Specification

SS 210 Corrosion Protection and Rehabilitation of Maintenance Holes

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Revision details

Version No.	Clause	Description of revision
1.0	N/A	New document
2.0	5.1 & 7.2	Alignment with SS 208
	5.2 & 7.3	Alignment with SS 204
	7.4	Making polyurethane only allowable for new construction.
	12.9	Making sulphuric acid the only chemical solution and reducing variations for pass criteria.
3.0	5.2 & 5.3	Separating epoxy mortar and epoxy novolac coating systems.
	7.1	Addition of application requirement to the roof section, adding requirement for joining details for multiple coating systems.
	7.2.1	Restriction to application of CAC to the roof section.
	7.2.2	Allowing reduction of thickness for the riser ring section.
	7.3	Allowing reduced coating thickness for new/resurfaced substrate to align with PCS 100 and increasing the maximum depth of application to 15 m.
	11.7	Reducing bond strength requirement to 1.5 MPa.
	11.10	Adding acid neutralisation capacity testing.
4.0	1.4	List of reference documents has been updated.
	5	A reference to WSA 201 has been added.
	5.1	Clause has been updated. User has been referred to SS 208.
	5.1.1	Clause has been deleted. User has been referred to SS 208.
	5.1.2	Clause has been deleted. User has been referred to SS 208.
	5.2.2	A 6-hour limit for compressive strength has been introduced.
		A minimum direct tensile strength requirement has been reduced from 6 to 3 MPa at 28 days.
		A minimum bond strength to the substrate material requirement has been increased from 1.0 to 1.5 MPa.
	5.5.1	Requirements to minimum number of anchoring studs and density have been updated.
	5.6	New clause. Geopolymer/alkali-activated binder mortar requirements have been introduced.
	6.1.2	Requirements for concrete surface finish have been updated.
	6.2.2	Requirement for a minimum cover has been updated to conform to Sydney Water Technical Specification – Civil.
	6.2.5 (former 6.4)	Width limit for non-active cracks has been reduced from 1.0 to 0.3 mm. Requirement for repair of cracks impacting the structural integrity has been introduced.
	6.2.7 (former 6.6)	Requirements for assessment of corroded reinforcement have been updated.
	6.3 (former 6.7)	Geopolymer/alkali-activated binder mortar has been added as an acceptable repointing material. Surface preparation requirements have been added.
	7.1	Requirement on the extent of application of protective lining/coating has been updated.
	7.2	Clause has been updated. User has been referred to SS 208.
	7.4	Requirements on minimum number of coats and minimum lining dry film thickness have been updated.
	7.6	Updated to remove ambiguity on what must be welded.
	7.7	New clause.Geopolymer/alkali-activated binder mortar application requirements have been introduced.
	9	User has been referred to Sydney Water Technical Specification – Civil.

Version No.	Clause	Description of revision
	9.2	Requirements for overlapping and mortar thickness have been removed.
	10	Requirements for cutting step irons have been updated.
	11	Requirements for inspection and test plan and Table 3 have been updated.
	11.1	Requirement to provide a photo and/or video footage of completed works has been introduced.
	11.3	Schmidt hammer testing has been removed.
	11.5	AS 3894.1 has been referenced.
	11.9	Test requirements have been updated.
	11.11	Sampling requirements have been introduced.

Introduction

This Specification is for the design, supply and construction, corrosion protection and rehabilitation of maintenance holes for Sydney Water assets.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification shall be sufficient to ensure safe systems or work or operation.

It is the user's sole responsibility to ensure that the copy of the Specification is the current version as in use by Sydney Water.

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1. General

1.1 Intent

This document provides the minimum requirements for corrosion protection and rehabilitation of maintenance holes.

1.2 Scope

The following are covered by this document:

- Application of protective coating on the internal surfaces. This includes the required surface preparation;
- Sealing of maintenance hole against inflow and infiltration;
- Repair and/or replacing maintenance hole frame and cover;
- Raising buried maintenance hole to improve access and to avoid water run-off over cover; and
- Removing and/or replacing step irons.

1.3 Responsibilities

All works are to be undertaken by the Contractor unless stated otherwise. Where a submission, request, proposal is required, it must be provided to Sydney Water for approval.

1.4 References

Reference documents are listed in Table 1.

Table 1 Reference documents

Document No	Title
ACP0172	Sydney Water Standard Specification SS 208 Rehabilitation and Corrosion Protection of Sewers using Calcium Aluminate Cement Mortar
AS 1012.9	Methods of testing concrete - Determination of the compressive strength of concrete specimens
AS 1379	Specification and supply of concrete
AS 1627.4	Metal finishing - Preparation and pre-treatment of surfaces - Abrasive blast cleaning of steel
AS/NZS 3582.1	Supplementary cementitious materials - Fly ash
AS/NZS 3582.2	Supplementary cementitious materials - Slag - Ground Granulated Blast-furnace
AS/NZS 3582.3	Supplementary cementitious materials - Amorphous Silica
AS 3894.1	Site testing of protective coatings. Method 1: Non-conductive coatings – Continuity testing – High voltage (brush) method
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
CPDMS0023	Sydney Water Technical Specification – Civil

Document No	Title
CPDMS0031	Sydney Water Standard Specification SS 212 Rehabilitation and Corrosion Protection of Sewers using Geopolymer and Alkali-Activated Binder Mortar
CEN/TS 14429	Characterization of waste. Leaching behaviour tests. Influence of pH on leaching with initial acid/base addition
CEN/TS 14997	Characterization of waste. Leaching behaviour tests. Influence of pH on leaching with continuous pH-control
ICRI Technical Guidelines 310.2R	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair
WSA 02-2002	Sewerage Code of Australia – Sydney Water Edition
WSA 201	Manual for Selection and Application of Protective Coatings
WSA PS-345	Polymeric Make-up Rings for Sewerage Access Chambers

2. Quality assurance

2.1 Control, handling and storage

All materials must be brought to the site in their original unopened containers with the Supplier's label, batch number, application instruction and expiry date. The materials must be stored under the conditions that would not lead to deterioration.

The materials batch numbers used for the works must be always recorded and provided to Sydney Water upon request.

2.2 Supplier specification

A written specification from the Supplier prior to the commencement of the work must be submitted for each product. It must contain the requirements for the supply, storage, mixing, equipment, surface preparation, application, curing, inspection, testing and repair of defects of each product.

2.3 Supplier supervision

A representative from the Supplier must witness the application of his/her product during the trial period and other times deemed required/critical. The representative must provide technical support relating to his/her product when required. The representative must ensure and be satisfied that his/her product has been applied in accordance with the Supplier’s specification.

2.4 Approved applicators

Application of each product must be carried out by an Applicator that is approved by the Supplier.

Upon request, Sydney Water must be provided with an up-to-date work record detailing the time, location, names of product, equipment, method, and applicator(s) of each product application. This record must be cross-checked for compliance with the Applicator data information submitted prior to commencement of the work.

2.5 Inspection and testing

It is the Applicator’s responsibility to carry out all required inspection and testing. However, Sydney Water may elect to carry out further inspection and testing to ensure that the works have been carried out in accordance with the relevant specifications. Where requested, access and quality control documentation must be provided to Sydney Water.

3. Submissions

3.1 Prior to commencing the work

The Contractor must submit the following information prior to commencing any work or trial:

a) Asset isolation plan;

b) Product data:

1. Supplier's specification (Clause 2.2);
2. Material Safety Data Sheet (MSDS);
3. Test certificates/reports issued by a NATA accredited material testing facility indicating that the requirements specified herein are met;

c) Applicator data:

1. Evidence of Applicator's accreditation and training issued by the Supplier;
2. Evidence of Applicator's equipment approval issued by the Supplier;
3. Evidence of successful similar work using method specified here in.

3.2 At the completion of pre-construction inspection and trial

A report detailing the findings from pre-construction inspection and trial must be submitted prior to commencing the work.

3.3 At the completion of the work

A report summarizing inspections and testings undertaken, observation/conclusion there-off must be submitted within 2 weeks after the completion of the work.

4. Associated works (where required)

4.1 Asset isolation

The Contractor must prepare plan and provide labour and equipment for asset isolation. It must be suitable for the expected flow conditions, which will prevail while work is being carried out.

The asset isolation/bypass must be set up in accordance with regulatory requirements and to the satisfaction of the relevant authorities and Sydney Water, particularly with respect to disruption of traffic and environmental safeguards.

4.2 Pre-construction inspection and trial

This requirement only applies to application of protective lining work to rehabilitated structures.

Surface condition must be verified prior to commencing surface preparation. Any noticeable discrepancy must be reported to Sydney Water. Sydney Water must be advised of the extent of work in cases where major variation is found. Allowances for variations in geometry and details arising from construction tolerances as well as corrosion must be made.

A minimum of one trial must be undertaken at the start of the work. The location and extent of the trial must be selected to reflect the actual work condition. The trial must include proposed methods of surface cleaning, surface restoration, and lining application. On completion of the trial, the testing specified herein must be undertaken and the results must be submitted.

If it becomes apparent during the trial that adjustments are required to the proposed materials, equipment or work methods, details of the necessary adjustments must be submitted for approval.

The trial area must be a part of the overall work. Any unsatisfactory trial Sydney Water must be removed and/or repaired at no additional cost to Sydney Water.

5. Materials

Materials used for this work must conform to this standard specification.

The following subsections provide the requirements of the products referred to in this specification and the products that have been approved by Sydney Water. The list of products that have been assessed by Sydney Water and deemed to meet the requirements can be found in WSA 201. Other products of equivalent properties may be used subject to prior approval from Sydney Water.

5.1 Calcium aluminate cement (CAC) mortar

A CAC mortar used for protective lining must be a proprietary pre-mixed product specially designed to withstand corrosive sewer environment. The CAC mortar must meet requirements of Sydney Water Standard Specification SS 208 Rehabilitation and Corrosion Protection of Sewers using Calcium Aluminate Cement Mortar.

5.2 Epoxy mortar

The product must be a multi-component epoxy mortar product suitable for concrete or masonry sewer repair applications. It may be trowel or spray applied.

5.2.1 Composition

The product must:

a) Be a mix of Bisphenol A epoxy resin and inorganic filler. The epoxy content level must be between 15 to 95% as determined using Loss on Ignition (LOI) method;

b) Have a maximum filler particle size of 250 microns for spray-applied epoxy or 750 microns for trowel-applied epoxy.

5.2.2 Performance

The product must:

a) Pass chemical resistance testing detailed in Clause 11.9;

b) Have a minimum thermal decomposition temperature of 370 °C as measured using a Thermo Gravimetric Analysis instrument with the following parameters:

- Purge gas: Nitrogen;
- Gas flow rate: 10 litres/min;
- Heating ramp rate: 10°C/min;
- Sample mass (minimum): 5 grams;

c) Have a minimum peak height ratio of metal-carbon to metal-oxide (indicating the interaction between filler and epoxy) of 0.8 as measured using a Fourier Transform Infrared (FTIR) spectroscopy instrument;

d) Have a minimum compressive strength of 10 MPa at 6 hours and 40 MPa at 28 days;

e) Have a minimum direct tensile strength of 3 MPa at 28 days;

f) Have a minimum bond strength of 1.5 MPa to the substrate material at 28 days;

g) Be suitable for application in confined space with limited application time;

h) Have a light colour surface finish of e.g. cream, light grey, or ivory.

5.3 Novolac epoxy coating

The product must be a multi-component Bisphenol F epoxy novolac epoxy resin based coating suitable for applications onto cementitious substrates. It may be brush or spray applied.

The product must pass chemical resistance testing detailed in Clause 11.9.

5.4 Polyurethane/polyurea lining

The product must be high build solventless and designed specifically for corrosion protection of concrete and masonry sewers. It must be spray applied using airless spray equipment. In addition, the product must:

a) Pass chemical resistance testing detailed in Clause 11.9;

b) Have a minimum compressive strength of 40 MPa;

c) Have a minimum tensile strength of 15 MPa;

d) Form a minimum bond strength of 2.5 MPa to the substrate material;

e) Have a minimum Shore D hardness scale of 50;

f) Have a minimum elongation at break of 250%;

g) Be suitable for application in confined space with limited application time;

h) Have a light colour surface finish of e.g. cream, light grey, or ivory.

5.5 Plastics liner

Plastics liner must be either high-density polyethylene (HDPE) or polyvinyl chloride (PVC).

5.5.1 HDPE liner

The HDPE liner must have anchoring studs manufactured during the extrusion process of the sheet. The minimum number of the anchoring studs must be 1200 per m². The liner must have a minimum pull out strength of 55 kg per anchoring stud.

In addition, the HDPE liner must meet the following requirements:

a) Pass chemical resistance testing detailed in Clause 11.9;

b) A minimum density of 940 kg/m^3;

c) A minimum yield strength of 15 MPa;

d) A minimum elongation at break of 400%;

e) A minimum Shore D hardness of 50;

f) Have a light colour surface finish of e.g. cream, light grey, or ivory.

5.5.2 PVC liner

The PVC liner must have continuous anchoring ribs manufactured during the extrusion process of the sheet.

In addition, the PVC liner must meet the following requirements:

a) A minimum pull out strength of 20 kg per linear centimetre;

b) Pass chemical resistance testing detailed in Clause 11.9;

c) A minimum PVC resin content of 99%;

d) A minimum yield strength of 15 MPa;

e) A minimum elongation at break 200%;

f) A minimum Shore D hardness of 50;

g) Have a light colour surface finish of e.g. cream, light grey, or ivory.

5.6 Geopolymer (GP)/alkali-activated binder (AAB) mortar

A GP/AAB mortar used for protective lining must be a proprietary pre-mixed product specially designed to withstand corrosive sewer environment. The GP/AAB mortar must meet requirements of Sydney Water Standard Specification SS 212 Rehabilitation and Corrosion Protection of Sewers using Geopolymer and Alkali-Activated Binder Mortar. The GP/AAB mortar can be used for trial applications only.

6. Surface preparation

The section is divided into two parts, new concrete and aged concrete. It also includes requirements for masonry structures.

6.1 New concrete

6.1.1 Curing

Unless approved otherwise, all new concrete works must be cured at least 28 days before application of polymeric linings.

6.1.2 Surface cleaning and roughening

Formwork release oil, surface hardeners, curing membrane, and all other foreign materials/contaminants must be removed with abrasive blasting or other means of appropriate cleaning methods. All debris must be removed following the cleaning and disposed of in an appropriate waste facility.

The concrete surface finish must be in accordance with ICRI Technical Guidelines 310.2R as recommended be the Supplier to provide surface profile required for the protective lining/coating to be applied. Typically, concrete surface profile must be CSP3 or coarser, unless otherwise specified by Sydney Water and/or the Supplier (Clause 6.2.5.5, WSA 201).

6.1.3 Defects

Repair all form of voids, bugholes, honeycombs, and other surface defects with a suitable patching product. Remove all form ties and metallic protrusions.

6.1.4 Moisture content

This clause only applies to polymeric linings (epoxy, polyurethane, and polyurea).

The moisture content of a concrete substrate must be tested using a moisture meter or qualitatively using the method described in ASTM D4263, which involves taping down a 450 mm by 450 mm piece of 75 to 150 microns thick polyethylene film for a period of 24 hours.

The polymeric linings must not be applied if any moisture is entrapped inside the film, or if the moisture content of the concrete substrate exceeds 4%.

6.2 Aged concrete

6.2.1 Surface cleaning and roughening

Clean and roughen surface as per Clause 6.1.2.

6.2.2 Patch Repair

Patch repair using a repair mortar must be undertaken for areas with deep voids. If reinforcement is exposed, clean and repair the reinforcement as required. All reinforcement must be fully embedded in concrete while patching. A minimum cover of 70 mm over the reinforcement must be maintained unless required to match adjacent surface.

6.2.3 Resurfacing

Resurfacing is large-scale repair of irregular concrete surfaces. It may be undertaken for creating a uniform surface profile using a repair mortar to minimise the amount of protective lining used or create an optimum substrate surface for the lining.

Where resurfacing is undertaken, the minimum thickness of repair mortar must be 20 mm. Some locations may require thicker application to suit the structural and geometry requirements. The finished surface profile must be made as such so an optimum bond with protective lining is achieved.

Where the invert and bench surfaces require repair, they must be smooth and sloped in the direction of the flow.

6.2.4 Infiltration repair

Active minor leaks should be stopped using a rapid setting hydraulic cement product designed specifically for such purpose.

For stopping major leaks, a chemical grout sealant injected forced into the joints and crack may be used. The sealant must be acrylamide or urethane base gel type. It should be tinted to allow detection of grout in drill holes or at leakage locations.

Where tree roots are present, the grout must have a root inhibitor agent. Any holes must be patched upon completion of the sealing operation.

6.2.5 Crack repair

All cracks must be reported to Sydney Water. A qualified structural engineer must then be engaged by the Contractor to assess if the cracks affect the structural integrity and to recommend a suitable repair method.

Active cracks that do not affect the structural integrity may be treated as joints and repaired in accordance with Clause 6.2.6.

Non-active cracks that do not affect the structural integrity and with opening greater than 0.3 mm, must be repaired using crack sealing method, where the path along the crack is opened up forming a wedge shape slot 20 mm wide x 20 mm deep and filled with a repair mortar.

Cracks that impact the structural integrity, must be repaired in accordance with a written instruction of the structural engineer who was engaged to carry out the initial investigation.

6.2.6 Joint repair

The purpose of the joint repair is to ensure the continuity of the protective lining system is maintained. It is also intended to address any areas where problems currently exist with either leakage or odour escape through the joints.

The system must be compatible with movements. The repaired joints must be airtight and watertight. Materials used to seal any joints in the lining need to be compatible with other repair materials for the adjacent concrete surfaces and have a comparable life expectancy.

The Contractor must be responsible for developing a joint repair method as required to suit actual site conditions and joint materials. It must be submitted to Sydney Water for approval prior to commencing the repair work.

6.2.7 Steel reinforcement cleaning and repair

Any exposed steel reinforcement must be cleaned to a class Sa 2½ of AS 1627.4 and then coated immediately with a corrosion resistant zinc rich primer to avoid flash rusting.

Any reinforcement that has lost 5% or more of its diameter due to corrosion must be reported to Sydney Water. A qualified structural engineer must be engaged by the Contractor to assess if the loss is acceptable. Any reinforcement that is considered unacceptable from structural adequacy consideration must be augmented by new reinforcement of similar size.

6.3 Masonry structure

Any loose and protruding brick must be removed using hammer and chisel. Voids caused by the removal of brick must be reconstructed using sound clean bricks and suitable mortar. Care must be taken to ensure the integrity of the structure during this process. Lost mortar joints must be repointed using a suitable mortar material, and the surface must be struck flush with the brick surface prior to lining application. CAC or GP/AAB mortar is an acceptable repointing material.

Any infiltration must be stopped first prior to undertaking the repair using the method specified in Clause 6.2.4.

Any contaminants – e.g. oil, grease, deteriorated coatings, loose materials and etc. – must be removed from the masonry structure by water jetting, abrasive blasting and/or chemical cleaning. All loose brickwork and voids in the mortar joints must be re-pointed.

7. Lining/coating application

7.1 General

Unless otherwise specified, the work consists of applying the lining/coating to all concrete surfaces of the maintenance holes i.e. wall, roof, bench, and invert. For maintenance holes deeper than 6 m, the application of lining/coating onto the wall element is only required for the bottom 5 m section (measured from the overt), unless otherwise identified during inspection and approved by Sydney Water.

The surface prior to lining/coating application must be clean and sound. Any crack, leak, defective joint, deteriorated inlet or outlet, or exposed reinforcement must be repaired. The surface preparation method must be in accordance with requirements detailed in Clause 6.

During application, the inlets, outlets, and access equipment (handle areas only) must be covered to prevent excess material from accumulating and contaminating the sewers.

The applied product must form a smooth, uniform, and monolithic protective liner. The bench, invert, and transitions to the pipes must be smooth and sloped in the direction of the flow. Abrupt irregularities must not exceed 1 mm. Gradual deviations from vertical or horizontal alignment of the finished coated surface must not exceed 10 mm when measured against a 1 m straight edge. A spray-applied product on the walls and soffit does not need a trowel finish, providing that the heights between peaks and valleys are less than 1 mm. Any horizontal flat surface area, which may be used as a walkway or as a step, must be made slip resistant.

Where two or more coating systems are used in a structure, their joints must be properly designed considering the durability and characteristics of each coating system.

The lining/coating must not be used for providing or restoring structural properties.

7.2 CAC mortar application

Only CAC mortar product(s) approved by Sydney Water must be used. The material must be applied strictly in accordance with the Supplier’s written recommendations and requirements specified in this Clause and Sydney Water Standard Specification SS 208 Rehabilitation and Corrosion Protection of Sewers using Calcium Aluminate Cement Mortar.

The application may be carried out using spinning head shotcreting equipment for circular maintenance hole that is not greater than 1.2 m in diameter. For straight back taper maintenance hole, the spinning head must be centrally located inside the shaft.

CAC mortar may not be hand applied to overhead or roof sections. Where CAC mortar is applied to the wall and bench sections, alternative lining system must be used for the roof section.

The application thickness may be reduced to 10 mm on the riser/make up ring section where a full thickness application would reduce the minimum internal diameter below the acceptable limit for a safe confined space entry. Alternatively, other lining system may be used for this section.

7.3 Epoxy mortar application

Application of this type of lining onto structures deeper than 15 m below ground level is not permitted without Sydney Water’s approval, due to potential debonding caused by presence of groundwater pressure. If epoxy mortar is used on these structures, a hydrophobic (water retardant) bonding agent must be applied.

The application may be undertaken either by spraying or trowelling. The concrete substrate must be fully cured and dry, and has been prepared in accordance with Clause 6.

The required lining thickness depends on the type of epoxy mortar, which is governed by the proportion of epoxy resin within the product. Table 2 provides the requirement of absolute minimum dry film thickness.

A minimum of two coats is required to avoid formation of pinholes. A primer coat, if applied, is not counted as a coat.

The product must be cured properly according to the Supplier's recommendation before returning to active flow. If subsequent layer of lining is required after the recommended relining period has elapsed or the lining has been exposed to flow, then the previous lining layer must be cleaned, roughened, and/or chemically activated to create optimum bonding.

Table 2 Minimum thickness of coating according to epoxy resin content

Epoxy resin (weight %)	95-88	87-80	79-72	71-64	63-56	55-48	47-40	39-32	31-24	23-15
For resurfaced/new structures (mm)	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
For non-resurfaced structures (mm)	6	7	8	9	10	11	12	13	14	15

7.4 Novolac epoxy application

This lining system is only applicable to new concrete substrate or where aged concrete has been completely resurfaced with suitable repair mortar. Additionally, application of this type of lining onto structures deeper than 15 m below ground level is not permitted without Sydney Water's approval, due to potential debonding caused by presence of groundwater pressure.

The application may be undertaken either by spraying or brushing. The concrete substrate must be fully cured and dry, and has been prepared in accordance with Clause 6.

A minimum of three coats is required to minimise formation of pinholes. A primer, if applied, is not counted as a coat. The total minimum lining dry film thickness is 490 µm (Clause 8.20, WSA 201).

The product must be cured according to the Supplier's recommendation before returning to active flow. If subsequent layer of lining is required after the recommended relining period has elapsed or the lining has been exposed to flow, then the previous lining layer must be cleaned, roughened, and/or chemically activated to create optimum surface for bonding.

7.5 Polyurethane/polyurea application

Unless otherwise approved, this type of lining must only be applied onto new structures that are not deeper than 6 m below ground level, due to potential debonding caused by presences of moisture in the substrate and groundwater pressure.

The application may only be undertaken by spraying method. The substrate must be fully cured and dry, and has been prepared in accordance with Clause 6.

To avoid delamination between multiple coats, only 1 coat must be applied. The primer, if applied, is not counted as a coat. The total minimum lining dry film thickness is 2 mm.

The product must be cured according to the Supplier's recommendation before returning to active flow. If subsequent layer of lining is required after the recommended relining period has elapsed or the lining has

been exposed to flow, then the previous lining layer must be cleaned, roughened, and/or chemically activated to create optimum surface for bonding.

7.6 Plastics liner application

Application of this lining onto structures deeper than 15 m below ground level is not permitted without Sydney Water's approval, due to potential debonding caused by presence of high groundwater pressure.

For new structures, the liner must be either installed in the precast yard or by fixing to the formwork in cast in-situ construction.

For aged structures, the concrete substrate must be prepared in accordance with Clause 6. The liner must be fixed to a formwork and to the original substrate using high strength pumpable grout approved by the manufacturer. The grout must fill all voids and crevices.

Nails should not be used for attaching liner to the formwork. Only use specially designed double-sided tapes. Liner may also be secured by tying the top anchors back to the formwork using strong non-corrosive wires. The wires must be removed prior to welding the liner.

Specially designed joiner pieces must be used to temporarily joint liner non-corner segments during concrete pouring, to ensure the segments are properly aligned and the joint area is free of contamination.

Where possible, pre-fabricated corners pieces should be used to minimise corner welding.

All joints must be welded in order to form a monolithic lining. The welding must only be carried by an accredited geomembrane welder and approved by the supplier. All welding must be tested in accordance with Clause 11.8.

The minimum thickness of the lining is 2 mm. A thicker application may be recommended by the manufacturer for application in more abrasive environment or areas with higher hydrostatic pressure.

7.7 GP/AAB mortar application

Only GP/AAB mortar product(s) approved by Sydney Water must be used. The material must be applied strictly in accordance with the Supplier's written recommendations and requirements specified in this Clause and Sydney Water Standard Specification SS 212 Rehabilitation and Corrosion Protection of Sewers using Geopolymer and Alkali-Activated Binder Mortar.

The application may be carried out using spinning head shotcreting equipment for circular maintenance hole that is not greater than 1.2 m in diameter. For straight back taper maintenance hole, the spinning head must be centrally located inside the shaft.

GP/AAB mortar may not be hand applied to overhead or roof sections. Where GP/AAB mortar is applied to the wall and bench sections, alternative lining system must be used for the roof section.

The application thickness may be reduced to 10 mm on the riser/make up ring section where a full thickness application would reduce the minimum internal diameter below the acceptable limit. Alternatively, other lining system may be used for this section.

8. Refurbishment / replacement of maintenance hole frame and cover

Existing maintenance hole frame and cover will normally be cleaned and reinstalled. Where required, the existing frame and cover must be removed and disposed appropriately and replaced with new ones. Lightweight plastics cover and frame must not be used in trafficable or bushfire prone locations.

New maintenance hole frame and cover must be in accordance with WSA 02-2002 Sewerage Code of Australia – Sydney Water Edition.

9. Raising of buried maintenance hole

The Contractor must submit a prosed structural design of maintenance hole extension to Sydney Water for acceptance. The proposed structural design must meet requirements of Sydney Water Technical Specification – Civil.

9.1 Raising ≤ 500 mm

Existing buried maintenance hole must be raised to ground level using either cast in-situ concrete, or pre-cast concrete or plastics make-up rings, or brickwork methods. Plastics make-up rings must not be used in vehicular loaded or bushfire prone locations. The plastic rings must meet requirements of WSA PS-345. Pre-cast concrete make up rinks and brickwork methods without structural connections must not be used in vehicular loaded locations.

The internal surface of the brickwork must be smooth rendered with a pre-packed quick setting mortar with a minimum thickness of 12 mm. Where applicable, protective lining must be applied to concrete and masonry elements.

The internal diameter of the raised maintenance hole must not be less than 600 mm.

9.2 Raising > 500 mm

Existing buried maintenance hole must be raised to ground level using either pre-cast or cast-in-situ concrete sections.

The internal dimension and access requirements (step irons/ladders) of the raised section must be in accordance with the Sewerage Code of Australia (Sydney Water Edition).

10. Refurbishment / replacement of step irons

The existing step irons must be inspected and assessed by a structural engineer. Identified defective steps irons must be cut back at least 10 mm below the surface and the hole must be plugged flush with the surface with an epoxy mortar which meets requirements of this Specification. If the maintenance hole is not being lined as part of the rehabilitation work, the exposed surface of the remaining step iron portions in the wall must be coated with epoxy lining. If ladders and landings/platforms are present, direction needs to be sought from Sydney Water regarding their requirements.

Unless otherwise stated, the Contractor must replace step irons in accordance with WSA 02-2002 Sewerage Code of Australia – Sydney Water Edition.

11. Inspection and testing

The inspection and testing of applied lining/coating must be undertaken in accordance with Table 3 which covers the minimum requirements. The Contractor must expand the provided inspection and test plan to cover all activities performed by the Contractor. The inspection and testing results must be reported by the Contractor to Sydney Water.

Table 3 Schedule of inspection and testing

	Visual inspection	Delamination survey	Compressive strength testing	Hardness testing	Spark Testing	Thickness measurement	Bond strength testing	Welded joint testing
Surface preparation	X	X	X			X	X	
Lining/coating application:								
• Epoxy/novolac epoxy/polyurethane	X	X		X	X	X	X	
• CAC	X	X	X			X	X	
• GP/AAB	X	X	X			X	X	
• Plastic	X	X		X	X		X	X

11.1 Visual inspection

All surfaces must be visually inspected before and after repair for cracks, spalls, rust stains, dampness, discolouration, honeycombing, etc. Any defects must be repaired at no cost to Sydney Water.

After completion of the rehabilitation/corrosion protection works, the Contractor must provide to Sydney Water a photo and/or video footage of the rehabilitated maintenance hole(s). A 360° camera footage is recommended.

11.2 Delamination survey

The applied lining/coating including patch repair or resurfacing material used in surface preparation must be inspected for delamination (drumminess) using light hammer.

Any areas found to be drummy must be assessed further. More tests may be required to determine the extent of defects. The Contractor may be instructed to remove and repair these areas at no cost to Sydney Water.

11.3 Compressive strength testing

For each batch or each day of the work, the Contractor must prepare and send a cast sample of the applied material for compressive strength testing. In the case of anchored plastic lining application, it must be undertaken for the grout used to fill the annular space. The testing must be in accordance with AS 1012.9 or equivalent and undertaken by a NATA accredited material testing facility approved by Sydney Water. The compressive strength must be tested at 24 hours and 28 days.

Any areas found to have less than the specified compressive strength must be assessed further. More tests may be required to determine the extent of defects. The Contractor may be instructed to remove and repair these areas at no cost to Sydney Water.

11.4 Hardness testing

Hardness testing must be carried out to verify that polymeric and cured in-place linings have cured properly. The sampling locations will be nominated by Sydney Water unless agreed to be randomly selected. Unless otherwise specified, the sampling rate must be at least one for every 10 m² area. The testing must be in accordance with ASTM D2240 or equivalent.

11.5 Holiday testing

The Contractor must undertake holiday testing in accordance with AS 3894.1 using appropriate high voltage holiday detection equipment to detect the presence of pinholes, cracks, or other discontinuities in all areas. Any defective areas must be repaired at no cost to Sydney Water.

11.6 Thickness measurement of applied material

The Contractor must measure the thickness of applied repair and/or lining material at any location selected by Sydney Water using core samples or a non-destructive method approved by Sydney Water.

Any areas found to be thinner than the specified minimum thickness must have additional material be applied at no cost to Sydney Water to make up to the required thickness.

Unless specified otherwise, the sampling rate must be one for every 10 m² repair area. The sampling frequency may be reduced by Sydney Water following consistent pass results.

11.7 Bond strength testing

Bond strength of the applied resurfacing/lining material must be tested using core samples or dollies (50 mm in diameter). The sampling locations will be nominated by Sydney Water unless agreed to be randomly selected.

The testing must be in accordance with AS 1580.408.5 or equivalent and undertaken by a NATA accredited material testing facility or an independent inspector approved by Sydney Water. All core locations must be repatched with the lining system.

Any areas found to have bond strength less than specified in Clause 5 must be further assessed by Sydney Water. More tests may be performed to determine the extent of deficient bonded areas. Where instructed by Sydney Water, they must be removed and repaired at no cost to Sydney Water.

Unless specified otherwise stated, the sampling rate must be one for every 10 m² repair area. Subject to approval from Sydney Water, the sampling rate may be reduced following consistent pass results.

11.8 Welded joint testing for plastics lining

The quality of every welded joint must be inspected visually and tested using vacuum box, pressure channel, or spark testing methods. The testing must be undertaken by a trained and certified personnel. Any defective welded joint must be repaired at no cost to Sydney Water.

11.9 Chemical resistance testing

The test method must be a modified ASTM D543 with a total exposure period of 112 days at 25±3°C. Test conditions/procedures, which are not discussed in this clause, must be in accordance with ASTM D543 and can be confirmed with Sydney Water.

Weight and hardness change specimens must be 50 mm in diameter. Thickness of the specimens must be the minimum thickness specified in Table 2. Samples for tensile strength testing must be prepared in accordance with ASTM C307 or equivalent.

The weight and hardness specimens must be initially pre-conditioned in a mechanical convection oven for 7 days at 43±3 °C, then cooled in a desiccator for 3 hours at 25±3°C, measured, and then immersed in 20% sulphuric acid solutions (% in V/V). The tensile strength samples must be initially pre-conditioned at 25±3 °C and 50±5% relative humidity for not less than 48 hours prior to immersion into the acid solution. All samples must be immersed fully the acid solution.

The sulphuric acid solution must be replaced with new solution once per 28 days.

At 28-day intervals selected specimens must be removed from the acid solution, washed, surface dried and measured. The same weight and hardness change specimens must be reconditioned in a mechanical convection oven for 7 days at 43±3°C, then cooled in a desiccator for 3 hours at 25±3°C and measured again. The tensile strength samples must be removed from the acid solution, washed, surface dried and tested. A reconditioning is not required for the tensile strength samples.

If any specimen fails to meet the requirements specified below, the material will be deemed unsatisfactory. A satisfactory chemical resistance is defined as having a maximum of:

1. 2% variation from the initial weight;
2. 5% variation from the initial material shore D hardness;
3. 10% reduction from the initial tensile strength.

11.10 Acid neutralisation capacity testing

The inhibitive property of cement-based materials arising from their ability to neutralise the acid produced by hydrolysis of the products of anodic dissolution may be characterised by their acid neutralisation capacity. It involves plotting the steady state pH against the quantity of acid added to a series of ground samples to obtain a titration curve. The method is adopted from European Committee's CEN/TS 14429 and CEN/TS 14997.

The method involves milling sample with a ball mill and separating particles that passes through 100 µm sieve. Minimised sample contact with air to avoid carbonation. A series of tests are undertaken to generate at least 25 different points along a titration curve.

Each test consists of adding 1 g of ground sample to 10 ml of acidic solution to maintain a solid:liquid ratio of 1:10. The acidic solution is prepared by adding a predetermined quantity of 70% nitric acid to deionised water to generate a range of pH from 4 to 12. The tubes are kept at 30°C and agitated daily until the pH of the solution reaches a steady state (variation in pH is within ±0.3 pH unit). The pH of the solution must be measured using a pH meter that had been calibrated using standard buffer solutions.

11.11 Sampling

Minimum number of samples/tests and test results acceptance criteria must be as per a relevant standard or this specification. Where a standard or this specification does not specify these requirements, minimum 3 tests must be conducted and the closeness of agreement between results must be within 5% of the mean value.

Ownership

Ownership

Role	Title
Group	Specialist Engineering, Engineering and Technical Support
Owner	Norbert Schaeper
Author	Maxim Kovtun

Change history

Version No.	Prepared by	Date	Approved by
1.0	Jerry Sunarho	03/05/2010	Janssen Chan
2.0	Jerry Sunarho	07/03/2011	Janssen Chan
3.0	Jerry Sunarho	18/10/2012	Peter Gillman
4.0	Maxim Kovtun, Senior Materials Engineer	03/03/2022	Norbert Schaeper, Engineering Manager