Water Quality in England Part 2

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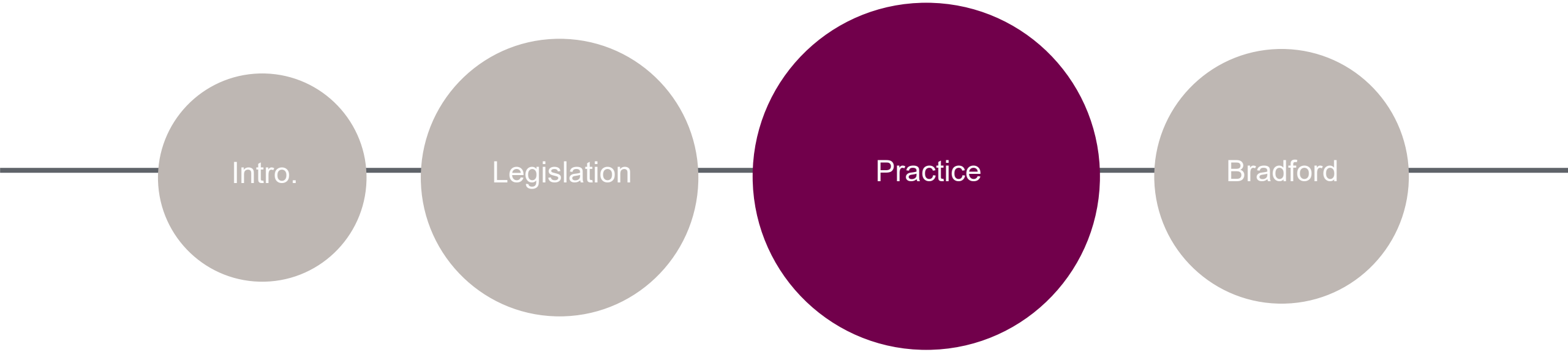
December 2022

Contents



Practice

- River Basin Management Plans
- Urban Pollution Manual (UPM)
- Event Duration Monitoring (EDM) and Storm Overflow Assessment Framework (SOAF)
- Solving water quality problems
- Public opinion

River Basin Management Plans

Bradford's Becks form part of the Humber RBMP

Contribution to environmental outcomes for 2021

- Work on 9 substantial weirs on the Aire should be complete by 2021, with non-governmental funding of approximately £4.3 million.
- In 2015-16 work will be done by Friends of Bradford Beck to identify sources of urban diffuse pollution on Bradford Beck and other nearby water bodies. This is a partnership project with Bradford Environmental Action Trust, Bradford Council, the Environment Agency, the University of Sheffield and Yorkshire Water. The work is supported by the Catchment Partnership Action Fund and partnership funding, £13,000 capital cost and £58,000 operational costs.

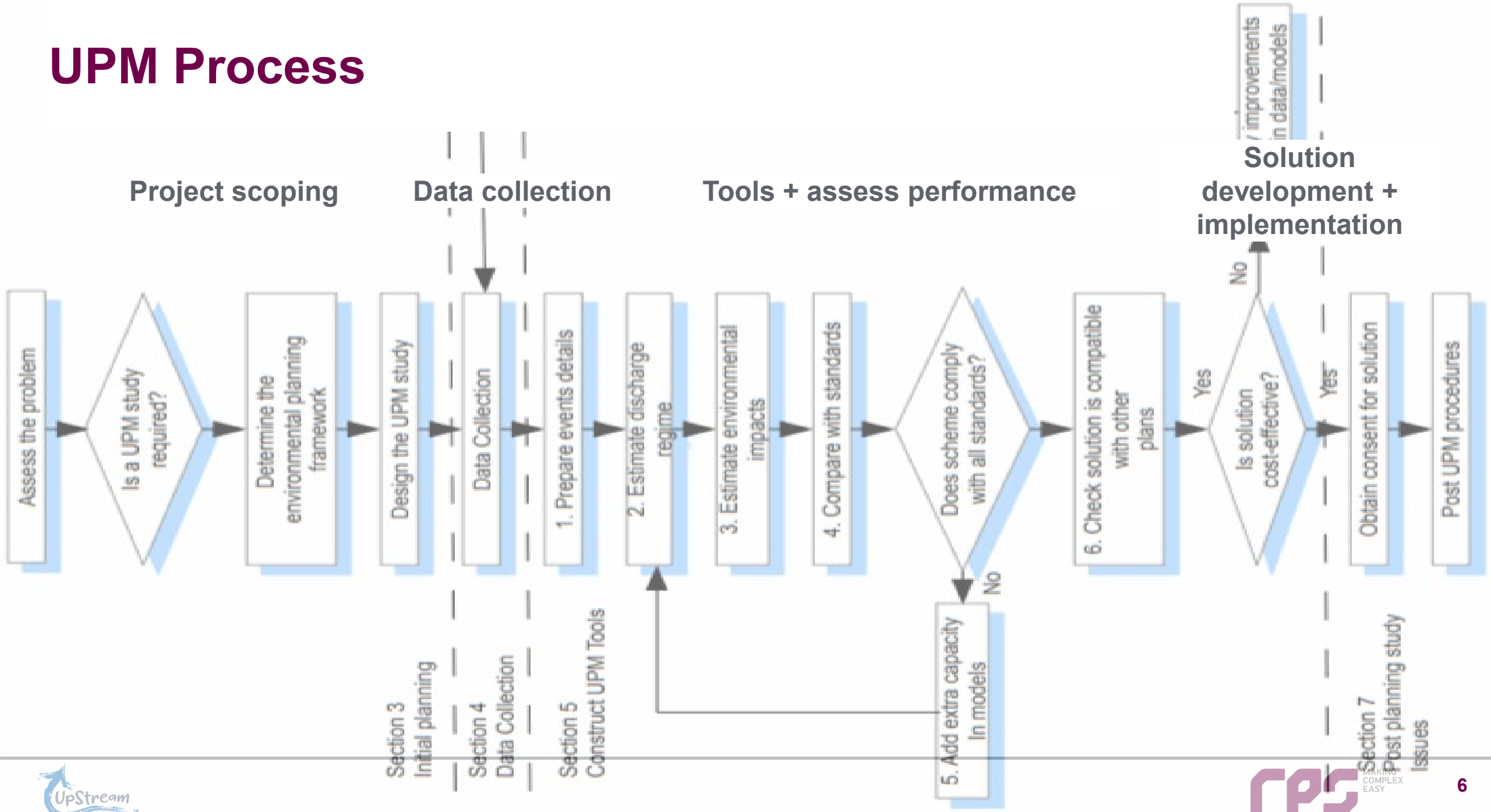
Water Company	Unique ID * (completed on company collation)	Scheme Name/Name of Investigation/Site Name/Licence name	Name of Waterbody	Waterbody ID	Water Body Type(s)	WFD Operational Catchment	Core Obligation	Action Type
Yorkshire Water Service	7YW201457	Bradford Beck study	Bradford Beck (Clayton Bk to R Aire	GB10402706286	River	Aire Middle	WFD	INV
Yorkshire Water Service	7YW201338	DOCK LANE/CSO	Bradford Beck (Clayton Bk to R Aire	GB10402706286	River	Aire Middle	U	INV
Yorkshire Water Service	7YW201447	FARNHAM ROAD/CSO	Bradford Beck (Clayton Bk to R Aire	GB10402706286	River	Aire Middle	U	INV
Yorkshire Water Service	7YW201406	LIDGET BRIDGE/CSO	Clayton Beck (Source to Bradford E	GB10402706286	River	Aire Middle	U	INV
Yorkshire Water Service	7YW201403	STEETON/CSO	Bradford Beck (Clayton Bk to R Aire	GB10402706286	River	Aire Middle	U	INV

http://jncc.defra.gov.uk/page-1375
https://www.gov.uk/government/collections/river-basin-management-plans-2015
https://wfduk.org/sites/default/files/Media/Environmental%20standards/UKTAG%20Environmental%20Standards%20Phase%203%20Final%20Report%2004112013.pdf

Urban Pollution Manual (UPM)

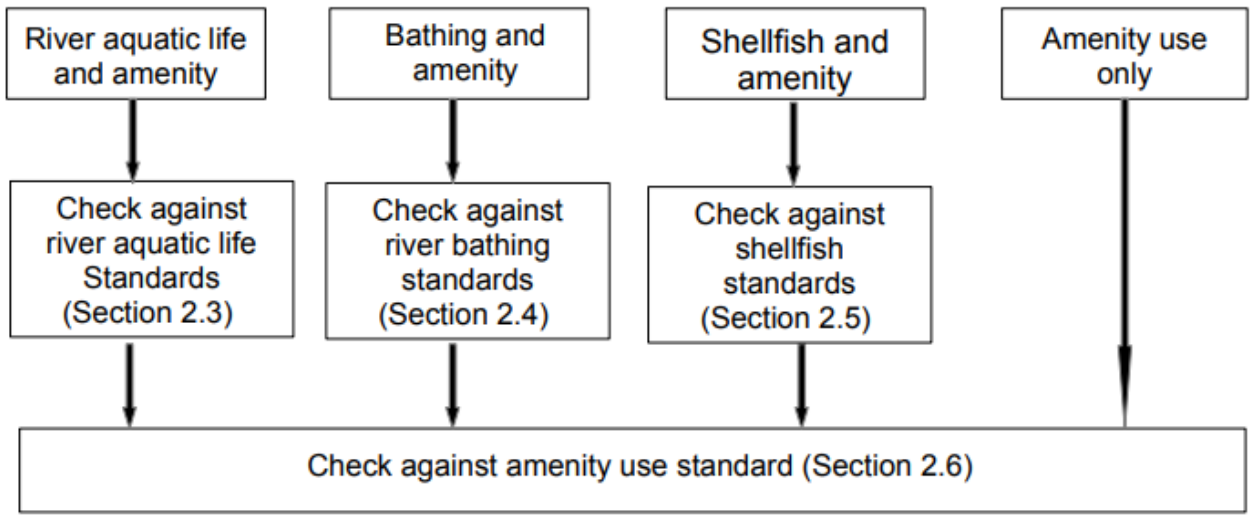
- Guidance on managing impacts of urban wastewater discharges systems on the environment under wet weather conditions. Surface waters only (not groundwater).
- Developed by water companies, Environment Agency, CIWEM Urban Drainage Group, Foundation for Water Research and WRc.
- Version 1 published 1994, version 2 in 1998, version 3 in 2012, version 3.1 in 2018.
- UPM is freely available online: http://www.fwr.org/UPM3/

UPM Process


Project scoping
Data collection
Tools + assess performance
Solution development + implementation
Assess the problem
Is a UPM study required?
Determine the environmental planning framework
Design the UPM study
Data Collection
1. Prepare events details
2. Estimate discharge regime
3. Estimate environmental impacts
4. Compare with standards
Does scheme comply with all standards?
No
5. Add extra capacity In models
6. Check solution is compatible with other plans
Yes
Is solution cost-effective?
No
Yes
Obtain consent for solution
Post UPM procedures
/ improvements in data/models
Section 3 Initial planning
Section 4 Data Collection
Section 5 Construct UPM Tools
Section 7 Post planning study Issues

Project scoping (section 2) – objectives and standards

- Environmental criteria ultimately to be set by environmental regulator (Environment Agency).
- For rivers, might include **Fundamental Intermittent Standards** and **percentile standards**.
- Since 1995, UK standard for **bathing** waters has been maximum of **three significant (>50m^3)** CSO spills per bathing season (May – Sept). Where aim is for 'excellent' status, frequency may be set to two.
- For **shellfish** waters, maximum of **ten** spills per year.
- For **amenity** use, focus on visible solids. **6mm screening** at overflows suggested and outfalls should be below water level.
- For brackish waters see further guidance in manual.
- Consider need for long enough record to assess compliance with standards.



Project scoping (section 3)

Decision to proceed with a UPM study based on one or more of the following: receiving waters known to be failing to achieve their environmental objectives; whilst a receiving water is currently satisfactory, proposed changes are likely to significantly deteriorate receiving water quality; confirming a suspected problem and identification of the likely causes; problem is associated with wet weather related discharges from the urban wastewater system; and, the nature and size/capacity of the solution cannot be determined by straightforward means.

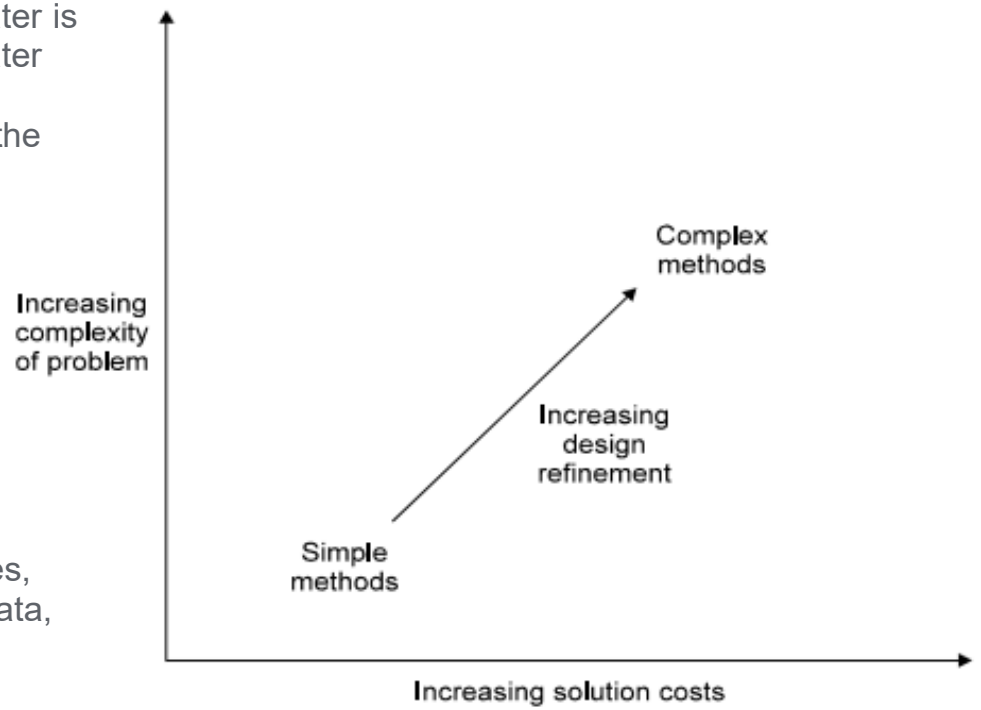
Scope statement should:

- Set out **reasons** for the study and objectives to be achieved
- Set out **background** and existing understanding – data, models, previous studies
- Define the water quality **standards** that apply
- State **models and procedures** appropriate to the study outcomes
- State **data gaps**
- Define the **programme and resource plan**

Section 3 sets out the **kind of information** that could be collected, including: spot samples, flow data, catchment management plans, permit details, theoretical and actual overflow data, wastewater treatment works performance data, data from previous studies.

Generally involves **source apportionment assessment**, to identify potential causes of changes in water quality.

Different levels of detail for urban drainage, treatment works, rivers, estuaries, coastal areas.



Data and tools should be technically acceptable and cost-effective

Data collection (section 4)

Generally need data for wet and dry weather periods for calibration of dynamic simulation models.

Data required often includes:

- **Rainfall data**, typically at 5-minute timesteps for urban catchments (fast storm response)
- **River flows** – generally from depth and velocity measurements
- **River geometry**
- **Liquid samples** to test quality – river, sewer, treatment works
- **Continuous monitoring** of selected parameters, such as dissolved oxygen (DO), temperature and pH
- **Sediment sampling** sometimes required

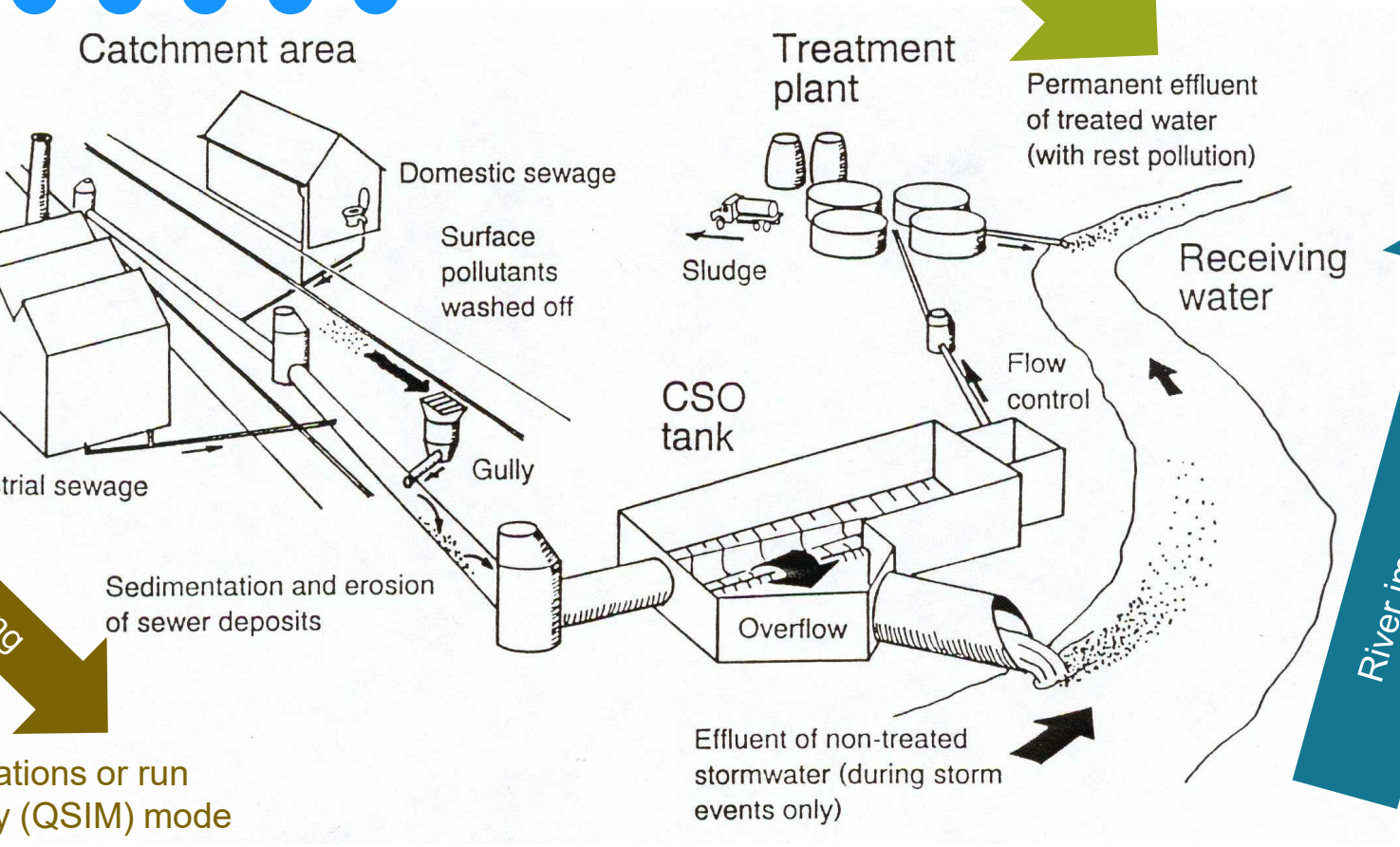
Further guidance in UPM about collecting each of these types of data.

Data collection **considerations** for rivers: suitability of the river channel, hydraulic conditions, access and equipment security. Ensure equipment is installed securely, referenced to a fixed point and 'positioned to take representative readings and samples during all flow conditions … seasonal variations in weed growth and sediment deposition may also vary …'

Need to balance model requirements, practical challenges of collecting samples/measurements, cost and timescales.

Tools + analysis (section 5)

Rainfall modelling



Sewage treatment works quality modelling

- Flow from sewer model or measured data
- Quality from sample data

Tidal waters modelling

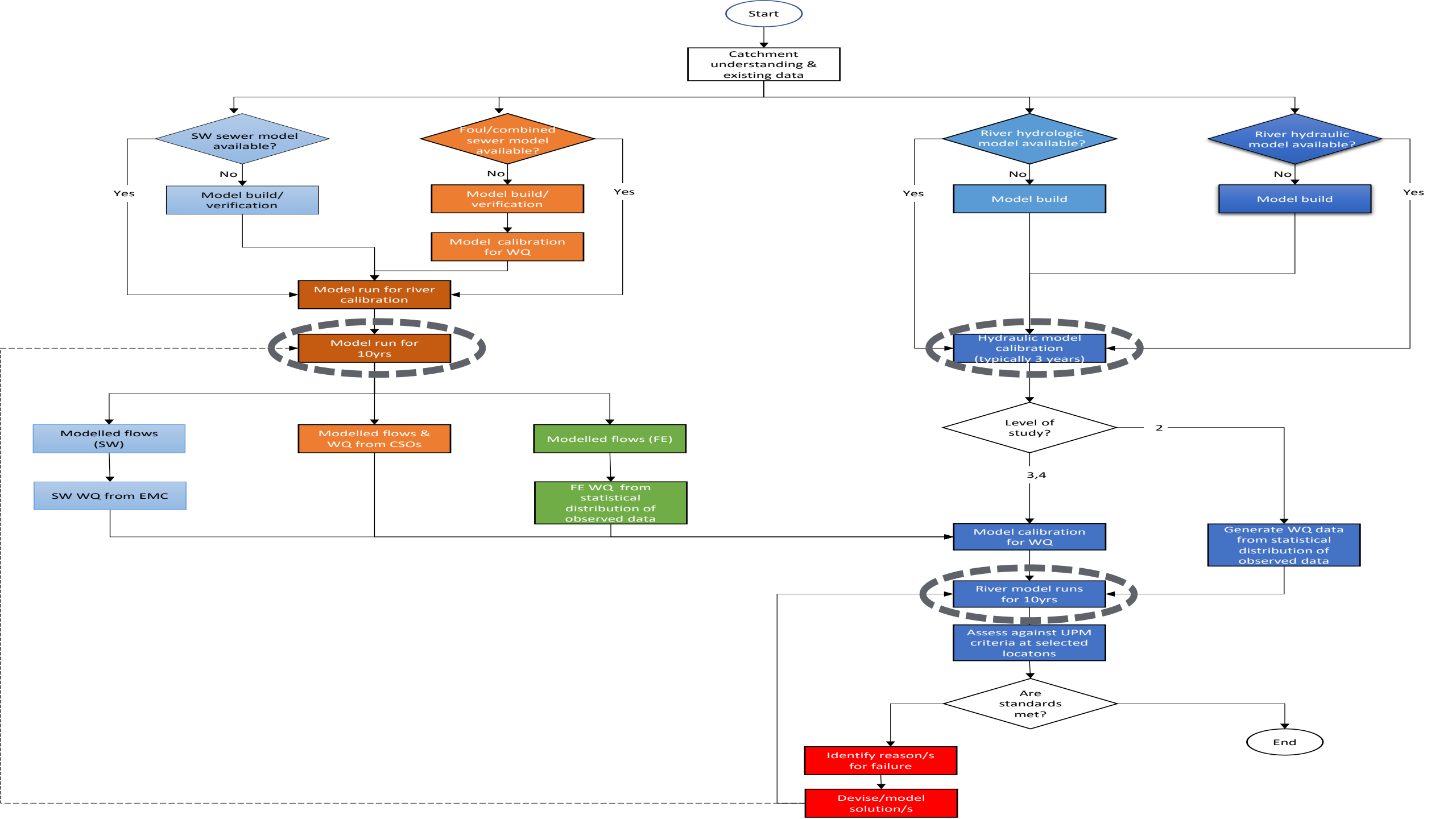
Sewer flow and quality modelling

- Flow from sewer model
- Apply event mean concentrations or run sewer model in water quality (QSIM) mode

River impact modelling

- Flow from EA gauge data or model
- Quality from sample data
- Processes – based on river geometry, roughness and other characteristics
- Temperature

- UPM doesn't recommend specific software, just approaches
- Integrated Urban Pollution Modelling also mentioned, but doesn't seem to be done much at present


Start
Catchment understanding & existing data
SW sewer model available?
No
Yes
Model build/ verification
Foul/combined sewer model available?
No
Yes
Model build/ verification
Model calibration for WQ
River hydrologic model available?
No
Yes
Model build
River hydraulic model available?
No
Yes
Model build
Model run for river calibration
Model run for 10yrs
Hydraulic model calibration (typically 3 years)
Modelled flows (SW)
SW WQ from EMC
Modelled flows & WQ from CSOs
Modelled flows (FE)
FE WQ from statistical distribution of observed data
Level of study?
2
3,4
Model calibration for WQ
Generate WQ data from statistical distribution of observed data
River model runs for 10yrs
Assess against UPM criteria at selected locatons
Are standards met?
End
Identify reason/s for failure
Devise/model solution/s

Rainfall modelling (section 5)

Rainfall requirements for UPM modelling

- **Long time series**, at least ten years – range of conditions
- Hourly or shorter **timesteps** (shorter for urban areas)
- Consider **spatial variability** across catchment

Historical rainfall time series

- From rain gauges or RaDAR. (RaDAR better for understanding spatial variability, but may not have long enough record.)
- Synthetic rainfall can be generated, but should be checked against local rainfall records

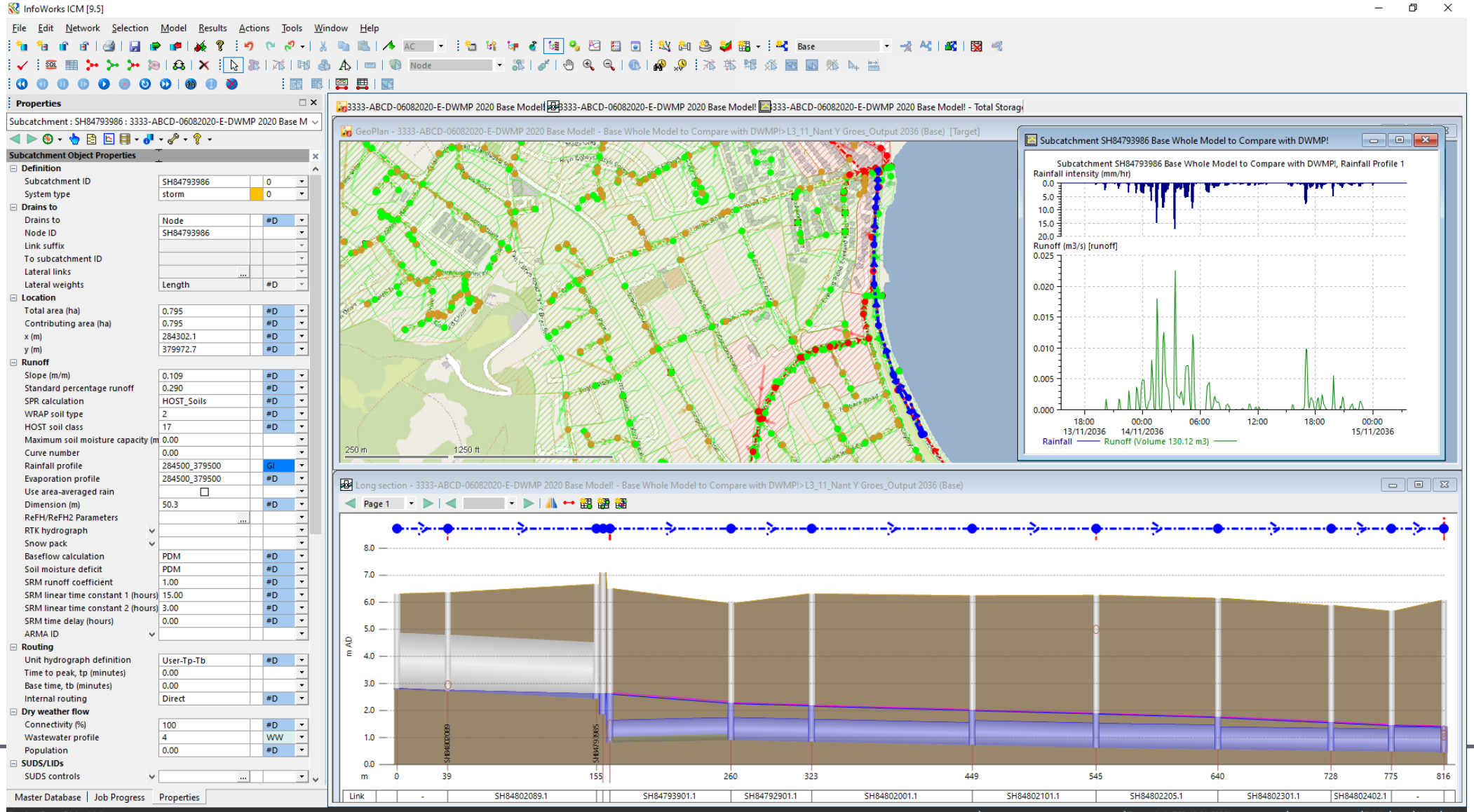
Tipping bucket rain gauge
Source: https://novalynx.com/store/pc/260-2501-A-Tipping-Bucket-Rain-Gauge-p227.htm

Sewer flow and quality modelling (section 5)

Sewer modelling – hydraulics

Typically using InfoWorks ICM

Simple sewer models can be used in very simple cases, e.g. if overflow spills are pumped into the watercourse (peak flow known).



Sewer flow and quality modelling (section 5)

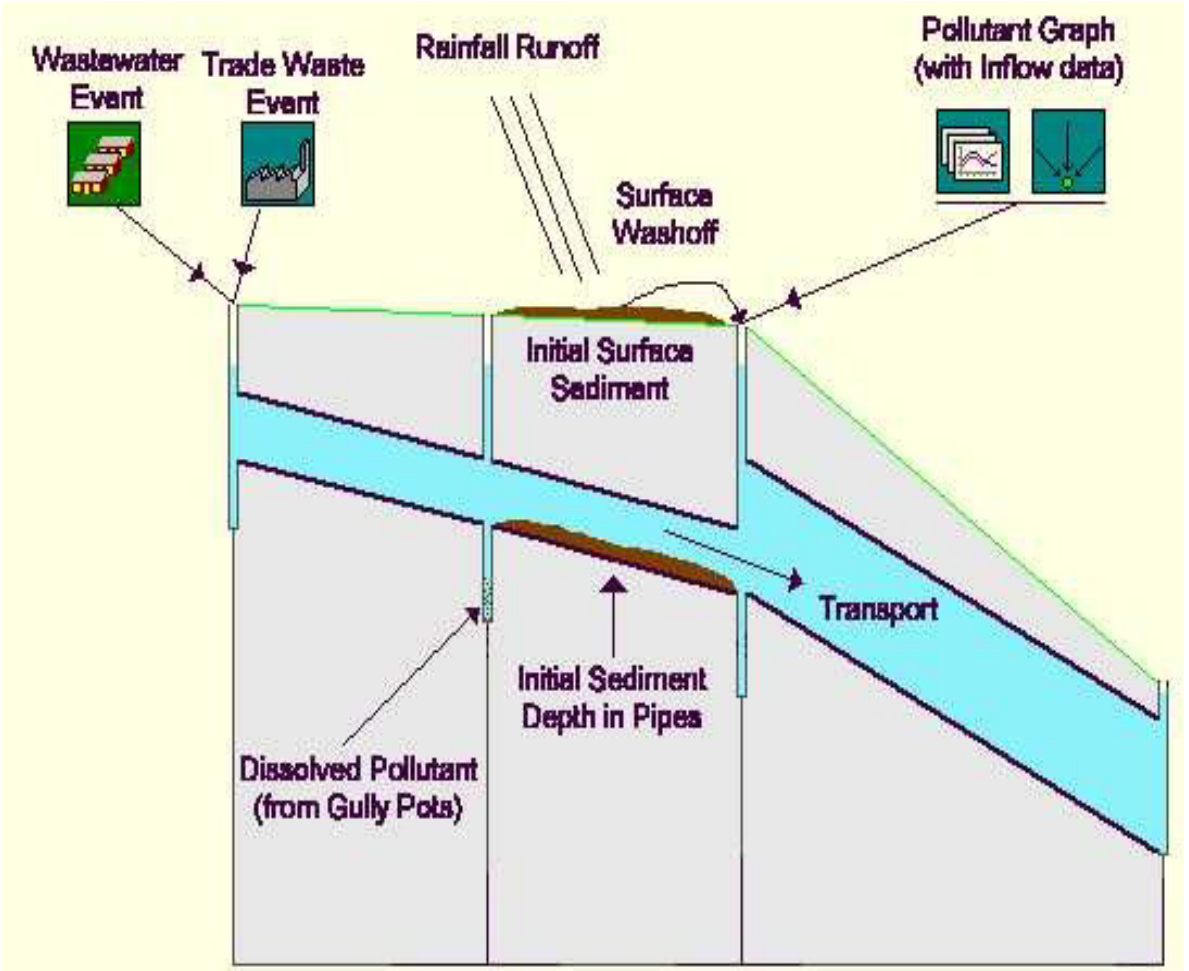
Sewage quality

Lots of processes affect quality: residential inputs, trade inputs, build-up and wash-off of sediment from surfaces, deposition and erosion of sediment in the sewer/tanks, advection, dispersion, biochemical reactions.

Different ways that these can be modelled: simple tank simulation models, detailed sewer models with ‘event mean concentrations’ or dynamic sewer quality models.

Guidance here

BOD, COD, ammonia and suspended solids normally modelled. Metals and bacteria can be modelled.



Modelling pollutant build-up in urban areas

Source: InfoWorks ICM Help

Sewer flow and quality modelling (section 5)

Sewage Treatment Works (STW) quality modelling

Potential for STW to perform differently in wet weather conditions. Effects are a function of the nature of the catchment, the size of the catchment, the size of the works, the treatment processes installed at the works and the effluent quality required.
Preferred [modelling] approach is to use a log-normal distribution for water quality, based on an analysis of treatment works data either collected for operational purposes, or if this is insufficient, enhanced by additional sampling.
Need to split the data between dry and wet conditions to check that there is no significant difference in performance.

Other mathematical models are available to describe treatment works performance, including:
• Detailed mechanistic – from theoretical equations to describe biological and physical processes. Most need site-specific calibration.
• Reduced-order – simplification of mechanistic models.
• Statistical correlation - based on the assumption that the effluent quality behaves as a random variable. Enhanced statistical distribution models have not been widely used because of the difficulty of creating an appropriate probability distribution function that includes the features of known effluent quality.

River impact modelling (section 5)

Effects of intermittent discharges on river quality

Consider: upstream quality and flow; channel slope; channel geometry and roughness; in-river structures; pH; temperature; ecology; and, nature of effluent discharged.

Types of modelling approach

Wide range: simple equations to complex; stochastic or deterministic; steady state or dynamic; with/without in-river processes.

Building, calibrating and verifying River Quality Impact Models (RQIMs)

- Building: river geometry, details of any in-river structures, model extents.
- Calibrating and verifying: historical records or a short-term survey of flow and quality for significant discharges into the river, and the river itself.
- Model should be representative of conditions under which model will be applied (summer/winter).

Potential problems and limitations of RQIMs

- Errors in hydraulics transfer to quality model.
- Model stability (numeric), esp. for low, fast flows.
- Reducing calculation timestep improves stability but increases model run times.
- Should not use outside calibration conditions.

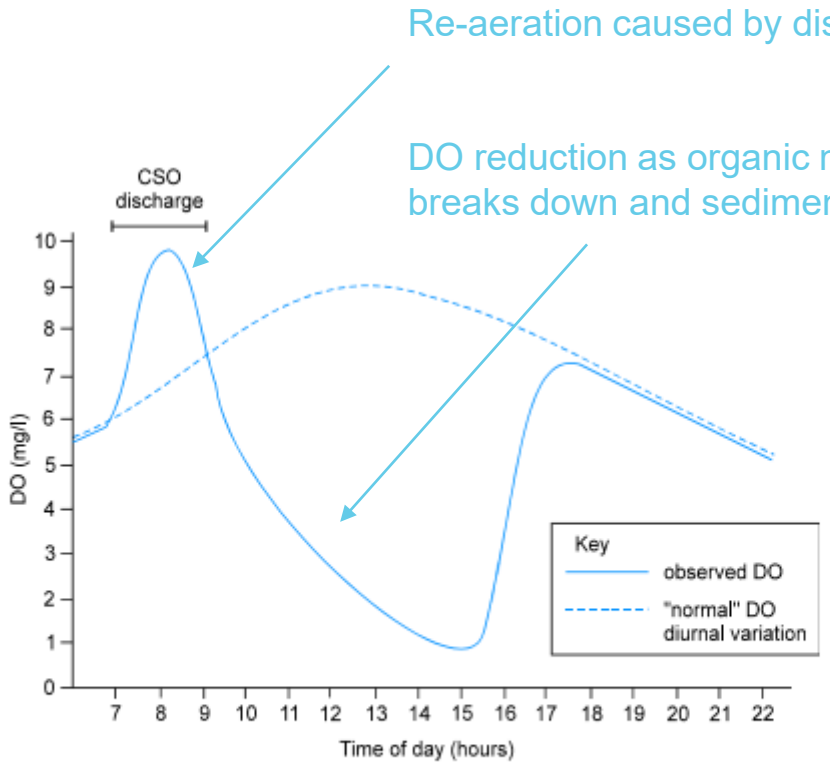


Figure 5.10 Example of measured DO concentrations in a river just downstream of a CSO following a storm discharge

Source: http://www.fwr.org/UPM3/Section5.pdf

Bringing it all together …

Level	Urban drainage inputs				Boundary river conditions		River model		Rainfall series
	Storm overflow flow	Storm sewage quality	WWTW flow	WWTW quality	Upstream river flow	Upstream river quality	Hydraulic	Water quality	
1	Verified sewer model	Event mean concentrations using default values (e.g. Dempsey, 2005) or sampled values	Statistical distribution from MCertified data	Statistical distribution from sampled effluent quality	Statistical distribution from gauged data or ungauged estimate	Statistical distribution from EA routine samples	Simplified channel, steady & uniform	Simplified WQ processes & re-aeration using default values for rate coefficients	10 year representative historic or synthetic time series
2	Verified sewer model	Event mean concentrations using default values (e.g. Dempsey, 2005) or sampled values	Predicted flow time series from verified sewer model	Statistical distribution from sampled effluent quality	10 year historic flow time series from EA gauging station or calibrated rainfall runoff model	Statistical distribution from EA routine samples	Simplified channel, steady & uniform	Simplified WQ processes & re-aeration using default values for rate coefficients	10 year representative historic or synthetic time series
3	Verified sewer model	Sampled values or calibrated sewer quality model	Predicted flow time series from verified sewer model	Statistical distribution from sampled effluent quality	10 year historic flow time series from EA gauging station or calibrated rainfall runoff model	Statistical distribution from EA routine samples	Calibrated flow routing model	Advective pollutant transport, WQ simulation calibrated from event sampling & sonde data	10 year representative historic or synthetic time series
4	Verified sewer model	Sampled values or calibrated sewer quality model	Predicted flow time series from verified model	Statistical distribution from sampled effluent quality	10 year historic flow time series from EA gauging station or calibrated rainfall runoff model	Statistical distribution from EA routine samples	Calibrated hydrodynamic model	Calibrated advection – dispersion model, WQ simulation calibrated from event sampling & sonde data	10 year representative historic or synthetic time series

Increasing complexity, time and cost

Source: https://www.water.org.uk/wp-content/uploads/2018/12/SOAF.pdf

Assessing performance (section 6)

Section 6 covers:

- Methodology for assessing performance against standards for protecting freshwater aquatic life
- Methodology for assessing performance against standards for protecting bathing or shellfish waters

Generic UPM methodology:

- **Step 1** – **Prepare simulation details** – Generally continuous time series, typically 10 years, decide on sewer/river/rain conditions
- **Step 2** – **Estimate discharge regime** – Structured approach to evaluating performance and potential improvements, select conditions to model
- **Step 3** – **Estimate environmental impacts** – River model run with discharges and associated rainfall to assess water quality impact
- **Step 4** – **Compare with environmental standards**
- **Step 5** – If scheme does not comply, **refine solution and repeat analysis**
- **Step 6** – If scheme does comply, **check solution is compatible with other plans** (e.g. no worsening of flooding)
- **Step 7** – If solution is not cost-effective, **identify if improvements needed in data/models**

Post planning study issues (section 7)

Turning conceptual design into reality.

Including:

- **Obtaining discharge permit** – close relationship with regulator throughout project. Need to translate detailed predictions of performance into something that can be readily monitored by regulator – e.g. continuation flow and that all available storage is used before spill occurs.
- **Engineering design** – designing CSO to ensure solid separation, considerations for tank design, sewer capacity, treatment works performance, real-time control
- **Performance monitoring** – asset performance (e.g. Event Duration Monitoring), aesthetic monitoring, monitoring receiving water quality, monitoring ecology.
- **Maintenance** of models and databases
- **Cost-benefit assessment**

Urban Pollution Manual (UPM)

- Freely available online: http://www.fwr.org/UPM3/

Event Duration Monitoring (EDM) and SOAF

- Government requested that each water company in England improves monitoring of CSOs, such that vast majority monitored by 2020.
- You can view the latest data here:
- https://www.theriverstrust.org/key-issues/sewage-in-rivers
- The sensors measure depth of flow in the CSO chamber. When the depth goes above a threshold level, spill occurs.
- Doesn't tell us volume of spill or impact on water quality, but is a huge step forward.
- Has generated huge investigation programmes, which follow the Storm Overflow Assessment Framework.

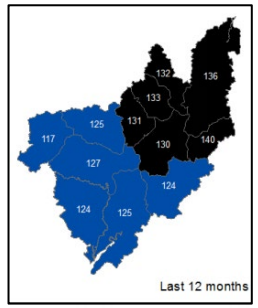
EDM data challenges

No. of years EDM data	Investigation trigger (average no. spills/year)
1	>60
2	>50
3 or more	>40

Removal of EDM data due to anomalies

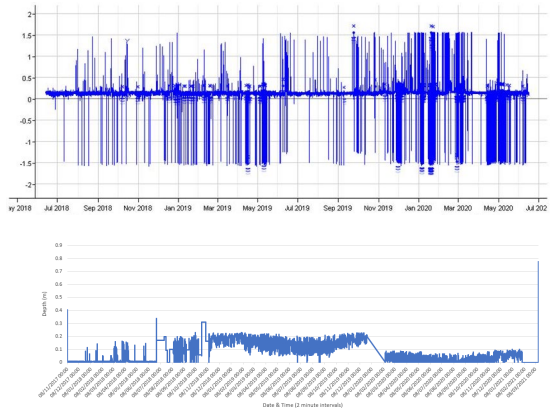
→ Is the asset in an exceptionally high rainfall region?

2019 Water Situation Report



Review data

→ Is the data reliable?



Review Maintenance

→ Could the spills be related to a maintenance issue?

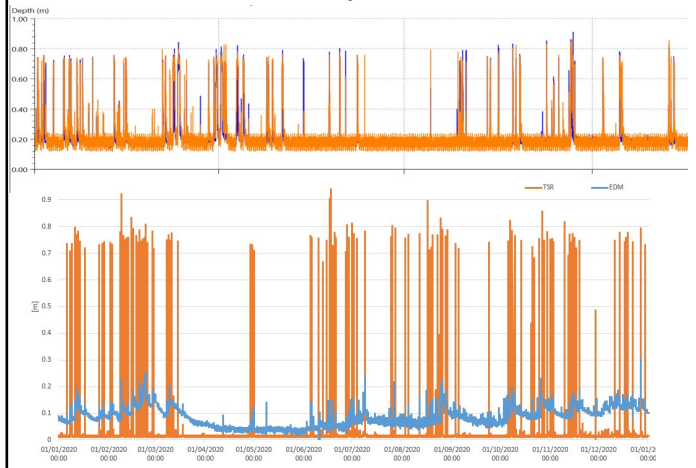
Mitigating Circumstances

Range of cases, including:

→ The EDM is not installed in the correct location
→ EDM not calibrated correctly

Hydraulic Model Review

→ Does the model replicate the EDM data?



… after all these checks

are we sure the high number of spills is mainly a hydraulic issue?

← No
re-assess next year

Yes →
progress for further investigation

Solving water quality problems

Improved land management – e.g. reducing fertiliser use or stopping cattle entering river

Aeration

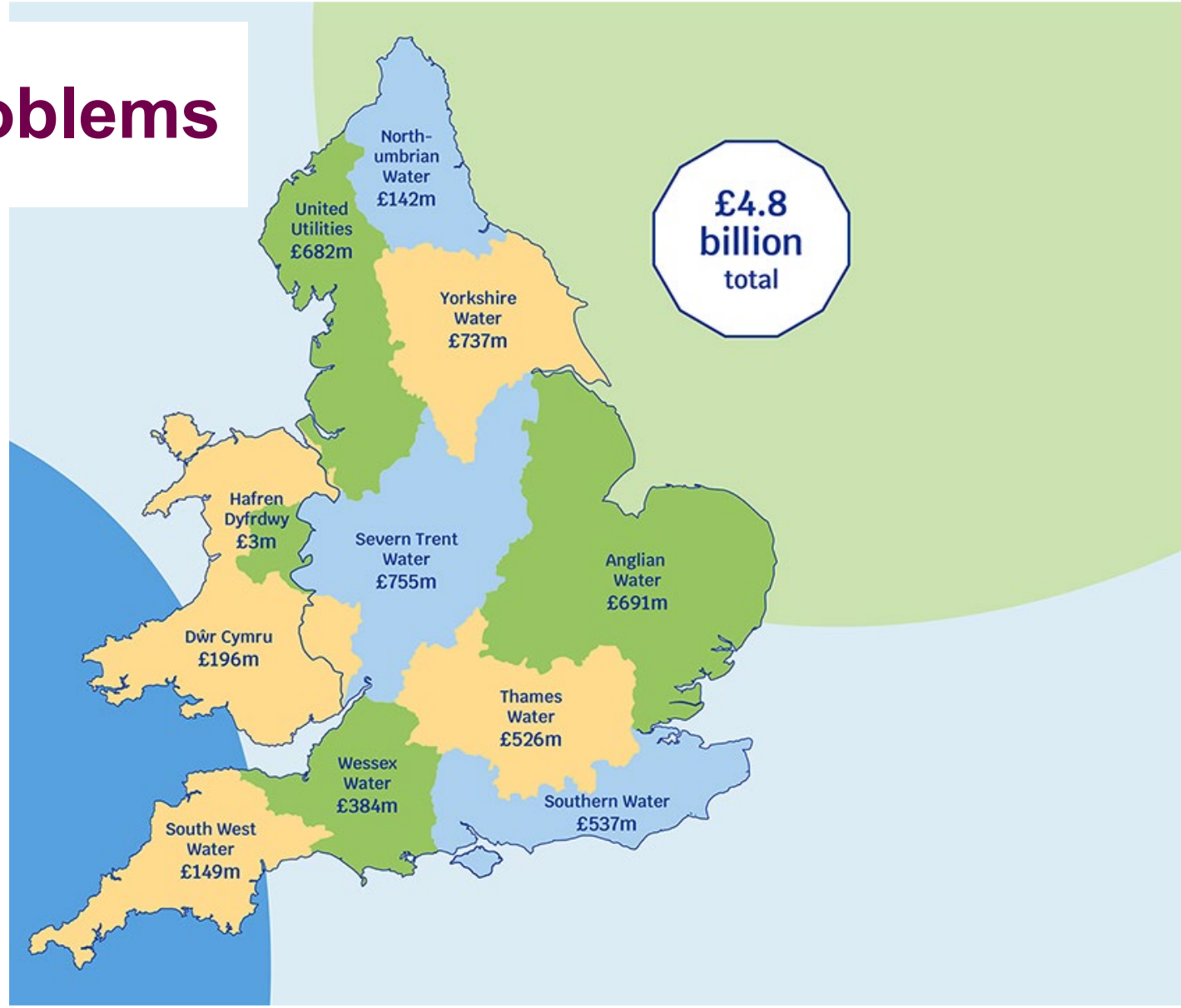
Reducing how often overflows spill – Sustainable Drainage Systems, bigger pipes or tanks in sewer network

Treating overflow spills – e.g. UV or wetlands may become more common

Improving wastewater treatment works

Solving water quality problems

Ofwat data – funding for improving the natural environment relating to wastewater 2020-2025



Impact of investment

Government Environmental Audit Committee report on health of rivers, Jan 2022:

- 'The establishment of a complete overview of the health of rivers in England and the pollution affecting them is hampered by **outdated, underfunded and inadequate monitoring regimes**. Many harmful pollutants are not routinely monitored, and the Environment Agency has reduced the number of monitoring sites.'
- '**Not a single river in England has received a clean bill of health** for chemical contamination.'
- 'The current **range of pollutants** being monitored is too narrow. The Environment Agency must begin work to extend the number of substances …'
- 'Regulators and water companies have made a great deal of progress since the 1990s in cleaning up and monitoring our coastal waters so that they are fit for **bathing**. This progress must now be extended to **rivers**.'
- Recommends 'that the Environment Agency work with water companies to ensure that easily accessible information on **sewage discharges in waterways in as near to real time as possible** is made available to the public, as now required under the Environment Act 2021.'
- '**Catchment sensitive farming**' proposed. 'We therefore recommend that DEFRA commission a periodic (five yearly) appraisal of catchment-wide nutrient flows across each of the major river catchments in England. Such appraisals should then be used by local authorities and planning authorities to inform decisions on new housing developments and intensive livestock units …' Indicates that farmers should better understand phosphate and nitrate levels on their land, through **annual chemical assessments**. New Environmental Land Management Scheme should provide financial help to farmers for measures to reduce phosphate and nitrates.
- 'We therefore found the claim made by the chief executive of Severn Trent that its sewer overflow discharges were 'pretty much already rainwater' to be disingenuous. As water companies do not routinely test the quality of the discharges from storm overflows, they are in no position to make this claim.'
- 'The technology for **continuous monitoring of water quality is evolving rapidly**. We recommend that the Environment Agency invite manufacturers to submit products for evaluation so that the Agency can rapidly introduce cost-efficient and effective sensors at an increased number of locations.'
- 'We recommend that Ofwat and the Environment Agency require each water and sewerage company in England to publish on its website, by the end of 2022, details of its discharge permits, its **permit compliance**, and full granular 15-minute data on spill duration, volume and water quality, to a standard format which facilitates **easy capture and analysis by members of the public**.'
- 'It is clear that there are **no quick fixes** to decades of under-investment in the sewerage network in England…'
- Discusses ways to **limit sources of pollution**: plastics in wet wipes, tyres, fashion.
- Impact of **highways** authorities noted: 1,326 high risk outfalls and soakaways.
- **Sustainable Drainage Systems** recommended (enact schedule 3 of Flood and Water Management Act 2010)
- 'The idea, for instance, that pollution can be tolerated in areas with low 'amenity value' belongs to a different era. **Pollution of rivers must be addressed wherever it occurs** because of the impact of such pollution has on freshwater ecosystems and ultimately the health of the oceans.'
- **Catchment Based Approach Partnerships** provide a good forum for coordinated action to improve river water quality.
- **Citizen science** should not be seen as an alternative to adequately funded environmental monitoring by regulators but it should be encouraged and recognised.

Public opinion

- Public + media disgusted by state of our rivers
- Surge in interest over past five years
- TV programmes, newspaper articles, action groups

theriverstrust.org/sewage-map

The Rivers Trust

Collection

Sewage in our Rivers

Sewage is discharged into our rivers on a daily basis. This isn't an isolated problem; it affects urban city centre rivers and pristine chalk streams alike. Find out if your river is fit to play in and take a deeper dive into the problem.

#EndSewagePollution

bbc.co.uk/programmes/m000vk71

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The River Pollution Scandal

Panorama investigates the scandal of our polluted rivers. Reporter Joe Crowley obtains data that reveals how some big water companies have been illegally dumping untreated sewage. He meets local people campaigning for a wholescale clean-up and exposes one company discharging sewage without a permit.

29 minutes

sas.org.uk/campaign/combined-sewage-overflows/

ABOUT US CONTACT US CHECK YOUR WATER QUALITY MEMBERS' AREA

SAS PRIVACY POLICY

SURFERS AGAINST SEWAGE

OUR WORK TAKE ACTION IN YOUR REGION SHOP NEWS JOIN/DONATE

Combined Sewer Overflows

There are approximately 21,462 Combined Sewer Overflows (CSOs) and pumping stations in the UK (excluding Scotland) (Environment Agency, 2020). Their sole purpose is to discharge untreated human sewage and waste-water when the sewerage system is overloaded. CSOs act as emergency discharge valves in our sewerage system, discharging untreated sewage and wastewater when the system comes close to bursting, supposedly during periods of intense rainfall. Without CSOs, sewage could start backing up in our houses and gardens, so they are a vital part of our sewerage infrastructure. However, SAS is increasingly concerned that they are being used to regularly dispose of untreated sewage, even during times of low rainfall or none at all.