Hunter Water Corporation A.B.N. 46 228 513 446

Standard Technical Specification for:

STS 408
WATER QUALITY ACCEPTANCE FOR WATER MAINS

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Appendices

Standard – STS 408

Water Quality Acceptance For Water Mains

1 Purpose

Hunter Water Corporation is required under its Operating Licence to maintain and fully implement a Drinking Water Quality Management System. As part of this obligation, Hunter Water must ensure appropriate preventative measures are in place to manage risks to the safety and quality of the drinking water supplied to customers. One risk to water quality is the potential contamination of pipes and water mains during such activities as construction and repair.

This Standard Technical Specification (STS 408) specifies Hunter Water Corporation's drinking water quality requirements that must be met during transport, storage, construction and commissioning of new water mains, and bringing existing water mains online after repair.

STS 408 describes requirements for the hygienic handling of water mains and includes practices for preventing microbiological contamination of pipes, fittings, tools and other equipment. This standard will need to be referred to and applied in specific, detailed work procedures to be prepared according to specific site conditions and job circumstances.

The purpose of the hygienic handling practices and water quality acceptance testing is to ensure the protection of public health and provide safe drinking water to Hunter Water's customers and the community.

1.1 Scope

STS 408 applies to all water main construction methodologies, including pipe bursting, slip lining, horizontal directional drilling (HDD) and conventional water main laying and repair work. STS 408 also applies to any activities for which contact with Hunter Water's potable water network will occur including:

- developer works to modify the network
- connection to the network
- major capital works projects to augment or upgrade the network
- reactive repairs and maintenance of the network

2 Interpretation

For the purposes of interpretation of this STS 408, except where the context requires otherwise:

- ‘Include’ means including but not limited to, and is used to provide clarification or examples of the type and nature of items intended
- 'Specification' means a specification detailing the work involved in a particular project
- ‘Standards’ means applicable industry standards including the Australian Standards (AS), Australian / New Zealand Standards (AS/NZS), American National Standards Institute (ANSI) and ISO Standards (ISO) referenced in Appendix A.
- 'Standard Technical Specification' (STS) references any of Hunter Water’s Standard Technical Specifications, as implied by the text.

Headings are for the convenience of the reader and shall not be used in the interpretation of this Standard Technical Specification.

Unless stated otherwise any expression such as "give notice", "submit", "approval", or "directed" means give notice to, submit to, approval by, or directed by the person nominated by Hunter Water.

Parts of this document nominate specific items where approval is required. Unless approval has been issued in writing (letter or email), approval has not been granted. Note that approval does not imply acceptance of responsibility by Hunter Water for compliance with this technical specification.

Failure to comply with the requirements of this STS or any referred documentation may result in rejection. Where equipment and / or manufacture is rejected, notice will be given by Hunter Water in writing. All associated rectification work shall be completed by the contractor at their cost.

2.1 Order of Precedence

All work shall meet all stated requirements in this STS in addition to project specifications or standards specified.

Any deviation from this STS shall be approved in writing on a case by case basis by Hunter Water’s Document Owner.

These standard technical specifications are available on the Hunter Water website: http://www.hunterwater.com.au

3 Roles and Responsibilities

3.1 Document Owner

The Document Owner of *STS 408 – Water Quality Acceptance for Water Mains* is Hunter Water's Group Manager Water Operations.

3.2 Responsibilities

Role	Responsibilities
Accredited Construction Contractor (ACC)	Ensure hygienic pipe handling and construction practices are used throughout water main construction works. Coordinate monitoring and reporting requirements during scouring and water quality acceptance testing. Complete Water Quality Acceptance Plan (WQAP) and Water Quality Acceptance Report (WQAR) in accordance with this document (STS 408) and to fulfil obligations under the Pollution of the Environment Act 1997 (POEO Act) for the management of water discharged to the environment.
Accredited Design Consultant (ADC)	Provide Water Quality Acceptance Plan (WQAP) and Water Quality Acceptance Report (WQAR) to HWC Water Network Operations.
Developer	Payment of fees associated with shutdown and water quality acceptance testing. In accordance with the Developer Works Deed, the Developer engages accredited suppliers (ADC & ACC) to perform construction services, including water quality acceptance testing and corrective actions for delivery of new water mains.
Hunter Water Corporation Works	
HWC Civil Maintenance Operator	Carry out water main works in accordance with this document (STS 408) and to manage discharge of water including dechlorination to fulfil obligations under the Pollution of the Environment Act 1997 (POEO Act) for the management of water discharged to the environment. Report and on site corrective actions related to any non-compliances identified. Manage corrective actions for repair and maintenance works.
HWC Civil Maintenance Supervisor	Ensure that resources and skills are available to carry out water main works in accordance with this document (STS 408) and to manage discharge of water including dechlorination to fulfil Hunter Water's legislative obligations under the Pollution of the Environment Operations Act 1997 (POEO Act) for the management of water discharged to the environment.
HWC Water Quality Representative	Perform field testing for water quality parameters including turbidity, chlorine residual, pH and odour. This is not a typical role and would only be worked out on an as required basis. The typical process would be for these tasks to be performed by NATA accredited laboratory.
HWC Water Network Operations (WNO)	Review WQAR as required to ensure compliance with this document (STS 408) and POEO Act 1997. Authorise the supply of water to customers after water quality acceptance tests have passed requirements as defined by this document (STS 408). Provide advice, direction and assessment of risk where STS-408 cannot be adhered to.
HWC Environmental Officer	Audit project specific scouring plans for adequate protection of environment when required. Carry out project inspections and audits of water release processes when required.

HWC Investment Planning	Maintain Standard Technical Specification document including updates and implementation.
HWC Internal Stakeholders	Review Standard Technical Specification to ensure it supports business requirements.
HWC Executive Management	Approve Standard Technical Specification and any major amendments.
HWC Surveillance Officer	Auditing the on-site activities of the ACC to ensure compliance with STS408

Any request for a variation to STS 408 shall be made in accordance with the change management process in the Hunter Water Asset Standards Management Plan.

3.3 Definitions

Where the following terms, abbreviations or expressions occur in STS 408, they are defined as follows:

Abbreviation	Definition
ACC	Accredited Construction Contractor for developer works
NATA Accredited	Certified under the NATA standard
ADC	Accredited Design Consultant for developer works
AIV	Actuated Inlet Valve
Backflow	A hydraulic condition, caused by a difference in pressures that causes an unauthorised transfer of water or other potentially unsafe fluid to flow into a potable water system.
Cap, Pipe Cap or End Cap	A type of pipe fitting for the end of a pipe used to protect the pipe ends and keep out dirt and other foreign materials or objects.
Chlorine, free	Also called free chlorine, the amount of chlorine available as dissolved gas (Cl2), hypochlorous acid (HOCl), and hypochlorite (OCl^-) that is not combined with ammonia (NH3) or other compounds in water that is available for disinfection.
Chlorine, total	A combination of free chlorine, combined chlorine, and organochlorine species.
Colorimeter	Device that measures the absorbance of particular wavelengths of light by a specific solution.
Contact Time	The time in which a chemical or constituent is in contact with another reacting chemical or constituent.
Contaminant	Any undesirable physical, chemical, biological, or radiological substance or matter in water.
Dechlorination	The process of removing chlorine (HOCl, OCl^-) from solution. Dechlorination is typically achieved through chemical addition of a reducing agent.
Depressurisation	Events or conditions of negative or low pressure in the potable water system that can potentially allow untreated water to flow into a water main through faulty joints, small leaks or breaks. Depressurisation also has potential to collapse the pipe if inadequately protected from negative pressure.

Disinfectant	An agent that destroys or inactivates harmful microorganisms. Sodium Hypochlorite, Calcium Hypochlorite solution, Ozone, or other approved Chemical.
Disinfection	The process of destroying or inactivating pathogenic organisms (bacteria, viruses, fungi, and protozoa) by either chemical or physical means. A minimum contact time is normally specified along with a disinfectant residual to effective disinfection.
E.coli	Escherichia coli, The group of bacteria used as warm-blooded animal faecal pollution indicator organisms of drinking water quality.
FCR	Free Chlorine Residual – see Chlorine, free
Flushing	The act of running water through a distribution system or water main to remove debris, discoloured water, or chemical solutions to clean the line or system.
Hunter Water, HWC	Hunter Water Corporation
Hydrant	A device connected to a water main and provided with necessary valves and outlets so that a hose may be attached for discharging water at a high rate of flow for the purpose of extinguishing fires, washing down streets, or flushing out the water main.
Hygienic	The improvement of environmental conditions favourable to public health protection and disease prevention.
Hypo solution	The abbreviation for sodium hypochlorite solution which is the most common disinfectant in water treatment. A 1% hypo solution with a minimum chlorine concentration of 1000 mg/L is applied for disinfection of all tools and materials.
Main Breaks, Water Main Break, Pipe Rupture or Break in a Pipeline	In a water pipe, localized pipe failure which can be associated with a sudden pressure surge, hydrostatic pressure, poor quality pipe, structural failure, corrosion, fatigue, external forces, loss of bedding, joint separation, freezing, temperature change or other causes. This can include the main and fittings as well as couplings and joints along the main.
Microbial contamination	The presence of microbiological contaminants of any sort
Microbiological Analysis/Bacteriological Testing	The use of various media, techniques and equipment to determine the presence/absence, density or numbers of microorganisms/bacteria in a sample.
MPN	Most Probable Number
NATA	National Association of Testing Authorities
NTU	Nephelometric Turbidity Units (standard unit for measuring turbidity)
ORP	Oxidation-Reduction Potential
Potable water	Water that is safe to drink
PSV	Pressure Sustaining Valve
Risk assessment	The overall process of risk identification, risk analysis and risk evaluation.
Sanitary	Hygienic, clean, sterile

Swabbing	Water main swabbing is the forceful introduction of a cleaning swab/tool through a pipe to physically remove debris such as stones and sand, typically prior to commissioning a water main. Swabbing is sometimes called 'pigging"
T&V	Tee and Valves
TC	Total Coliforms, which are not a reliable indicator of faecal contamination, however their presence may suggest regrowth or possible ingress of foreign material (TC count includes E.coli)
Trench	An excavation made for installing pipes, as well as for other purposes.
Trench Water	When construction or repair of pipes occurs in open trenches or excavations, water from different sources, e.g. groundwater, rainfall, surface water, stormwater or agricultural water runoff, sewer, water main breaks, may enter the trench. This water inside the trench is referred to as "trench water".
Turbidity	A condition in water caused by the presence of suspended matter including dirt, clay, dissolved gasses etc., resulting in the scattering and absorbance of light. It is an analytical quantity, usually reported in Nephelometric Turbidity Units (NTU).
T&V	Tee and Valve
WNO	Water Network Operations – a division of Hunter Water responsible for safe operation of the potable water network
WQAP	Water Quality Acceptance Plan – document prepared by the ADC and submitted as part of the Shutdown Plan Request outlining the risk controls, water quality practices and flushing procedures that will be implemented to manage water quality throughout construction works to satisfy the requirements detailed in this document (STS 408). The WQAP must include water quality risk controls and a flushing plan with associated flushing legs identified. An example WQAP is provided in the appendices.
WQAR	Water Quality Acceptance Report – completed by ACC after performing the steps required in the WQAP. The WQAR details the results of water quality testing to confirm the safe supply of drinking water to customers after construction works. The WQAR must be submitted with the flushing plan from the WQAP attached for assessment of results.

4 Preventative measures

Hunter Water requires all new water mains to be transported, stored and constructed in accordance with the mandatory actions outlined in this standard.

The Water Supply Code of Australia Hunter Water Edition 2017 (particularly sections 15.1.1 to 15.1.4 and section 18) must also be adhered to.

All contractors are to develop and implement appropriate procedures and Inspection and Test Plans (ITPs) to cover the risks identified in this standard.

Only products that comply with Water Services Association of Australia (WSAA) or Hunter Water Approved Product Specifications shall be used in the construction of drinking and non-drinking water mains.

Potential contamination of reticulated drinking water poses a risk to public health. Inadequate implementation of controls during water main repair and construction mains is a potential cause of contamination. The risk of contamination can be minimised by thoroughly considering and adhering to this STS before, during and after the installation of new mains, or when undertaking repair work.

4.1 Personal, Tools and Equipment Hygiene

All parties, including HWC operators and contractors, developers and their accredited suppliers involved in water main installation and repairs, shall maintain a high standard of personal hygiene and actively prevent any contamination during water main construction or repair activities.

Where practical this entails separation of sewer and water tools, equipment, boots and clothing.

Figure 1: Colour coded boots for water and sewer jobs

In the event that separate equipment is unavailable, the below good practice is to be followed:

- Disposable gloves should be used for sewer jobs and/or hands thoroughly washed following job completion
- Either disposable overalls should be worn on jobs that it is likely to come into contact with waste water, or overalls should be changed on job completion if contact with wastewater occurs.
- Tools, machinery, equipment and boots must be fully ***cleaned*** and then ***disinfected*** after finishing work on sewer network assets. Disinfection includes spraying with a 1% hypochlorite solution or approved alternative.
- Water pump station equipment, reservoir instrumentation and component replacement such as AIVs, PSVs, stop valves, and flow meters must be fully ***cleaned*** and then ***disinfected*** using the disinfectant spray solution prior to installation.

Figure 2: Tools and backhoe buckets are disinfected after sewer jobs

Failure of hygienic work practices can result in contamination of water supplied to consumers. Regular field audits must be carried out to verify adherence to hygienic work practices. HWC officers will possess appropriate authority to suspend works upon identification of unacceptable hygiene practices.

4.2 Hygienic Storage in Vehicles and Stores

Section 12.3 (Transportation, Handling and Storage of Products and Materials) of the Water Supply Code of Australia (WSA 03-2011) Hunter Water Edition 2017 requires the inside of all items to be kept clean and dry during storage via the use of caps, plugs or flanges. The World Health Organisation (WHO) code of practice notes that capping/sealing of pipes during construction/storage is critical to minimise entry of debris, vermin, soil, chemicals, groundwater or rainwater entering a pipe.

A high standard of cleanliness must be maintained in material stores and storage locations as well as the interior and exterior of all vehicles used for water reticulation works. The following actions are mandatory:

1. All *pipes* must be capped/sealed under hygienic conditions either from the manufacturer's/ suppliers premises or upon receipt. All *pipes* are to be visually inspected to the extent possible for contaminants prior to capping (small diameter pipe may only allow for inspection at the ends). The *pipe internals* are to be cleaned if any foreign materials are identified.

Figure 3: Pipes stored with protective caps

2. Items such as meters, gaskets, seals and materials like jointing lubricants delivered for construction shall be stored and handled so as to minimise contamination by foreign materials.
3. Water supply and wastewater equipment must be stored separately and/or adequately segregated to prevent cross contamination occurring during storage and handling. If this is not possible disinfection must occur prior to use of the tools or equipment.
4. Vehicles must be equipped with disinfectant (e.g. 1% sodium hypochlorite solution or sachets of calcium hypochlorite), spray bottles and sanitary wipes, and antibacterial liquid hand sanitiser when working on site.

4.3 Hygienic Transport and Construction Activities

The following actions are mandatory for all water main construction and repair activities:

4.3.1 Before Commencement of Site Works

1. All *pipes* are to be transported to site with protective end caps and are not to be uncovered or unwrapped until immediately before use.

   Note: In case the *pipes* were not capped and inspected for foreign material for any reason prior to storing, they are to be cleaned internally, then sprayed with 1% hypo solution or approved equivalent with a minimum contact time of ten (10) minutes (unless otherwise mentioned in the disinfectant instruction), and capped/sealed until use.

Figure 4 Pipes are to be cleaned internally if not capped

2. Without exception all main *taps, fittings, necessary tools and items* that come into contact with the treated water shall be sprayed with 1% hypochlorite solution or other approved disinfectants just prior to installation.

Figure 5: Pipe saw disinfected before installation

3. *Tools*, *fittings* and *pipe sections* are to be placed on a clean, intermediate barrier off the ground to prevent contamination from the environment.

Figure 6: Tools, fittings and pipe sections placed on a drop sheet

4.3.2 During and After the Site Works

1. During pipe laying operations, in order to prevent contamination, the constructor shall supply and use caps or equivalent to seal all open ends of *pipes* and *fittings* to prevent foreign matter including soil, water and animals from entering pipe. This will be required when construction activities have ceased – such as a break for lunch and at the end of each day.
2. When recommencing works any water is to be removed from the trench prior to the removal of caps/plug or seal.
3. During repairs or construction the pipe area to be cut should be ***cleaned*** to remove any foreign material from the outside of the pipe. The area to be cut should also be ***disinfected***.

Figure 7: Pipes remain capped until final installation

4. Debris must be cleared from hole-saws after each drilling. Speed bores are not to be used.

Figure 8: Speed bores are not to be used

5. A minimum clearance gap of 100 mm is to be maintained between the trench bottom and bottom of open pipes. The gap shall only be backfilled once the pipe is connected.

Figure 9: Minimum clearance gap – 100mm

6. All tools should be cleaned after work activities.
7. All machinery & equipment coming into contact with contaminants are to be *cleaned*.

8. All excavation equipment shall be *pressure washed* between water and wastewater jobs.

Figure 10: Excavation equipment are to be pressure washed

9. In the event of contamination, all internal surfaces are to be scoured or scraped clean, followed by disinfection with 1% hypochlorite solution or approved alternative.
10. Where the tapping of water main is carried out under pressure, the drilling equipment is required to be sprayed with 1% hypochlorite solution or approved alternative and the exposed section of the pipeline cleaned as outlined above.

It is the responsibility of the constructor/maintainer to ensure that construction of new mains or repair activities are undertaken in accordance with this procedure.

5 Water Quality Acceptance Guideline

The level of water quality acceptance testing required is dependent on the associated risk of the activity undertaken, and is summarised in Table 1 for all new construction works.

Table 1: Mandatory Water Quality Acceptance Testing – New Works

Risk Level	Activity	Flush	Odour/ Visual	Field Test – Free Chlorine, Turbidity	Disinfect	Microbiology Test - E Coli, Total Coliforms
HIGH RISK	**New Works**	✔	✔	✔	✔	✔

Mandatory water quality acceptance testing for main repairs and T&V Installation could also be found in Table 2.

Table 2 Mandatory Water Quality Acceptance Testing – HWC Repairs and T&V Installation

Risk Level[1]	Flush	Odour/ Visual	Field Test – Free Chlorine, Turbidity	Disinfect	Microbiology Test - E Coli, Total Coliforms
HIGH RISK High risk/ confirmed contamination identified.	✔	✔	✔	✔	✔
MEDIUM RISK Medium risk/ potential risk of contamination identified.	✔	✔	✔		
LOW RISK Low risk of contamination identified.	✔ [2]	✔			
NEGLIGIBLE RISK Works Performed Under Pressure					

[1] Risk levels are further defined in WI 001 Working on Potable Water Mains and Fittings
[2] Until air is removed and water appears clear

5.1 Microbiological Contamination Causes

There are several pathways by which microbiological contamination of water mains can occur during installation and repair activities. The most common scenarios which might make microbiology testing and disinfection necessary are:

- Low or negative pressure changes that draw in contamination through faulty seals or broken pipe. The contamination risk level is higher when sewer or environmental water (wetland/creek) entering trench.
- Not following preventative measures stated in section 4, which may result in:
    - Accumulation of soil, sediment, and other foreign material on pipe interior and appurtenance surfaces during storage and installation
    - Unsanitary human contact with pipes and fittings,
    - Animals and insects that enter pipe during storage or installation,
    - Contact with or entry of non-potable water during storage and installation activities. Examples of non-potable water include: trench water, stormwater, sewage, and other sources of environmental water (e.g. agricultural run-off).
- Not achieving sufficient flushing velocity (1 m/s)
- Contaminated land adjacent to the new/repaired water main.

Therefore, in addition to all new mains, if there is reason to believe that the repaired asset has been exposed to microbiological contamination, or when the main has been isolated for a long period, ***disinfection*** is necessary.

6 Flushing

6.1 Flushing of Water Mains

All new water main constructions and repairs that require a shutdown are to be flushed while offline to achieve a pipe velocity of at least 1 metre per second (1 m/s) to remove sand, debris and mitigate microbiological contamination in the pipe. Table 3 can be used as a guide for flushing flow rates and times to achieve this pipe velocity/flow rate and flushing volume. Flushing must be performed until the water quality is compliant with Table6 for a minimum of one and a half pipe volumes.

As Table 3 demonstrates, for water mains of large diameter (typically ≥DN 200) it is not easy to reach a velocity of 1 m/s and it may be necessary to install a number of standpipes on hydrants to achieve the desired rate. Where 1 m/s cannot be achieved, disinfection may be required. Disinfection is required on all new water mains regardless of flushing performed.

An appropriate means must be used to confirm flow rates.

Where hygienic practices have failed in mains larger than DN750 and contamination is present, these can be manually cleaned in stages by sweeping, hosing and sealing after completion of internal works and prior to disinfection.

Table 3: Flushing Flow Rates and Times

Pipe Diameter (mm)	Flowrate Needed (L/sec) for Velocity 1 m/s	Approximate Number of Standpipes Required	One and a Half Pipe Volumes Approximate Flushing Times for Pipe Lengths of constructed works at 1m/s (minutes)		
			100m	200m	300m
100	8	1	2.5	5	7.5
150	18	1- 2	2.5	5	7.5
200	31	2	2.5	5	7.5
250	50	Flushing with standpipes not practical to achieve required velocity	2.5	5	7.5
300	71		2.5	5	7.5

7 Disinfection

New water mains as well as high risk water main repairs are required to be disinfected before being put into service to protect public health. The two types of disinfection acceptable to HWC are Superchlorination and Ozonation. Any other disinfectants require prior approval from HWC.

A pressure test must be completed and passed prior to disinfection and sampling. The water main must not be depressurised until immediately before connection. At the time of connection, fittings and pipe openings are to be disinfected and mains flushed prior to bringing online.

Sampling should be in accordance with the following section to ensure adequate coverage (multiple samples required for long runs or distinct sections of branching mains).

7.1 Superchlorination

Superchlorination, also known as hyper-chlorination, temporarily increases the Free Chlorine Residual (FCR) in a water distribution system. A high FCR is effective against most bacteria (including Legionella) and can be used in hot, warm and cold water distribution systems, although in hot water systems chlorine degrades rapidly. Superchlorination requires that the water treated has low turbidity (<2 NTU) to ensure pathogens are not shielded by solid material.

Chlorine could be used as the disinfectant in the form of ***sodium hypochlorite solution***. The disinfectant must stay in the new water main for a minimum contact time of 60 minutes as per Table 44 depending on its concentration to achieve a C.t of 300 mg.min/L. **The concentration in Table 4 is the concentration at the end of the contact time** – in practice this will require an initial dose/residual that is higher at allow for some chlorine loss. In practice longer contact times will help ensure that the disinfection is effective. This assumes that all hygienic practices have been applied and the main is cleaned before superchlorination.

Table 4: Free Chlorine Residual and Minimum Contact Times

Free Chlorine Residual (C) (mg/L)	Minimum Contact Time (t) (min)	C.t (mg.min/L)
5.0 or greater *	60	300
4.0	85	300
3.0	100	300
2.5	120	300
2.0	150	300

Professional analytical equipment should be used to measure the chlorine residual, such as a digital colorimeter or spectrophotometer (paper strip tests cannot be used for chlorine residual). FCR levels should be recorded in the Water Quality Acceptance Report (WQAR) and include details of where, when, concentration of chlorine, by whom and any additional comments.

The disinfected new water main shall be isolated from the existing water supply system to prevent backflow during the injection period e.g. double isolation, zero pressure tests, blank flange and physical barriers should be considered.

Table 5 summarises the required **sampling and analysis**.

Table 5: Physical/Chemical Testing for Superchlorination

When	What	Why	Who
During flushing before adding disinfectant	Free Chlorine , Turbidity and pH* / Table6	This is to ensure the main is clean and the disinfectant is effective and not consumed by contaminants. **This is recorded on the WQAR under Field Test**	NATA Lab
While adding disinfectant	Free Chlorine and Turbidity / Table6	Ensure the target concentration of the disinfectant is met throughout all sections of the pipework. **This is recorded on the WQAR under Superchlorination**	NATA Lab
After disinfection contact time	Free Chlorine and Turbidity / Table6	Ensure main has received adequate disinfection, is returned to potable water quality (in particular noting chlorine residual <5 mg/L) and ensure discharge is compliant with the POEO Act.	NATA Lab
If chlorine residual is >5 mg/L after contact time, water must be discharged, dechlorinated and flushed with potable quality water before proceeding.			
After disinfection with potable quality water in main	Free Chlorine and Turbidity and **Microbiology** tests / Table6 and Table 7	Ensure the water is safe (microbiologically and chemically). **This is recorded on the WQAR under Disinfection Confirmation (pH/FCR) and Microbiology Test (E.coli / TC)**	NATA Lab
Immediately prior to the water main being brought online.	Free Chlorine, Turbidity and pH *	Ensure the water is safe.	Hunter Water or NATA Lab

* pH test only required for cement mortar lined mains.

7.2 Water Discharge & De-chlorination

Following the completion of superchlorination (refer to Table 4 and Table), the chlorinated water shall be dechlorinated and tested prior to discharge into the environment in accordance with POEO Act, to ensure that the chlorine level has been reduced appropriately and other parameters are compliant.

Super-chlorinated water main shall be flushed with potable water for a minimum of one and a half pipe volumes and until FCR and Turbidity satisfies the requirements outlined in Table6 (ideally as part of the charge up and final flush to minimise water loss).

7.3 Ozonation

Ozonation is acceptable to Hunter Water as a means to disinfect water mains. Ozonation, which is an alternative to superchlorination, provides a high level of confidence in regards to bacterial inactivation while being able to break down into harmless oxygen as the job is being completed. This reduces the risk in relation to chemicals coming into contact with operators (in terms of health and safety) and eliminates the risk of causing environmental harm. The following criteria are required for each section of main that is disinfected using ozonation before the main can be regarded as effectively disinfected:

- Turbidity at the discharge point <= 2 NTU for two consecutive minutes
- ORP >= 750mV for a minimum time of 2 consecutive minutes.

These are standard acceptance criteria for ozonation disinfection units. Where ozonation is chosen as the preferred method, ozonation of water mains must be carried out by a HWC approved contractor/service provider.

8 Water Quality Testing Parameters

8.1 Field Testing

Testing results of water quality parameters are not always reliable. Parameters such as pH, Free Chlorine, Turbidity and Odour can become unstable in a very short time. These parameters are better suited for field testing rather than waiting for lab time. Field test are carried out on site and reliable results can only be undertaken by NATA accredited testers. For internal jobs a HWC Water Quality Representative may perform this task however this is not a routine option and should not be relied upon.

New water mains as well as medium & high risk water main repairs require field testing to pass water quality acceptance. The required field test parameters are outlined in Table6.

Table 6: Field Testing Parameters

Parameter	Acceptance Criteria	Typical Analysis Time
Free Chlorine	0.2 – 2.0 mg/L	Field test, 5 mins
Turbidity	<2 NTU	Field test, 5 mins
Odour	non-objectionable	Field test, 2 mins
pH	6.5 – 8.5	Field test, 5 mins

Should the water main flushing activities not be able to meet these parameters, then comparison with the local feed water can be considered as a base line to pass results.

8.2 Microbiology Testing

New water mains as well as high risk water main repairs require microbiology testing to pass water quality acceptance. The required microbiology test parameters are outlined in Table 7.

Microbiology sampling and testing is to be carried out by a NATA accredited laboratory. *E. coli* and Total Coliform results have a typical analysis time of 24hrs, which require a HOLD POINT before water mains can be approved to bring on line.

Where there is potential risk of contamination (assessed as Medium risk in Table 1), microbiology testing is conducted only for quality control purposes and the main could be brought online after field tests.

Table 7: Microbiology Testing Criteria

Parameter	Acceptance Criteria	Typical Analysis Time
E.coli	<1 MPN/100 mL	24 hrs
Total Coliforms	<1 MPN/100 mL	24 hrs

Where test results do not comply, further mains cleaning work shall be undertaken before re-sampling and retesting until all test results comply.

It should be noted that the typical analysis times listed in Table6 and Table 7 are a guide only.

8.3 Water Quality Sampling

Sampling is the action or process of taking samples of something for analysis. There are requirements for valid sampling, including that sampling must be representative of the water contained throughout the main, and microbiology samples must be collected by a NATA accredited laboratory. Sampling should also occur at a minimum of 3 sample locations along the pipe length incorporating both ends and midsection if possible. All dead ends in the section of pipe must also be included in sampling. For pipe lengths greater than 500m sampling must occur approximately every 500m along the pipe length as well as at both ends.

For special cases where sampling along the pipe length is not able to be achieved, samples shall be collected from the end of the pipe as it is flushed. A number of samples proportional to the pipe length are to be collected at appropriate time intervals (calculated from flow rate and volume of pipe) to ensure one sample for every 500m of pipe.

If any failure of the Microbiology Testing Criteria occurs, flushing is to commence immediately. Sampling shall be continued until two consecutive 'Non Detect' samples are reported from the laboratory. Should water sampling continue to reveal positive results, the water service shall be disinfected and re-flushed.

9 Authorisation to Connect to Hunter Waters Operating Network

9.1 Required Documentation - WQAR

The party constructing the water main is responsible for carrying out hygienic pre-construction and construction practices as well as the disinfection and water quality tests* for all new water mains. The evidence of this must be detailed in the Water Quality Acceptance Report (WQAR)** attached in Appendix C, and provided to shutdownrequests@hunterwater.com.au, prior to a date being scheduled for connection.

The WQAR will be assessed by HWC Water Network Operations team and providing the detail of the report complies with this document STS-408, the new water mains will be approved for connection and a connection date can be scheduled.

In the case that the WQAR does not satisfy STS-408, the Water Network Operations team will request further work to be completed before a shutdown can be provided.

The connection to the network must be completed within 6 weeks from the date of disinfection.

** Where microbiology tests are required, the test reports from a NATA accredited lab must be attached to the WQAR.*

***HWC Civil Operators may provide details of water quality management within AOMS comments in place of providing a WQAR.*

9.2 Completing the Water Quality Acceptance Report (WQAR)

The Water Quality Acceptance Report (WQAR) attached to this document in Appendix B, is a template form of what HWC requires as evidence that work has been carried out to satisfy the requirements of this document STS 408.

The following points are provided to assist in the completion of the WQAR and ensure works are approved for connection:

1. Provide a plan view of the works with the disinfected main highlighted and flushing points identified.
2. Where multiple legs of new water main are being commissioned, provide a plan view of works with each leg numbered on the plan to associate with a test result line on the WQAR.
3. Photographic evidence of hygienic pre-construction and construction practices is preferable.

10 Critical Customers

Critical customers are likely to be more vulnerable to any possible water contamination events. As such critical customers will be identified and their service connections isolated and provided alternate water supply during water main construction or renewal activities.

At the completion of water main construction or renewal, the service connections will be put back into service, flushed and water quality testing completed to confirm water quality targets have been met before returning them to normal supply. Critical customers include; Hospitals, Day Surgery Centres, Age Care Facilitates, Nursing Homes, Pre-school Centres, Schools and Home Dialysis/Life Support Customers.

11 Related Documents

In addition to STS 408, all work must comply with relevant current Standards and Regulations inclusive of all amendments. In particular:

- Workplace Health and Safety Regulations
- WorkCover NSW Codes of Practice
- Safe Work Australia Model Codes of Practice
- Hunter Water's Design Manuals
- Hunter Water's Standard Technical Specifications
- Hunter Water's Standard Drawings

12 Document Control

Document Owner: Group Manager Water Operations

Version	Date	Author	Details of Change	Approval Date	Approved By	Next Scheduled Review
1.0	March 2018	D. Kingsland	Initial Release	June 2018	D. Cleary	March 2020
2.0	December 2019	C. Hancock	Addition of Pipe Laying requirements and Preventative measures; Flushing, Disinfection, Critical customers. Addition of template WQAP & WQAR.	December 2019	C. Thomson	December 2021

Appendix A: Standards

For clarity, where a standard has several parts and/or amendments and/or supplements, the reference number is for the leading part of the standard. The standards listed below are deemed relevant to this STS.

This is not an exhaustive list.

Reference Number	Title
WSA 03	Water Supply Code of Australia Hunter Water Edition 2017
ISBN 978-1-60573-211-4	Good Practices for Preventing Microbial Contamination of Water Mains. Field Pocket Guide. 2014 Update
ADWG Version 3.4 Updated October 2017	National Water Quality Management Strategy. Australian Drinking Water Guidelines 6 2011. Australian Government, National Health and Medical Research Council
HW2012-738/4/16.001	Hunter Water Procedure EP0112 – Dechlorination of discharge water

Appendix B: Water Quality Acceptance Plan (WQAP) – Template

WATER QUALITY ACCEPTANCE PLAN (WQAP)		
This report is to be completed by the ACC or HWC field operator prior to bringing new mains online.		
JOB DETAILS		
JOB DESCRIPTION	**LOCATION (Street, Suburb)**	**HWC REF # (TRIM/AOMS)**

Water Quality Risk Controls				
Pre-construction Risks	**YES**	**NO**	**N/A**	**Risk Control**
Personal, Tools and Equipment (STS sect 5.1)				Hands washed prior to construction work.
				Tools and boots separate to sewer use, if not, disinfected.
Storage in Vehicles and Stores (STS sect 5.2)				Pipes capped or sealed.
				Pipes visually inspected for contaminants.
				Items and materials stored in hygienic location.
				Water and wastewater equipment stored separately.
				Vehicles equipped with disinfectant (e.g. 1% hypochlorite solution or approved alternative).
Transportation (STS sect 5.3)				Pipes transported to site with protective caps/plugs.
				Pipes capped or sealed when arrived on site.
				Pipes kept sealed until immediately before use.
Construction / Repair Risks	**YES**	**NO**	**N/A**	**Risk Control**
Construction / Repair (STS sect 5.3)				Fittings and tools all sprayed with 1% hypochlorite solution or approved alternative.
				Tools, fittings and pipe ends placed on a clean barrier/ protective layer covering the ground
				Any trench water removed prior to removal of pipe seals.
				During repairs pipe area to be cut, cleaned with wipe.
				Debris cleaned from hole saws.
				100mm minimum clearance between open pipe and trench bottom.
				Backhoe buckets pressure washed.
				Vac truck hose vacuum and fittings cleaned.
				In the event of contamination, all internal surfaces scoured and disinfected with 1% hypochlorite solution or approved alternative.
Post Construction / Repair Risk	**YES**	**NO**	**N/A**	**Risk Control**
Water Quality Verification (STS sect 6) *Detail results on next page*				Flushing
				Odour / Visual
				Field Test – Turbidity, Free Chlorine, pH
				Disinfection
				Microbiology Test – Total Coliforms, E coli
Disinfection (STS sect 6.3)				Super Chlorination
				Ozone

*Attach water main plans showing injection points (tanker or existing hydrant), discharge points (sample and flushing), flushing legs etc. to clearly demonstrate how the new water main is flushed and disinfected

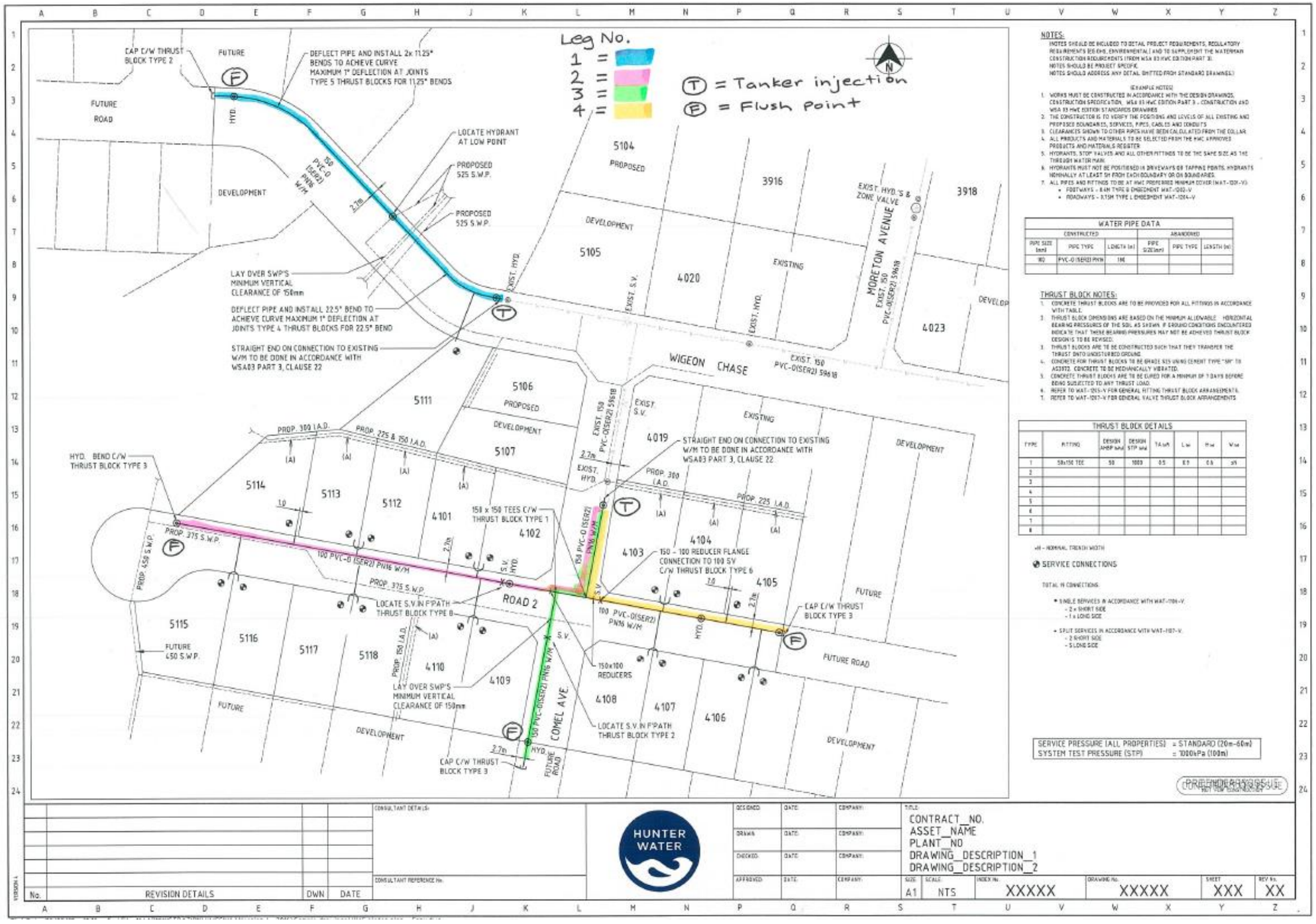
Appendix C: Water Quality Acceptance Plan (WQAP) – Example

WATER QUALITY ACCEPTANCE PLAN (WQAP)		
This report is to be completed by the ACC or HWC field operator prior to bringing new or repaired mains online.		
JOB DETAILS		
JOB DESCRIPTION	**LOCATION (Street, Suburb)**	**HWC REF # (TRIM/AOMS)**
New water main Excellence Estate	Hancock Ave, Colinsville	HWC2019-1234

Water Quality Risk Controls				
Pre-construction Risks	**YES**	**NO**	**N/A**	**Risk Control**
Personal, Tools and Equipment (STS sect 5.1)	✓			Hands washed prior to construction work.
	✓			Tools and boots separate to sewer use, if not, disinfected.
Storage in Vehicles and Stores (STS sect 5.2)	✓			Pipes capped or sealed.
	✓			Pipes visually inspected for contaminants.
	✓			Items and materials stored in hygienic location.
			✓	Water and wastewater equipment stored separately.
	✓			Vehicles equipped with disinfectant (e.g. 1% hypochlorite solution or approved alternative).
Transportation (STS sect 5.3)		✓		Pipes transported to site with protective caps/plugs.
	✓			Pipes capped or sealed when arrived on site.
	✓			Pipes kept sealed until immediately before use.
Construction / Repair Risks	**YES**	**NO**	**N/A**	**Risk Control**
Construction / Repair (STS sect 5.3)	✓			Fittings and tools all sprayed with 1% hypochlorite solution or approved alternative.
	✓			Tools, fittings and pipe sections placed on a clean barrier/ protective layer covering the ground
	✓			Any trench water removed prior to removal of pipe seals.
	✓			During repairs pipe area to be cut, cleaned with wipe.
	✓			Debris cleaned from hole saws.
	✓			200mm minimum clearance between open pipe and trench bottom
	✓			Backhoe buckets pressure washed.
	✓			Vac truck hose vacuum and fittings cleaned.
	✓			In the event of contamination, all internal surfaces scoured and disinfected with 1% hypochlorite solution or approved alternative.
Post Construction / Repair Risks	**YES**	**NO**	**N/A**	**Risk Control**
Water Quality Verification (STS sect 6) *Detail results on next page*	✓			Flushing
	✓			Odour / Visual
	✓			Field Test – Turbidity, Free Chlorine, pH
	✓			Disinfection
	✓			Microbiology Test – Total Coliforms, E coli
Disinfection (STS sect 6.3)	✓			Super Chlorination
		✓		Ozone

*Attach water main plans showing injection points (tanker or existing hydrant), discharge points (sample and flushing), flushing legs etc. to clearly demonstrate how the new water main is flushed and disinfected

WATER QUALITY ACCEPATANCE PLAN – WATER MAIN PLAN/FLUSHING PLAN EXAMPLE



Appendix D: Water Quality Acceptance Report (WQAR) – Template/Example

DISINFECTION & WATER QUALITY TEST RESULTS																	
OCCURENCE			FLUSHING				FIELD TEST			DISINFECTION			DISINFECTION CONFIRMATION		MICROBIOLOGY TEST		PASS (Y/N)
										Super-Chlorination		Ozone					
LEG (No.)	Date	Time	Size (DN)	Length (m)	HYDs (No. of)	Duration (mins)	Free Chlorine (0.2 – 2 mg/L)	Turbidity (<2 NTU)	pH (6.5 - 8.5)	Free Chlorine at each HYD (mg/L)	Contact Time (min)	ORP (mV)	Turbidity (<2 NTU)	Free Chlorine (mg/L)	E. Coli (<1 MPN/ 100mL)	T.C. (<1 MPN/ 100mL)	

* Attach copies of all analytical reports

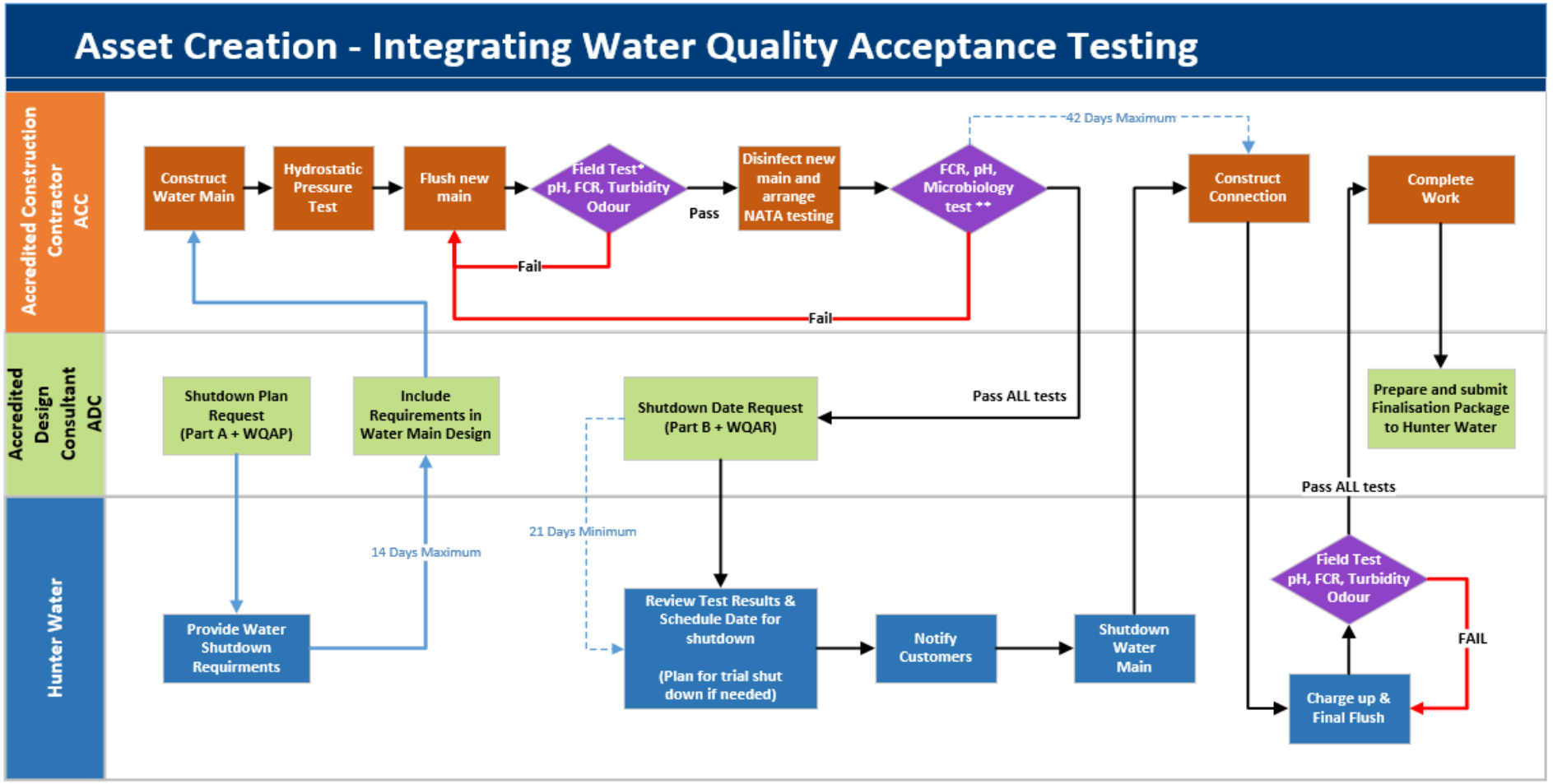
AUTHORITY OF WATER QUALITY REPORT			
☐ The details of report represent accurate pict of water quality management.	REPORT COMPLETED BY: COMPANY:	SIGN:	DATE:
☐ The water quality tests have been complete a NATA accredited or HWC qualified tester.	TESTING PERSON: COMPANY:	SIGN:	DATE:

DISINFECTION & WATER QUALITY TEST RESULTS																
OCCURENCE			FLUSHING				FIELD TEST			DISINFECTION			DISINFECTION CONFIRMATION		MICROBIOLOGY TEST		PASS (Y/N)
										Super-Chlorination		Ozone					
LEG (No.)	Date	Time	Size (DN)	Length (m)	HYDs (No. of)	Duration (mins)	Free Chlorine (0.2 – 2 mg/L)	Turbidity (<2 NTU)	pH (6.5 - 8.5)	Free Chlorine at each HYD (mg/L)	Contact Time (min)	ORP (mV)	Turbidity (<2 NTU)	Free Chlorine (mg/L)	E. Coli (<1 MPN/ 100mL)	T.C. (<1 MPN/ 100mL)	
1	20/9/19	8:00	150	100	2	3	1.8	1.5	7	5.7 5.5	60	-	1.3	5.3	<1	<1	Y
2	20/9/19	9:00	100	120	1	5.5	1.7	1.1	7.5	5.6	60	-	1.0	5.2	<1	<1	Y
3	20/9/19	10:00	150	50	1	2	1.5	1.4	7	5.2 4.8	85	-	1.3	4.5	<1	<1	Y
4	20/9/19	11:00	100	50	1	2	1.8	1.6	7	5.5	60	-	1.2	5.1	<1	<1	Y

* Attach copies of all analytical reports

AUTHORITY OF WATER QUALITY REPORT			
☐ The details of report represent accurate pict of water quality management.	REPORT COMPLETED BY: COMPANY:	SIGN:	DATE:
☐ The water quality tests have been complete a NATA accredited or HWC qualified tester.	TESTING PERSON: COMPANY:	SIGN:	DATE:

Appendix E: Water Quality Acceptance Testing – Process Flow Diagram



Process Notes:

The Developer asset creation process requires that the Developer Works Deed is executed and submitted to Hunter Water and only after this is done, can the design, construction and commissioning of new assets take place.

* Field test to achieve criteria in "Field Testing Parameters" table so that disinfection can be effective

** Microbiology test is to be conducted after disinfection on water that complies with ADWG, in particular noting that the free chlorine residual must be less than 5 mg/L to ensure that it is representative of water supplied to customers. Microbiology test is not needed in case of the use of Ozonation for disinfection.

Appendix F: Summary of Actions

No	Steps	Actions
1	Condition and storage of water pipes, fittings, valves and materials	• Inspect all new pipe, fittings, valves and materials before accepting delivery • Inspect, clean (if required) and cap all pipes. • Inspect and clean (if required) all valves and fittings. • Use and maintain caps, plugs, plastic wrapping (if appropriate) or other protective devices until installation • Securely store all pipe, fittings, valves and materials to prevent contamination
2	Construction	• All pipes shall be capped or sealed with plastic wrapping during storage and shall only be removed when pipes are being installed into the trench onsite. • Jointing lubricants shall be stored in sealed containers and kept in a clean condition at all times. • Each pipe and fitting is to be visually inspected for contaminants prior to laying. • All fittings and valves to be disinfected prior to installation. • Any contaminant materials are to be removed and pipe/fittings thoroughly wiped clean and disinfected prior to installation. • Following unwrapping and/or disinfection all pipe/fittings must not be placed directly upon the ground prior to installation in the trench. • Use suitable clean plastic matting or sheeting or support cradles to temporarily store pipe/fittings prior to installation in the trench. • Valves will typically require a hydrant connection within 1 m on both sides to facilitate flushing and disinfection requirements unless other suitable arrangement can be made

No	Steps	Actions
3	Temporary Capping During Construction	• During and after pipe laying operations in order to prevent contamination, the installer/contractor shall supply and use exclusion caps, plugs or blank flanges of approved design to seal all open ends of pipes at all times. • At the end of each day pipes and fittings in excavations are to be sealed to prevent water or contaminants entering the pipe. The trench shall be backfilled or suitable trench barrier covers placed over any open excavations and fencing is to be provided to secure any open excavations. • When recommencing installation works any trench water is to be removed from the trench prior to the removal of caps/plugs or seals. • External water sources should be prevented from entering the pipe. Any water which has entered into the new pipe work should be drained and removed from the pipework where practical.
4	Filling of New Water Mains	• Filling of new water mains must be completed to ensure that no contamination can enter into the existing water supply system or impact upon water consumers. • Initial connection of new water mains to existing water mains for the purposes of filling, testing and/or flushing must be completed using standpipes connected by a hose with suitable backflow prevention devices to protect the existing water main from contamination.
5	Flushing	• All water mains shall be flushed at a scour flow velocity > 1 metre per second (1 m/s) for one and a half pipe volumes and until the water quality is compliant with Table 6. • Hydrant boxes, mushroom tops and lugs shall be cleaned and be free of water or debris. • Disinfect hydrant mushroom top and lugs with hypo spray before attaching standpipes. • Spray standpipe hydrant ends with hypo spray before attaching to hydrant. • Flushing water shall be suitably directed and/or detained to allow gross solids to settle out and reduce chlorine to acceptable levels before final discharge to the environment. • Alternatively flush water into a water tanker or adjacent sewer manhole (HWC approval required).

No	Steps	Actions

6	Conduct water quality testing	• Samples shall be collected at a minimum of three locations (i.e. each pipe end and mid-point) from the new water main. cations
		• One sample shall be collected at each pipe termination (e.g. one sample required at each dead end)
		• For water mains with length >500m, collect additional samples approximately every 200-500m (e.g. an 800m section of main would have 4 samples – one from each end and two from along the pipe)
		• Carry out turbidity, pH and odour testing on samples
		• Record results to verify all locations water quality meets Water Quality Acceptance Plan (WQAPs) including;
		  ○ Turbidity less than 2 NTU
		  ○ pH greater than 6.5 and less than 8.5
		  ○ Odour – non objectionable.
		<u>Additional Actions For Water Quality Failures</u>
		• Should water quality results fail to meet the WQAP then firstly confirm the water quality of the feed water from the existing water main.
		• If the feed water quality is satisfactory then proceed to flushing of the new water main again.

7	Disinfection	• Following successful flushing and water quality testing, all new water mains shall be disinfected by super chlorination or ozonation. • The new water main to be disinfected must be isolated from the existing water supply system to prevent any backflow during the super chlorination. • In case of superchlorination, ▪ The disinfectant shall be added to the water main via a suitable injection point just downstream (within 3m) of the connection of the new water main to the existing main

No	Steps	Actions
		▪ A hydrant is a suitable injection point - ideally chemical injection into feed water which is then injected into the water main (hydrant to hydrant). ▪ The disinfectant shall be injected into the water main when there is a known water flow measured using the feed water or discharge flow meter, which shall be adjusted to match the disinfectant dose. ▪ The flow of disinfectant into the new water main shall be calculated to achieve minimum continuous free chlorine residual as specified in Table 44. ▪ The injection of the disinfectant shall be terminated when the free chlorine residual in the discharge water is at the required level or greater than specified in Table 44. ▪ The disinfectant shall be discharged from the end of the water main via a suitable discharge point (within 3m of end) – a hydrant or other suitable control valve is a suitable discharge point. ▪ The disinfectant must stay in the new water main for a minimum contact time as per Table 44. • Note that the Free Chlorine Residual (FCR) is the value measured after the contact time. If the FCR has dropped below the specified value, the contact time may needs to be increased to meet the Ct requirement at the new (lower) concentration.
8	Water Discharge & De-chlorination	• If disinfection occurred at a Free Chlorine Residual (FCR) greater than 5.0 the water needs to be drained and refilled with potable quality water prior to microbiological sampling • Chlorinated water main shall be de-chlorinated if water is discharged to the environment. • Water with a chlorine residual could be discharged to water tankers for transport to a suitable disposal location (e.g. tertiary effluent ponds or STP sludge lagoons) or discharged into the sewer system at a suitable location. In new subdivisions it may be possible to complete de-chlorination in a downstream wastewater pumping station. • De-chlorination can be achieved using chemicals such as sodium ascorbate or calcium thiosulfate. • The FCR measurements of the discharge water to the environment must be taken to confirm < 0.1 mg/L residual chlorine levels to verify de-chlorination.

No	Steps	Actions
9	Re-Filling of New Water Main	• Following disinfection, the new water main will remain charged and isolated • Microbiological samples must be taken after disinfection on potable quality water.
10	Microbiological Sampling and Testing	• A minimum of 3 sample points must be used covering the 2 ends of the system and one midpoint • Additional samples are required at each dead end if the system has branch mains and/or other dead-ends • Additional samples are required approximately every 500m. • Carry out water quality testing including; turbidity, pH, odour, FCR and microbiological analysis on samples collected at a minimum of three locations (i.e. each pipe end and mid-point) from the new water main. • Transport refrigerated microbiological samples immediately to a NATA laboratory for testing.
11	Commissioning of New Water Mains	• Final Flushing to achieve potable water quality parameters specified in Table 6. • Check odour & taste is non-objectionable. • The new water main can then be connected to the existing water supply system, by the opening of isolation valves and/or removal of blanking plates, to allow final system commissioning.