Treatment – Plant Design

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DWQR Risk Assessment Training

2018

Drinking Water Quality Regulator for Scotland

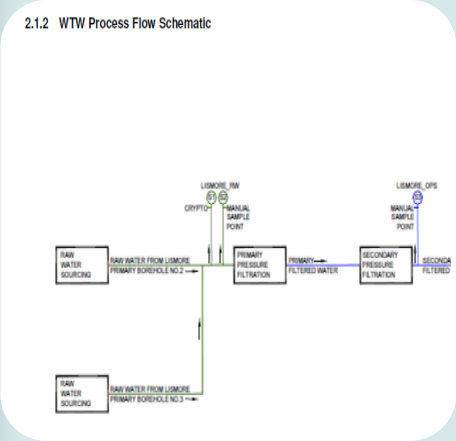
Process Design

Take a step back – see the big picture

- Consider raw water quality
  - Is there enough information?
- Emerging risks
- What is water used for?
- Where does the water need to go?

Process Design

Ask Yourself a Few Questions



- How would I design the treatment process from scratch?
- Is everything that is here necessary?
- Is there anything here that isn't needed?
- Is it dealing with all water quality issues
  - Regulated and unregulated (Crypto)
- What could go wrong?
- Where does the water need to go?

Capacity & Flow

- What is the max water flow through the process?
- Is flow measured anywhere?
- Some process are sized for a certain flow
  - UV
  - Chemical filters
  - Is there a flow "pinch point"?
- How variable is the flow?
  - Can the process cope with that (chemical dosing needs to adjust)
- Is the process reliant on blending out contaminants?
  - This needs to be controlled and monitored

Quality

- How is it being monitored?
- How does it change over time?
- Some processes need stable quality; others will only work within certain parameters
- Some parameters / process need regular checks
  - Chemical dosing
  - Chemical filters

Installation

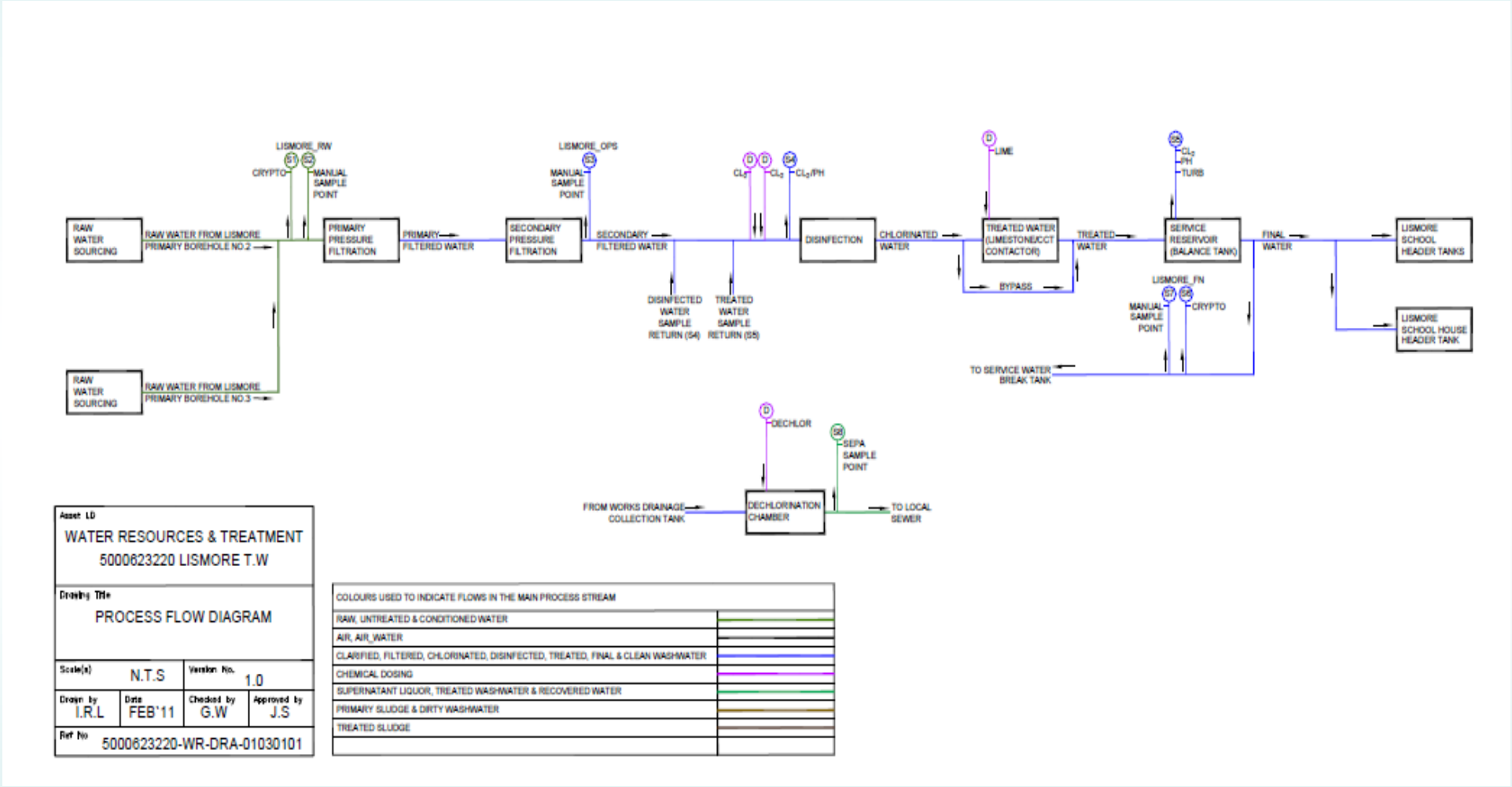
- Stuff only works when it is fitted correctly……
- Follow the process - does it look logical to you?
- Competent installer?
- In line with manufacturers' specifications / guidance?
- Should be installed with maintenance in mind
- Pitfalls – Bypasses, Short-circuiting, Contamination

Records and Information

Ideally…..

- A schematic diagram of whole treatment process
- Operating manual for each process
- Required maintenance
  - Parts
  - Chemical specifications
- Validation information / certification
- We'll come back to this subject in MANAGEMENT CONTROL……..

Records and Information



Questions

TPD1	Is the treatment process layout inadequately documented?	A treatment plan or schematic should be available, this can be a simple sketch or a more complex and detailed drawing depending on the scale of the treatment. This should at least include locations of the incoming water flow, direction of flow, bypass points, dosing points, treatment type and points, monitor locations, out flow, etc. and materials. It need not be to scale but should represent the main treatment of the supply.	5
TPD2	Has there been inadequate consideration of Cryptosporidium in design of treatment?	Cryptosporidium is found in faecal matter from livestock and wildlife and in sewage. It can affect any surface water sources or vulnerable ground water sources influenced by surface water. A multi-barrier approach is recommended to remove Cryptosporidium from supplies; coagulation, clarification and filtration for example. Chlorination is not effective against Cryptosporidium, however, UV treatment will inactivate it.	5
TPD3	Is the treatment plant operating outside its design capacity?	For any treatment process, there are operational limits beyond which treatment performance diminishes. The quality of the drinking water being produced may be adversely affected if this occurs. Therefore any process being used beyond its designed capacity or specification requires action to be taken. Refer to any available information provided by the manufacturer on the design specification for the treatment and criteria on which the treatment process was designed. Check whether the 'demand' on the supply has significantly increased since the plant was designed and built, e.g. from additional commercial premises, large numbers of additional houses. Check the volume of water being treated and the type of treatment process. Flows greater than design capacity will compromise water quality, e.g. due to insufficient contact time with UV or overloading of filters.	5
TPD4	Is there a lack of knowledge and documentation on the treatment plant design / capability / capacity?	It is essential to have a knowledge of the treatment so that any problems can be identified and appropriate mitigation action taken. If an understanding of the treatment of the supply is not demonstrated and no maintenance contract is in place, then the likelihood should be scored as 5. Manuals or manufacturer's instructions for the treatment should be available at the site.	5
TPD5	Is it possible to by-pass any stage of treatment?	Check for pipe work and/or valves that by-pass any treatment stage. If a UV lamp can be easily switched off (e.g. to save electricity) this is bypassing a treatment stage.	5

Questions

TPD5	Is it possible to by-pass any stage of treatment?	Check for pipe work and/or valves that by-pass any treatment stage. If a UV lamp can be easily switched off (e.g. to save electricity) this is bypassing a treatment stage.	5
TPD6	Where there is a blending facility, is the blending strategy inappropriate?	Blending can be the mixing of a public water supply with a private supply or between multiple private water sources. This may be carried out to meet water quality standards. Assessment of the blending strategy requires interpretation of sample results and knowledge of seasonal variations, e.g. of boron, arsenic, fluoride and nitrates. Check that procedures are in place for the calculation and management of the blending ratio. I.e. are the sources being blended in the correct quantities to meet the criteria defined in procedures to eliminate exceedances of the standards? Does the strategy take into account seasonal variations?	4
TPD7	Are there frequent flow/demand variations through the treatment plant, which render the treatment process inadequate in terms of either sufficiency or quality?	Variations in flow rates can cause low pressure, insufficient or loss of supply to properties. Flow variations may also compromise water quality by affecting coagulation, clarification, filtration and disinfection treatment processes, particularly when sudden changes occur. Changes to flow rates should therefore be made gradually and should not exceed the design capacity of any individual treatment process.	4
TPD8	Are there large raw water quality variations, which could exceed the design capability of the treatment process ?	Some treatment processes struggle to cope with rapid changes in the quality of the water they are required to treat. If this is the case it may be necessary to install pre-treatment or storage in order to ensure a more consistent quality of water entering the main treatment process.	4
TPD9	Does / could inadequate installation cause quality problems?	Potentially effective treatment processes can be rendered less effective by innappropriate installation, in terms of siting and the way in which they are connected or commissioned. Check for obvious issues such as short circuiting and post-treatment contamination. Treatment equipment should come with detailed installation instructions and / or be fitted by a trained person.	5

Treatment – Process Resilience

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Treatment Process Resilience

- A bit of a "Catch all" section relating to the ability of treatment to operate under all situations and the ability to pick up issues if they occur
  - Chemical contamination
  - Severe weather
  - Third party interference
  - Power issues
- Testing and monitoring
- Emergency planning

Treatment Process Resilience

Chemicals

- Wrong chemical
  - Unapproved / inappropriate for drinking water
  - Out of date
  - Incorrectly stored
- Incorrect use of chemical
  - Wrong dose
  - Added in wrong place
  - Added to wrong storage vessel
- Chemical contamination

Treatment Process Resilience

Weather

- Affecting Treatment Process
  - Freezing
  - Access to site

Power Supply

- Complete failure
- Inadequate / no back-up power
- Process fails to restart when restored

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Treatment Process Resilience

Monitoring

- Sufficent
  - Onsite testing
  - Online monitors
- Alarms
- Maintained

Third Party

- Vandalism
- Interference
- Inadvertent contamination

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Treatment Process Resilience

Emergency Plan

Event	Location	Action to be taken	Comments
Source blocks			
Source water quality deteriorates significantly			
Raw water pipe bursts			
Power to water treatment fails			
Filtration Process Stops stops producing water			
Arsenic concentrations rise above 10ug/l PCV			
Distribution pipe bursts			
Water samples contain bacteria			
Water becomes discoloured			
Add events here as necessary			

Questions

TPR1	Is there a risk of chemicals used for water treatment being unapproved or out of date?	Check all chemicals being used on site are approved for drinking water use and that they are within their expiry dates.	5
TPR2	Could chemicals be added to the wrong storage vessel?	Check how chemical deliveries are made and ensure there are controls in place to avoid mix up of chemicals, e.g. check dosing points are unique and labelled, chemical deliveries are always accompanied by competent person, an approved chemical deliverer is employed, or that a chemical specification sheet accompanies any delivery.	4
TPR3	Could adverse weather conditions render the treatment process and/or chemicals ineffective?	Cold weather can cause dosing lines to freeze and have a direct adverse impact on the efficacy of treatment processes. Pipes should be lagged where appropriate and equipment protected from frost/freezing. During periods of cold weather treatment processes should be checked and there should be adequate contingency procedures should pipes or processes fail.	5
TPR4	Could stored chemicals or oil cause contamination due to inadequate bunding?	Chemical storage should be contained in a bunded area sufficient to hold all the chemical compound in the event of a burst container. Check there are no drain holes in the bunding and that the containment area is not liable to fill with rain water. This can be a robust solid crate or tub if large enough. Any fuels / oil should be stored well away from treatmnet chemicals.	4
TPR5	Is there a risk of chemical injection point(s) being damaged, for example by frost?	Ask for evidence as to how any dosing point is protected from extremes of weather or physical damage.	5
TPR6	Is there a risk of treatment not being re-established after any loss of power supply?	Check there is an adequate procedure in place to restart treatment processes after loss of power, including checks of individual processes to ensure they are working within specification. Some processes such as biological filters may require a period of run to waste.	5
TPR7	Is there a risk of any power back-up or alternative power supply being inadequate?	Does the site have a back up generator that is sufficient to power up all the critical treatment processes? Where an alternate power supply is not present; what contingency is in place for the provision of alternate supplies of drinking water?	5
TPR8	Is there a risk of vandalism?	Treatment processes should be in secure buildings. Check perimeter fencing, access gates and the control of the use of any security keys.	5
TPR9	Is the site/access to site liable to flooding which would result in loss or restriction of treatment process?	Gauge from surrounding topography if the site is at risk of flooding. Ask the person in control if the site has been flooded in the past. Gauge from topography and access routes if the site could become isolated during adverse weather. Ask the person in control if the site has been isolated in adverse weather conditions such as flooding or heavy snow. Lack of access during these times may mean essential water quality checks can not be made, or that chemicals stocks can not be replenished. For sites where access is difficult during periods of adverse weather there should be adequate procedures to manage stocks of treatment chemicals and communication with consumers should boil water advice be necessary.	5
TPR10	Is quality monitoring of the treatment process inadequate?	On-line monitors should be appropriate to any treatment processes present. Where filtration is practised or UV treatment is in place, turbidity monitors allow the operators to check that filtration is effective in reducing the turbidity levels, so that water presented for disinfection is below 1 NTU. In areas with naturally coloured water, transmissivity / colour / TOC monitors may be appropriate to ensure UV will be effective. If the supply is chlorinated, a chlorine monitor will ensure that the supply is maintaining the effective chlorine dose for disinfection. If appropriate manual checks are not carried out (with appropriate documentation), on-line monitors or an equivalent system should be used.	5

Questions

TPR11	Is there a risk that process issues go undetected due to lack of alarms?	This should be proportionate to the size of the supply. One with two or three domestic dwellings may not require alarms, but a supply with several properties including commercial premises should have alarms on the monitors. If they do, are the trigger levels appropriate? Turbidity on filtered water should alarm at 1NTU as above this any subsequent UV treatment will not be fully effective. UV will also be compromised if the transmissivity of the water falls below a certain level (should be documented with installation). An alarm for UV failure may be particularly appropriate as the loss of disinfection is immediate when the UV is off. If chlorine disinfection is practised, the operator should specify triggers for low or high dose which should alarm if breached to alert them to the fact that either the water is not being adequately disinfected, or that water is being supplied with high levels of chlorine, which may be unacceptable to the consumer. Check what action is taken if the alarm is triggered - is the response time appropriate and is there evidence the procedures are being adhered to? Is there an auto shutdown of the supply if disinfection fails? An auto shut down would be appropriate if no one could hear the alarm and it could not be acted on.	5
TPR12	Is there a risk that any monitors are not correctly calibrated and maintained?	Most on-line monitors require regular calibration and occasional maintenance to ensure their measurements are accurate and the person in control of the supply can be assured that the process is operating within specification. The manufacturers should specify the frequency, but as a rule calibration with standards should be at least monthly. If this is carried out through a service agreement with the installer or other contractor, then you should confirm that the number of visits is appropriate and there is evidence the service agreement is being adhered to.	3
TPR13	Is there a risk of inadequate / incorrect onsite water quality testing ?	On-site testing kits are available for many water quality parameters, and they can be useful for checking quality and verifying that processes are working. Sometimes, such tests may not be as reliable as on-line monitoring and laboratory analysed samples, especially if they are not used in strict accordance with manufacturers' instructions. Sometimes misleading results can be obtained which can give a false sense of security that treatment processes are working (or that there is an issue that doesnt exist). Any test reagents should be correct and in date.	3
TPR14	Is there an inadequate emergency plan in place should treatment fail, especially for disinfection treatment?	If water treatment processes fail, the water may not be safe to drink. It is vital that users are made aware of this as soon as possible and contingency arrangements made. Having an up to date emergency plan that all who manage and use the supply are aware of is highly recommended, and should be in place prior to any issue occurring.	3