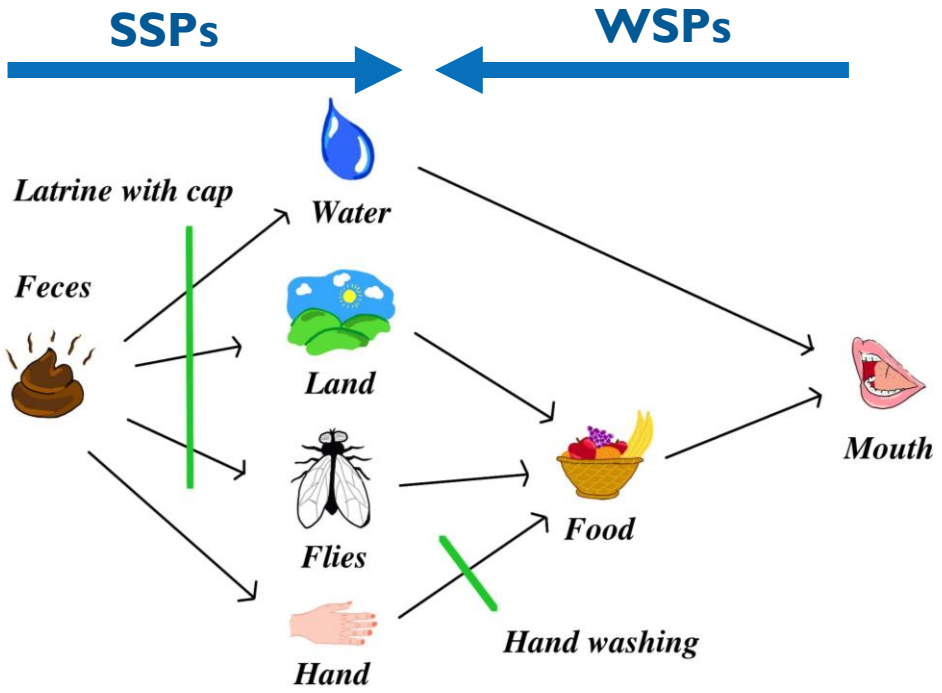
Framework for Safe Drinking Water



WHO, 2004

Sanitation Safety Plans?

- Codependency: Part of protecting source water and distribution system
- Basis in Stockholm Framework



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