Technical Support Instrument

Supporting reforms in 27 Member States

Waste Water Collection and Treatment

Understanding key risks and mitigation factors

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EPD, Vilnius

13th February 2025

Funded by the European Union

OECD

Introduction to the Presenter – Simon Bingham

Regulatory Experience – 30+ years

Permitter, Inspector, Specialist & Manager

Implementer of new legislation (Waste, Water, Integrated, Radioactive)

Developer of systems (Permitting, Risk & Inspection Frequency etc)

Trainer

International Experience – 19+ years

Project Executive & Project Manger of numerous technical projects

Team Leader of 15+ organizational reviews

IMPEL Board Member & Expert Team Leader for 9 years

Worked in Europe, America, Asia & Africa

Icebreaker

Question: How many years have you worked on the topic of water regulation?

Action: Line up from least to most experience

This Afternoon's Agenda

Rough Timings	Wastewater Collection & Treatment Agenda
1330 -	Introduction
- 1415	Wastewater Collection Networks – CSOs & EOs (& complaints)
1415 - 1430	Break
1430 - 1545	WWTW – Preliminary, Primary & Secondary Treatment
1545 - 1600	Break
1600 -	WWTW –Treatment continued
-	Risk & planning
- 1700	Enforcement response
1700	End

Slide 1 of 493+

My rules of engagement

1.	You can ask questions at any time – I will of you ☺!
2	There are no daft or stupid questions (don't assume others all know the answers already – they probably don't – help them out by asking! I assume there is a knowledge range in the room
3.	Respect each other (don't talk over each other)
4.	Have fun
5.	Any questions about this?

AB + 5 = Y

Don’t be shy

Question:

Is there any specific areas you want me to cover or questions you would like me to answer this afternoon?

Why oh Why is the answer = 43

1. Introduction - (The big issues)

Your context

1. Describe your permits. What do they cover?

2. Describe your inspection process. Do you use the permit as part of the inspection. Do you check every permit condition?

3. How do you choose the sites to inspect?

4. How long does an inspection take?

If you were to inspect this WWTW, what would be the most important part of the inspection? And why?

My order of importance

1. Impact on the receiving watercourse

2. Quality of effluent discharge

3. Some elements of the treatment process

The environment is our primary focus and reason for existence

What is the impact on the receiving watercourse?

- Sewage Solids
- Presence of excessive sewage fungus
- Excessive Foaming
- Significant discolouration
- Visible oil or grease
- Pooling of effluent/ adequate dilution and dispersal

- Compare upstream and downstream
- Describe river flow conditions and colour etc

Serious impact of sewage solids

Sewage Fungus – Bioindicator of organic pollution

Natural – Okay

Effluent fed - Unacceptable

- It is actually a complex biomicrobial mat and not a fungus – it feeds on nutrients
- Not just sewage – agricultural runoff, papermill, airport de-ice fluid etc

Poorly sited / performing effluent discharge

How would we design a checklist to capture ‘impact on the receiving watercourse’?

- Sewage Solids
- Sewage fungus
- Foaming
- Discolouration
- Visible oil or grease
- Pooling of effluent/ adequate dilution and dispersal

Personal Protective Equipment & Risk Assessment (You can't inspect if you are dead!)

PPE will vary based on RA

- **Protective Footwear**
- **High-Vis Jacket**
- **Gloves & Safety Glasses (Mask?)**
- **Ability to store PPE safely / change of clothes**
- **Ability to clean hands etc**

- **Hard Hat**
- **Life jacket**
- **Inoculations – Hep A & B, Tdap booster etc**

What sort of risks are you likely to encounter?

The primary EU Directives that impact Wastewater Treatment & Collection

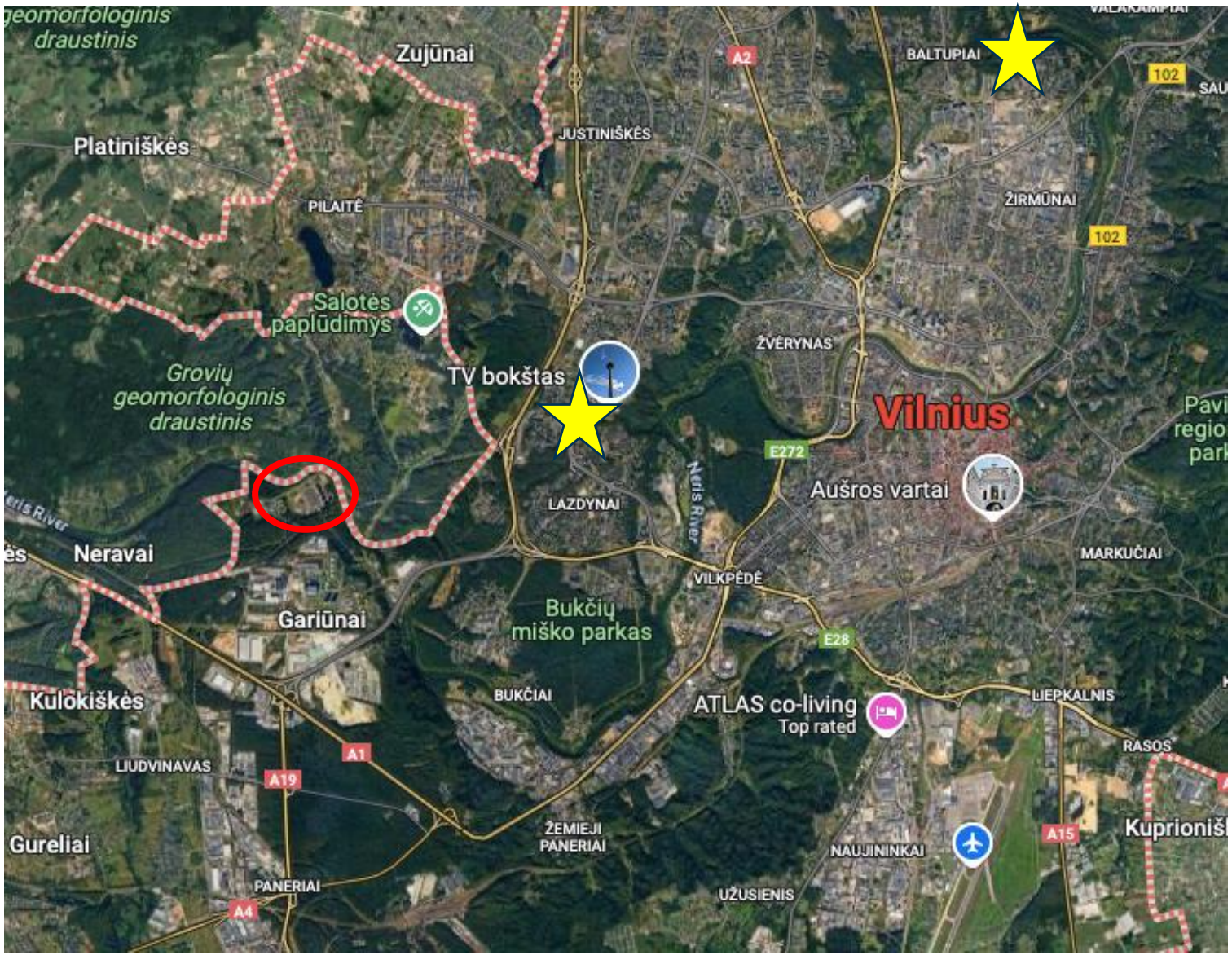
Dir. Number	Directive Name	Covers
91/271/EEC	Urban Wastewater Treatment Directive	Minimum standards, population thresholds, discharge limits
91/676/EEC	Nitrates Directive	Protects from nitrate pollution, stricter stds in NVZ
2000/60/EC	Water Framework Directive	Prevent waterbody deterioration, achieve good status
2006/7/EC	Bathing Water Directive	Prevents impact, requires microbiological monitoring
2008/105/EC	Environmental Quality Standards Directive	Standards set
2010/75/EU	Industrial Emissions Directive	Large WWTW & industrial effluents, sludge incineration
2011/92/EU	Environmental Impact Assessment Directive	Needed for new or expanded WWTWs
2024/3019	Urban Wastewater Treatment Directive (recast)	Sets future WWTW standards

Q1: Many of these Directives have been recast or amended. What came into force on the 1st January 2025

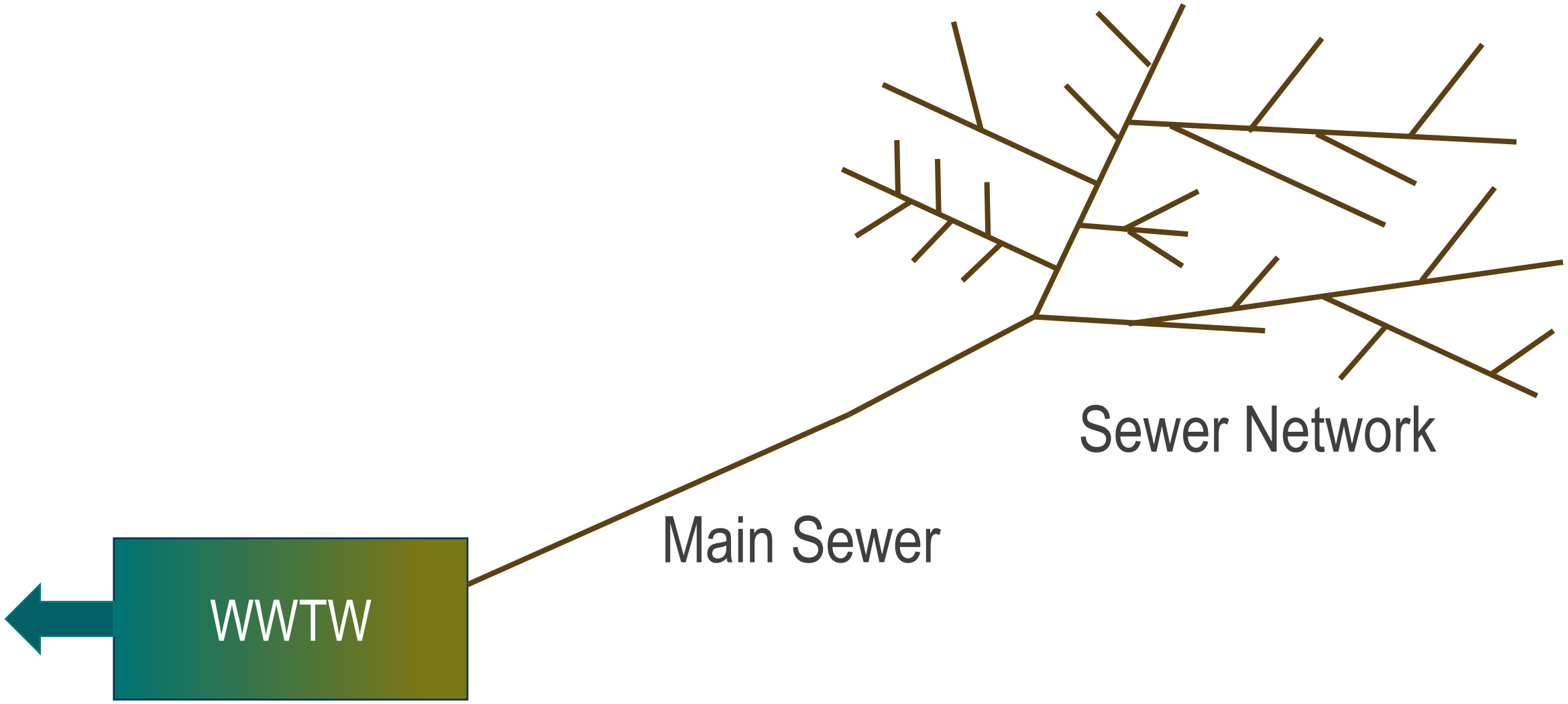
Q2: What is the primary document that we inspect against called? **The Permit**

2. Wastewater Collection

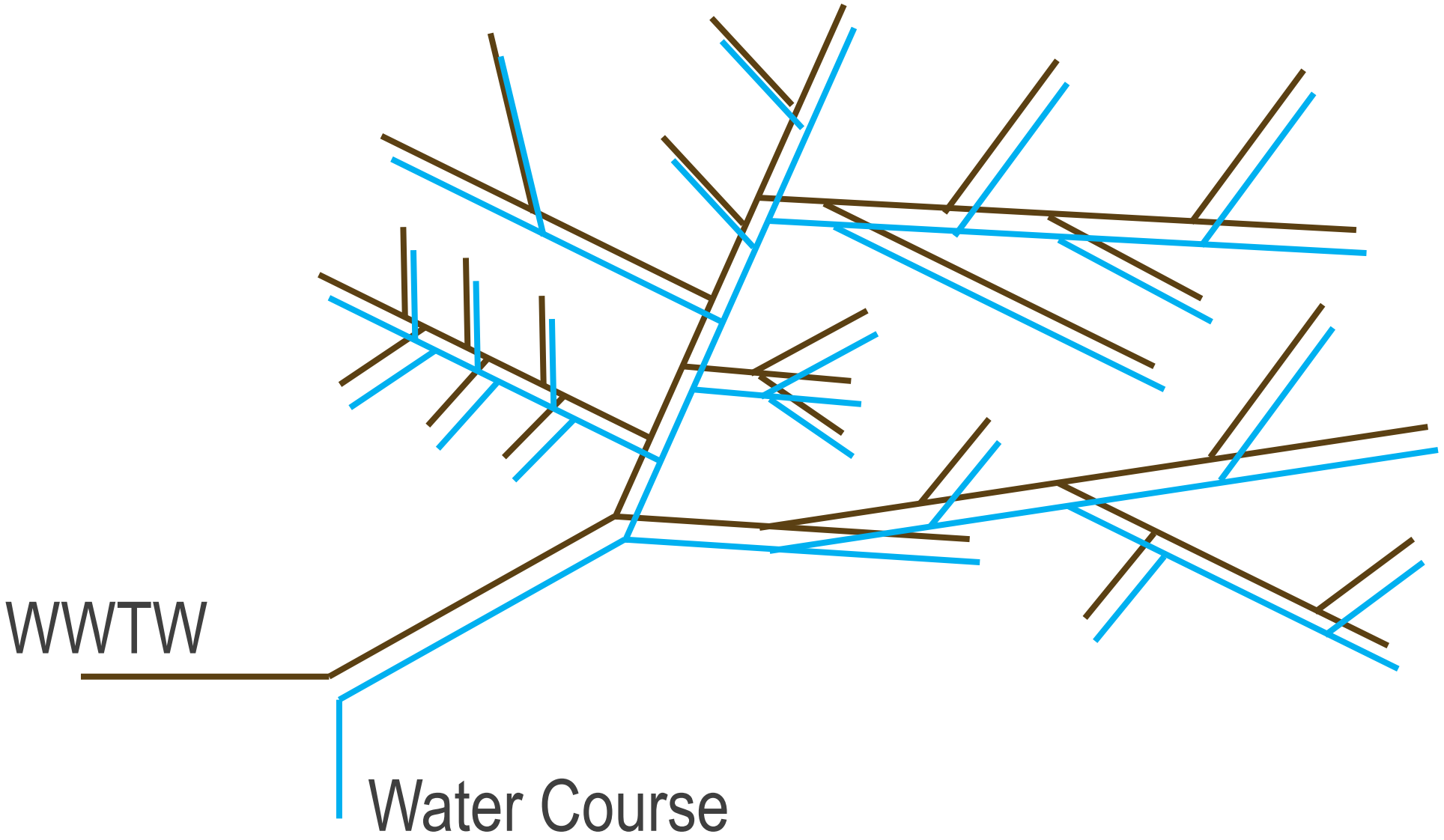
Where is Vilnius WWTW located?



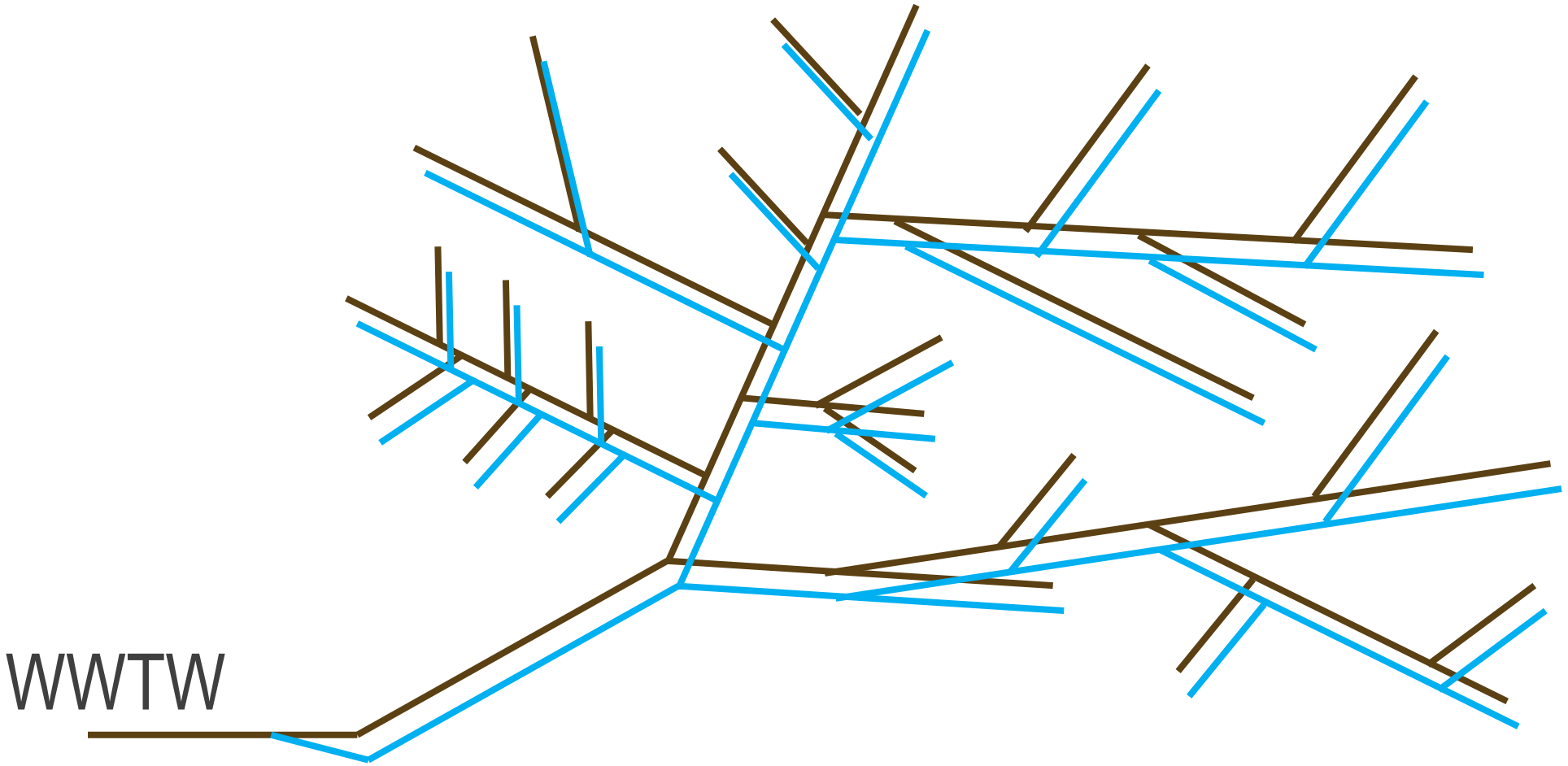
Gravity systems where possible



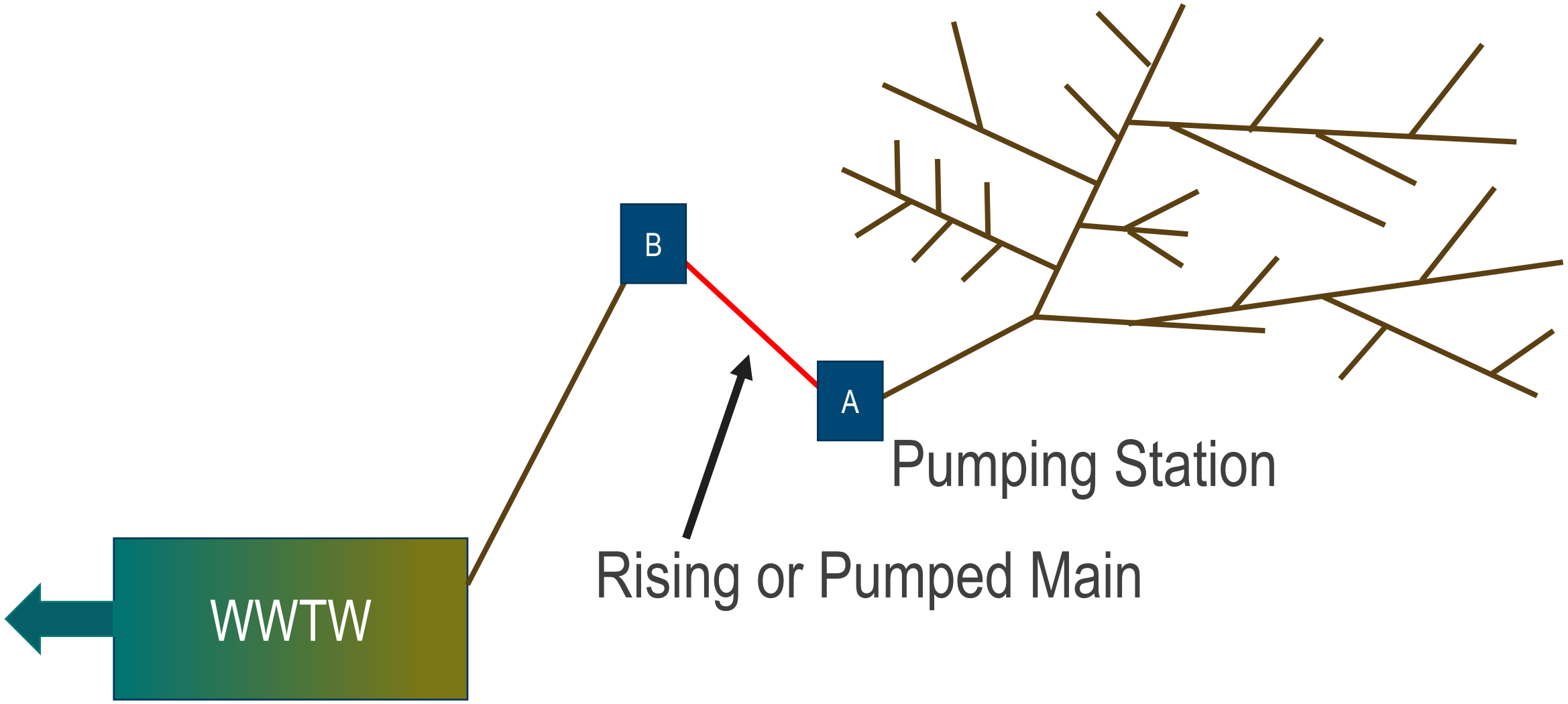
The ideal is a separate collection systems for sewage and surface water



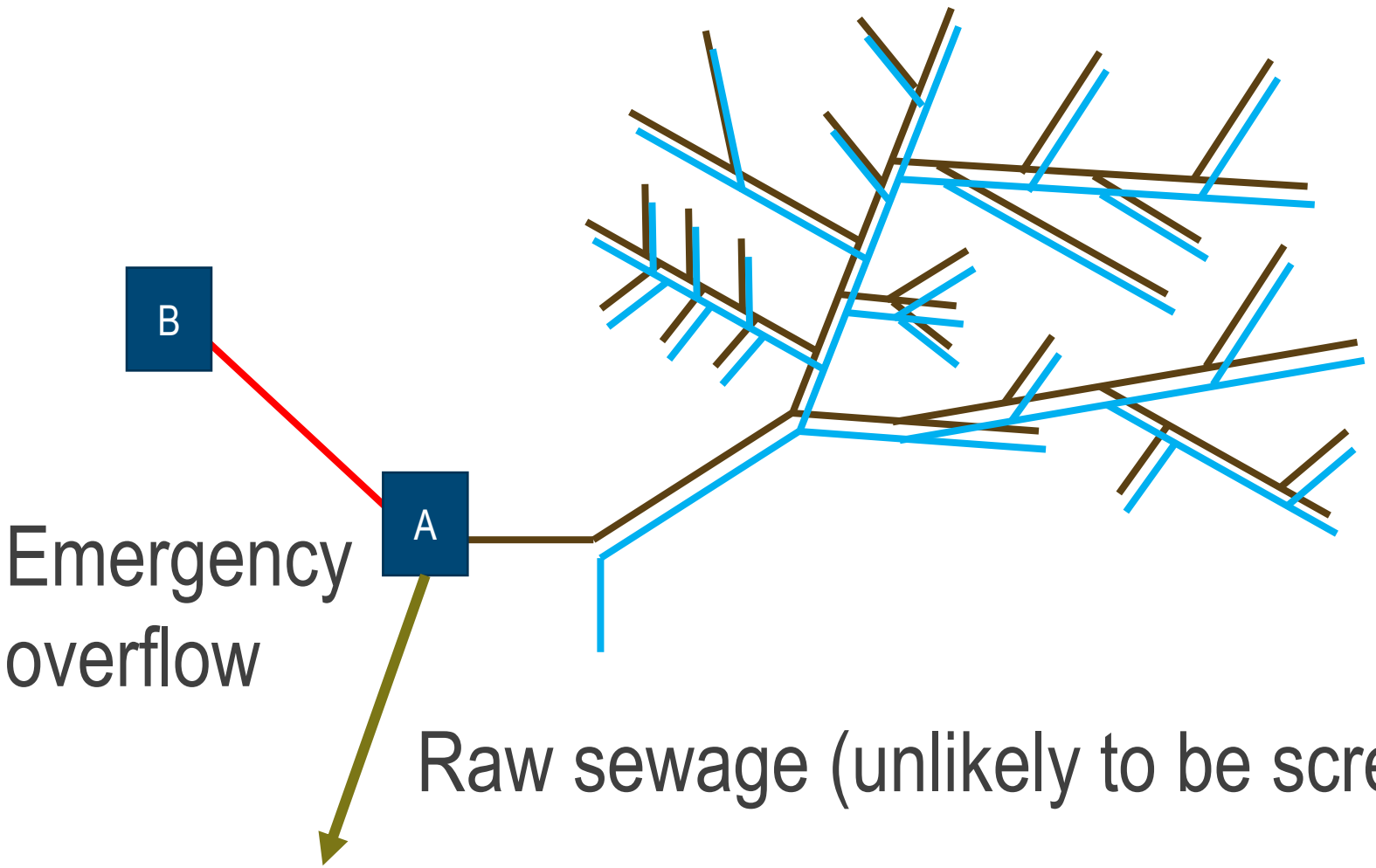
Beware some separated systems are re-combined further down the network!



Where gravity systems are not possible you have to pump



Emergency Overflow at Pumping Station (discharge to prevent the network flooding)



What does good look like:

- Back-up power (uncommon)
- Flow monitoring
- Telemetry
- Requirement to clean watercourse

(***all should be covered in the permit***)

Visible impact of untreated sewage on a watercourse (after the discharge has stopped)

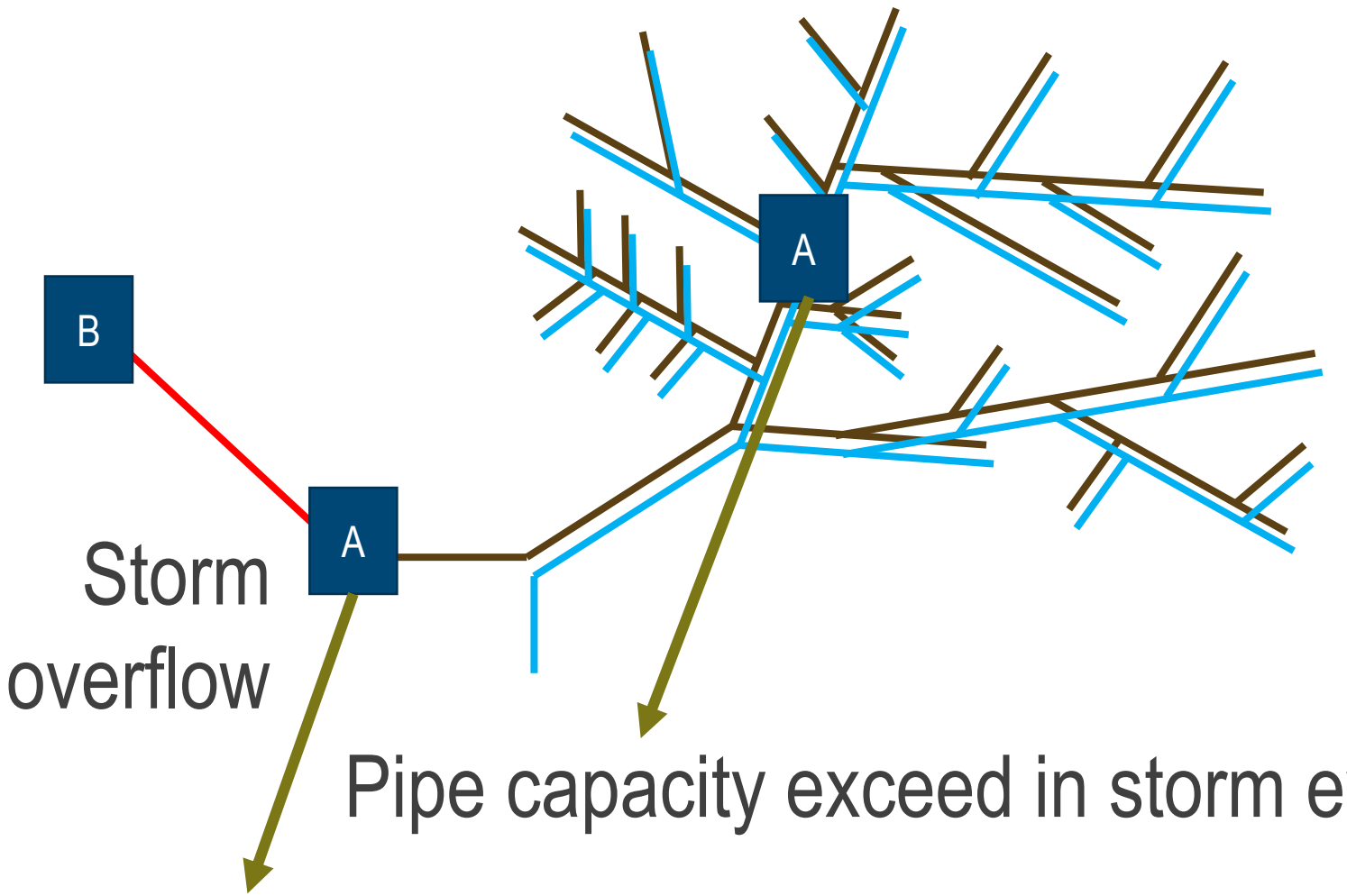
Top 5 most common rubbish items flushed down a toilet

- Q-Tips (cotton buds)
- Condoms
- Sanitary pads/tampons
- Contact lenses
- Wet wipes

Inspection Tips

- Upstream & Downstream ass.
- Photographs (methodology?)
- Can bag physical evidence

Storm Overflow (also called Combined Sewer Overflow (CSO))



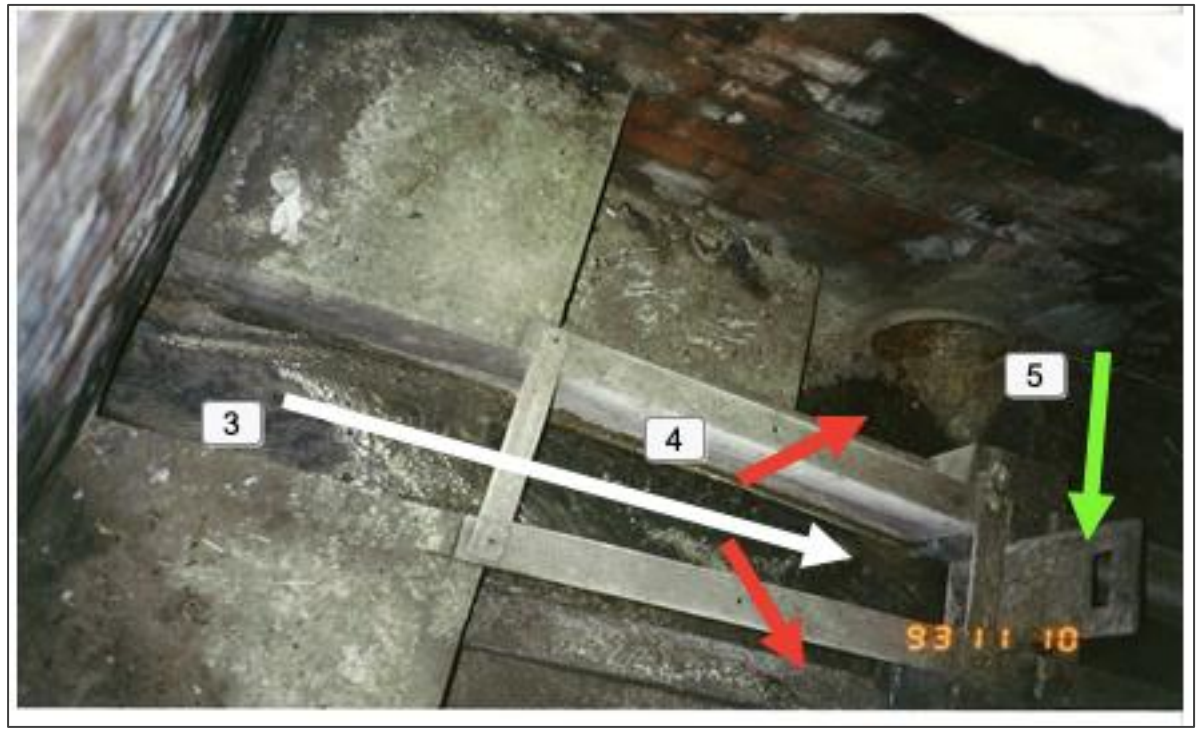
What does good look like:

- Flow monitoring
- Telemetry
- Requirement to clean watercourse
- Temporary storage (rare)
- Screens (mechanical)

(*all are permit conditions*)

Water Course

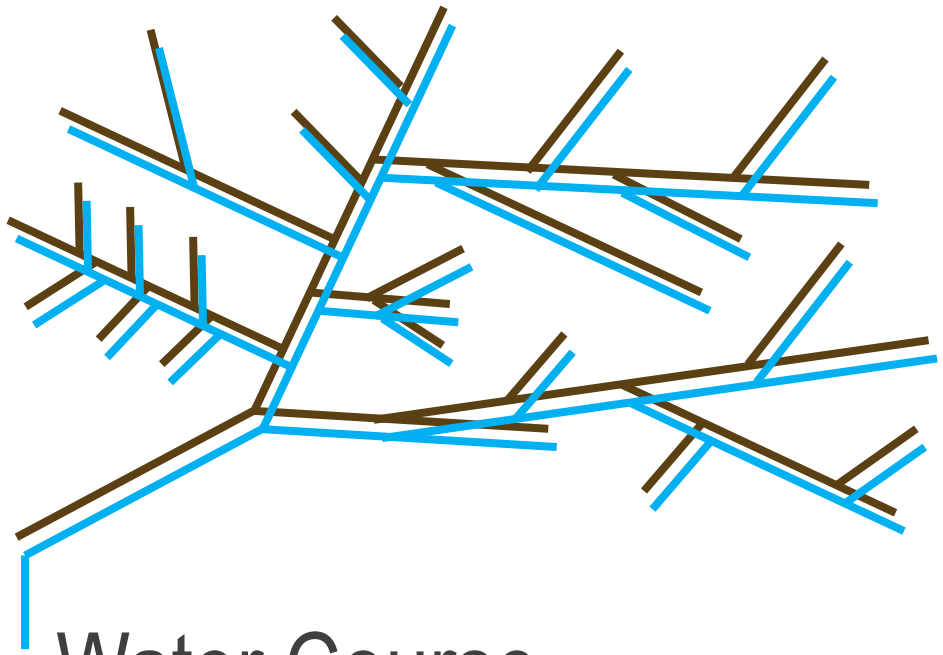
Combined Sewer Overflow (CSO) large design variability (both unscreened)



What is the most important aspect of inspecting a CSO or EO?

They should only operate when necessary! i.e. storms or emergencies

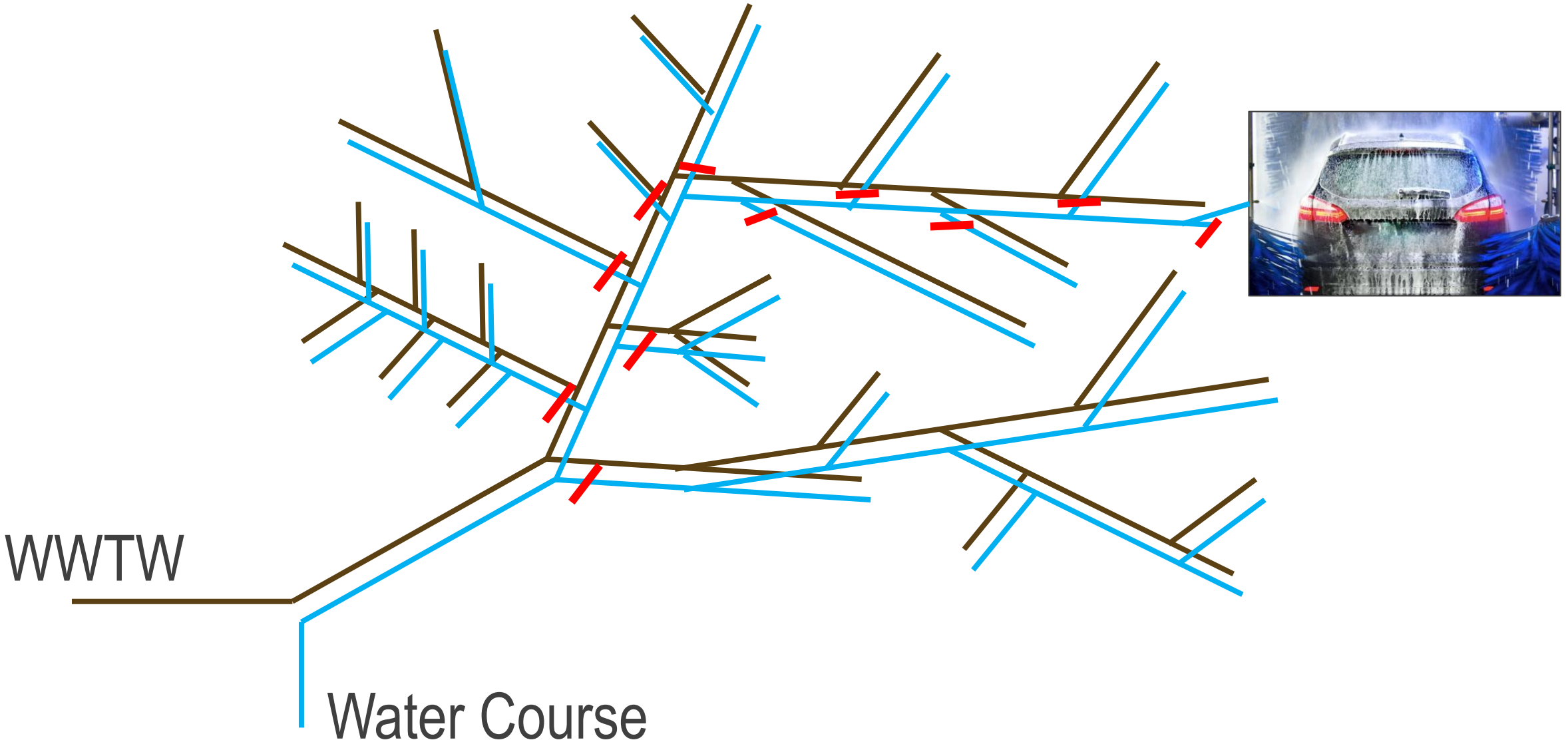
The surface water discharge



Water Course

SW system - wrong connection? - follow the bubbles (or oil for interceptor problems)

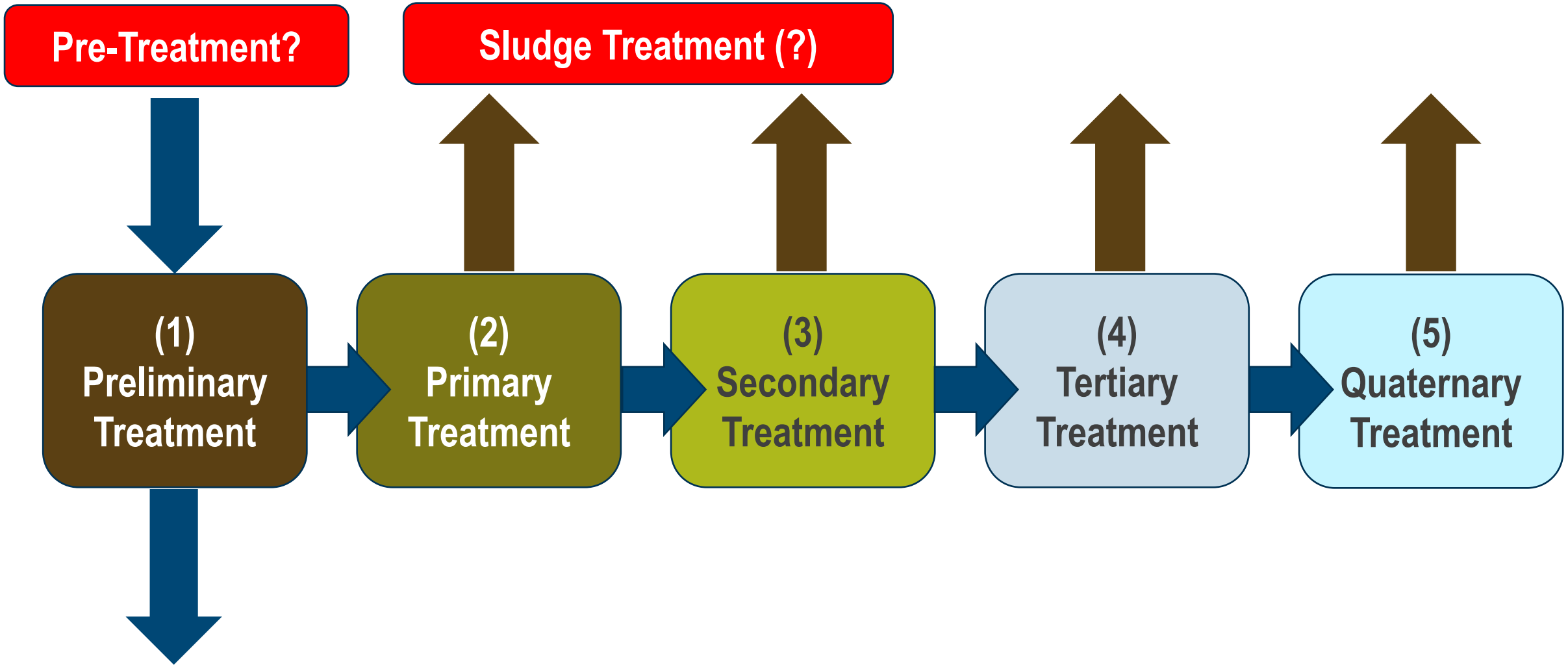
Searching for the source: Game of elimination, lifting manholes



What would you put in a checklist to cover the wastewater collection system?

3. The Wastewater Treatment Works (WWTW)

The key stages of effluent treatment

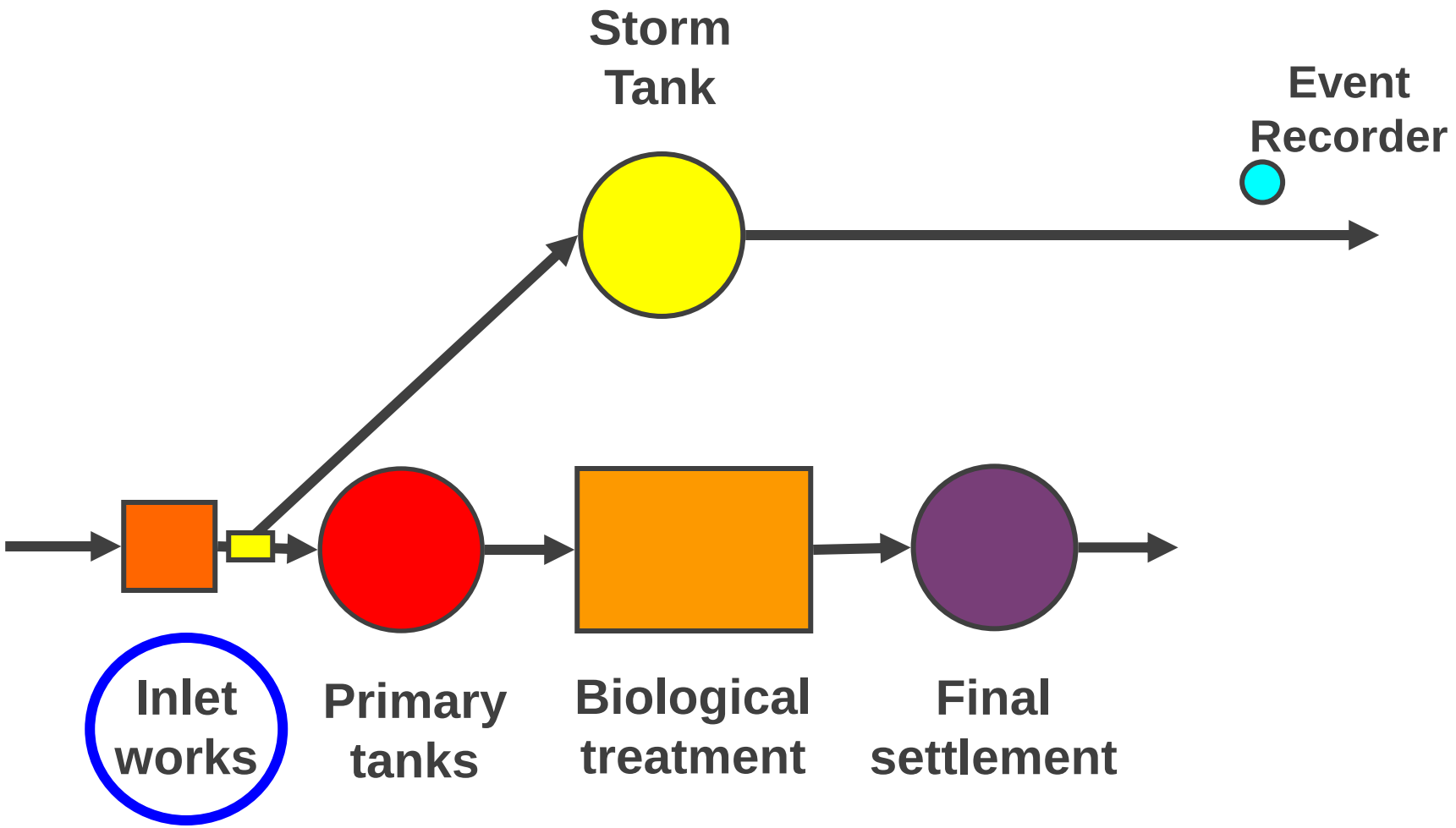


Note: some stages may not be present on your site inspection

Common elements of a ‘normal – mid-size’ WWTW

Note: size varies based on capacity of the works, levels of treatment vary based on WWTD & the receiving environment

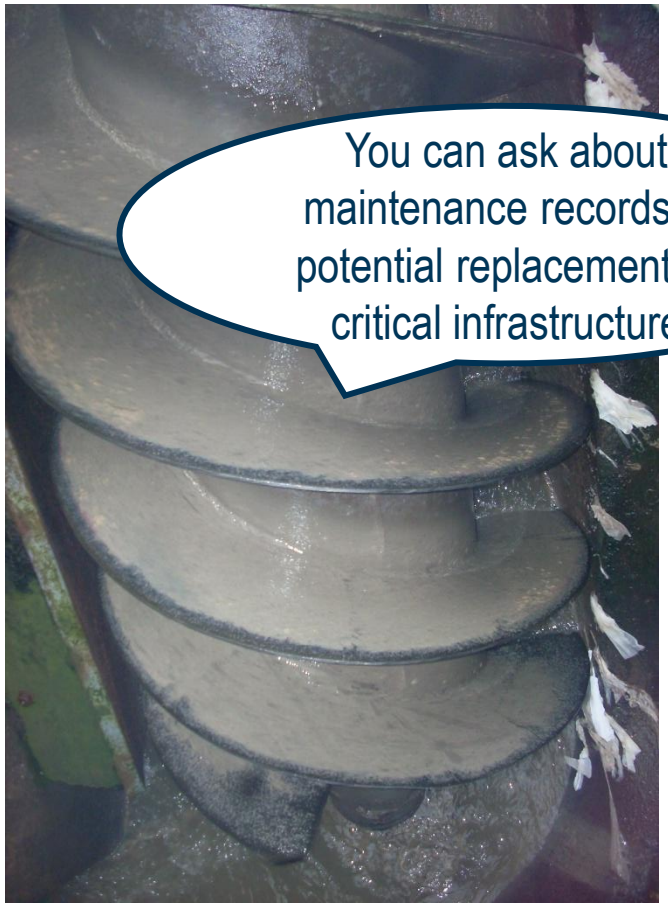
Inlet works


Storm
Tank
Event
Recorder
Inlet
works
Primary
tanks
Biological
treatment
Final
settlement

Inlet works – Key areas of inspection

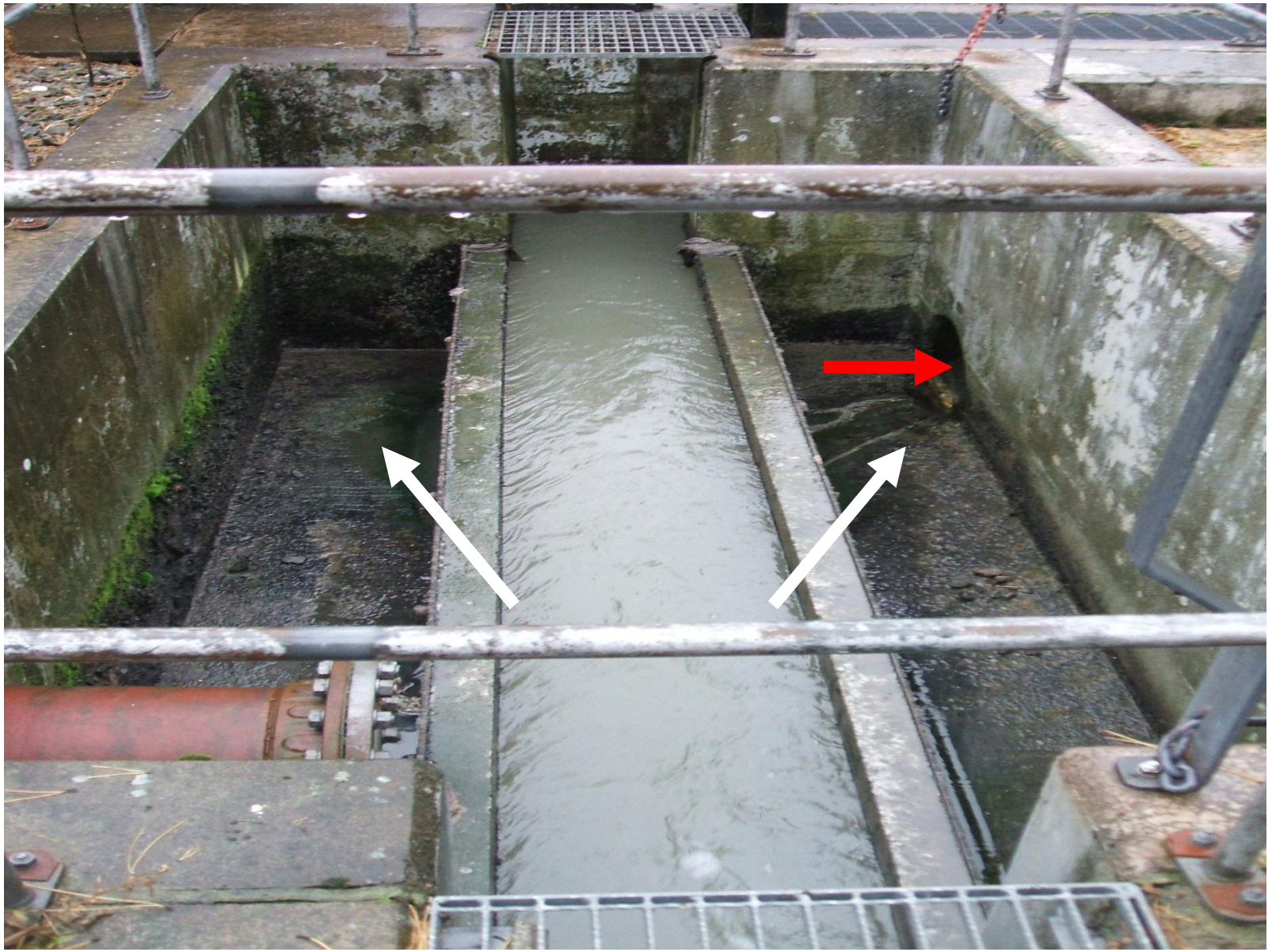
- Pumps
- Overflows (storm tanks?)
- Screens
- Flow data

Inlet pumps – needed to achieve gravitational head (if needed at all)



Note: There should be duty and standby pumps
There will be an EO associated with the pumps

Combined Sewer Overflow at the works



CSO basics:

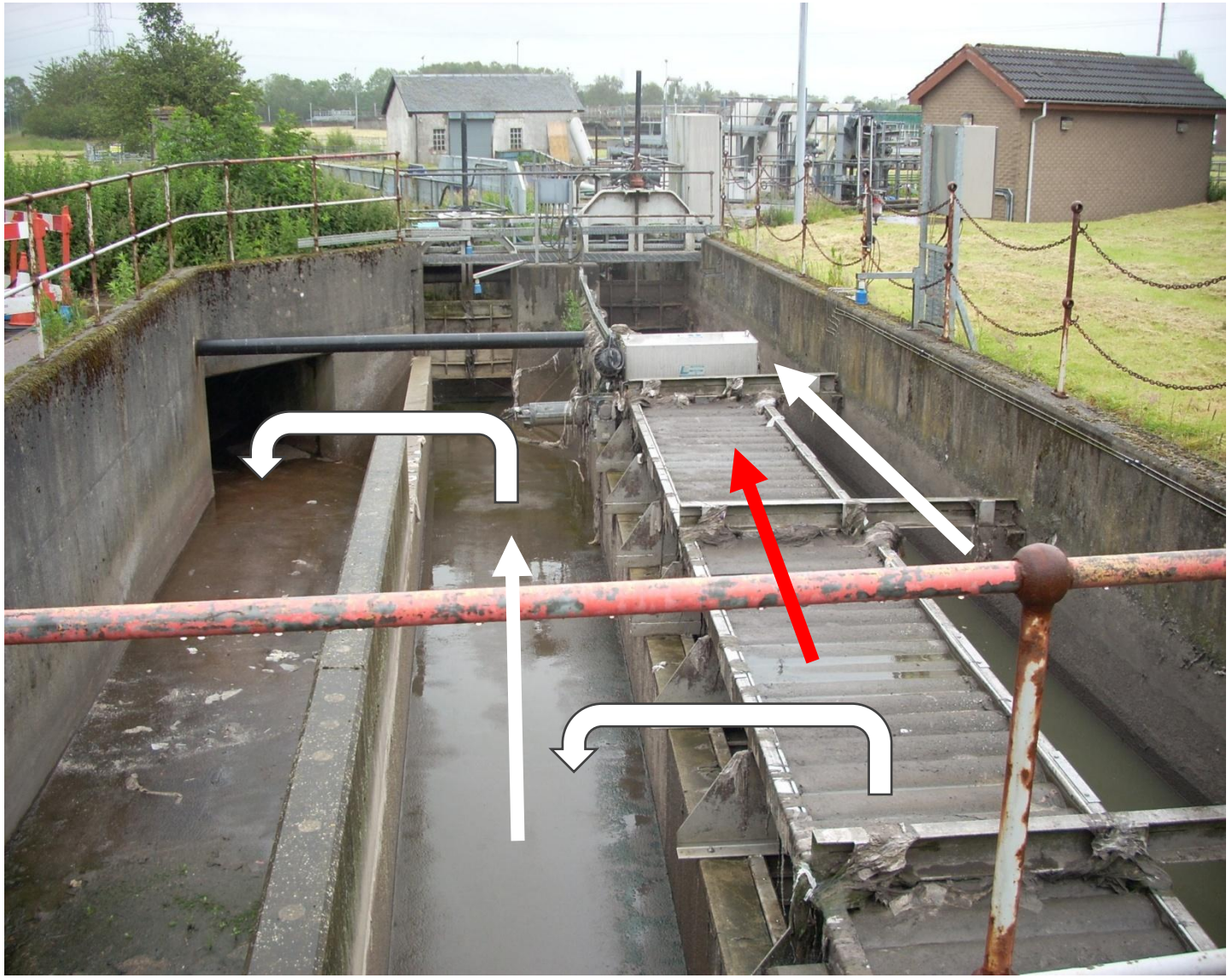
- Set at x litres per second
- Based on multiples of Dry Weather Flow (DWF)
- Often set at 3 or 6DWF

What does good look like:

- Screens (cleaned)
- Move to 6mm 3D screens (smaller clog more often)

(*all should be in permit conditions*)

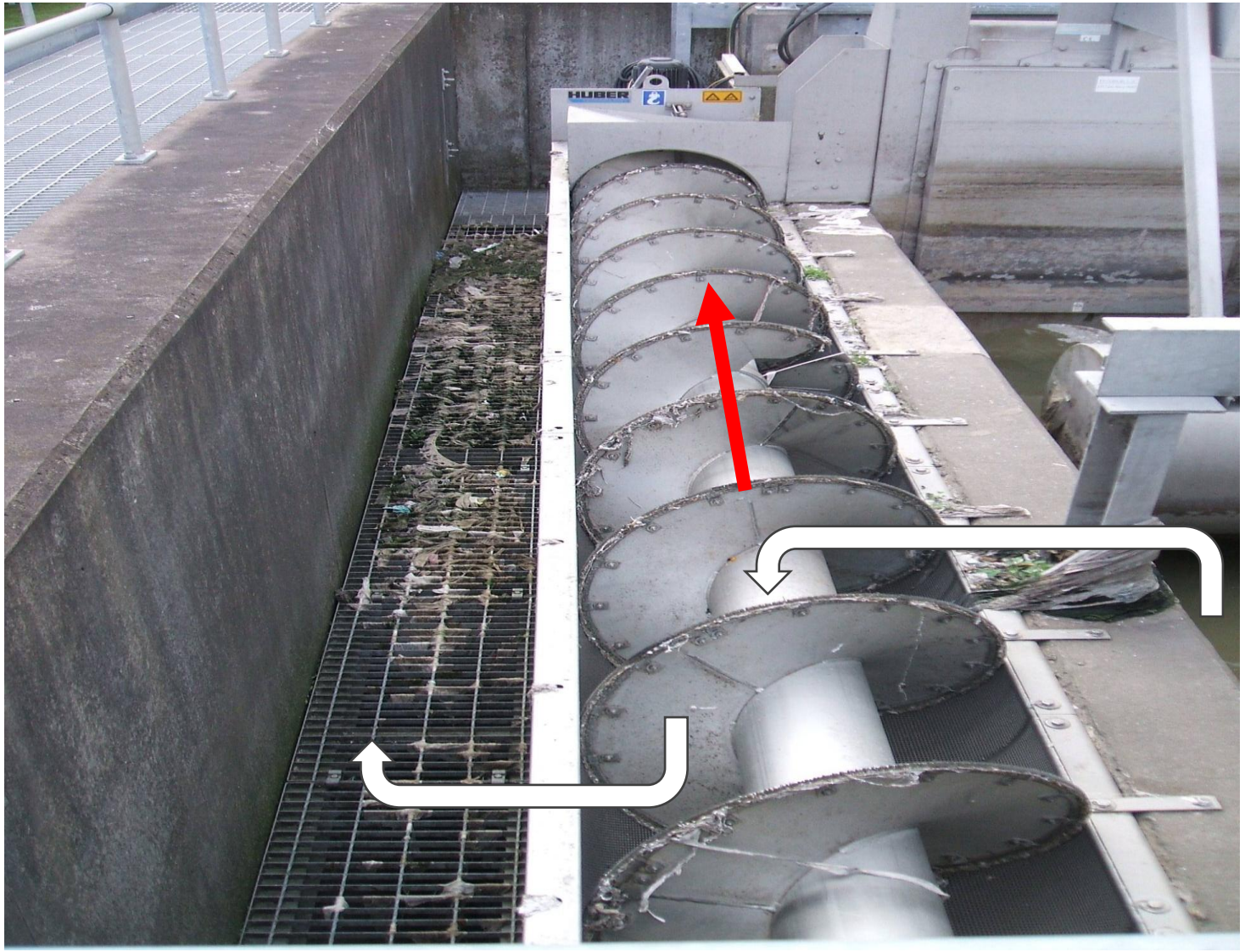
Perforated band CSO (storm tank and discharge to the environment)



What does good look like:

- Screenings returned to main flow
- Automated cleaning of screens

(*all should be in permit conditions*)



What does good look like:

- Screens should be clean when not operating
- CSOs should not be operating in dry weather*

(*all should be in permit conditions*)

CopaSac often used on smaller CSOs

What does good look like:

- Sacks manually removed and replaced after operation
- Sacks should be appropriately disposed off
- Access should allow easy checking and replacement

(*should be in permit conditions*)

Storm Tank Theory

- Should be no discharge in dry weather – only during storm event & when incoming flow to works >3DWF

- As storm increases
  - Hydraulic capacity of WWTW exceeded
  - Overflow to storm tank (captures most polluting ‘first flush’)
  - As storm continues watercourse flow increases & eventually settled storm sewage overflows to watercourse

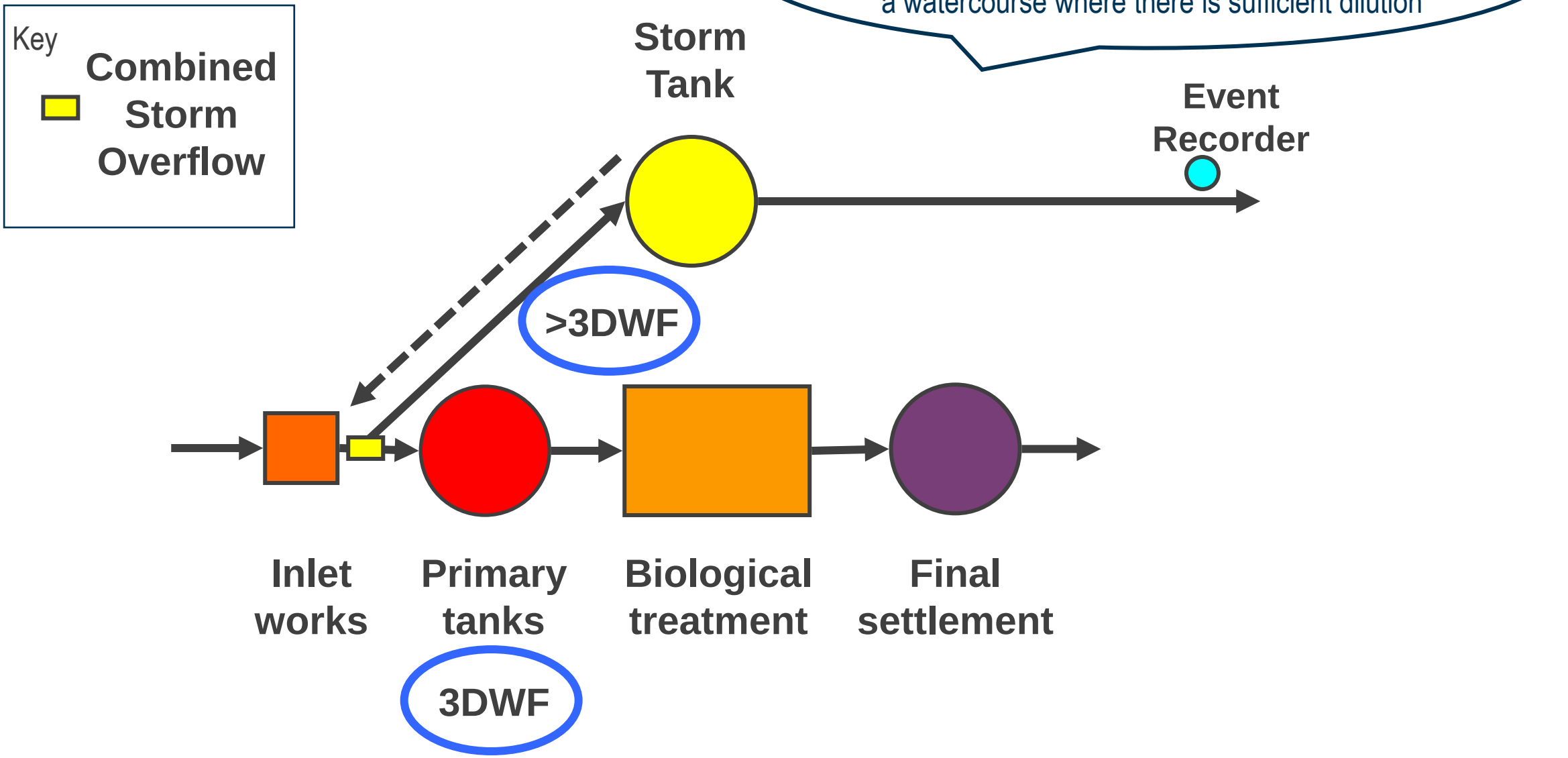
- The storm tank is emptied back into WWTW as flow allows.

*Storm flow graph

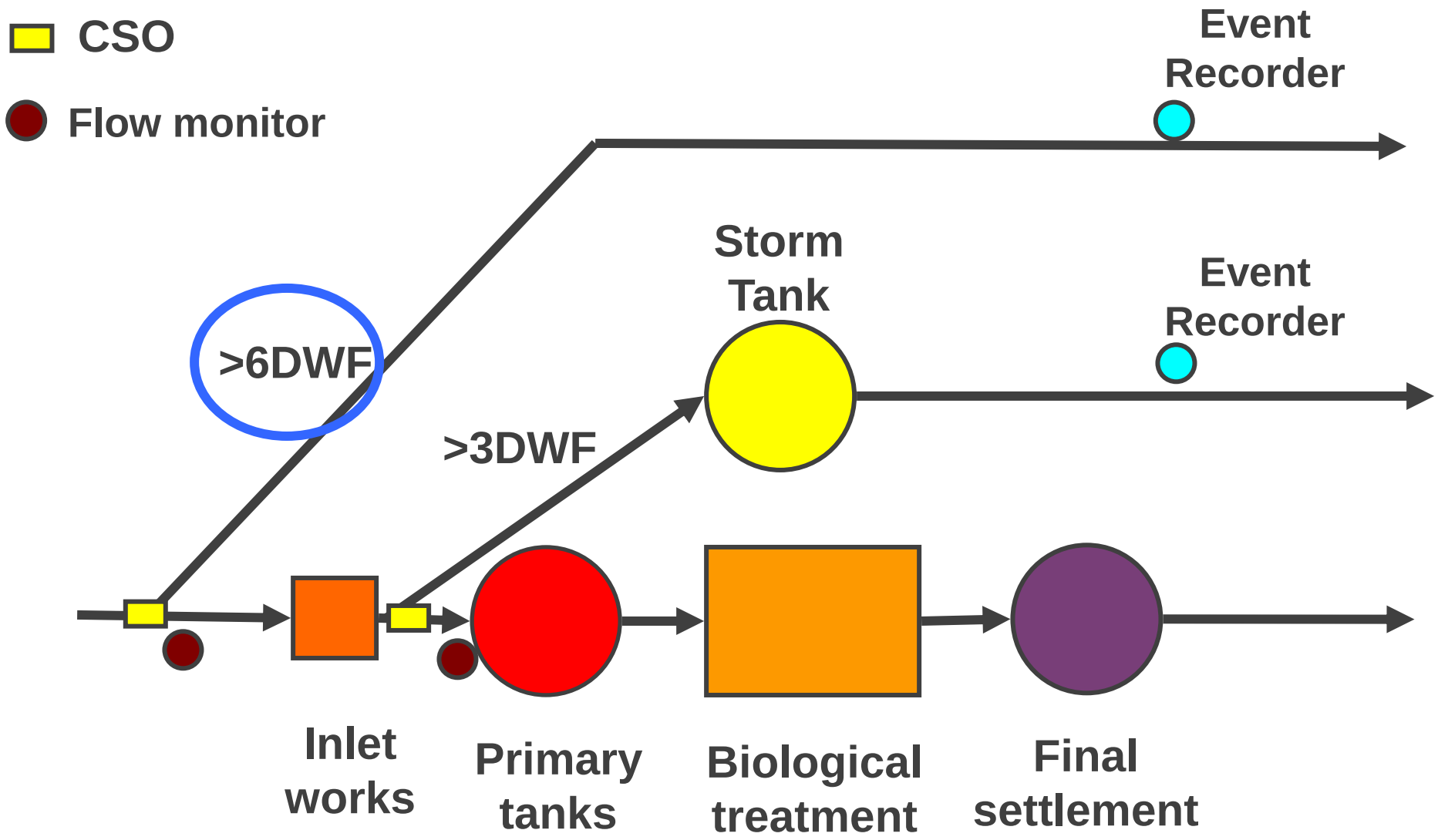
Storm tank

Storm tank & CSOs on a WWTW

Ideally storm water should go to a storm tank but it may potentially be discharged directly to a watercourse where there is sufficient dilution



Multiple storm overflows possible



Inlet Screens

- Objective is to protect works from larger items & prevent contamination of environment & potentially sewage sludge
- Types
  - **Bar screens – manual or automatically raked**
  - **Band screens**
  - **Drum**
- Often 6mm inlet at large modern STWs
- Screenings
  - **Remove, compact and dispose - skip/bag to landfill or incineration**
- Grit Removal
  - **Removes grit, small stones that could damage pumps**

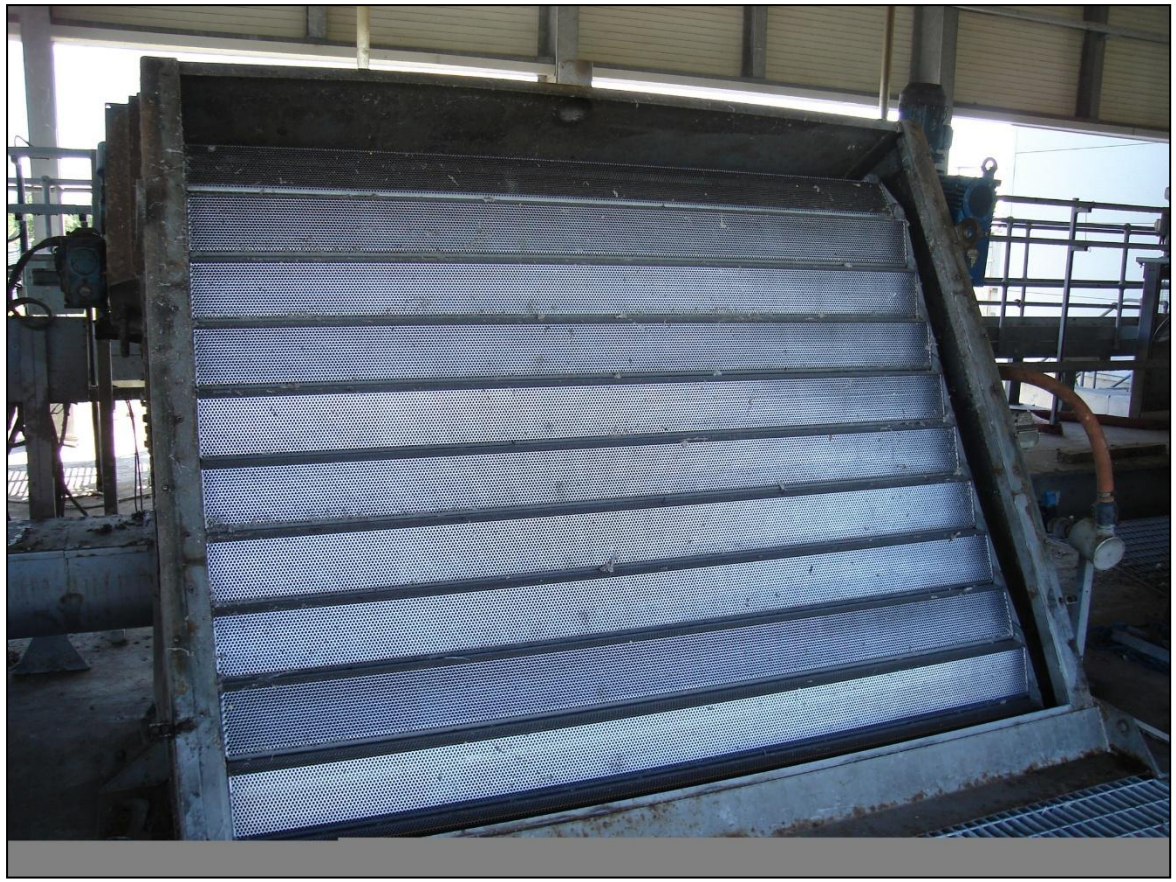
Manually raked screen (older systems or used in conjunction with additional methodology)

What does good look like:

- Difficult to keep clean, however, they require regular cleaning to stop blockage. There should be no significant build-up
- Waste should be appropriately disposed off

(*should be in permit conditions*)

Band screen (rotates)



Rotating drum screen

Screenings & grit collection

What does good look like:

- Waste is collected in a controlled way
- Waste is appropriately disposed off

(requirement *should be in permit conditions*)

Minor non-compliance

Grit removal (another minor non-compliance)

Telemetric sensors (event monitors)

What does good look like:

- Telemetric sensors in place as required.
- Here it would pick up a rise in influent which would show the screen is blocked

(requirement *should be in permit conditions*)

Serious issue (Inlet screens completely blocked – effluent backing up)

Evidence of previous issues – require clean-up

Flow monitors

Flow to Full Treatment (FFT)

FFT is usually 3DWF
(more is better)

The exact volume should be
in the permit

The volume passed forward
to FFT should always be
checked and recorded
during inspection

Be aware of the economic
incentive not to treat 3DWF!

Additional inlet requirements

- ## Flow Measurement and Flow Rate

Most licences now have a Dry Weather Flow limit on the influent and there may also be flow related conditions on CSO's within the works. A good permit will not only give limits but also describe how & where the data can be accessed on site

- ## Inlet Autosampler

UWWTD requires flow-proportional or time-based sampling for some WWTW. Autosamplers are often used to comply with this requirement. Is it working? Temperature?

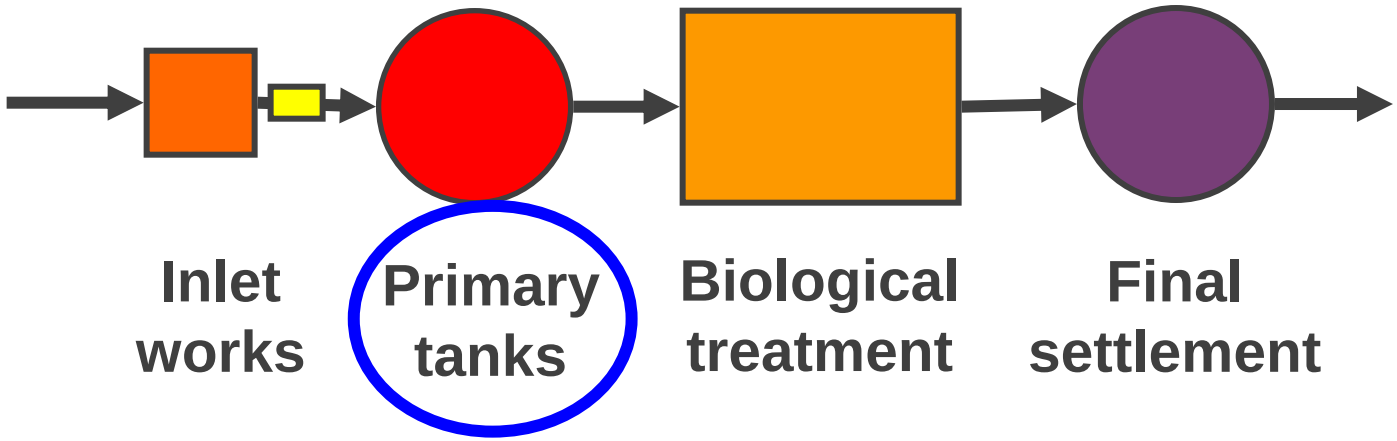
- ## Pre-Treatment

This may include chemical dosing to assist the treatment process e.g. assist suspended solid removal, nutrients etc

Development of an inlet checklist

- Pumps
- Overflows (storm tanks?)
- Screens
- Flow data
- Autosampler (if required)
- Pre-treatment (if required)

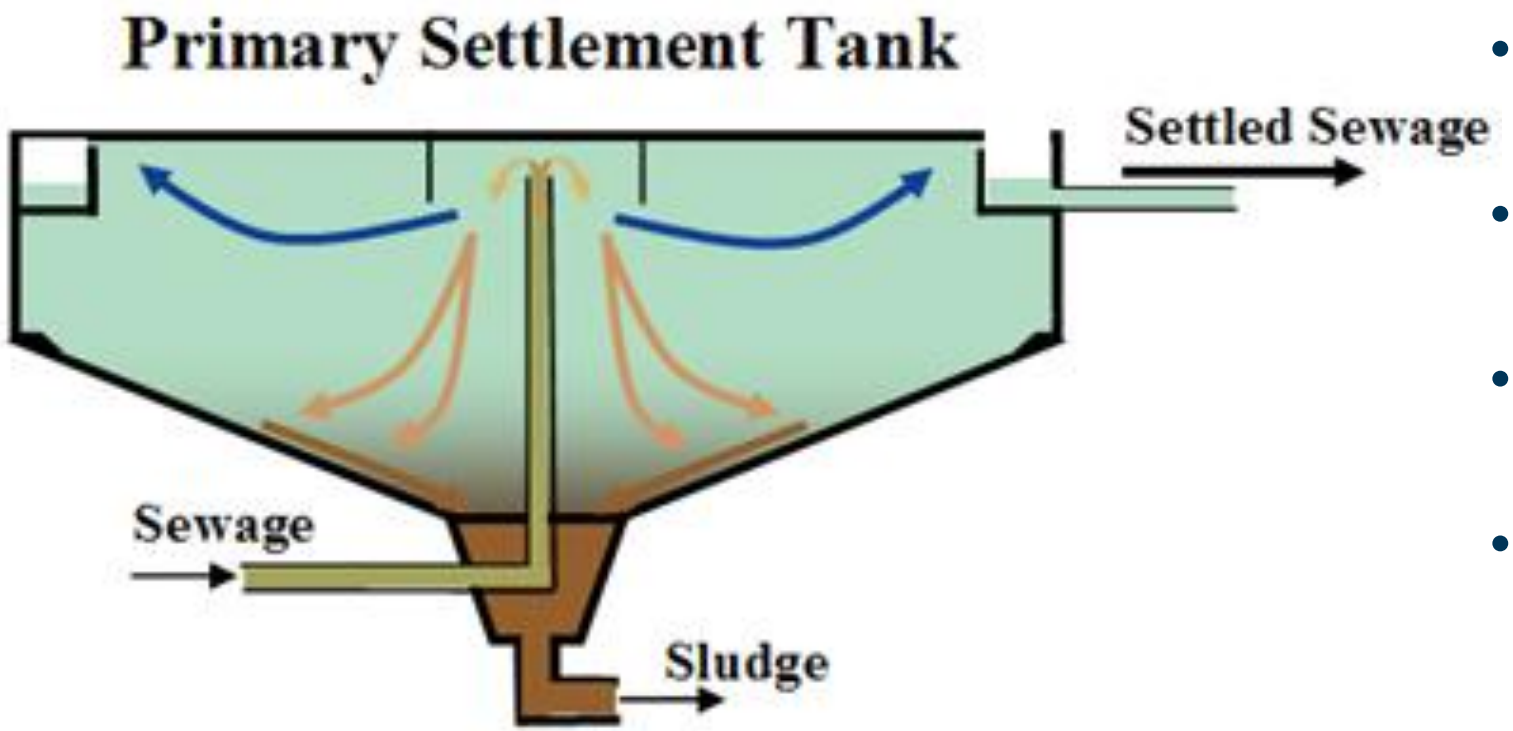
Primary Treatment - Primary Settlement Tanks (PST)



Primary objective: Remove organic matter

Allow solids to settle, forming sludge, while grease and oils etc float to the surface for removal

Primary Settlement Tank



- Can be circular or rectangular
- Reduce suspended solids by 50 to 80%
- Reduce BOD by typically 30%
- Manual or automatically desludged
- Reduces bacterial load by 25-50%

How a Primary Settlement Tank (PST) works

PST Scum Board (or Scum Baffle)

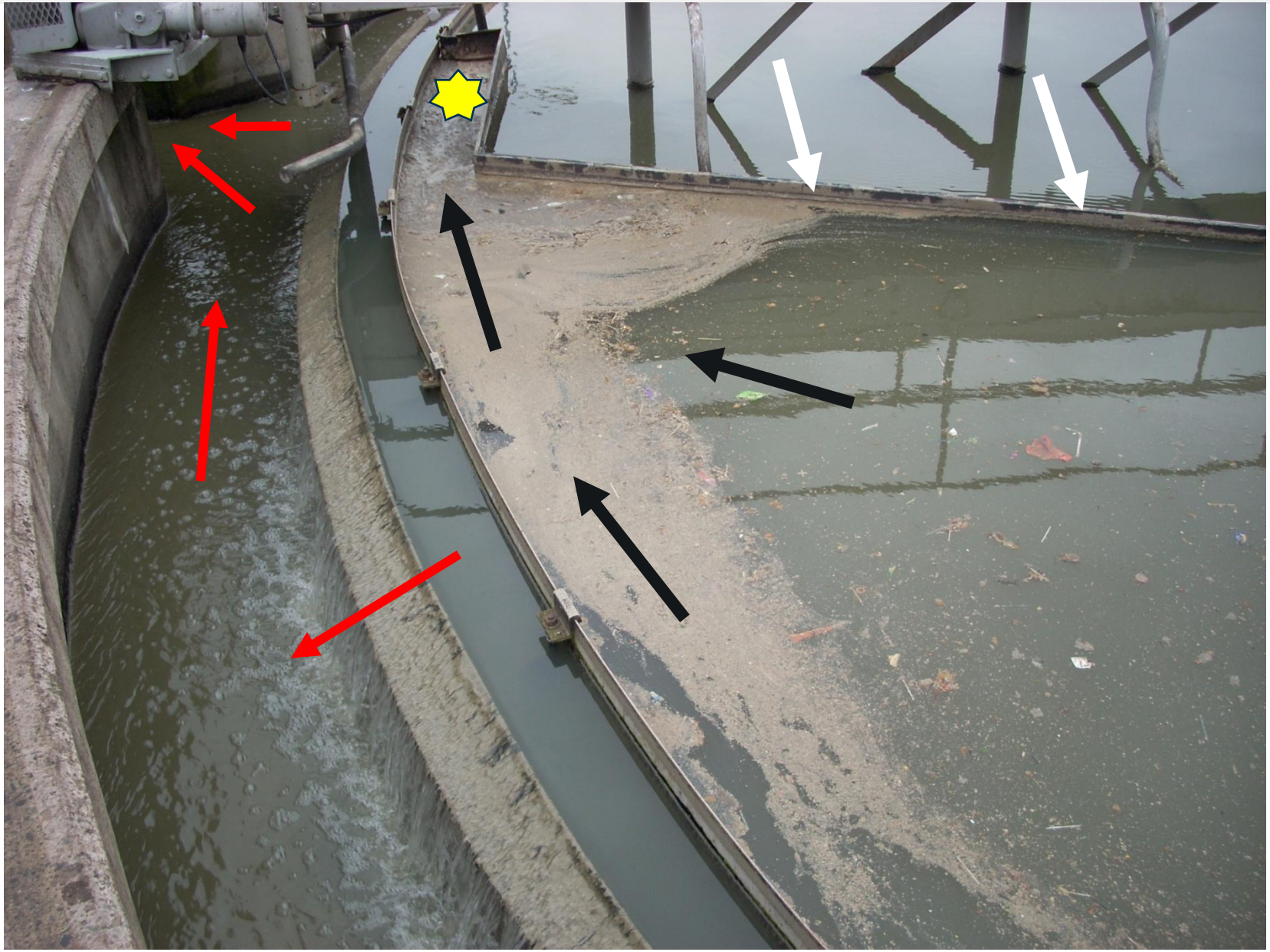
PST Scum Board

Retention: 1.5 - 2 hours

Primary Settlement Tank

What does good look like:

- Arm rotating
- Floating scum (including fat & oils) remains on the inside of the Scum Board
- Floating scum collected and removed from skimmer
- Channels free from sewage fungus (often brushed). These are sometimes painted white to highlight



Rectangular PST(works the same way as circular tanks)

Floating scum carried over (Is this a non-compliance?)

Poor maintenance (Is this a non-compliance?)

Solids on the wrong side of the scum board & plant growth

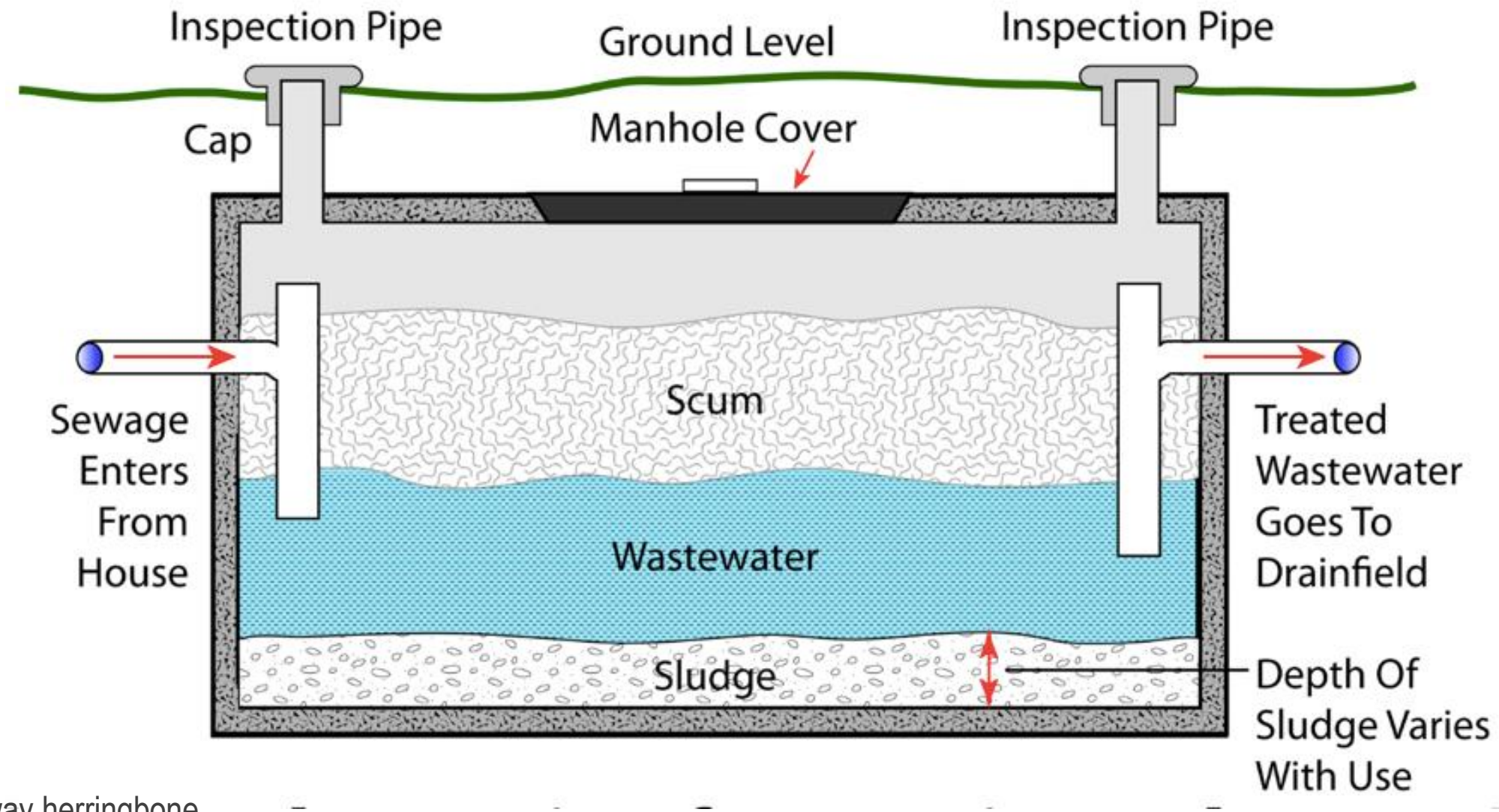
Septic tank – Primary treatment for a rural location

Use: Where there is no access to a centralised sewer network – single house to a small rural settlement

- Works by separating solids & liquids (shown on diagram next slide)
- Anaerobic digestion – bacteria break down organic matter in the absence of oxygen, reducing sludge volume

- It does not fully treat wastewater
- It does not remove nutrients
- It requires limited maintenance, however, should be emptied (3-5 years domestic)
- You have to be careful what you put into it
- It should discharge to a soakaway or partial soakaway

Septic Tank (locally built rectangular or off-the-shelf ‘onion’) – Primary Treatment Only

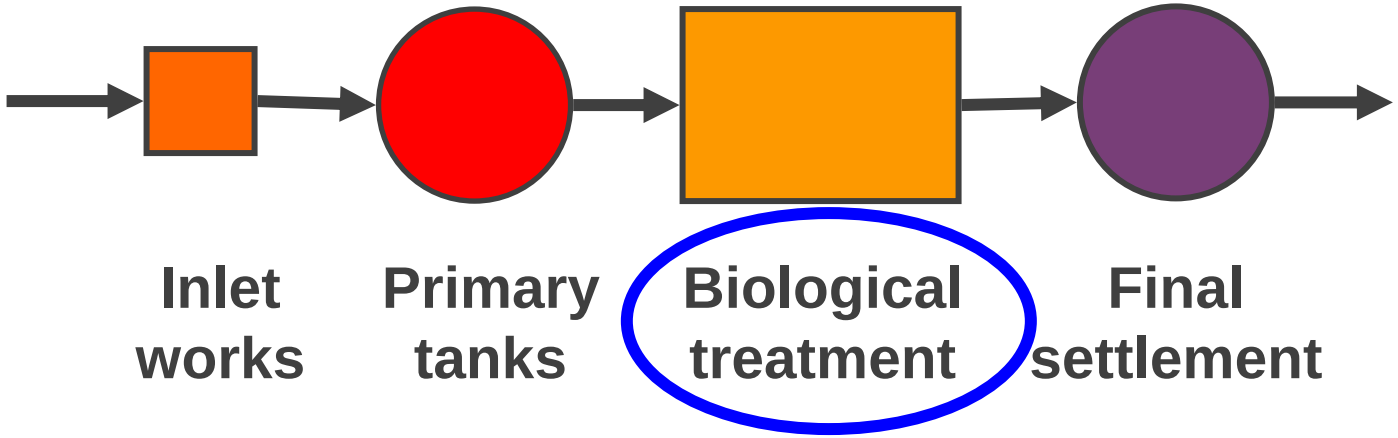


*soakaway herringbone

Primary Treatment Checklist

?

Secondary Treatment in the form of Biological Treatment



Biological Treatment – 3 types of process

- Suspended Growth Systems
- Attached Growth Systems
- ~~Advanced Biological Nutrient Removal (BNR)~~

- Microorganisms suspended in water
- Microorganisms grow on surfaces
- Microorganisms remove key nutrients (e.g. enhanced nitrogen removal)

Biological Treatment

Varied, potentially complex

Fortunately for us there is little to check during routine inspection!

Reduces bacterial load by 80-99%

Q. All things being equal does municipal sewage change its strength during the year?

1. Suspended Growth Systems

- **High organic matter removal (BOD & COD reduction)**
- **Some biological nutrient removal (nitrogen)**
- **Can be used for municipal and industrial wastewater (scalable & modifiable)**
- **Can handle variable loads – flow & load (seasonal or industrial variations)**
- **Disadvantages include high energy costs & requires careful sludge management**

Activated Sludge Process (2 common approaches)

Diffused Air

Whisk

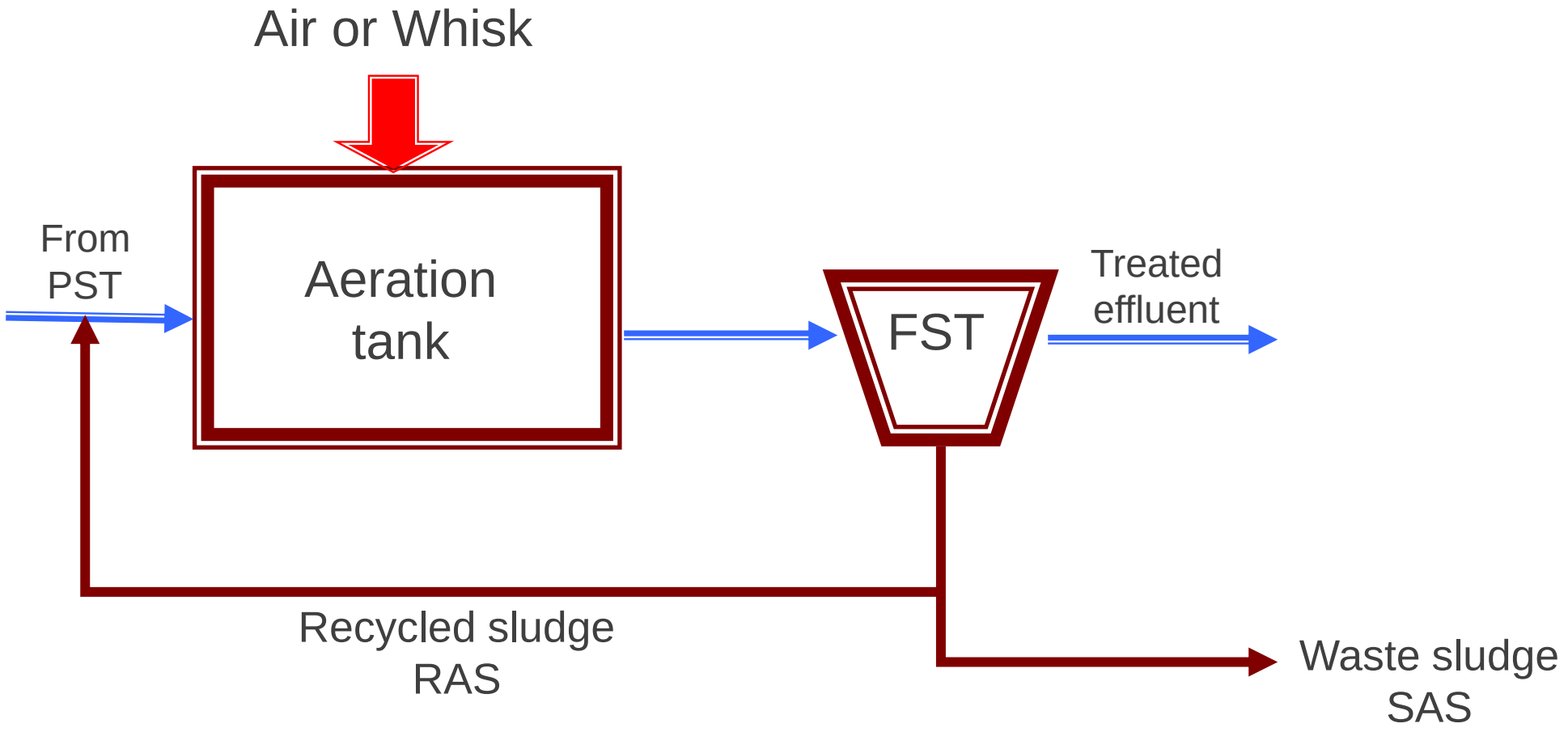
Retention: 6-8 hours longer for ammonia removal

Mixed Liquor Suspended Solids (MLSS)

MLSS refers to the concentration of suspended solids (microorganisms, organic and inorganic particles) in the aeration tank of an activated sludge system. It represents the total amount of microrganisms available to break down organic pollutants

- **It is a key parameter used by WWTW operators to monitor and control the process**
- **Measured by filtering, drying & weighing to determine solid concentration in mg/l**
- **Helps operators optimize aeration. MLSS controlled by return activated sludge rate**
- **Higher MLSS can give better treatment performance but could cause poor sludge settling**
- **Lower MLSS may reduce treatment efficiency leading to higher BOD and ammonia in the effluent**
- **Typical MLSS Range 1500-2000 mg/l but 4000 mg/l for nitrification (ammonia removal)**

Activated Sludge (AS) Process & Sludge Collection



Most settled sludge eturned to AS inlet (RAS) since need the bacterial culture. Excess sludge (Surplus AS or SAS) removed from process, either passed to inlet to PST for settlement or at FST. Goes to sludge holding tanks for treatment and disposal

2. Attached Growth Systems

- More resistant to shock loads
- Lower sludge production than suspended growth systems
- Potentially very low energy requirement
- Less day-to-day maintenance
- Disadvantages: Can clog and less good at nutrient removal

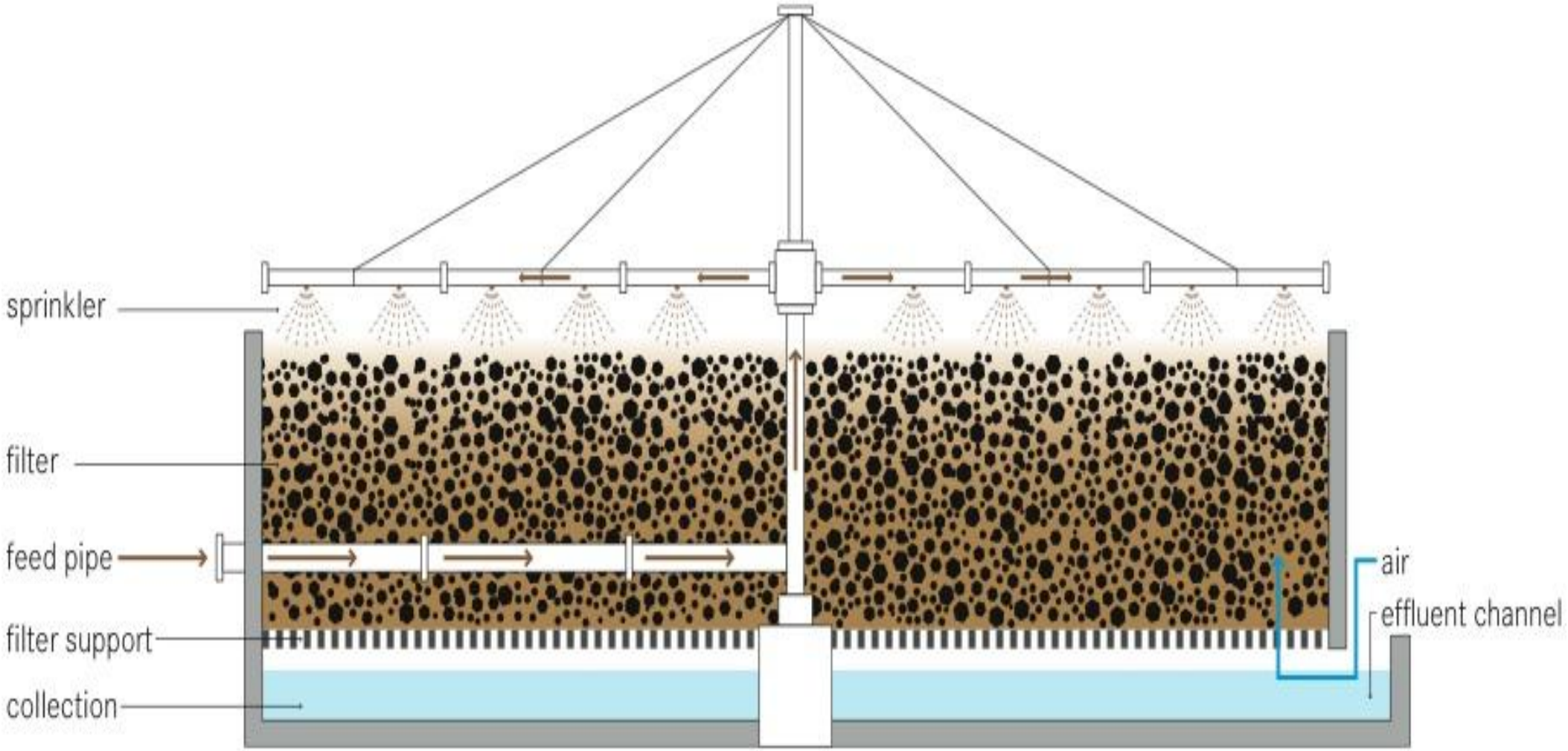
Percolating or trickling filters

- Much bigger footprint than activated sludge
- Some motorised but often work on effluent pressure (high head pressure required)
- Old proven technology (1900s)

*Tipping bucket diagram

- Media: stones or plastic
- Normally 2m+ deep (weight of media limits)
- Approximately 30-minute retention
- Can recirculate in dry weather

Percolating filter schematic



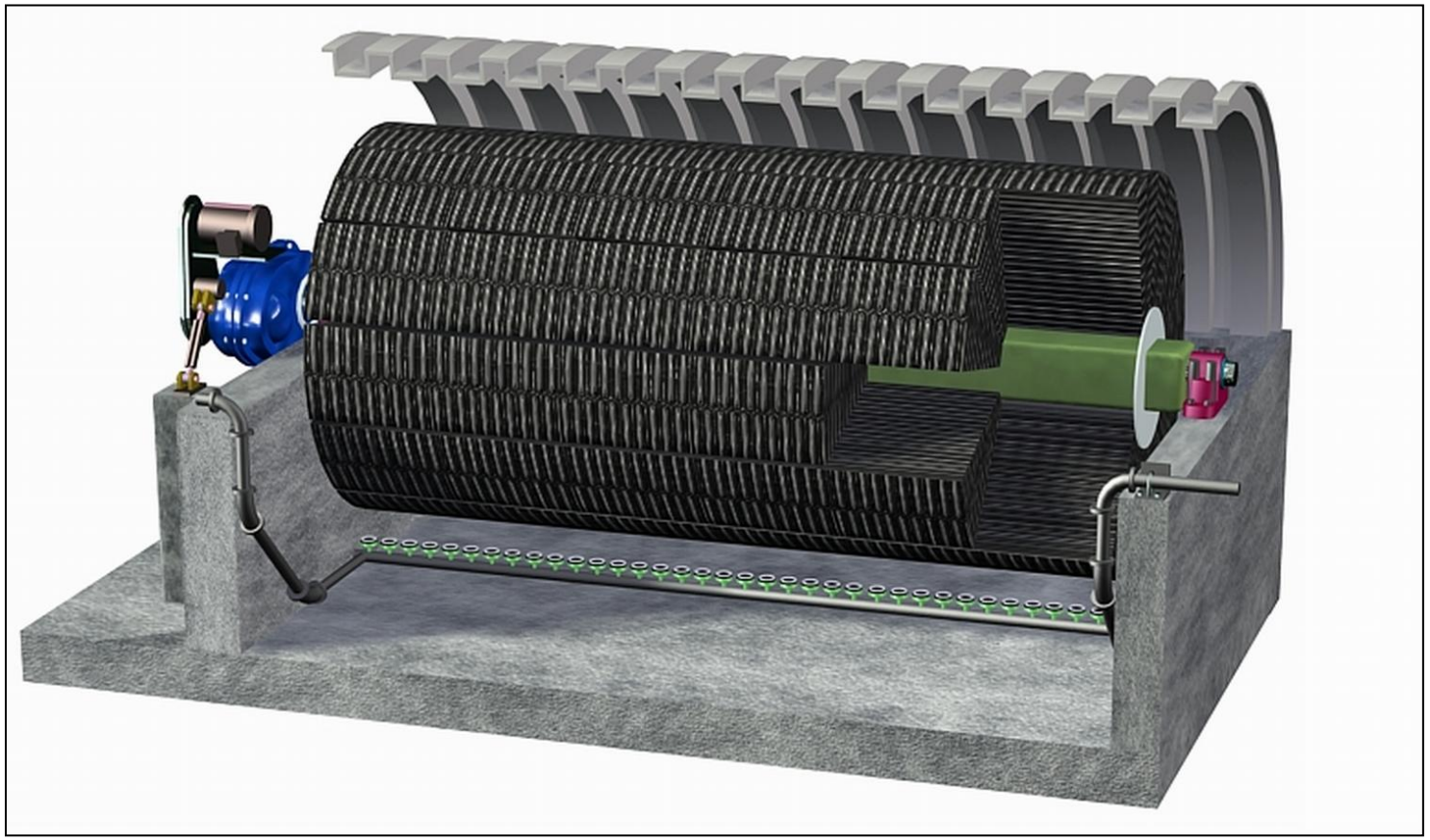
Spot the issue (is it a non-compliance?)

*Let's talk about flies

A more obvious maintenance issue (is it a non-compliance?)

Package plants – common biological treatment for rural developments (<1000 pe)

- RBC – Rotating Biological Contact
- Slow rotating discs
- Bacterial film on discs
- No flies, limited odour
- Don’t work when power off



Simple Inspection

- Moving
- Light brown to grey film

Final Settlement Tank (FST)

- Half the size of PST as sludge more easily settled (retention approx. 1.5 hours)
- The settlement tank after a percolating filter is called a humus tank – different sludge.

Final Settlement Tank (FST)

- Used after activated sludge process to remove solids

Skimmers

Carryover of sludge from the activated sludge process to the final settlement tanks

- **Non-compliance?**

Secondary Treatment Checklist

?

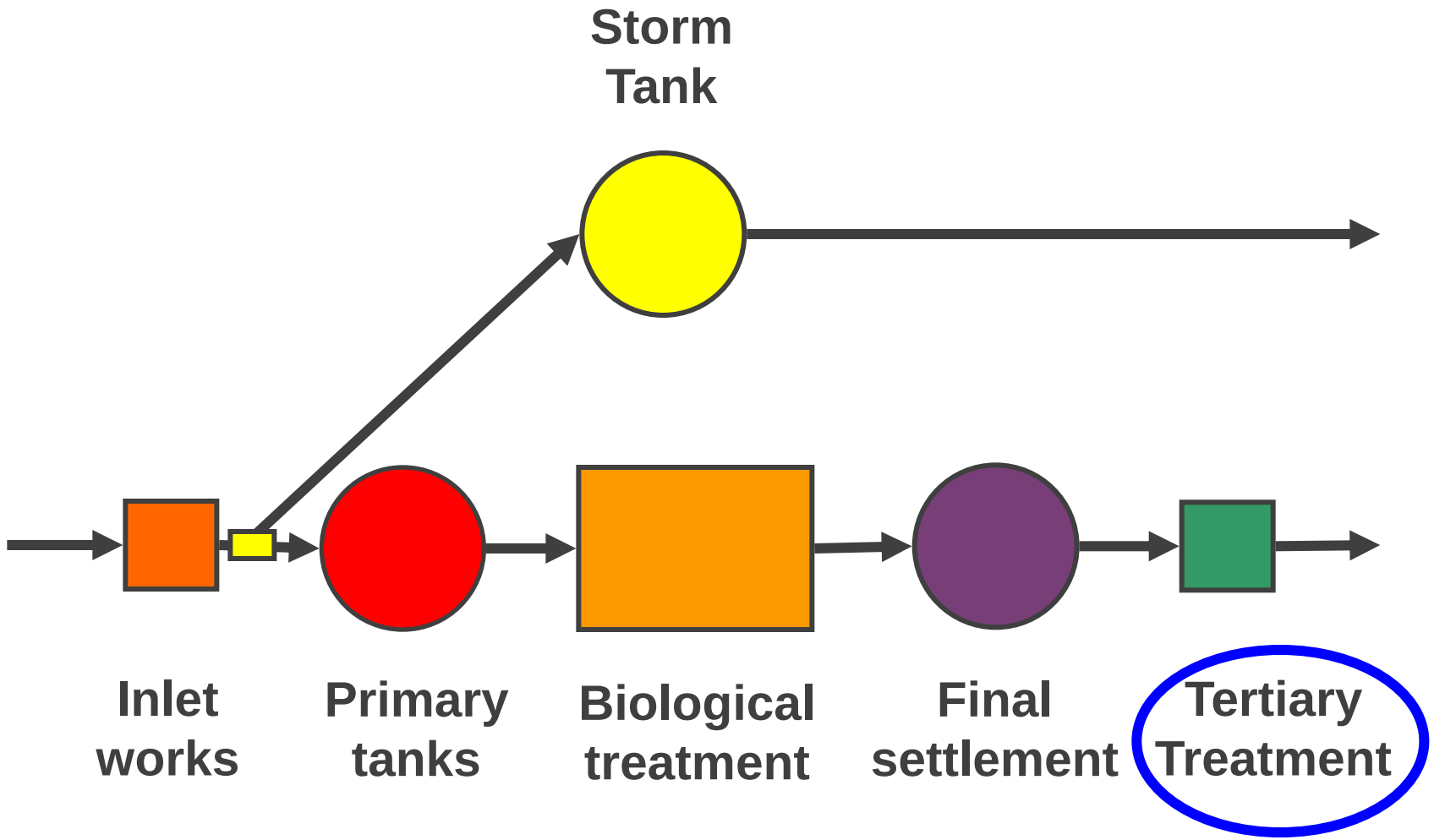
Effluent discharge point

- **Should be a requirement in permit for a clearly marked location (e.g. map or an actual sign at location) where a mixed sample can be taken.**

Single white tile – an inspector's friend

Final discharge with upstream & downstream ‘enforcement samples’

Tertiary treatment (a few slides only on most common options)



Objective to improve or ‘polish’ quality of secondary treated effluent by removing suspended solids, BOD, nutrients, ammonia or pathogens

Sand filters

- Sand filters – effectively a filter which gets blocked by particulates – so need to backwash to clean
- Pumping – energy cost
- Can remove 70% of SS and BOD

Reed beds

- Sustainable
- Low maintenance
- No power but not cheap
- Need to control level of sewage

Other methodologies

- **Micro-strainers** like sand filters & reed beds designed to reduce SS/BOD (often are rotating drums – require back washing)
- **Chemical dosing** used for nutrient removal (P) e.g. ferric sulphate dosing
- **Disinfection** used to reduce bacterial load for discharges that could impact bathing beaches or shellfish (UV & ozone – chlorine not favoured due to the productions of chloramines which are toxic to aquatic life
- **Plastic media towers** (like percolating filters but finer grade media) used to reduce ammonia. Nitrifying bacteria are added.

Somewhere closer to home – what do you see?

The hydrology of the discharge

Time to be a bit more strategic

Does size matter?

How do you prioritise what you are going to inspect?

Do you have to inspect every site?

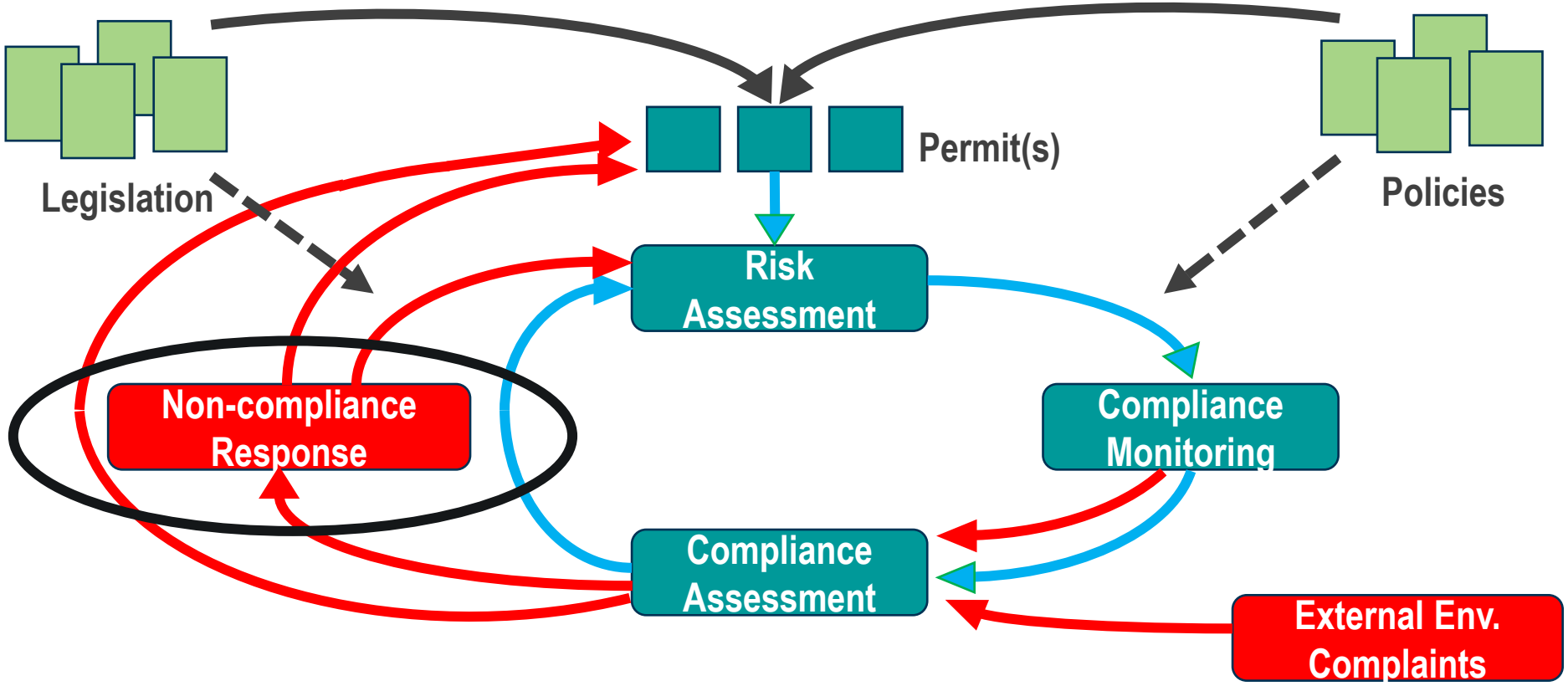
There should be a reason for every inspection

Risk (how do you prioritise?)

My priority list (in no particular order) :

- **Currently causing pollution or is significantly non-compliant**
- **Actual or high potential to impact a sensitive area/site**
- **Where improvement in this site would cause (or significantly increase water quality towards) good status (WFD) to be achieved**
- **Where the site is causing or significantly contributing to a downgrade in WQ**
- **Other strategic priorities**

Simplified Regulatory Cycle



This presentation was produced with the financial assistance of the European Union. Its content is the sole responsibility of the authors. The views expressed herein can in no way be taken to reflect the official opinion of the European Union.

The project is funded by the European Union via the Technical Support Instrument, managed by the European Commission Directorate-General for Structural Reform Support.