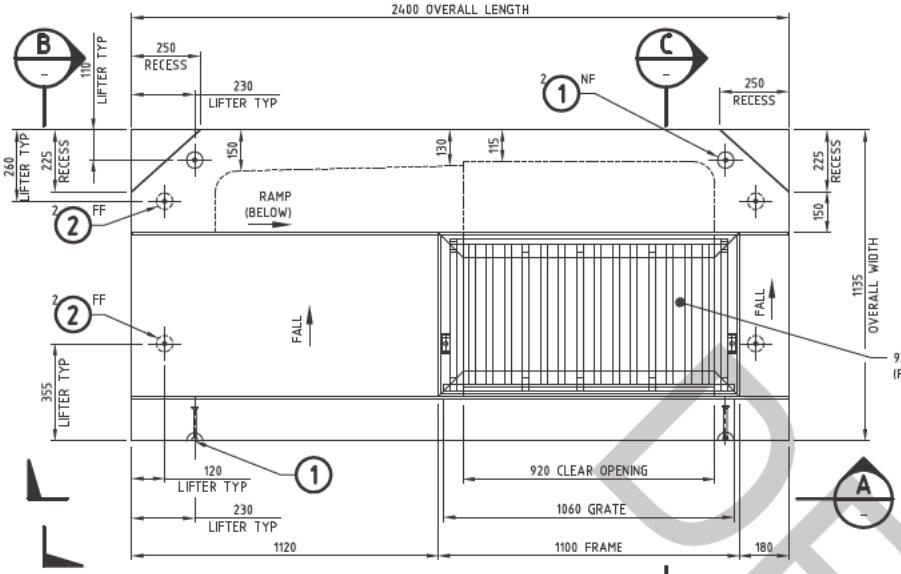
INDEX No.	PART NAME	DESCRIPTION & SIZE	No OFF	COMMENTS
1	"UNILIFT" CONE ANCHORS	1.3t - 120 Lg	4	SITE LIFT
2	"UNILIFT" CONE ANCHORS	1.3t - 120 Lg	4	DEMOULDING

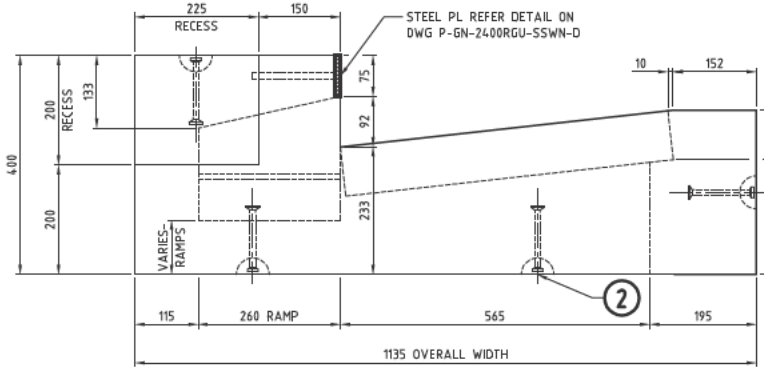
UNCONTROLLED COPY WHEN PRINTED

ISSUE	DETAILS OF ALTERATION	DWN	DATE	CHD
0	ISSUED FOR MANUFACTURE.	JPN	18-11-20	CKH
1	GENERAL REVISION. RE-ISSUED FOR MANUFACTURE.	JPN	18-11-20	CKH

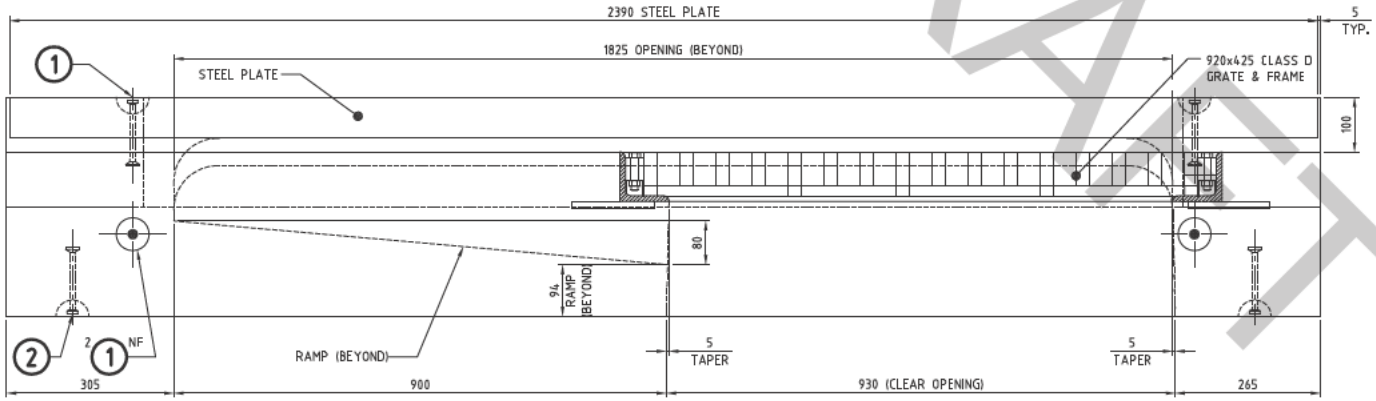
FOI 26 202 Document 2



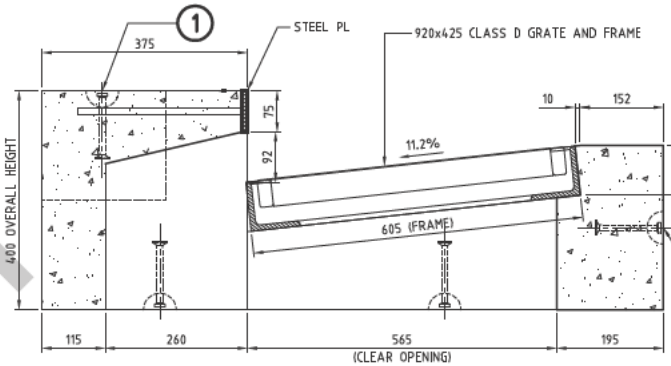
PLAN - AS INSTALLED
SCALE 1:10



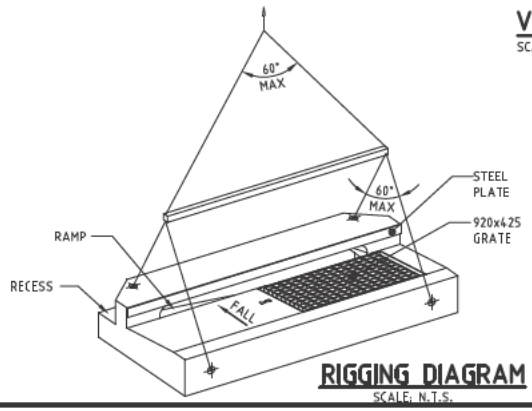
VIEW B AS INSTALLED
SCALE 1:5



VIEW A AS INSTALLED
SCALE 1:5



SECTION C AS INSTALLED
SCALE 1:5



RIGGING DIAGRAM
SCALE: N.T.S.

HUMES HEALTH SAFETY & ENVIRONMENT

1. LIFTERS TO BE PLACED IN LOCATIONS SHOWN BY DRAWINGS ONLY. LIFTERS FOR SINGLE UNIT LIFT ONLY.
2. ALL PRECAST UNITS SHALL BE HANDLED AND ERECTED IN ACCORDANCE WITH HUMES RECOMMENDATIONS IN THE SPECIFIC HANDLING AND INSTALLATION GUIDES

APPROVAL OF THIS DRAWING PROVIDES AN UNDERTAKING THAT SAFETY IN DESIGN HAS BEEN CONSIDERED FOR ALL ASSOCIATED DRAWINGS AND WHERE APPROPRIATE INCORPORATED INTO THE DESIGN. IDENTIFIED SAFETY RISKS WHICH COULD NOT BE MITIGATED THROUGH DESIGN HAVE BEEN HIGHLIGHTED ABOVE. THESE DO NOT INCLUDE RISKS THAT AN EXPERIENCED OPERATOR WOULD TYPICALLY BE AWARE OF AND FURTHER HSE RISK ASSESSMENTS ARE TO BE UNDERTAKEN AS REQUIRED.

PRODUCT NOTES:

1. MANUFACTURED IN ACCORDANCE WITH AS3600.
2. DESIGN LIFE = 50 YEARS
3. EXPOSURE CLASSIFICATION: B2
4. NOMINAL COVR TO REINFORCEMENT = 35 mm UNO
5. CONCRETE GRAGE: S50/20
6. STEEL FORMWORK AND SUPERWORKABLE CONCRETE TO BE USED FOR CASTING.
7. REFER TO DRAWING PP-GN-2400RGU-RWLP-WA-R FOR REINFORCEMENT DETAILS.
8. REFER TO DRAWING PP-GN-2400RGU-SSWN-D FOR STEEL PLATE DETAILS.
9. 920x425 GRATE AND FRAME TO BE CLASS D RATED TO AS3996. HOT DIPPED GALVANISED TO AS4680.
10. APPROXIMATE UNIT MASS = 1.51 t

LIFTING NOTES:

1. LIFTING DESIGN IN ACCORDANCE WITH AS3850.
2. MINIMUM FACTOR OF SAFETY = 2.25
3. MINIMUM CONCRETE STRENGTH AT TIME OF INITIAL LIFT = 20MPa.
4. SPREADER BEAM TO BE USED FOR LIFTING AND HANDLING.
5. MOULD SUCTION FACTOR = 1.2 (SMOOTH, OILED STEEL MOULD).
6. DYNAMIC IMPACT FACTOR = 2.0 (MOBILE CRANE ON PREPARED EVEN SURFACE).

LEGACY PROJECT No. 24605

Humes TECHNICAL SERVICES BRISBANE, QUEENSLAND

Holcim (Australia) Pty Ltd ABN 87 099 732 297

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DRN.	-	
DSN CHK.	-	
CHK.	BHD	05-12-19
QA.	CKH	13-12-19
APP.	MJE	13-12-19

SUPERSEDES

PLOT SCALE 1:1

HUMES WELSHPOOL
HUMES STANDARD DRAWINGS
PIPES - GENERIC
2400 ROAD GULLY UNIT - LIGHT
PRODUCT DETAILS

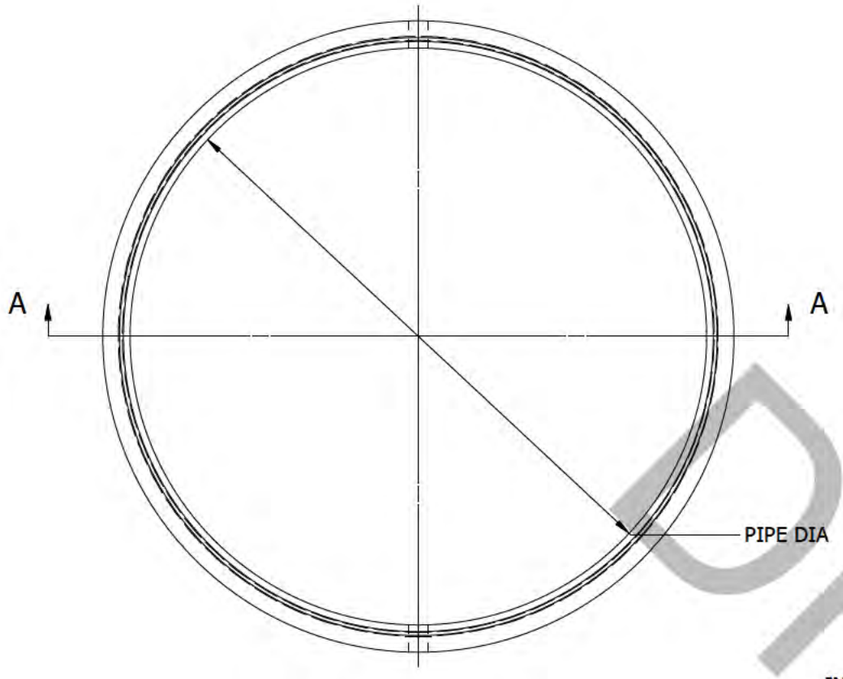
SIZE A1 | DRG. NO. PP-GN-2400RGU-RWLP-WA-P | ISSUE 1

DRAFT

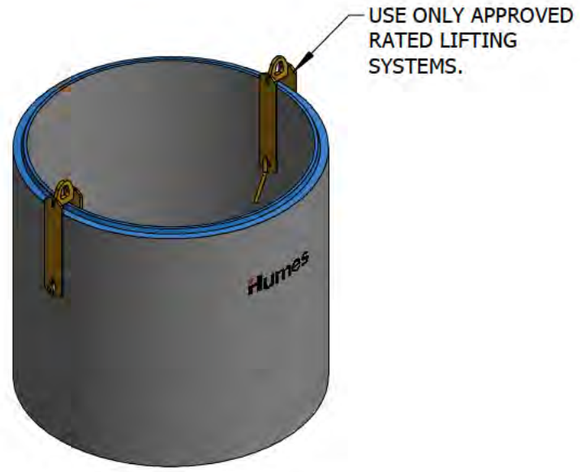
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PATHNAME: TECHNICAL\CAD\STANDARD DRAWINGS\PIPES\GENERIC\2400 ROAD GULLY UNIT\PP-GN-2400RGU-RWLP-WA-P.DWG

FOI 26-292 - Document 27



SECTION A-A
SCALE 1 : 10



INTERLOCKING JOINT WELL LINER
ISO VIEW
SCALE 1 : 20

STANDARD SIZES				
CODE	PIPE DIA	PIPE WALL	PIPE LENGTH	PIPE WEIGHT
#	mm	mm	mm	Kg
5022091	940	44	310	105
5022092	940	44	610	210
5022093	940	44	910	315
5022094	940	44	1220	420
5022139	1092	51	310	141
5022140	1092	51	610	282
5022141	1092	51	910	423
5022142	1092	51	1220	565
5022161	1224	57	310	181
5022162	1224	57	610	362
5022163	1224	57	910	543
5022164	1224	57	1220	724

NOTE: PIPE DIMENSIONS & WEIGHTS ARE NOMINAL

IF IN DOUBT
ASK!

DRAFT

REV	DRN	DESCRIPTION	DATE	APP
0	PS	ISSUED FOR CLIENT INFORMATION	26/03/2020	GA

REVISION HISTORY

SHEET 1 OF 1

USED ON

Holcim

Holcim Australia & New Zealand (HANZ)
OPERATIONS & ENGINEERING

Holcim (Australia) Pty Ltd
ABN 87 099 732 297
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TOLERANCES
UNLESS OTHERWISE SPECIFIED

1. INTERPRET DIMENSIONAL TOLERANCES AS PER AS1100 PART 201
2. INTERPRET GEOMETRICAL TOLERANCES AS PER AS1100 PART 201
3. FOR DEFINITION OF MACHINING SYMBOLS AS PER AS1100 PART 201
4. FOR DEFINITION OF WELDING SYMBOLS TO AS1101-3
5. TOLERANCES - DIMENSIONAL:
   a. MACHINING 500mm & BELOW ± 0.25mm; ABOVE 500mm ± 0.50mm
   b. STRUCTURAL 150mm & BELOW ± 1.00mm; ABOVE 150mm ± 1.50mm
   c. CASTING 300mm & BELOW ± 1.5; ABOVE 500mm ± 3.00mm
   d. ANGULAR + ½

DSN	PRS	24/03/2020
DSN CHK		
DRN	PS	24/03/2020
CKD	GA	25/03/2020
APP	AG	26/03/2020

SCALE 1 : 10

HUMES - WELSHPOOL - WA
PRODUCTS - PIPES
WELL LINERS - INTERLOCKING JOINT

PRODUCT DETAIL

SIZE	DRG NUMBER	REV
A3	H-13134-100	0

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ers\pskinner_WorkingFolder\Engineering Data\To-13200\13134\H-13134-100.dwg - 24/03/2020

FOI 26-292 - Document 27

GATIC®

CIRCULAR COVERS

GM300C - CIRCULAR CONCRETE INFILL

PRODUCT CODE	CLEAR OPENING DIA	OVERALL FRAME DIA	OVERALL COVER DIA	COVER SEATING DEPTH	OVERALL FRAME HEIGHT	COVER BELLY DEPTH	MASS FRAME KG	MASS COVER KG	MASS COVER (INCLUDING CONCRETE) KG	MARKINGS ON TOP	COMMENT
Class B											
GM300C6B2N	610	810	686	38	65	67	15	31	59	SEWER	Comes with 1xM10 SS SHC Bolt
Class D											
*GM300C6D2	614	825	698	57	102	93	33	42	95	SEWER	Add '2SB' to the end of Product Code for Boltdown option
GM300C6D2N	610	810	686	50	98	75	25	38	69	SEWER	
GM300C6D3	610	810	686	50	98	75	25	38	69	STORM WATER	

Note:
- *GM300C6D2 comes with a Cellular Frame
- Other markings may be available upon request

GM300S - CIRCULAR SOLID TOP

PRODUCT CODE	CLEAR OPENING DIA	OVERALL FRAME DIA	OVERALL COVER DIA	COVER SEATING DEPTH	OVERALL FRAME HEIGHT	COVER BELLY DEPTH	MASS FRAME KG	MASS COVER KG	MARKINGS ON TOP	COMMENT
Class B										
GM300S6B2	610	810	686	38	68	38	15	28	SEWER	Comes with 1xM10 SS SHC Bolt
GM300S6B3	610	810	686	38	68	38	15	28	STORM WATER	
GM300S6B4	610	810	686	38	68	38	15	28	SAN-SEW	
Class D										
GM300S6D2	610	810	686	50	98	70	24	38	SEWER	Add '2SB' to the end of Code for Boltdown option
GM300S6D3	610	810	686	50	98	70	24	38	STORM WATER	
GM300S6D4	610	810	686	50	98	70	24	38	SAN-SEW	
GM300S9D2I36	914	1144	990	57	100	81	32	89	SEWER	See Note*

*Note:
- Comes with Ø360C/O Solid Top Maintenance Shaft Insert and 6xM10 SS SHC Bolts

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CIRCULAR COVERS

GM300S - CIRCULAR SOLID TOP

PRODUCT CODE	CLEAR OPENING DIA	OVERALL FRAME DIA	OVERALL COVER DIA	COVER SEATING DEPTH	OVERALL FRAME HEIGHT	COVER BELLY DEPTH	MASS FRAME KG	MASS COVER KG	MARKINGS ON TOP	COMMENT
Class G										
GM300S6G	610	790	712	72	109	100	36	62	BLANK	Comes with 4xM12 SS SHC Bolts
GM300S6G2	610	790	712	72	109	100	36	62	SEWER	
GM300S6G3	610	790	712	72	109	100	36	62	STORM WATER	
GM300S6G5	610	790	712	72	109	100	36	62	ELECTRICAL	

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ACO Infrastructure TraffikDrain

Typical Applications

- Motorways and highways
- Streetscapes with shared zones for pedestrians and vehicles
- Busways, bus stops and railway interchanges
- Bridge abutments and tunnel portals
- Median strips
- Right hand turn bays
- Kerbside gutters

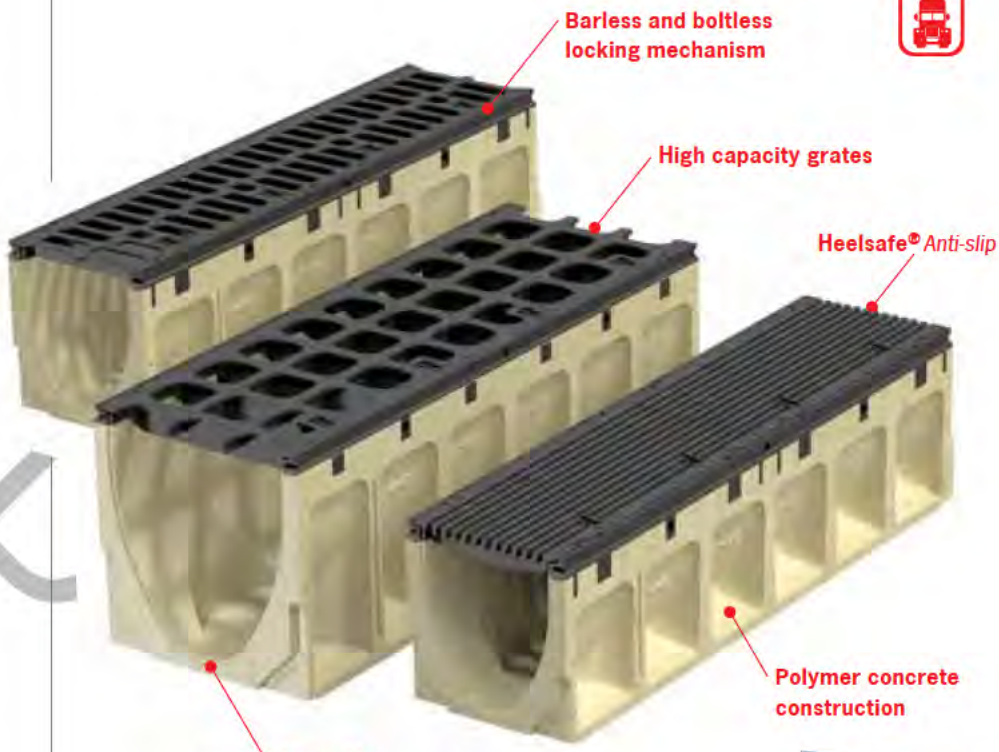
Problem Areas

- Flat pavements and road surfaces
- Restricted road shoulders
- Limited space due to underground services

Water Management

- Provision of continuous capture inlets
- Prevention of aquaplaning, property damage and water splashing pedestrians
- Containment of toxins and fuel spills in environmentally sensitive areas

Grated trench drains for roads



Austroads Guide to Road Design Part 5A: Drainage, acknowledges **ACO's TraffikDrain** as a practical solution to control the width of gutter flow through the drain's continuous capture inlets.









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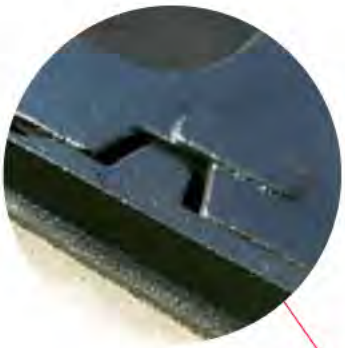
FOI 26-292 - Document 27

TraffikDrain combines the benefits of **Polycrete®** *Channels*[1] with a choice of purpose designed grates to minimise ponding and other dangers to road users.

The iron **Hi-Flo** and **Transverse** grates ensure maximum water intake, resulting in quick removal of water from the road surface. The iron **Heelsafe®** *Anti-Slip*[2] grate provides pedestrian safety in heavily foot trafficked areas.

All grates are secured with the **PowerLok®** barless and boltless locking system that enables quick and easy access for maintenance operations.

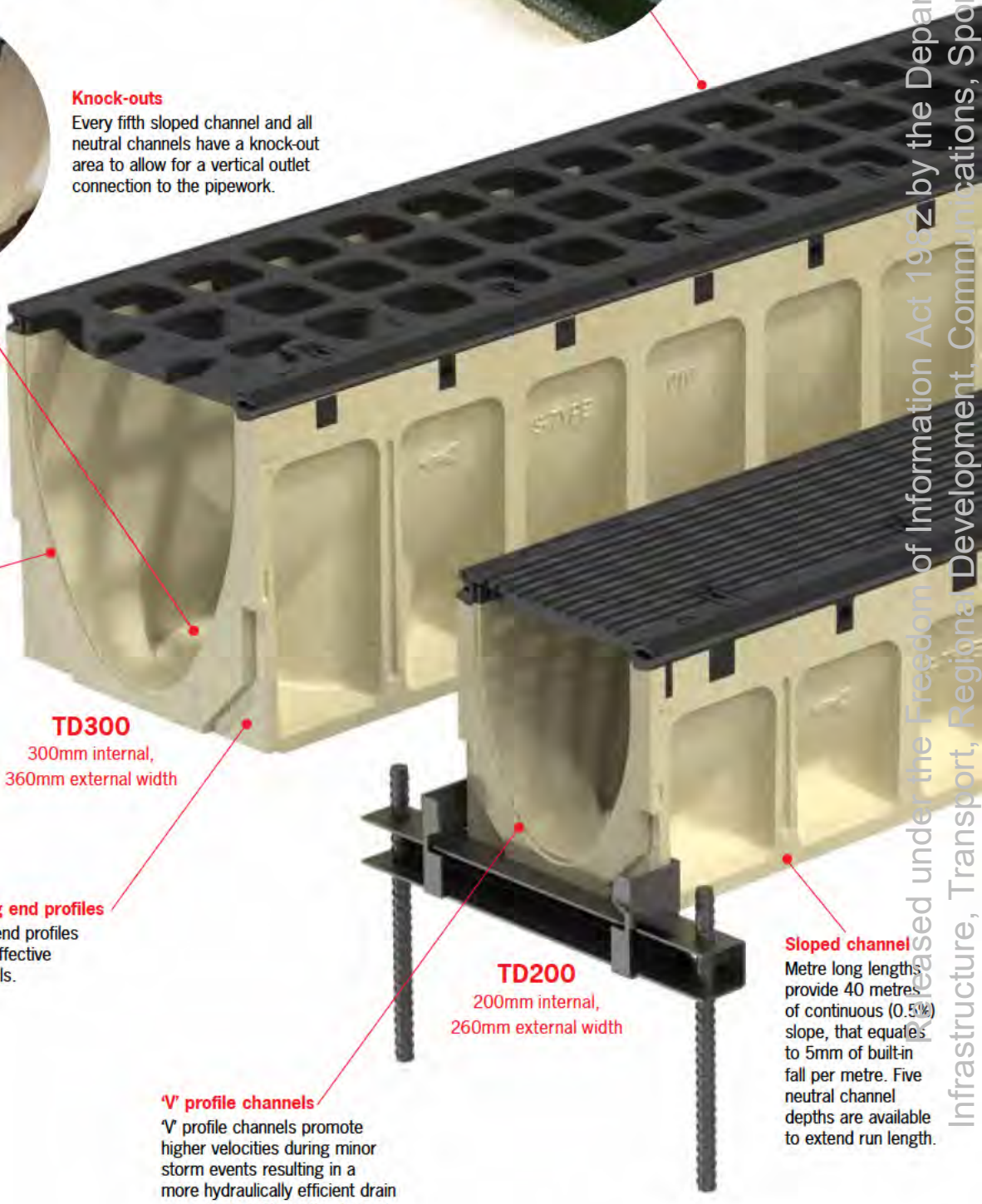
[1]Polycrete® refers to ACO products made from polymer concrete.
[2]Heelsafe® is ACO's trademark for a pedestrian friendly grate.



Anti-shunt lugs
Recesses in grates fit around anti-shunt lugs on the edge rail to prevent longitudinal movement under dynamic wheel loads.



Knock-outs
Every fifth sloped channel and all neutral channels have a knock-out area to allow for a vertical outlet connection to the pipework.



SF Sealant Groove
SF Sealant Groove is cast into both ends of the channel and allows for a bead of flexible sealant to be applied at the channel joints. The sealant ensures contaminated water does not infiltrate into environmentally sensitive areas.

TD300
300mm internal,
360mm external width

Interconnecting end profiles
Interconnecting end profiles allow easy and effective joining of channels.

TD200
200mm internal,
260mm external width

'V' profile channels
'V' profile channels promote higher velocities during minor storm events resulting in a more hydraulically efficient drain compared to 'U' profile channels.

Sloped channel
Metre long lengths provide 40 metres of continuous (0.5%) slope, that equates to 5mm of built-in fall per metre. Five neutral channel depths are available to extend run length.

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Ductile iron grates
Hi-Flo, Intercept **Heelsafe®** *Anti-Slip* and Transverse ductile iron grates are heavy duty and rated up to AS 3996 Load Class D (approx. 8 tonne wheel load).

Ductile iron edge rail
Integrally cast-in rail provides maximum strength and protection for channel body.

Polymer concrete
Polymer concrete is a durable, lightweight material made from a polyester resin binder, reinforced by mineral aggregates and fillers.

Profiled side walls
Profiled side walls provide channel body strength and mechanical keying to concrete encasement.

PowerLok®
A patented, barless and boltless locking system that provides easy fitting and removal of grates reducing installation time and maintenance time.

Channel numbering
Channel numbering is located on the sidewalls and the invert base of the channel. The number of the connecting channel is embossed and located at the end of each channel to aid identification.

Installation Device
Installation devices are available from ACO, to reduce installation time and labour costs. The device clamps the channels together and braces them to prevent movement. The device also stops the channels from floating during the single concrete pour.



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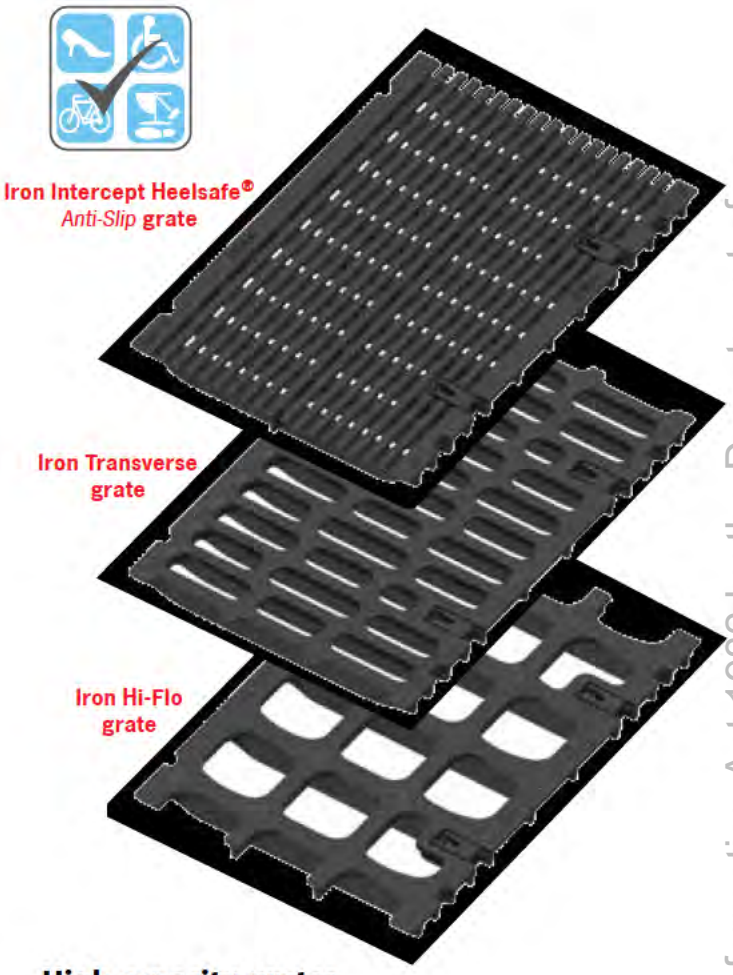
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TraffikDrain grates

All TraffikDrain grates are purpose designed to meet Australian road requirements.

- Rated to Load Class D 210kN, AS 3996 *Access Covers and Grates*. NATA endorsed test reports available
- Bicycle wheel compliant in all directions, AS 3996
- Manufactured from ductile iron Grade 500/7, AS 1831 *Ductile Cast Iron*
- Anti-shunt provisions prevent longitudinal movements from dynamic wheel loads
- **PowerLok®** is a barless and boltless locking system that provides easy fitting and removal of grates reducing installation time and maintenance time





Pedestrian safe grate

Iron Intercept Heelsafe® ***Anti-Slip*** **grate**

The Iron Intercept **Heelsafe®** *Anti-Slip* grate is designed to be heel friendly and slip resistant for pedestrian crossings and other high pedestrian traffic areas.

The grate has 8mm slots that meet the requirements of:

- Clause 3.3.5 – Surface Openings in Pedestrian Areas, AS 3996 *Access Covers and Grates*
- Clause 9(c) – Ground and Floor Surfaces addressing wheelchair and walking cane safety, AS 1428.2 *Design for Access and Mobility*

This grate is independently tested for slip resistance to P3 (wet pendulum) and R10 (oil-wet platform), AS 4586 *Slip resistance classification of new pedestrian surface materials*. NATA endorsed test reports are available.



High capacity grates

Iron Hi-Flo and Iron Transverse grate

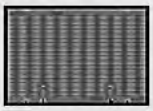
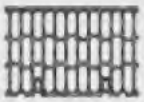
ACO's high capacity grates are designed with large efficient inlets to ensure high water intake, resulting in quick stormwater removal from road surfaces. These features offer the following benefits:

- Easy cleaning with or without grate removal
- Channel can be inspected through the top of the grate
- Leaves do not block inlets



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TD200 Grates (to suit 200mm channels)		Length mm	Part No.	Weight kg				
LOAD CLASS D 210kN – AS3996 (approximate wheel load 8,000kg)								
	Iron Hi-Flo	500	142127	6.1	×	×	✓	×
	Iron Intercept[1] **Heelsafe®** *Anti-Slip*	500	142125	8.7	✓	✓	✓	✓
	Iron Transverse	500	142145	6.8	×	×	✓	×

TD300 Grates (to suit 300mm channels)		Length mm	Part No.	Weight kg				
LOAD CLASS D 210kN – AS3996 (approximate wheel load 8,000kg)								
	Iron Hi-Flo	500	142128	10.5	×	×	✓	×
	Iron Intercept[1] **Heelsafe®** *Anti-Slip*	500	142126	14.8	✓	✓	✓	✓
	Iron Transverse	500	142146	11.2	×	×	✓	×

[1] Meets ASME A112.6.3 Section 7.12 (American high heel standard).

PowerLok® safety clip *(optional)*





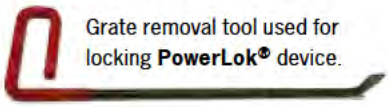
Safety clip sits flush with grate surface and grate cannot be unlocked. The red coloured safety clips provide a visual indication that the grates are locked.

Specific user requirements

ACO's grates meet some or all of the legislative requirements described below:

- Wheelchair compliant to AS 1428.2, Clause 9(c). Slots cannot exceed 13mm (width), 150mm (length). Longitudinal grates are to be placed at right angles to the principal direction of travel.
- Grates designed to resist the penetration of a 10mm heel.
- Bicycle tyre penetration resistant to AS 3996. Criteria on slot length dependant on slot width.
- Pedestrian safe grates with slip resistance, rated to AS 4586.

PowerLok® barless & boltless locking system *(standard)*



Grate removal tool used for locking **PowerLok®** device.



To open **PowerLok®**, insert tool between rail and **PowerLok®** device.



Rotate tool 90°; **PowerLok®** device should push away from rail.

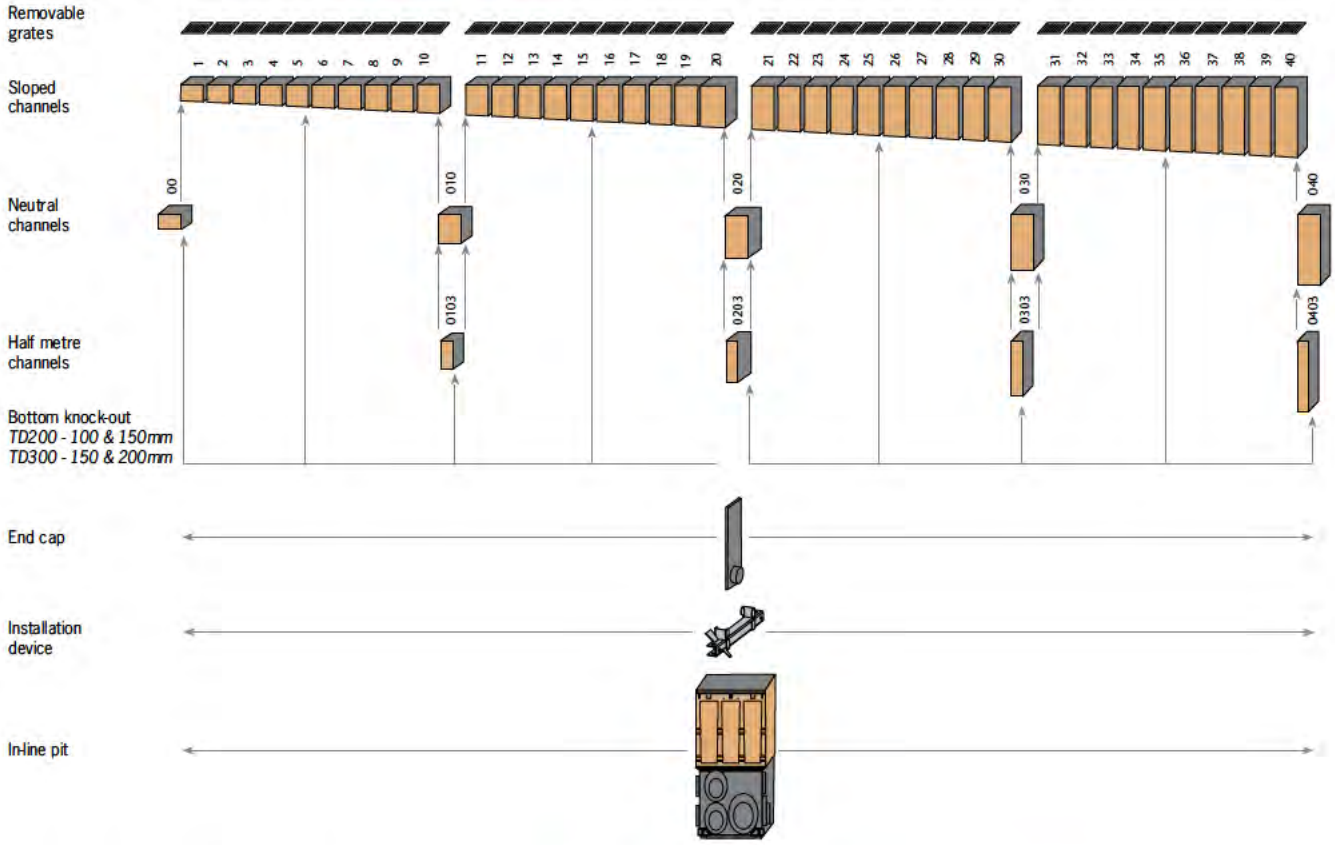


To close, place hook part of tool into 'V' and push towards rail.

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FOI 26-292 - Document 27

Typical system layout – TD200 / TD300



In-line pit options

Polymer concrete in-line pits are most commonly used as the outlet to the underground pipework for a trench run. They provide the highest hydraulic output and allow easy access to the pipe system for maintenance.

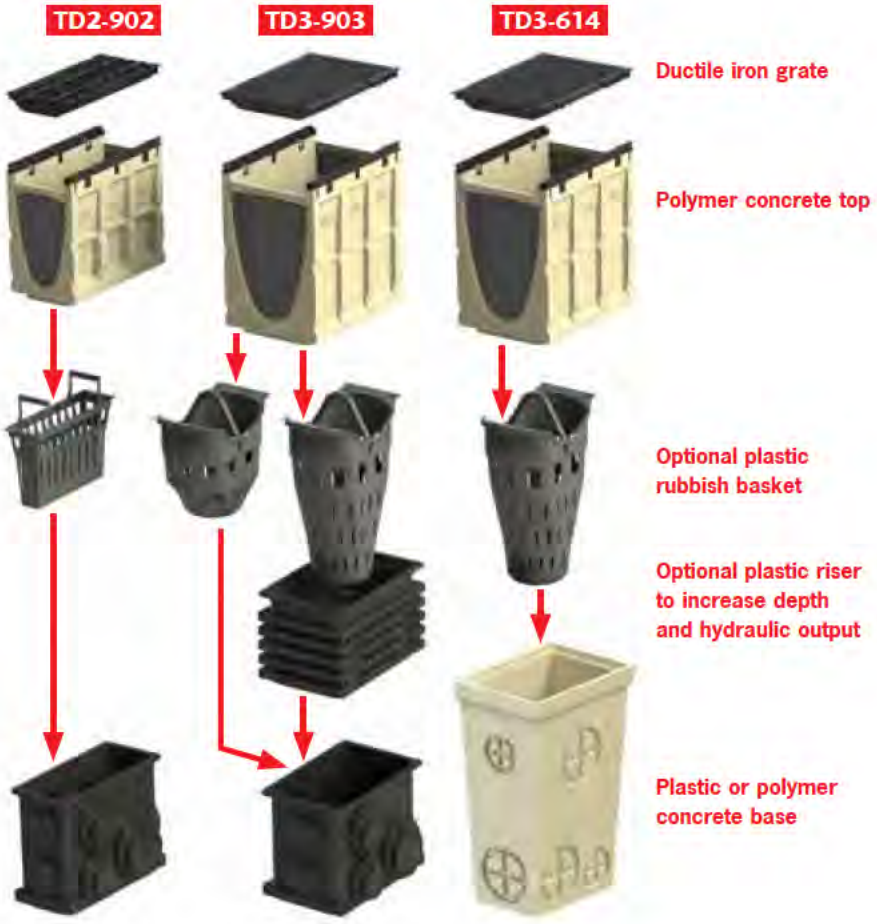
Type 900 in-line pits are the same width as the trench run.

The polymer concrete in-line top enables the same grate to be used as the trench run for a seamless finish.





TD3-614 in-line pit allows for connection through the long side wall with a reinforced concrete pipe up to DN375.



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Parts table

	TD200 – 200mm internal width			TD300 – 300mm internal width		
	Channel Part No.	Invert[2] mm	Weight kg	Channel Part No.	Invert[2] mm	Weight kg
00 Neutral channel (1m)[1]	**148041**	200	36.1	**149041**	300	59.1
1 Sloped channel (1m)	**148001**	205	36.1	**149001**	305	59.1
2 Sloped channel (1m)	**148002**	210	36.6	**149002**	310	59.6
3 Sloped channel (1m)	**148003**	215	37.1	**149003**	315	60.2
4 Sloped channel (1m)	**148004**	220	37.6	**149004**	320	60.7
5 Sloped channel (1m)[1]	**148005**	225	38.1	**149005**	325	61.3
6 Sloped channel (1m)	**148006**	230	38.6	**149006**	330	61.9
7 Sloped channel (1m)	**148007**	235	39.1	**149007**	335	62.4
8 Sloped channel (1m)	**148008**	240	39.6	**149008**	340	63.0
9 Sloped channel (1m)	**148009**	245	40.1	**149009**	345	63.5
10 Sloped channel (1m)[1]	**148010**	250	40.6	**149010**	350	64.1
010 Neutral channel (1m)[1]	**148043**	250	40.6	**149042**	350	64.1
0103 Neutral channel (0.5m)[1]	**148044**	250	26.5	**149045**	350	35.3
11 Sloped channel (1m)	**148011**	255	41.1	**149011**	355	64.6
12 Sloped channel (1m)	**148012**	260	41.6	**149012**	360	65.2
13 Sloped channel (1m)	**148013**	265	42.1	**149013**	365	65.8
14 Sloped channel (1m)	**148014**	270	42.6	**149014**	370	66.3
15 Sloped channel (1m)[1]	**148015**	275	43.1	**149015**	375	66.9
16 Sloped channel (1m)	**148016**	280	43.6	**149016**	380	67.4
17 Sloped channel (1m)	**148017**	285	44.1	**149017**	385	68.0
18 Sloped channel (1m)	**148018**	290	44.6	**149018**	390	68.5
19 Sloped channel (1m)	**148019**	295	45.1	**149019**	395	69.1
20 Sloped channel(1m)[1]	**148020**	300	45.6	**149020**	400	69.7
020 Neutral channel (1m)[1]	**148045**	300	45.6	**149044**	400	69.7
0203 Neutral channel (0.5m)[1]	**148046**	300	29.9	**149047**	400	38.5
21 Sloped channel (1m)	**148021**	305	46.1	**149021**	405	70.2
22 Sloped channel (1m)	**148022**	310	46.6	**149022**	410	70.8
23 Sloped channel (1m)	**148023**	315	47.1	**149023**	415	71.4
24 Sloped channel (1m)	**148024**	320	47.6	**149024**	420	71.9
25 Sloped channel (1m)[1]	**148025**	325	48.1	**149025**	425	72.4
26 Sloped channel (1m)	**148026**	330	48.6	**149026**	430	73.0
27 Sloped channel (1m)	**148027**	335	49.1	**149027**	435	73.6
28 Sloped channel (1m)	**148028**	340	49.6	**149028**	440	74.1
29 Sloped channel (1m)	**148029**	345	50.1	**149029**	445	74.7
30 Sloped channel (1m)[1]	**148030**	350	50.6	**149030**	450	75.3
030 Neutral channel (1m)[1]	**148047**	350	50.6	**149046**	450	75.3
0303 Neutral channel (0.5m)[1]	**148048**	350	32.0	**149049**	450	41.8
31 Sloped channel (1m)	**148031**	355	51.2	**149031**	455	75.8
32 Sloped channel (1m)	**148032**	360	51.7	**149032**	460	76.4
33 Sloped channel (1m)	**148033**	365	52.2	**149033**	465	76.9
34 Sloped channel (1m)	**148034**	370	52.7	**149034**	470	77.5
35 Sloped channel (1m)[1]	**148035**	375	53.2	**149035**	475	78.1
36 Sloped channel (1m)	**148036**	380	53.7	**149036**	480	78.6
37 Sloped channel (1m)	**148037**	385	54.2	**149037**	485	79.2
38 Sloped channel (1m)	**148038**	390	54.7	**149038**	490	79.7
39 Sloped channel (1m)	**148039**	395	55.2	**149039**	495	80.3
40 Sloped channel (1m)[1]	**148040**	400	55.7	**149040**	500	80.8
040 Neutral channel (1m)[1]	**148049**	400	55.7	**149048**	500	80.8
0403 Neutral channel (0.5m)[1]	**148050**	400	36.0	**149050**	500	45.5
Type 900 In-line pit (0.5m)[3]	**142687**	843[5]	32.3	**142688**	956[5]	39.9
Type 900 In-line plastic rubbish basket	**13999**	–	0.5	**98653**	–	1.6
Optional plastic riser				**141729**	300	4.5
Plastic rubbish basket – long				**98665**	–	1.8
Type 614 in-line pit (0.5m)[4]				**142689**	1261[5]	103.2
Universal end cap	**96823**	420[5]	0.6	**96827**	520[5]	1.1
Debris strainer for 100mm knockout	**93488**	–	0.1			
Installation device	**97478**	–	1.8	**97479**	–	2.2
Grate removal tool	**01318**	–	0.1	**01318**	–	0.1
PowerLok safety clip	**10443**	–	–	**10443**	–	–







Notes:

1. These channels have a knock-out for a vertical outlet: TD200 – 100mm and 150mm round, TD300 – 150mm and 200mm round.
2. Inverts shown are male end, for female invert depths – subtract 5mm from male invert (except neutral channels where it will be the same as the male invert). To calculate overall channel depth, add 25mm to invert depth.
3. Type 900 In-line pit assembly (Polycrete® top and plastic base).
4. Type 614 In-line pit assembly (Polycrete® top and Polycrete® base).
5. Overall depth of in-line pit and end caps.

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FOI 26-292 - Document 27

Technical support and services

ACO has an established Technical Services Department with many years experience advising on surface drainage in road applications.

This free service is offered with no obligation and is supported with extensive, high quality information, brochures and technical documentation.

Services include advice at project design stage through to on-site support as required.

Trench and grate hydraulics

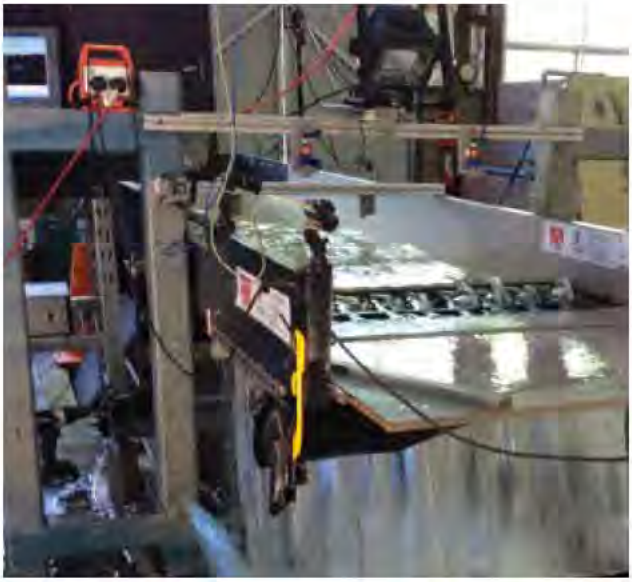
- Used to correctly size up trench drains
- Determine pit spacings
- Allow gutter flow width to be calculated
- Grate intake testing based on experimental results and software developed by the UNSW Water Research Laboratory

Certification

- Certificate of Compliance/Conformance available
- NATA endorsed load test reports to AS 3996
- NATA accredited ACO Laboratory – Accreditation No: 15193

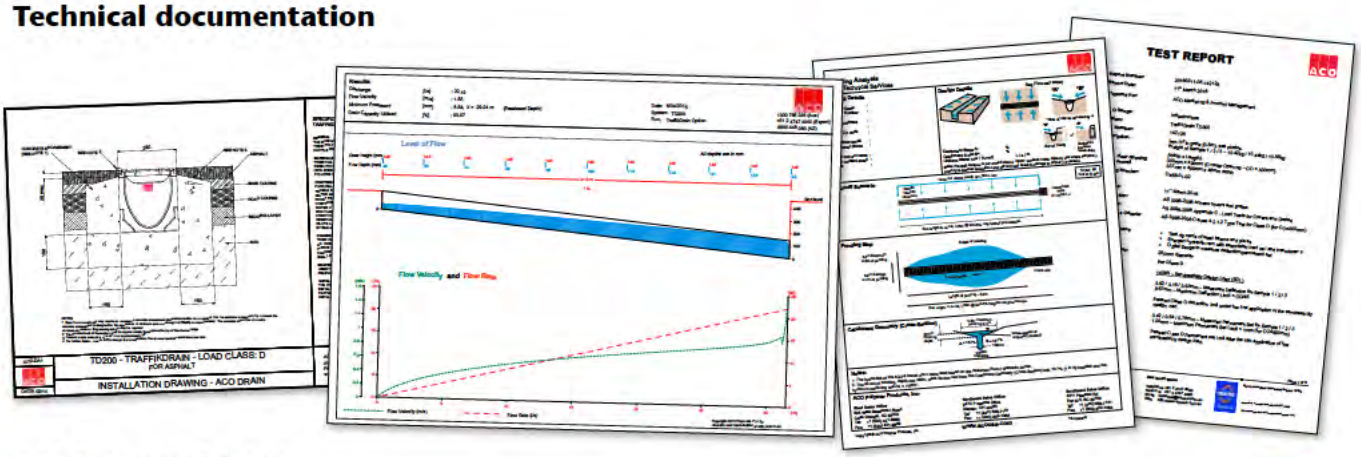
Installation

- Plan and long section drawings for complex layouts
- Recommended installation drawings
- Installation cost estimate
- Cross section detail of trench drain with standard kerb and gutter
- Pit connection detail with standard Road Authority pits
- Step by step site installation manual and installation device instructions with templates are available on ACO's website





Technical documentation



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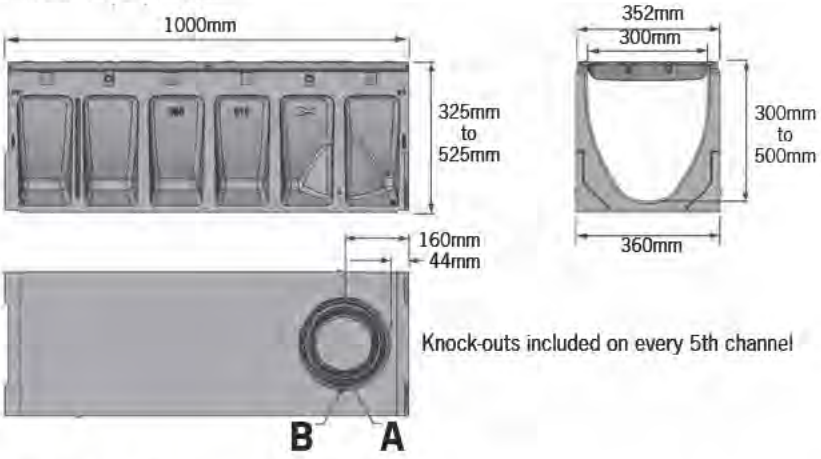
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FOI 26-292 - Document 27

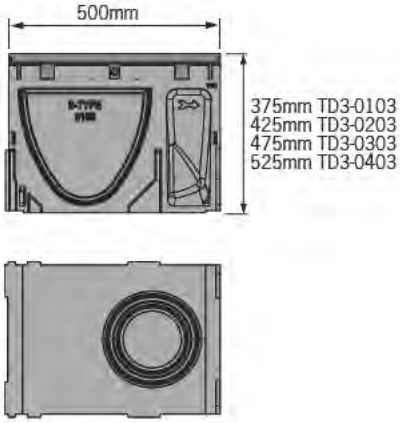
TraffikDrain - TD300 Iron edge rail channel system

D

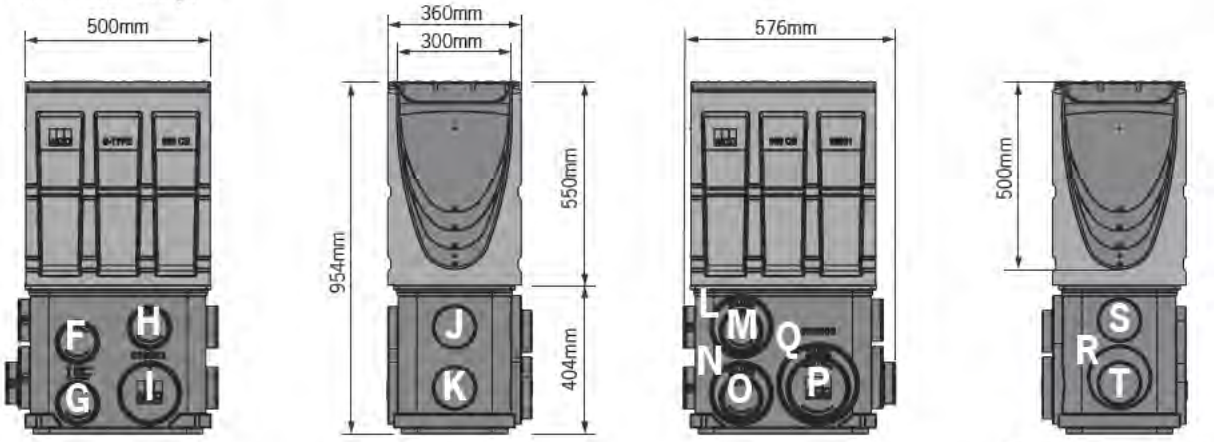
One metre channel



Half metre channel



TD3-903 In-line pit



Total capacity = 120 litres

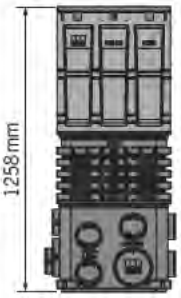
Outlet flow rates

Outlet	Product	Outlet size	Invert Depth (mm)	L/s
A	Bottom outlet - TD3-00	150mm round	300	27.9
A	Bottom outlet - TD3-040	150mm round	500	36.0
B	Bottom outlet - TD3-00	200mm round	300	49.5
B	Bottom outlet - TD3-040	200mm round	500	64.0
C	End outlet - TD3-00	150mm round	300	19.7
C	End outlet - TD3-040	150mm round	500	30.1
D	End outlet - TD3-010	200mm round	350	35.0
D	End outlet - TD3-040	200mm round	500	49.5
E	End outlet - TD3-020	250mm round	400	54.7
E	End outlet - TD3-040	250mm round	500	70.7
F	TD3-903	100mm round	757	18.3
G	TD3-903	100mm round	922	20.5
H	TD3-903	100mm round	717	17.8
I	TD3-903	150mm round	922	44.7
J	TD3-903	100mm round	721	17.8
K	TD3-903	100mm round	886	20.0
L	TD3-903	150mm round	740	39.1
M	TD3-903	100mm round	726	17.9
N	TD3-903	150mm round	922	44.7
O	TD3-903	100mm round	907	20.3
P	TD3-903	150mm round	907	44.3
Q	TD3-903	200mm round	922	76.8
R	TD3-903	150mm round	883	43.6
S	TD3-903	100mm round	702	17.5
T	TD3-903	100mm round	873	19.9

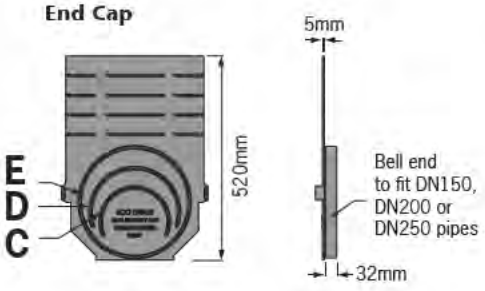
Note: These are the pipe flow rates at the specified outlet, **NOT** channel flow rates. In-line pit flow rates are without rubbish basket - using rubbish basket reduces flow.

TD3-903 In-line pit with riser

Notes:
1. Riser can be cut down in 25mm increments.
2. Maximum capacity including riser 160 litres.
3. Add 300mm to all heights if using riser.
4. Outlet flow rates will be higher due to increased depth. Contact ACO Sales Office for more details.



End Cap



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FOI 26-292 - Document 27

ACO INFRASTRUCTURE®

TraffikDrain - TD300 Iron edge rail channel system

Description	Part No.	Invert[2] (mm)	Weight (kg)
TD3-00 Neutral channel - (1m)[1]	**149041**	**300**	**59.1**
TD3-1 Sloped channel - (1m)	149001	305	59.1
TD3-2 Sloped channel - (1m)	149002	310	59.6
TD3-3 Sloped channel - (1m)	149003	315	60.2
TD3-4 Sloped channel - (1m)	149004	320	60.7
TD3-5 Sloped channel - (1m)[1]	149005	325	61.3
TD3-6 Sloped channel - (1m)	149006	330	61.9
TD3-7 Sloped channel - (1m)	149007	335	62.4
TD3-8 Sloped channel - (1m)	149008	340	63.0
TD3-9 Sloped channel - (1m)	149009	345	63.5
TD3-10 Sloped channel - (1m)[1]	149010	350	64.1
TD3-010 Neutral channel - (1m)[1]	**149042**	**350**	**64.1**
TD3-0103 Neutral channel - (0.5m)[1]	**149045**	**350**	**35.3**
TD3-11 Sloped channel - (1m)	149011	355	64.6
TD3-12 Sloped channel - (1m)	149012	360	65.2
TD3-13 Sloped channel - (1m)	149013	365	65.8
TD3-14 Sloped channel - (1m)	149014	370	66.3
TD3-15 Sloped channel - (1m)[1]	149015	375	66.9
TD3-16 Sloped channel - (1m)	149016	380	67.4
TD3-17 Sloped channel - (1m)	149017	385	68.0
TD3-18 Sloped channel - (1m)	149018	390	68.5
TD3-19 Sloped channel - (1m)	149019	395	69.1
TD3-20 Sloped channel - (1m)[1]	149020	400	69.7
TD3-020 Neutral channel - (1m)[1]	**149044**	**400**	**69.7**
TD3-0203 Neutral channel - (0.5m)[1]	**149047**	**400**	**38.5**
TD3-21 Sloped channel - (1m)	149021	405	70.2
TD3-22 Sloped channel - (1m)	149022	410	70.8
TD3-23 Sloped channel - (1m)	149023	415	71.4
TD3-24 Sloped channel - (1m)	149024	420	71.9
TD3-25 Sloped channel - (1m)[1]	149025	425	72.4
TD3-26 Sloped channel - (1m)	149026	430	73.0
TD3-27 Sloped channel - (1m)	149027	435	73.6

Description	Part No.	Invert[2] (mm)	Weight (kg)
TD3-28 Sloped channel - (1m)	149028	440	74.1
TD3-29 Sloped channel - (1m)	149029	445	74.7
TD3-30 Sloped channel - (1m)[1]	149030	450	75.3
TD3-030 Neutral channel - (1m)[1]	**149046**	**450**	**75.3**
TD3-0303 Neutral channel - (0.5m)[1]	**149049**	**450**	**41.8**
TD3-31 Sloped channel - (1m)	149031	455	75.8
TD3-32 Sloped channel - (1m)	149032	460	76.4
TD3-33 Sloped channel - (1m)	149033	465	76.9
TD3-34 Sloped channel - (1m)	149034	470	77.5
TD3-35 Sloped channel - (1m)[1]	149035	475	78.1
TD3-36 Sloped channel - (1m)	149036	480	78.6
TD3-37 Sloped channel - (1m)	149037	485	79.2
TD3-38 Sloped channel - (1m)	149038	490	79.7
TD3-39 Sloped channel - (1m)	149039	495	80.3
TD3-40 Sloped channel - (1m)[1]	149040	500	80.8
TD3-040 Neutral channel - (1m)[1]	**149048**	**500**	**80.8**
TD3-0403 Neutral channel - (0.5m)[1]	**149050**	**500**	**45.5**
TD3-903 In-line pit (0.5m)[3]	142688	954[4]	39.9
Type 900 In-line plastic rubbish basket	98653	-	1.6
Optional plastic riser	141729	300	4.5
Plastic rubbish basket - long	98665	-	1.8
TD3-614 In-line pit (0.5m)[3]	142689	1261[4]	103.2
Universal end cap	96827	520[4]	1.1
Installation device	97479	-	2.2
Grate removal tool	01318	-	0.1
PowerLok safety clip	10443	-	-

Notes:
1. This channel offers bottom knockout feature; 150mm and 200mm round.
2. Inverts shown are male end; for female invert depths – subtract 5mm from male invert (except neutral channels where it will be the same as the male invert). To calculate overall channel depth, add 25mm to invert depth.
3. In-line pit assembly (polymer concrete top with ductile iron edge rail and base).
4. Overall depth of in-line pit and end cap.

Specifications

The surface drainage system shall be ACO's TraffikDrain TD300 polymer concrete V-profile channel system with ductile iron edge rails as manufactured by ACO.

Channels
TD300 channel shall be 300mm nominal internal width with an overall width of 360mm. Channel invert shall have a V-profile to allow efficient drainage and channel walls shall have deep pockets and vertical ribs for mechanical keying. TD300 sloped channels shall have a built-in slope of 0.5%. All channels shall be interlocking with a male/female joint and have provisions for the installation device.

Grates
Insert specification for the selected grate. Refer to the relevant ACO Specification Information sheet, at: http://www.acoaus.com.au/infrastructure

Installation
The complete drainage system shall be by ACO and to be installed for its intended purpose. Any deviation or partial use of the specified system and/or improper installation will void all warranties provided by ACO.

Materials
TD300 channel shall be manufactured from polyester resin polymer concrete with integrally cast-in ductile iron edge rails with anti-shunt lugs.

Properties of polymer concrete will be as follows with supporting documentation:

Compressive Strength:	98 MPa
Flexural Strength:	26 MPa
Tensile Strength:	14 MPa
Water Absorption:	0.07%
Frost Proof:	YES
Coefficient of Expansion and Contraction:	2.02×10^{-5}/°C
Water Vapour Transmission:	0.0364g/m²
Non Flammable:	YES
Roughness (Mannings):	n=0.011
Resistant to Weathering:	YES
Dilute Acid and Alkali Resistant:	YES
SF Sealant Groove:	YES

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SPEC INFO ACO

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ACO Specification Information

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FOI 26-292 - Document 27

ACO INFRASTRUCTURE®

TD300 Iron Hi-Flo grate

Product Features

Certified to AS 3996 Load Class D (210kN)
(NATA endorsed load test reports available)

AS 3996 (Clause 3.3.6) compliant for bicycle tyre penetration resistance

- Large aperture inlets for high water intake
- Recesses in grate fit around 'anti-shunt' lugs on the edge rail to prevent longitudinal movement
- PowerLok boltless locking system
- Suitable for use with TD300 channels
- Manufactured from ductile iron to AS 1831 Grade 500-7



Specifications

The grate shall be ACO TD300 Iron Hi-Flo grate with **PowerLok** boltless locking system as manufactured by ACO. This grate has an overall width of 337mm and overall length of 500mm. Slot widths measure at a maximum of 80mm.

Materials & Design

The grate shall be manufactured from ductile iron and have **minimum** properties and characteristics as follows:

- Large aperture inlets for high water intake
- Recesses in grate fit around 'anti-shunt' lugs on the edge rail to prevent longitudinal movement
- Manufactured from ductile iron to AS 1831 Grade 500-7
- Certified to AS 3996 Load Class D (210kN)[1]
- Meets AS 3996 (Clause 3.3.6)
- Intake area of 84,500mm² per half metre of grate

[1] NATA endorsed test reports available

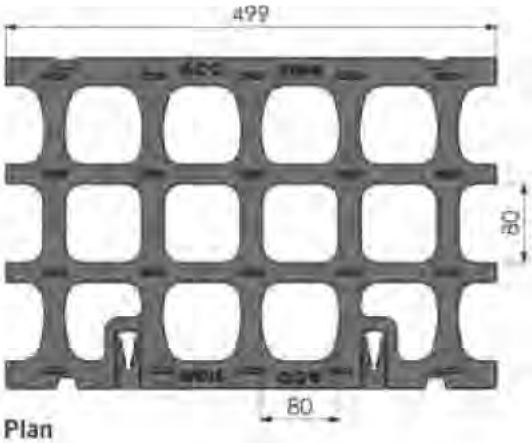
For the specification of the ACO TraffikDrain channel system selected, click: http://www.acoaus.com.au/infrastructure

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ACO INFRASTRUCTURE®

TD300 Iron Hi-Flo grate





Plan



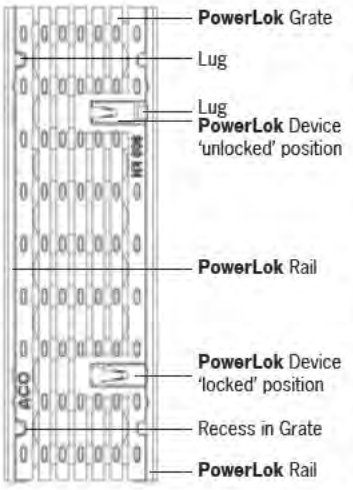
Side Elevation



End Elevation

Description	Part No.	Length (mm)	Width (mm)	Weight (kg)
PowerLok grate				
TD300 Iron Hi-Flo	**142128**	500	337	10.5
Grate removal tool	**01318**	-	-	0.1
PowerLok safety clip	**10443**	-	-	-

PowerLok locking mechanism



ACO **PowerLok** is a patented boltless locking system, grates are removed and replaced with the minimum time and effort for ease of maintenance.

Lugs on the rail opposite the **PowerLok** device slots into recesses in the grate, the **PowerLok** device is used to engage the lug on the rail at two locations per grate to 'lock' the grate to the channel.

ACO Pty Ltd
Australia

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ACO Limited
New Zealand

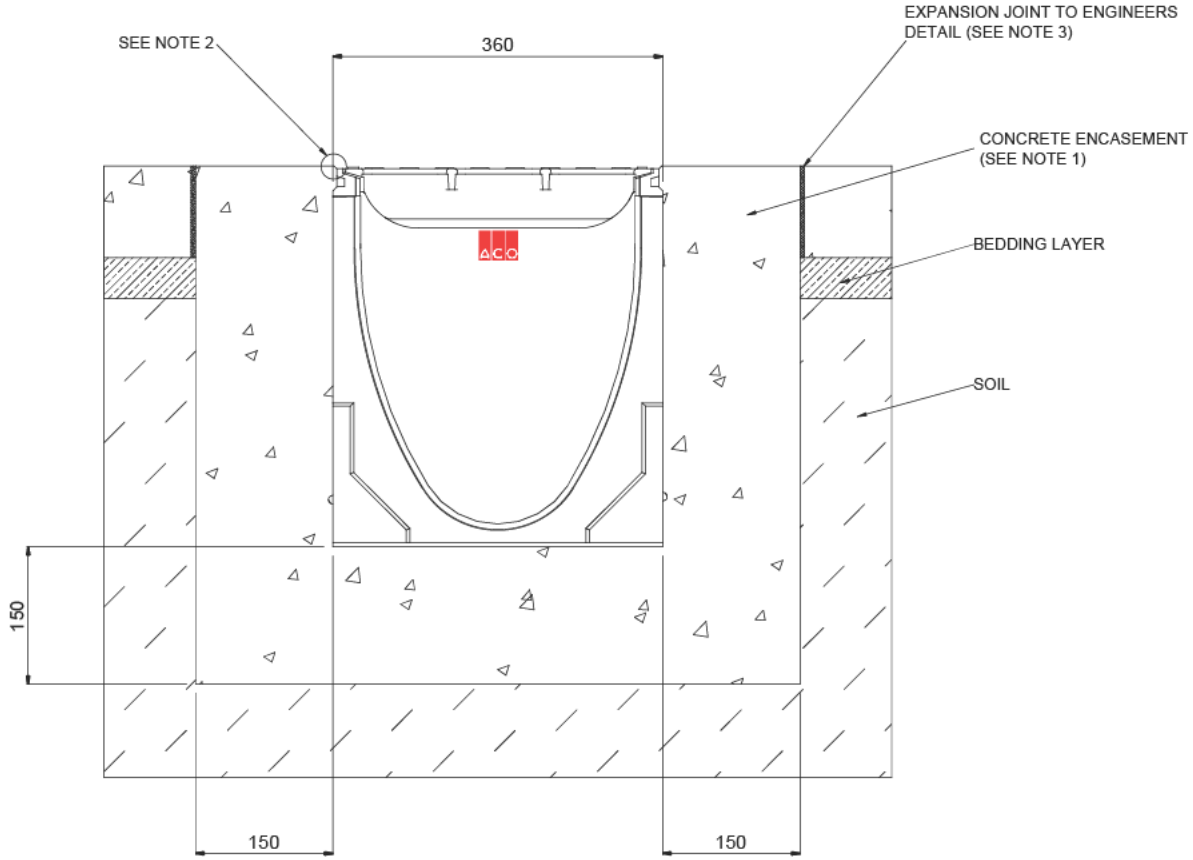
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FOI 26-292 - Document 27



NOTES:
1. Specific site conditions may require an increase in the concrete encasement dimensions and/or reinforcement. It is the customer's responsibility to ensure the concrete encasement is designed for the application. A minimum concrete strength of 25MPa is recommended. The concrete should be vibrated to eliminate air pockets. *Engineering advice may be required.*
2. The finished level of the concrete encasement must be approximately 3mm above the top of the channel edge.
3. Expansion and crack control joints are recommended to protect the channel and the concrete encasement. *Engineering advice may be required.*
4. For further details, refer to ACO's design & site installation files at www.acodrain.com.au/resources.html

SPECIFICATION CLAUSE
TRAFFIKDRAIN TD300 - LOAD CLASS D

GENERAL
THE SURFACE DRAINAGE SYSTEM SHALL BE ACO'S TRAFFIKDRAIN TD300 POLYMER CONCRETE V-PROFILE CHANNEL SYSTEM WITH DUCTILE IRON EDGE RAILS AS MANUFACTURED BY ACO.

MATERIALS
TD300 CHANNELS SHALL BE MANUFACTURED FROM POLYESTER RESIN POLYMER CONCRETE WITH AN INTEGRALLY CAST-IN DUCTILE IRON EDGE RAIL. PROPERTIES OF POLYMER CONCRETE WILL BE AS FOLLOWS WITH SUPPORTING DOCUMENTATION:

COMPRESSIVE STRENGTH:	**98 MPa**
FLEXURAL STRENGTH:	**26 MPa**
TENSILE STRENGTH:	**14 MPa**
WATER ABSORPTION:	**0.07%**
FROST PROOF:	**YES**
COEFFICIENT OF EXPANSION/CONTRACTION:	**2.02×10^{-5}/°C**
WATER VAPOUR TRANSMISSION:	**0.0364g/m²**
NON FLAMMABLE:	**YES**
COEFFICIENT OF ROUGHNESS (MANNINGS):	**n=0.011**
RESISTANT TO WEATHERING:	**YES**
DILUTE ACID AND ALKALI RESISTANT:	**YES**
SF SEALANT GROOVE	**YES**

CHANNELS
TD300 CHANNEL SHALL BE 300mm NOMINAL INTERNAL WIDTH WITH AN OVERALL WIDTH OF 360mm. CHANNEL INVERT SHALL HAVE A V-PROFILE TO ALLOW EFFICIENT DRAINAGE. TD300 SLOPED CHANNELS SHALL HAVE A BUILT-IN SLOPE OF 0.5%. ALL CHANNELS SHALL BE INTERLOCKING WITH A MALE/FEMALE JOINT.

GRATES
INSERT SPECIFICATION FOR THE SELECTED GRATE. REFER TO THE RELEVANT ACO SPECIFICATION INFORMATION SHEET, CLICK HERE.

INSTALLATION
THE COMPLETE DRAINAGE SYSTEM SHALL BE BY ACO AND TO BE INSTALLED FOR ITS INTENDED PURPOSE. ANY DEVIATION OR PARTIAL USE OF THE SPECIFIED SYSTEM AND/OR IMPROPER INSTALLATION WILL VOID ALL WARRANTIES PROVIDED BY ACO.

XIT3-DC

DATE: 02/14

TD300 - TRAFFIKDRAIN - LOAD CLASS: D
FOR CONCRETE SLAB

INSTALLATION DRAWING - ACO DRAIN

ACO Polycrete Pty Ltd
Australia
Ph: 1300 765 226
www.acodrain.com.au

ACO Limited
New Zealand
Ph: 0800 448 080
www.acodrain.co.nz

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TECHNICAL DATA SHEET:
TYPICAL VALUES

BIDIM®

Nonwoven Geotextiles







bidim geotextile is the most well known nonwoven geotextile product on the market today.

bidim leads the way in terms of technical performance and versatility and has applications in virtually every civil engineering construction project.

bidim nonwoven geotextiles provide an effective, economical solution to a range of engineering problems including weak soil, rutted and cracked roads and liquid and gas leaks from landfill sites.

bidim nonwoven geotextiles provide excellent filtration, separation and cushioning properties and feature a strong three-dimensional structure with high elongation. bidim nonwoven geotextiles also have a high melting point and high UV resistance.

All bidim nonwoven geotextiles are manufactured in Australia to ISO 9001 standards and are supported by a rigorous MQA process as well as being designed to meet the requirements of Australian and New Zealand road and rail authorities.

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GEOFABRICS®
Smarter Infrastructure

SECTOR SUITABILITY

Roads · Rail · Coastal · Waste · Mining · Civic & Landscaping · Ports & Aviation · Water · Primary Industries · Sports & Recreation · Slopes & Walls · Building

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BIDIM NON WOVEN GEOTEXTILES - A12 - A64 TYPICAL VALUES

Technical Data

TEST	STANDARD	UNITS	A12		A14		A24		A34		A44		A64	
Mechanical Properties														
Wide Strip Tensile Strength (MD/XMD)	AS3706.2	kN/m	8.0	8.0	11.0	11.0	14.0	14.0	18.5	18.5	26.5	26.5	37.5	37.5
Wide Strip Toughness (MD/XMD)	AS3706.2	kJ/m^2	1.5	1.5	3.1	3.1	2.7	2.7	3.5	3.5	4.8	4.8	8.2	8.2
Grab Tensile Strength (MD/XMD)	AS3706.2	N	500	500	720	720	850	850	1,270	1,270	1,850	1,850	2,620	2,620
Trapezoidal Tear Strength (MD/XMD)	AS3706.3	N	200	200	300	300	345	345	440	440	590	590	830	830
CBR Burst Strength	AS3706.4	N	1,500		2,000		2,500		3,400		4,650		6,400	
G Rating	Austroads	-	1,200		1,550		1,900		2,510		3,500		5,100	
Hydraulic Properties														
Pore Size (095)	AS3706.7	µm	130		110		80		75		75		75	
Permittivity	AS3706.9	s^{-1}	3.40		3.20		2.65		1.75		1.35		0.90	
Coefficient of Permeability	AS3706.9	m/s x10^{-4}	43		43		43		43		43		43	
Flow Rate @ 100mm Head	AS3706.9	$l/m^2/sec$	340		320		265		175		135		90	

The typical values published in this leaflet are to the best of our knowledge true and correct. The product specification may change at any time without prior notice. No warranty is expressed or implied. Manufactured by Geofabrics Australasia Pty Ltd in a facility certified to the ISO 9001 Quality Management System Standard.

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TECHNICAL DATA SHEET:

COIR NET

Biodegradable Erosion Control Mat

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Coir Net biodegradable erosion control mat is manufactured from 100% natural coir fibre extracted from coconut husk.

Coir Net has both greater tensile strength and life expectancy than other bio-degradable products due to the strong fibrous quality of coir fibre. It can last up to 48 months depending on the climatic conditions.

Due to its smaller aperture size Coir Net protects both seed and tube stock prior to germination from wind and water erosion.

Coir Net can be used in both seeded revegetation applications for grass establishment or tube stock revegetation. The coir fibre can retain moisture providing ideal germination conditions while protecting soil from erosion.

Coir Net can be used for:

- Revegetation of slopes up to 1:1 grade
- Wetland construction and establishment
- Channel and river bank revegetation protection
- Swale drains
- Mining rehabilitation works.

SECTOR SUITABILITY

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Coir Net biodegradable erosion control matting is available in three grades: 400gsm, 700gsm and 900gsm.

PROPERTY	400GSM	700GSM	900GSM
Roll Size	2 m x 25 m	2 m x 25 m	2 m x 25 m
Colour	Brown	Brown	Brown
Material	Coconut Fibre	Coconut Fibre	Coconut Fibre
Mesh Aperture Size	25 mm x 25 mm	12 mm x 12 mm	8 mm x 8 mm
Thickness	7.6 mm	7.6 mm	7.6 mm
Tensile Strength	643 x 205 kg/m	2,006 x 931 kg/m	2,490 x 1,050
Elongation	26% x 32%	34% x 38%	36% x 40%
Flexibility (mg/cm)	19,920 x 16,790	65,050 x 29,590	76,590 x 37,400
Maximum Flow Velocity	2.7 m/s	3.3 m/s	4.2 m/s
Weight (tolerance 5% +/-)	400 gsm	700 gsm	900 gsm
C Factor	0.002	0.002	0.002
Open Area Measured	65%	50%	34%
Slope (Recommended)	<2h:1v	>1h:1v	>1h:1v

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FOI 26-292 - Document 27



TEC Mat® Coir

Erosion Control

TEC Mat® Coir is a natural fibre matting made from 100% natural coconut fibre that is spun and woven into a matting available in various grades. TEC Mat® Coir is an open weave geotextile that is fully biodegradable adding organic matter to the soil. As coir is an abundant and renewable resource, TEC Mat® Coir is widely used in civil engineering, landscape and slope stabilisation applications. When vegetated, it has the mechanical strength necessary to hold soil in place and prevent erosion. The coir netting slows down runoff from heavy rains and dissipates the energy of flowing water and wind. TEC Mat® Coir also promotes the growth of new vegetation by absorbing water and preventing the topsoil from drying out.



TEC Mat® Coir has double the life of jute and higher tensile strength than other organic geotextiles with longevity of around 3-5 years. This allows ample time for natural vegetation to establish and therefore stabilise the area.

TEC Mat® Coir is ideally suited for preventing and controlling erosion even on steep slopes. When installed according to our recommendations and planted into or seeded, the TEC Mat® Coir will not only stabilise the area but also retain moisture and assist seed germination.

Specifications

Conditions	TEC Mat® Coir 4	TEC Mat® Coir 7	TEC Mat® Coir 9
	Level 1	Level 2	Level 3,4,5
Water Flow Velocity (m/s) (observed)	2.7	3.8	4.8
Slope/Profile	<70°	<70°	<85°
Minimum Vegetation Required	Tube Plants	Tube Plants or Gro-Tubes	Gro-Tubes
Open area measured (per sqm)	65%	50%	39%
Mass per unit area	400gsm (nominal)	700gsm	900gsm
Thickness (at 2kPa)	7mm (nominal)	7.5mm	7.5mm
Roll Size	2m x 25m	2m x 25m	2m x 25m

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Consult Polyfabrics Australasia or a certified Engineer for site specific installation instructions. Polyfabrics Australasia reserves the right to change its product specification at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance.

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TEC Mat® Coir

Erosion Control

INSTALLATION GUIDE

TEC Mat® Coir is an effective way to prevent soil erosion on slopes and re-establish natural vegetation. The coir matting is easy to install and is fully biodegradable. Apart from the usual maintenance required to sustain the vegetation, no further work is needed after the initial installation.

1. Prepare the area to be treated to a smooth even grade. Remove all protruding rocks, root stumps, etc. and treat the soil to promote maximum plant growth.
2. Lay the TEC Mat® Coir rolls in the direction of water flow. Adjoining rolls should be overlapped by a minimum of 100mm.
3. TEC Mat® Coir should be overlapped away from prevailing wind and water flow direction.
4. A trench, no less than 300mm deep, should be dug at the top of the embankment. Peg the TEC Mat® Coir down into the trench at a minimum of 1m centres or closer. Backfill the trench and compact.
5. Depending on the steepness of the slope, TEC Mat® Coir should be pegged at a minimum of 1m centres, (i.e. the more pegs used, the more secure the matting will be) with particular attention being paid to side and end runs. Side and downhill joins should overlap by no less than 100mm with the top run overlapping.
6. As water velocities increase, TEC Mat® Coir should be pinned at reduced centres.
7. Peg down the nettings as above using steel pegs to suit the site.
8. Vegetate the site as specified.
9. Maintain and water the site as required to promote the growth of vegetation.



NOTE

All erosion control matting should be pinned at 1 metre centres or closer if required.
For steep slopes and embankments, EcoLogs® will provide an added barrier to reinforce the use of products listed above. EcoLogs® should be staked at 1 metre intervals.

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ADMIX C-5000

CEMENTITIOUS CRYSTALLINE

Durability Enhancing & Waterproofing Admixture

Description

XYPEX ADMIX C-5000 is a unique chemical treatment that has been specially formulated to enhance the durability of reinforced concrete exposed to aggressive conditions as well as delivering superior □ □ □ □ □ □ □performance to concrete. Xypex Admix C-5000 is added to the concrete mix at the time of batching.

Features and Benefits

Xypex Admix C-5000 is a powdered additive consisting of Portland cement and various active proprietary chemicals. These active chemicals react with the moisture in fresh concrete and the by-products of cement hydration to cause a catalytic reaction which generates a non-soluble crystalline formation throughout the pores, capillary tracts, and microcracks within the concrete. Crystalline formation prevents penetration of deleterious substances and water into ordinary or blended Portland cement concrete, significantly. Experimental investigations conducted in Australia, Canada, and Japan have demonstrated that Xypex Admix C-Series enhance the durability of the concrete exposed to aggressive environmental conditions such as, but not limited to, marine environment, sulphate attack, and acid attack whilst maintaining excellent hydrostatic pressure resistance.

NOTE: The Xypex Admix C-Series has been specially formulated to meet varying project and temperature conditions (see Setting Time and Strength). Consult with a Xypex Representative to determine the most appropriate Xypex Admix and to obtain technical support literature for your project.

Compliance

Xypex Admix C-5000 complies with the requirements of AS 1478.1, as a type SN Special Purpose Admixture.

Recommended For:

- Marine Structures
- Water and Wastewater Treatment Plants and Sewage Systems
- Secondary Containment Structures
- Chemical Processing Facilities
- Reservoirs, Dams and Irrigation Structures
- Power Generating Stations
- Foundations / Basements / Parking Structures
- Bridges
- Tunnels, Subway Systems and Underground Vaults
- Pre-Stressed and Pre-Cast Components
- Shotcrete Installations
- Swimming Pools and Aquatic Facilities

Advantages

- Improves fresh and hardened concrete properties
- □ □ □ □ □ □

DRYING SHRINKAGE

AS 1012.13, "Determination of Drying Shrinkage of Concrete", Australia Centre of Construction and Innovation, University of New South Wales, Sydney, Australia

Concrete samples incorporating Xypex Admix C-5000 indicated lower drying shrinkage by up to 25% compared to the control mixes using Type-GB cement.

PERMEABILITY

ACCI Water Permeability Test, "Water Permeability of Concrete", Australia Centre of Construction and Innovation, University of New South Wales, Sydney, Australia

Concrete samples containing Xypex Admix C-5000 were tested for water permeability against control samples. All the samples were subjected to a pressure of 10 bars (100 meters water-head) for 2 weeks. Water permeability were calculated and the Xypex Admix concrete showed reduction in water permeability by up to 81%.

CHEMICAL RESISTANCE

AS2350.14, "Length Change in Sulphate Solution", Australia Centre of Construction and Innovation, University of New South Wales, Sydney, Australia

Potential expansion of concrete in sulphate environments was assessed in accordance with AS2350.14 by immersing samples in a sulphate solution over 16 weeks. Concrete samples containing Xypex Admix C-5000 were tested against untreated control samples for sulphate resistance. The test data showed the use of Xypex Admix demonstrated improvements in sulphate resistance (low expansion) by up to 26%.

NT BUILD 443, ACCI Modified Test, "Chloride Diffusion by NordTest with 3% NaCl solution", Australia Centre of Construction and Innovation, University of New South Wales, Sydney, Australia

Xypex Admix concretes were immersed in a 3.0% sodium chloride solution for at least 35 days. The chloride were calculated according to Fick's Second Law based on the chloride content in the concrete samples after immersion. - cant reductions in the chloride were found with all the Xypex Admix concretes by up to 50% compared to control concretes. The concretes with Xypex Admix C-5000 demonstrated the highest level of protection against chloride ingress in the testing.

POTABLE WATER EXPOSURE

AS/NZS 4020 "Products for Use in Contact with Drinking Water", Australian Water Quality Centre, Adelaide, South Australia

Exposure testing of potable water in contact with Xypex-

Directions for Use

Xypex Admix C-5000 is added to the concrete at the time of batching. It is important to obtain a homogeneous mixture of Xypex Admix with the concrete. Do not add dry Admix powder directly to wet mixed concrete as this could cause clumping and thorough dispersion may not occur. The sequence of procedures for addition will vary according to the type of batch plant operation and equipment. The following methods have been used successfully in the past and it is recommended that the local Xypex Representative be consulted about the best method to use.

1. ADDITION TO COARSE AGGREGATE BELT Add Xypex Admix powder directly to the coarse aggregate conveyor belt manually or through computer controlled mass batching system. Account for worker health and safety issues with moving belts and wind-blown dust issues.

2. TRUCK ADDITION (AT PLANT) Add Xypex Admix in bulk powder or soluble bag form to the drum of the ready-mix truck immediately prior to driving the truck under the batch plant and adding the balance of the materials or the premixed concrete in accordance with standard concrete batching practices. Measures to ensure soluble bags are dispersed include adding the bags as far forward in the drum as possible, adding a small amount of batch water with the bags, and spinning the drum prior to adding remaining ingredients. Avoid delays in adding other components and utilise high speed mixing to ensure homogeneity of mix. Where there may be water for thorough dispersion of the bulk powder, a water slurry can be made with the Admix added to the truck mixer drum prior to batching. Account for added water in the mix design and slump.

3. ADDITION TO CENTRAL MIXER Load the Admix in bulk powder form or in soluble bags along with the other components. Mix as per standard batching practices to ensure thorough dispersal of the Admix resulting in a homogeneous mixture. Account for worker safety issues when accessing the equipment.

NOTE

i. Although not normally recommended, should on-site dosing of Xypex Admix be required, the admix shall be added in slurry form to the concrete mixture in the mixing truck. Mix the slurry with a ratio of 1kg of powder to 1.85kg of clean water in a suitable container with at least twice the volume of the mixture. Use appropriate mixing equipment and pestle to ensure any clumps of powder disperse and all of the admixture is hydrated. All water added to the slurry mixture is to be included in the concrete mix design including water needed to remove any residual paste. Add the water to the powder slowly and mix gradually to avoid reaction and spillage. Add the slurry mixture to the concrete mixer en-

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suring thorough dispersion occurs. Clean □ □any residue into the concrete mix by using additional free water. Mix the dosed concrete for a minimum of 5 minutes on high speed to fully disperse the admixture. Should personnel not be experienced in the dosing of Xypex Admix, Xypex recommends that trial mixing be conducted.

ii. Concrete containing the Xypex Admix does not preclude the requirement for design of crack control, construction joint detailing, proper placement, consolidation and curing of the concrete and measures for repairing defects such as honeycombing, tie holes, cracks beyond □ □ □ □ □ □ □ □ □

iii. Further guidelines are available that address the use of Xypex Admix for a □ □ □ □□□
use of ice in hot concrete, cold-weather concreting, etc.). Consult with a local Xypex Representative or Xypex Australia's Technical Department for further information.

Setting Time and Strength

The setting time of concrete is □ □ □ □ □ - cal and physical composition of ingredients, temperature of the concrete and climatic conditions. Extension of set time may occur when using Xypex Admix C-5000. The amount of extended set will depend upon the concrete mix design and the dosage rate of the Admix. Concrete containing Xypex Admix may develop higher ultimate strengths than plain concrete.

Trial mixes should be carried out under project conditions to determine setting time and strength of the concrete.

Limitations

When incorporating Xypex Admix, the temperature of the concrete mix should be above 4ºC.

Technical Services

For more instructions, alternative application methods, or information concerning the compatibility of the Xypex treatment with other products or technologies, contact the Technical Department of Xypex Australia or your local Xypex Representative.

Safe Handling Information

Xypex is alkaline. As a cementitious powder or mixture, Xypex may cause □ □ □ □ □ skin and eye irritation. Directions for treating these problems are clearly detailed on all Xypex buckets and packaging. The Manufacturer also maintains comprehensive and up-to-date Material Safety Data Sheets on all its products. Each sheet contains health and safety information for the protection of your employees and customers. Contact Xypex Australia or your local Xypex Representative to obtain copies of Material Safety Data Sheets prior to product storage or use.

Warranty

Concrete W□ □ □ □ □ □ □ - ing as Xypex Australia) (the "Manufacturer") warrants that the products manufactured by it shall be free from material defects and be of a consistent quality. Should any of the products be proven defective, the liability of the Manufacturer shall be limited to replacement of the product ex-factory. The Manufacturer gives no warranty as to □ □ □ □of the products for any particular purpose. The user shall: determine the suitability of the product for its intended use; comply with the directions for use and safe handling information available from Xypex; and assume all risks and liabilities in connection with the use of this product.

Sustainability

Both GreenTag LCARate and GreenRate are recognised third party certification schemes for Green Star® in Australia and NZ and can certify in a single certificate all Materials Calculators, VOCs, Formaldehyde Reduction, Best Practice PVC and Post Consumer Recycled Content credits. GreenTag is a unique Australian Competition and Consumer Commission (ACCC) approved National Certification Mark and is also registered as a Certification Mark in the EU and UK and is also the Preferred Certifier for the EarthCheck Eco-hospitality certification program.



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Fosroc® Conbextra® GP

constructive solutions

General purpose, high flow, Class A shrinkage compensated grout - (gaps 10mm to 100mm thickness)

Uses

Conbextra GP is used for general purpose grouting where it is essential to eliminate shrinkage when completely filling voids or grouting between a base plate and substrate, e.g. the grouting of a stanchion base plate. It can also be used for anchoring a wide range of fixings such as masts and anchor bolts.

Advantages

- High ultimate strength and low permeability ensure the durability of the hardened grout
- Gaseous expansion system compensates for shrinkage and settlement in the plastic state
- Can be dry packed, rammed, trowelled, poured and pumped
- Pre-packaged material overcomes potential on-site mixing variations
- Develops high early strength without the use of chlorides
- No metallic iron content to cause staining
- Complies to AS/NZS 4020:2005 Products in Contact with Potable Water

Description

Conbextra GP, a general purpose shrinkage compensated cementitious grout, is supplied as a ready to use dry powder. The addition of a controlled amount of clean water produces a flowing shrinkage compensated grout for gap thicknesses from 10mm up to 100mm.

Conbextra GP is a blend of Portland cement, graded fillers and chemical additives which impart controlled expansion in the plastic state whilst minimising water demand. The low water demand ensures high early strength. The graded filler is designed to assist uniform mixing and produce a consistent grout.

Maximum aggregrate size for pumping is 0.7mm.

Standards compliance

AS 1478.2-2005 Appendix E Early Volume Change

AS1478.2-2005 Table 4.1.2.2 Consistency

AS/NZS 4020:2005 Products in Contact with Drinking Water

Specification clauses

Supplier specification

All grouting where shown on the drawing must be carried out using Conbextra GP manufactured by Fosroc and used in accordance with the manufacturer's data sheet.

Performance specification

To the nominated area(s) (specify details and areas of application), grouting must be carried out using a pre-packaged, chloride free, dry powder blend of cements, graded fillers and chemical additives.

It is to be mixed with clean water to the required consistency. The plastic grout must not bleed or segregate. The storage, handling and placement of the grout must be in strict accordance with the manufacturer's instructions.

A positive volumetric expansion of 1-3% shall occur while the grout is plastic by means of a gaseous system.

It shall exhibit Flow Characteristics when tested to AS 1478.2.2005 of 400 - 600mm flow trough procedure.

The compressive strength of the grout must exceed 43MPa at 7 days and 65MPa at 28 days when used at a flowable consistency.

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Fosroc®
Conbextra® GP

Properties

Test Method	Standard	Result				
Compressive Strength	AS 1478.2:2005	Consistency	Water Addition	1 Day	7 Days	28 Days
		Stiff	2.9-3.6	34	50	75
		Plastic	3.6-3.8	33	45	70
		Flowable	3.8-4.0	32	43	65
Flexural Strength (Modulus of Rupture)	AS 1012.11 - 2000	1 Day 7 Days 28 Days	4.4 MPa 8.7 MPa 13.6 MPa			
Indirect Tensile Strength	AS 1012.10.2000	1 Day 7 Days 28 Days	3.5 MPa 5.6 MPa 6.1 MPa			
Setting Time	AS 1012.18:1996	5.5 hours - initial set 7.5 hours - final set				
Fresh Wet Density		2200 kg/m³ - depending on consistency used				
Alkali reactive particles	Rapid Mortar Bar Test (RTA T363)	Non-reactive				
Flow Characteristics	AS 1478.2:2005	400 - 600mm (Flow Trough)				
Minimum Thickness **Maximum Thickness**		10 mm 100 mm				

Clarification of property values: The typical properties given above are derived from laboratory testing. Compressive strengths stated above were measured using cube samples. Test results obtained will vary if carried out to an alternative standard or sample dimensions are used.

Note: Compressive strengths stated were measured at bottom end water, eg., the 28 day strength of 65 MPa for flowable consistency was obtained at a water addition of 3.8 litres water per 20kg bag of Conbextra GP.

Test Results to ASTM Specification C1107: 2001

Test Method	Standard	Result	
Flow Consistency	ASTM C1437:2007	144%	
Setting Time	ASTM C191:2008	Initial: Final:	4.75 hours 5.25 hours
Plastic Volume Change	ASTM C827:2010	+0.55%	
Hardened Volume Change	ASTM C1090:2010	1 day 3 days 14 days 28 days 56 days	0.08% 0.08% 0.08% 0.07% 0.04%
Compressive Strength	ASTM C109:2011b	1 day 3 days 7 days 28 days	37.8 MPa 55.2 MPa 60.3 MPa 68.6 MPa

Note: All tests were carried out at 25°C ± 2°C until the age of the test. All above test results are independent third party results.Copies of these test results are available on request. The tests were carried out at a water addition rate of 3.8L per 20kg.

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Fosroc®
Conbextra® GP

Application Instructions

Preparation

Foundation surface

The substrate surface must be free from oil, grease or any loosely adherent material. If the concrete surface is defective or has laitance, it must be cut back to a sound base. Bolt holes or fixing pockets must be blown clean of any dirt or debris.

Pre-soaking

Several hours prior to grouting, the area of cleaned foundation should be flooded with fresh water. Immediately before grouting takes place, any free water should be removed with particular care being taken to blow out all bolt holes and pockets.

Base plate

It is essential that this is clean and free from oil, grease or scale. Air pressure relief holes should be provided to allow venting of any isolated high spots.

Levelling shims

If these are to be removed after the grout has hardened, they should be treated with a thin layer of grease.

Formwork

The formwork should be constructed to be leakproof. This can be achieved by using foam rubber strip or silicone sealant beneath the constructed formwork and between joints.

In some cases it is practical to use a sacrificial semi-dry sand and cement formwork. The formwork should include outlets for pre-soaking.

This must be kept to a minimum. Generally the gap width between the perimeter formwork and the plate edge should not exceed 150mm on the pouring side and 50mm on the opposite side. It is advisable where practical to have no gap at the flank sides.

Mixing

A forced-action mixer is essential. Mixing at a slow speed A forced-action mixer is essential. Mix for 3 to 5 minutes at a slow speed (400/500rpm) in a suitably sized drum using appropriate equipment such the Ransom MDR59 140 x 600 M14 Helical mixing paddle (product code: N4020892-UNIT) fitted to a heavy-duty 1600W mixer, such as Ransom RAN160 (product code: NP7AN160-UNIT) or equivalent.

Larger quantities will require a high shear vane mixer. Do not use a colloidal impeller mixer.

To enable the grouting operation to be carried out continuously, it is essential that sufficient mixing capacity and labour are available. The use of a grout holding tank with provision to gently agitate the grout, following correct mixing, may be required.

Placing

At 20°C place the grout within 20 minutes of mixing to gain full benefit of the expansion process.

Conbextra GP can be placed in thicknesses from 10mm up to 100mm in a single pour when used as an underplate grout. Where the grouting gap beneath the base plate exceeds the maximum thickness allowed, then the grout can filled / bulked out with Conbextra Grout Aggregate to minimise exotherm heat build up. Alternatively Conbextra Deep pour is available for pours up to 500mm thick.

Filling/bulking out of the grout should not exceed a ratio of 2:1 grout:aggregate by weight. Please refer to the Conbextra Grout Aggregate TDS for more guidance on bulking out of cement based grouts.

Any bolt pockets must be grouted prior to grouting between the substrate and the base plate.

Continuous grout flow is essential. Sufficient grout must be prepared before starting. The time taken to pour a batch must be regulated to the time to prepare the next one.

Pouring should be from one side of the void to eliminate any air or pre-soaking water becoming trapped under the baseplate. It is advisable to pour the grout across the shortest distance of travel. The grout head must be maintained at all times so that a continuous grout front is achieved.

Flow properties of mixed grout

The flow distances given below in (mm) are intended as a guide. Actual flow distances will vary depending on site conditions:

Gap Depth (mm)	Flowable 100mm head (mm)	Flowable 250mm head (mm)
10	320	1080
20	850	2300
30	1350	2700
40	2000	2700+
50	2700	2700+

Pumping

Where large volumes have to be placed Conbextra GP may be pumped. The maximum aggregate size in Conbextra GP is 0.7mm, only use pumps capable of pumping this size aggregate.

Curing

On completion of the grouting operation, exposed areas should be thoroughly cured. This should be done by the use of Concure curing membrane, continuous application of water and/or wet hessian.

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Conbextra® GP

Cleaning

Conbextra GP should be removed from tools and equipment with clean water immediately after use. Cured material can be removed mechanically.

Limitations

Low temperature working

When the air or contact surface temperatures are 5°C or below on a falling thermometer, warm water (30 - 40°C) is recommended to accelerate strength development.

For ambient temperatures below 10°C the formwork should be kept in place for at least 36 hours.

Normal precautions for winter working with cementitious materials should then be adopted.

High temperature working

At ambient temperatures above 35°C cool water (below 20°C) should be used for mixing the grout prior to placement.

Supply

Conbextra GP 20kg:	FC501020-20KG

Yield

Allowance should be made for wastage when estimating quantities required. The approximate yield of a 20kg bag for different consistencies is:

Consistency (AS 1478.2 - 2005 Table 4.1.2.2)	Yield (Litres of mixed material)
Stiff	10.6
Plastic	10.7
Flowable	10.8

Storage

Conbextra GP has a shelf life of 36 months from date of manufacture if kept in the original, unopened bags. Refer to the manufacture date indicated on the packaging. Do not use if there are lumps in the product, or a loss of workability (requiring more water to be added) is experienced.

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Important notice

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Product disclaimer

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Fosroc®
Conbextra® HES

FOSROC constructive solutions

High early strength, rapid setting, flowable, cementitious precision grout

Uses

Conbextra HES is used for free flow grouting in a wide range of applications where rapid strength gain is a prerequisite.

Advantages

- Rapid strength gain facilitates rapid installation and operation of plant within a matter of hours
- High strength gain is achievable even at low temperatures
- Excellent initial flow and flow retention
- Unique system compensates for shrinkage in hardened state
- High ultimate strength and low permeability ensure durability of the hardened grout
- Chloride free
- Suitable for pumping or pouring over a large range of application consistencies and temperatures

Description

Conbextra HES, rapid set high strength cementitious precision grout, is supplied as a ready to use powder. The addition of a controlled amount of clean water produces a free-flowing grout for gap thicknesses of 15 - 150mm. In addition the low water requirement ensures high early strength and long term durability.

Conbextra HES is a blend of cements, graded aggregates and additives which impart controlled expansion in hardened state. The aggregate grading minimises segregation and bleeding over a wide range of application consistencies.

Maximum aggregate size is 5.0mm.

Specification Clause

Performance specification

All grouting (specify details and areas of application) must be carried out with a pre-packaged cement based product, which is non-metallic and chloride-free.

It shall be mixed with clean water to the required consistency and not exhibit bleed or segregation.

The compressive strength of the grout must be at least 35MPa at 4 hours (Plastic consistency).

The storage, handling and placement of the grout must be in strict accordance with the manufacturer's instructions.

Application Instructions

Foundation surface

The substrate surface must be free from oil, grease or any loosely adherent material. If the concrete surface is defective or has laitance, it must be cut back to a sound base. Bolt holes or fixing pockets must be blown clean of any dirt or debris.

Pre-soaking

Several hours prior to grouting, the area of cleaned foundation should be flooded with fresh water. Immediately before grouting takes place, any free water should be removed. Particular care should be taken to blow out all bolt holes and pockets.

Base plate

It is essential that this is clean and free from oil, grease, paint or scale. Air pressure relief holes should be provided to allow venting of any isolated high spots.

Levelling shims

If these are to be removed after the grout has hardened, they should be treated with a thin layer of grease.

Formwork

The formwork should be constructed to be leakproof as Conbextra HES is a free flowing grout. This can be achieved by using foam rubber strip or silicone sealant beneath the constructed formwork and between joints.

In some cases it is practical to use a sacrificial semi-dry sand and cement formwork. The formwork should include outlets for the pre-soaking water.

The unrestrained surface area of the grout must be kept to a minimum. Generally the gap width between the perimeter formwork and the plate edge should not exceed 150mm on the pouring side and 50mm on the opposite side. There should be no gap at the flank sides.

Mixing

A forced-action mixer is essential. Mix for 3 to 5 minutes at a slow speed (400/500rpm) in a suitably sized drum using appropriate equipment such the Ransom MDR59 140 x 600 M14 Helical mixing paddle (product code: N4020892-UNIT) fitted to a heavy-duty 1600W mixer, such as Ransom RAN160 (product code: NP7AN160-UNIT) or equivalent.

Larger quantities will require a high shear vane mixer. Do not use a colloidal impeller mixer.

It is essential that machine mixing capacity and labour availability is adequate to enable the grouting operation to be carried out continuously. This may require the use of a holding tank with provision for gentle agitation to maintain fluidity.

The selected water content should be accurately measured into the mixer. Slowly add the total contents of the Conbextra HES bag, mix continuously for 5 minutes, ensuring a smooth, even consistency is obtained.

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Fosroc®
Conbextra® HES

Properties

Test Method	Standard	Result						
Compressive Strength	AS 1478.2:2005	Consistency	Water Addition	2 hours	4 hours	8 hours	24 hours	28 days
		Plastic	2.0-2.3	30	35	40	42	58
		Flowable	2.3-2.6	25	30	35	37	50
Flexural Strength (Modulus of Rupture)	AS 1012.11 - 2000	1 Day 7 Days 28 Days	3.0 MPa 4.5 MPa 6.5 MPa					
Indirect Tensile Strength	AS 1012.10.2000	1 Day 7 Days 28 Days	1.5 MPa 2.5 MPa 3.0 MPa					
Setting Time	AS 1012.18:1996	30-40 mins - initial set 50-50 mins - final set						
Fresh Wet Density		2200 kg/m³ - depending on consistency used						
Alkali reactive particles	Rapid Mortar Bar Test (RTA T363)	Non-reactive						
Flow Characteristics	AS 1478.2:2005	350mm (Flow Trough)						
Minimum Thickness **Maximum Thickness**		15mm 150mm						

Clarification of property values: The typical properties given above are derived from laboratory testing. Compressive strengths stated above were measured using cube samples. Test results obtained will vary if carried out to an alternative standard or sample dimensions are used.

Note: Compressive strengths stated were measured at bottom end water, eg., the 28 day strength of 50 MPa for flowable consistency was obtained at a water addition of 2.3 litres water per 20kg bag of Conbextra HES.

Test Results to ASTM Specification C1107: 2001

Test Method	Standard	Result	
Flow Consistency	ASTM C1437:2007	136%	
Setting Time	ASTM C191:2008	Initial: Final:	30 minutes 65 minutes
Plastic Volume Change	ASTM C827:2010	+0.38%	
Hardened Volume Change	ASTM C1090:2010	1 day 3 days 14 days 28 days 56 days	0.007% 0.04% 0.03% 0.03% 0.03%

Note: All tests were carried out at 25°C ± 2°C until the age of the test. All above test results are independent third party results. Copies of these test results are available on request. The tests were carried out at a water addition rate of 2.3L per 20kg.

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Conbextra® HES

Placing

Place the grout within 10 minutes of mixing.

Conbextra HES can be placed in thicknesses from 15mm up to 150mm in a single pour when used as an underplate grout. Where the grouting gap beneath the base plate exceeds the maximum thickness allowed, then the grout can filled / bulked out with Conbextra Grout Aggregate* to minimise exotherm heat build up. Alternatively Conbextra Deep pour is available for pours up to 500mm thick.

Filling/bulking out of the grout should not exceed a ratio of 1:1. Please refer to the Conbextra Grout Aggregate TDS for more guidance on bulking out of cement based grouts.Continuous grout flow is essential.

Sufficient grout must be available prior to starting and the time taken to pour a batch must be regulated to the time taken to prepare the next one.

The mixed grout should be poured only from one side of the void to eliminate the entrapment of air or surplus pre-soaking water. This is best achieved by pouring the grout across the shortest distance of travel. The grout head must be maintained at all times so that a continuous grout front is achieved.

Curing

On completion of the grouting operation, exposed areas should be thoroughly cured. This should be done by the use of a Concure curing membrane, or the continuous application of water and/or wet hessian.

Cleaning

Conbextra HES should be removed from tools and equipment with clean water immediately after use. Cured material can be removed mechanically.

Limitations

Low temperature working

When the air or contact surface temperatures are 15°C or below on a falling thermometer, warm water (30°C) is recommended to accelerate strength development.

For ambient temperatures below 15°C the grout consistency should be flowable and the formwork should be maintained in place for a minimum of 24 hours.

Normal precautions for winter working with cementitious materials should be adopted.

High temperature working

Conbextra HES should not be used at ambient temperatures above 35°C as premature setting of the grout may occur making handling and placement very difficult.

Supply

Conbextra HES 20kg:	FC501060-20KG

Yield per 20kg bag mixed	
Plastic consistency	10.0 litres
Flowable consistency	10.2 litres

Storage

Conbextra HES has a shelf life of 18 months from date of manufacture if kept in the original, unopened bags. Refer to the manufacture date indicated on the packaging. Do not use if there are lumps in the product, or a loss of workability (requiring more water to be added) is experienced.

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FOI 26-292 - Document 27

Fosroc®
Conbextra® HF

constructive solutions

Highly fluid, dual shrinkage compensated precision, cementitious grout for gaps 10mm to 125mm thick

Uses

Conbextra HF is used for free flow precision grouting in a wide range of applications. Typical pplications include:

- Critical machine base plates, sole plates and columns
- Joints between pre-cast concrete panels
- Pumped grouting applications
- Grouting applications where pouring access is restricted

Advantages

- Excellent initial flow and flow retention
- Rapid strength gain facilitates efficient installation and operation of plant
- High ultimate strength and low permeability ensure durability of the hardened grout
- Hydrogen-free gaseous expansion
- Chloride free
- Suitable for pumping or pouring

Standards Compliance

AS 1478.2-2005 Appendix E Early Volume Change

AS 1478.2-2005 Table 4.1.2.2 Consistency

Description

Conbextra HF, dual shrinkage compensated cementitious precision grout, is supplied as a ready to use dry powder. The addition of a controlled amount of clean water produces a free-flowing precision grout for gap thicknesses 10mm to 125mm. In addition the low water requirement ensures high early strength and long term durability.

Conbextra HF is a blend of Portland cements, graded fillers and chemical additives which impart controlled expansion in both the plastic and hardened states.

The filler grading minimises segregation and bleeding over a wide range of application consistencies.

Maximum aggregate size for pumping is 2.5mm.

Specification Clauses

Supplier specification

All precision grouting (specify details and areas of application) must be carried out using Conbextra HF manufactured by Fosroc and used in accordance with the manufacturer's current Technical Data Sheet.

Performance specification

To the nominated area(s) (specify details and areas of application), grouting must be carried out using a pre-packaged, non-metallic and chloride free, dry powder blend of cements, graded fillers and chemical additives.

It is to be mixed with clean water to the required consistency. The plastic grout must not bleed or segregate. The storage, handling and placement of the grout must be in strict accordance with the manufacturer's instructions.

A positive volumetric expansion up to 3% shall occur while the grout is plastic by means of a gaseous, hydrogen free system. Additionally the grout is to be formulated to compensate for long term shrinkage in the hardened state.

It shall exhibit Flow Characteristics when tested to AS 1478.2.2005 of 10 - 30 seconds using the flow cone procedure.

The compressive strength of the grout must exceed 40MPa at 7 days and 60MPa at 28 days.

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Properties

Test Method	Standard	Result				
Compressive Strength	AS 1478.2:2005	Consistency	Water Addition	1 Day	7 Days	28 Days
		Stiff	2.6-3.4	50	68	77
		Plastic	3.4-3.6	38	53	64
		Flowable	3.6-3.8	31	48	62
		Fluid	3.8-4.0	27	46	60
Flexural Strength (Modulus of Rupture)	AS 1012.11 - 2000	1 Day 7 Days 28 Days	3.2 MPa 9.5 MPa 10.0 MPa			
Indirect Tensile Strength	AS 1012.10.2000	1 Day 7 Days 28 Days	2.5 MPa 4.5 MPa 4.7 MPa			
Setting Time	AS 1012.18:1996	5.5 hours - initial set 7.5 hours - final set				
Fresh Wet Density		2200 kg/m³ - depending on consistency used				
Alkali reactive particles	Rapid Mortar Bar Test (RTA T363)	Non-reactive				
Flow Characteristics	AS 1478.2:2005	19-25 seconds (Flow Cone)				
Minimum Thickness **Maximum Thickness**		10mm 125mm				

Clarification of property values: The typical properties given above are derived from laboratory testing. Compressive strengths stated above were measured using cube samples. Test results obtained will vary if carried out to an alternative standard or sample dimensions are used.

Note: Compressive strengths stated were measured at bottom end water, eg., the 28 day strength of 62MPa for flowable consistency was obtained at a water addition of 3.6 litres water per 20kg bag of Conbextra HF.

Test Results to ASTM Specification C1107: 2001

Test Method	Standard	Result	
Flow Consistency	ASTM C1437:2007	145%	
Setting Time	ASTM C191:2008	Initial: Final:	5.75 hours 6.75 hours
Plastic Volume Change	ASTM C827:2010	+0.57%	
Hardened Volume Change	ASTM C1090:2010	1 day 3 days 14 days 28 days 56 days	0.12% 0.12% 0.12% 0.12% 0.10%
Compressive Strength	ASTM C109:2011b	1 day 3 days 7 days 28 days	34.4 MPa 53.5 MPa 63.7 MPa 70.1 MPa

Note: All tests were carried out at 25°C ± 2°C until the age of the test. All above test results are independent third party results. Copies of these test results are available on request. The tests were carried out at a water addition rate of 3.6 litres per 20kg.

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Fosroc®
Conbextra® HF

Flow properties of mixed grout

The flow distances given below in (mm) are intended as a guide. Actual flow distances will vary depending on site conditions:

Gap Depth (mm)	Flowable 100mm head (mm)	Flowable 250mm head (mm)	Fluid 100mm head (mm)	Fluid 250mm head (mm)
10	360	1200	900	2500
20	950	2600	1900	3000
30	1500	3000	3000	3000+
40	2200	3000+	3000+	3000+
50	3000	3000+	-	-

Preparation

Foundation surface

The substrate surface must be free from oil, grease or any loosely adherent material. Concrete laitance should be removed using low impact scabbling or with needle guns to the degree where aggregate is starting to show.

Bolt holes or fixing pockets must be blown clean of any dirt or debris. Bolt holes should also be roughen up using mechanical means.

Pre-soaking

Several hours prior to grouting, the area of cleaned foundation should be flooded with fresh water. Immediately before grouting takes place, any free water should be removed. Particular care should be taken to blow out all bolt holes and pockets.

Base plate / grout interface

It is essential that this is clean and free from oil, grease, scale, paint or coating of any kind. Air pressure relief holes should be provided to allow venting of any isolated high spots.

Levelling shims

If these are to be removed after the grout has hardened, they should be treated with a thin layer of grease.

Formwork

The formwork should be constructed to be leakproof as Conbextra HF is a free flowing grout. This can be achieved by using foam rubber strip or silicone sealant beneath the constructed formwork and between joints.

The formwork should include outlets for the pre-soaking water.

The unrestrained surface area of the grout must be kept to a minimum. Generally the gap width between the perimeter formwork and the plate edge should not exceed 150mm on the pouring side and 50mm on the opposite side. There should be no gap at the flank sides.

Mixing

A forced-action mixer is essential. Mix for 3 to 5 minutes at a slow speed (400/500rpm) in a suitably sized drum using appropriate equipment such the Ransom MDR59 140 x 600 M14 Helical mixing paddle (product code: N4020892-UNIT) fitted to a heavy-duty 1600W mixer, such as Ransom RAN160 (product code: NP7AN160-UNIT) or equivalent.

Larger quantities will require a high shear vane mixer. Do not use a colloidal impeller mixer.

It is essential that machine mixing capacity and labour availability is adequate to enable grouting operation to be carried out continuously. This may require the use of a holding tank with provision for gentle agitation to maintain fluidity.

The selected water content should be accurately measured into the mixer. Slowly add the total contents of the Conbextra HF bag, mix continuously for 5 minutes, ensuring a smooth, even consistency is obtained.

Deeper grout pours

Where grout gap depth is in excess of 125mm up to 500mm, Conbextra Deep Pour should be used.

Placing

Place the grout within 15 minutes of mixing to gain the full benefit of the expansion process.

Conbextra HF can be placed in thicknesses from 10mm up to 125mm in a single pour when used as an underplate grout. Where the grouting gap beneath the base plate exceeds the maximum thickness allowed, then the grout can filled / bulked out with Conbextra Grout Aggregate* to minimise exotherm heat build up. Alternatively Conbextra Deep Pour is available for pours up to 500mm thick.

Filling/bulking out of the grout should not exceed a ratio of 1:1. Please refer to the Conbextra Grout Aggregate TDS for more guidance on bulking out of cement based grouts.

Any bolt pockets must be grouted prior to grouting between the substrate and the base plate. Continuous grout flow is essential.

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FOI 26-292 - Document 27

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For larger pours the grout may be hand placed or pumped into a removable hopper (trough).

Sufficient grout must be available prior to starting and the time taken to pour a batch must be regulated to the time taken to prepare the next one. Continual grout pour must be ensured.

The mixed grout should be poured only from one side of the void to eliminate the entrapment of air or surplus pre-soaking water. This is best achieved by pouring the grout across the shortest distance of travel.

The grout head must be maintained at all times so that a continuous grout front is achieved.

Pumping

Where large volumes have to be placed Conbextra HF may be pumped. A heavy duty diaphragm pump is recommended for this purpose. Screw feed and piston pumps may also be suitable. Maximum aggregate is 2.5mm. Ensure pump is capable of pumping this size aggregate.

Curing

On completion of the grouting operation, exposed areas should be thoroughly cured. This should be done by the use of Concure A99 curing membrane or wet hessian.

Cleaning

Conbextra HF should be removed from tools and equipment with clean water immediately after use. Cured material can be removed mechanically.

Limitations

Low temperature working

When the air or contact surface temperatures are 5°C or below on a falling thermometer, warm water (30-40°C) is recommended to accelerate strength development.

For ambient temperatures below 10°C the grout consistency should be flowable and the formwork should be maintained in place for at least 36 hours.

Normal precautions for winter working with cementitious materials should then be adopted.

High temperature working

At ambient temperatures above 35˚C the mixed grout should be stored in the shade. Cool water (below 20˚C) should be used for mixing the grout.

Supply

Conbextra HF 20kg:	FC501050-20KG

Yield

Consistency (AS 1478.2-2005 Table 4.1.2.2)	Yield / 20 kg bag (Litres of mixed material)
Stiff	10.4 litres
Plastic	10.7 litres
Flowable	10.8 litres
Fluid	10.9 litres

Storage

Conbextra HF has a shelf life of 36 months from date of manufacture if kept in the original, unopened bags. Refer to the manufacture date indicated on the packaging. Do not use if there are lumps in the product, or a loss of workability (requiring more water to be added) is experienced.

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PRODUCT DATA SHEET

DENSOPOL 60 & 60HT TAPE

Heavy Duty PVC/Bitumen Fabric-Reinforced Tape

Description

Densopol 60 & 60 HT is a cold applied, synthetic fabric reinforcement coated with rubber bitumen adhesive and backed with a PVC film.

Uses

For the corrosion protection of buried or immersed pipes and fittings. Used for external joint sealing to prevent backfill infiltration in concrete pipes, culverts and crown units. The tapes can be applied by hand to weld joints, bends, bare pipe lengths and pipe fittings.

Features

- Applied to marginally prepared surfaces (SSPC SP 2-3)
- Cold applied
- Good comformability
- Good impact resistance
- Excellent adhesion to pipe and self
- Excellent resistance to cathodic disbonding
- Compatible with common pipe coatings

Application

Prepare steel to St2 (power brushed)/AS 1627 P.2 (minimum). Surface must be clean, dry and free of grease. Apply thin film of Denso Primer D to all surfaces to be protected and allow to dry. Peel back interleaving and apply adhesive side of the tape to the primed surface and press down. Apply the tape spirally with enough tension to make it conform. Remove interleaving as wrapping proceeds. Overlap each turn by 55% to achieve double thickness.

Irregular surfaces such as valves, flanges, etc. may require the use of Denso Bitumen Mastic, Denso Mastic or Denso Profiling Mastic. Refer to the product sheets for these specific products for information on application and selection.

Denso®

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FOI 26-292 - Document 27

Densopol 60 & 60HT Tape

Property Specifications

Properties	Densopol 60 Value	Densopol 60HT Value
Thickness (ASTM D1000)		
Backing	*0.085 mm*	*0.085 mm*
Adhesive	*1.515 mm*	*1.515 mm*
Total	*1.60 mm*	*1.60 mm*
Weight	*1.8 kg/m²*	*1.8 kg/m²*
Breaking Strength (ASTM 1000)	*8 N/mm*	*8 N/mm*
Tear Strength (ASTM 1004)	*20 N*	*20 N*
Elongation @ Break	*22%*	*22%*
Adhesion Peel Strength (ASTM D1000)		
To Primed Steel	*2.5 N/mm*	*3.0 N/mm*
To Self	*2.5 N/mm*	*2.5 N/mm*
Impact Strength (ASTM G-14)	*4 N/mm*	*5 N/mm*
Dielectric Strength	*20 kV*	*20 kV*
Resistance to Cathodic Disbondment		
(ASTM G-8 30 Days Group B)	*350 mm² avg.*	*350 mm² avg.*
Temperature Range		
For Application	*5°C to 45°C*	*15°C to 50°C*
For Service	*60°C*	*75°C*
Recommended Holiday Test Voltage		
Single Layer	*10 kV*	*10 kV*
Double Layer	*15 kV*	*15 kV*
Roll Widths	*50, 100, 150 mm*	*50, 100, 150 mm*
Roll Length	*10 m*	*10 m*
Recommended Primer	Denso Primer D	Denso Primer D
Color (Backing)	Black	Black

Quantity Estimates

Tape Width	Tape Length	Rolls/ Case	Coverage with 55% Overlap
in.	ft.	ea.	ea.
2" (50 mm)	33' (10 m)	24	59 ft² (5.5 m²/case)
4" (100 mm)	33' (10 m)	12	59 ft² (5.5 m²/case)
6" (150 mm)	33' (10 m)	8	59 ft² (5.5 m²/case)

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Acromastic Black

FEATURES

Acromastic Black is a water based Bitumastic water proofing membrane coating. Formulated with a high grade bitumen emulsion and a styrene acrylic copolymer, **Acromastic Black** will form a highly flexible and durable water resistant barrier which will adhere to a wide variety of surfaces.

The product has been designed to be applied at high builds, possible by several application techniques, onto horizontal and vertical surfaces.

Acromastic Black provides excellent protection on concealed surfaces, but is also suitable for exterior exposure due to its acrylic modification - providing protection for up to 10 years.

RECOMMENDED USES

Acromastic Black is suitable for use over metal surfaces, including galvanised steel, concrete, fibre cement sheets and panels, bricks and timber. Its suitable for above and below ground structures, and is ideal for:

- Out side of tanks
- Retainer walls
- Lining inverted roofs
- Lining box gutters
- Balconies

Acromastic Black is ideal for use wherever a flexible water-proofing membrane is desired.

SPECIFICATION DATA

Colour:	Black
Finish:	Satin
Density:	~1.3 g/cc
Volume Solids:	~46%
Packaging:	4, 10, 20 and 200 litre
Application:	Airless spray or roller
Cleanup:	Water
Storage:	Store under cool dry conditions.

Dry Film Thickness:	400 - 800µ DFT
Wet Film Thickness:	900 - 1800µ WFT
Coverage:	1 - 2 m^2 / litre @ 400µ DFT
Number of Coats:	1 coat
Touch Dry:	60 - 90 minutes @ 25°C
Dry to Recoat:	24 hours (if required)
Hard Dry:	6 - 8 hours @ 25°C
Full Cure:	36 - 48 hours

PERFORMANCE

Temperature Resistance:	Good
Abrasion Resistance:	Very Good
Weatherability:	Excellent
Water Resistance:	Excellent
Chemical Resistance:	Good for mild alkali, acids, salts and oil.

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DIRECTIONS FOR USE

Ensure all surfaces are clean, dry, and free from contamination, including salts, surface rust, fungal or algal growth. If the previous coating is sound, with no peeling or flaking, then **Acromastic Black** may be applied direct. If not, then prepare the substrate to a sound surface.

Acromastic Black is best applied by airless spray using a minimum pump ratio of 30:1, and a minimum tip size of 525µ (21 thou) Spray sufficient coats wet on wet to achieve the required film build. The product will easily build to 2000µ.

Application by roller should be with a textured sleeve.

In areas having excessive structural movement. A polyester woven fabric can be embedded into the coating whilst still wet. In this case, a further coat must be applied after 24 hours.

Stir thoroughly before use - apply un-thinned.

Provide adequate natural ventilation during use. Wash equipment immediately after use with water.

DO NOT apply if temperature is below 10°C or if relative humidity is >85% or rain is imminent.

Typical Specifications

Surface	*Preparation	System	Dry Film Build
Plaster, masonry, brick, cement, cement render or fibre sheeting.	Thoroughly clean the surface ensuring all traces of loose material and surface contamination (oil, grease etc) are removed. Remove any flaking or peeling paint, fill and sand surface (if required). If surface rust is present the prepare to SSPC-SP-2 or SSPC-SP-3, then degrease to SSPC-SP-1	1. Acromastic Black 2. (1) Polyester woven fabric 3. (1) Acromastic Black	400 - 800µ 400 - 800µ
New Steel or Galvanised metal			

(1) Optional;

**Previously coated surfaces that are sound and show good adhesion may be coated direct with Acromastic Black.*

PRECAUTIONS

See the Cameleon Paints General Safety Data Sheet, Product label, and Material Safety Data Sheet (MSDS) for health and safety information prior to use.

CAMELEON PAINTS

Manufacturers of a complete range of quality paints

A Division of Red Fire Holdings PTY Ltd ABN 65 009 407 381
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PO Box 1473, Wangara, Western Australia 6947
Telephone (+61) 8 9302 2577 Fax (+61) 8 9302 2578
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FOI 26-292 - Document 27



EcoPrime®

Eco-Friendly Base Preparation

COLAS Solutions™

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EcoPrime®

The best and most eco-friendly base preparation for a quality pavement

A pavement is only as good as its foundation–its base. Traditionally, road bases have been prepared for surfacing with prime coats to protect the granular base during construction and help reduce dust. Prime seals provide a good bond between the underlying base and hot mix asphalt overlays. On low volume roads, they bond the base to chip seals or other thin surfaces, which might otherwise delaminate. As traffic increases, these treatments serve well as foundations for staged construction of future overlays. In the past, most primes were made from cutback asphalts or other petroleum-based materials that are slow to cure and emit volatile organic compounds. Some of these materials also had poor penetration into compacted bases, thereby reducing their bonding effectiveness. Worse still, there have also been incidents where run-off from these materials has polluted the soil and even nearby streams.

EcoPrime® is an eco-friendly, solventless prime.

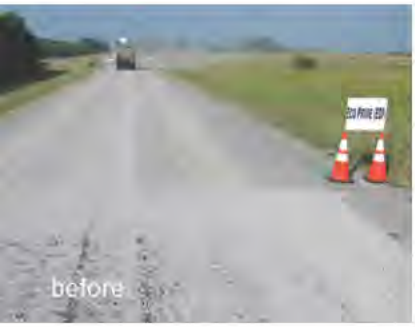
It contains no petroleum solvents that have flammable vapors, are hazardous to workers and release harmful VOC's into the environment. It is made from sustainable, natural resources that do not pollute waterways. It is water-based, safe for workers and easy to use. The innovative Colas Solutions™ technology is engineered to give superior penetration into the base, binding surface fines and superior bonding between the underlying surface and overlays. EcoPrime® also serves as excellent dust control, taking particulates out of the air we breathe.

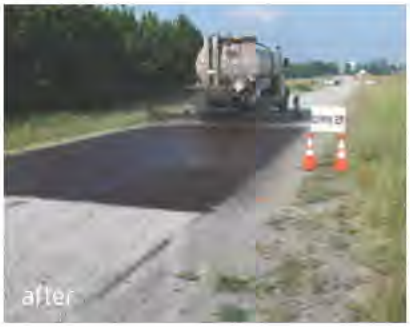
Easy on workers, budgets and the environment

EcoPrime® is supplied as a liquid which may be diluted to give an accurate shot rate when sprayed through a distributor over a prepared, compacted base. The water based emulsion is safely sprayed at ambient temperatures by a calibrated pressure distributor at a uniform rate, without splattering or drilling from the spray bar. The nozzle angle and spray bar height are adjusted to insure that the spray pattern is even and will give the best prime. The application rate should give a uniform coverage of just enough sealant for a thin, tacky, adhesive film without running off the road's surface.

Engineering solutions that work – a Superior Prime and a Superior Dust Suppressant

The economical treatment can be used as a soil stabilizer and dust suppressant. As a prime, it protects the underlying layers from wet weather by providing a temporary waterproofing layer. It can also be used to reduce soil erosion on ditch banks and shoulders. It does not harm vegetation.





Pavement engineers are struggling with increasing traffic and loads, dwindling funds and rising material costs. Increasing capacity is an important part of maintaining an effective road infrastructure. Colas Solutions™ and the family of Colas companies believe in designing solutions that provide long lasting pavements that are built right the first time, while minimizing effects on the environment and health. EcoPrime® is just one of those solutions engineered to give excellent performance during and after construction.

Protection from the elements

The mark of a good prime is the penetration it obtains into the granular base material. Prime that sits on top may look pretty, but if it doesn't soak in, then it simply isn't getting the job done. EcoPrime® soaks in to provide protection from the elements while creating a strong base that is ready for the next layer, no matter if that's tomorrow or a few weeks from now.



Good prime coat soaks in



Poor prime stays on surface

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EcoPrime® Benefits



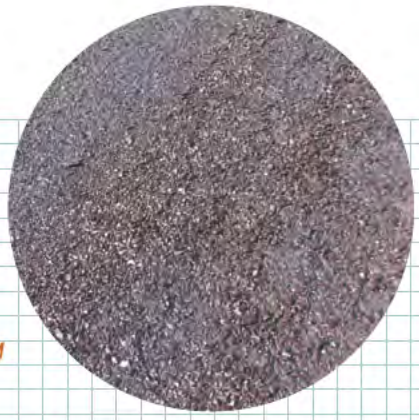
EcoPrime® accounts for just a small fraction of the total project cost, but it makes a big contribution to the overall project success. Just some of the advantages of EcoPrime® include:

- Solventless, no flammable or harmful volatiles
- Easily diluted in water
- Made from renewable resources
- Superior penetration into all types of compacted base materials
- Excellent dust control
- Toughens the base surface to prevent damage from construction equipment
- Protects the base from moisture
- Coats and bonds loose material on the surface of the base
- Provides excellent adhesion between the base and the succeeding course
- Less expensive

The EcoPrime® residue not only suppresses the dust layer, but it binds the dust into a thin membrane that protects the surface.

EcoPrime® has none of the drawbacks of conventional prime coats and dust suppressants. Unlike cutbacks, such as MC-30, other primes containing solvent and chemical dust suppressants like calcium chloride, it does NOT:

- Pollute the soil and ground water
- Harm vegetation
- Replace one atmospheric pollutant (dust) with another (VOC's)
- Cause a fire hazard
- Cost more



Colas Solutions™ is proud to bring you EcoPrime®. It is just one of our global solutions engineered for environmentally responsible construction materials with reliable, proven performance.

Better Performance – Better for the Environment™

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Quality Adherence

The Colas quality system provides the tools by which we measure our performance, acting as a catalyst in promoting continuous improvement. It plays an integral part in all our day-to-day activities. Colas Solutions™ is committed to the provision of products and services that meet or exceed Colas and industry requirements. Through a structured program of quality improvement projects, specific initiatives, measurement of performance and encouragement of ideas, we aim to exceed our target of continuous improvement in the quality of every thing we do.

U.S. GREEN BUILDING COUNCIL MEMBER

A world of innovation, with a local presence™

Colas Solutions™ brings a world of innovations to you through the hands of our highly-trained and experienced local contractors and representatives. We work with you to survey conditions and choose the right solution. Many times we already know the neighborhood, infrastructure and preservation needs because we also live there.

With Colas Solutions™, we don't just sell products and services. We believe in education and strive to help you understand how to choose the right systems, materials, and construction resources. We work with your staff to provide the technical assistance and construction services they may need to effectively design, build, maintain, and preserve your pavement and infrastructure investment network. We work with each of our customers with a high level of integrity and business ethics, cognizant of the fact that trust must be earned before it can be given. And when you choose Colas Solutions™, you'll know that you are getting products and services that respect and protect the environment, as well as the safety of the communities in which we live. After all,

We're all in this together™

For more information or the name of your local supplier contact:

Colas Solutions, Inc.
7374 Main Street
Cincinnati, Ohio 45244
T: 888.369.3163
www.colassolutions.com

COLAS Solutions™

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FOI 26-202 - Document 27

CONCRETE CANVAS®

DATA SHEET

Concrete Canvas® (CC) properties — 2002.01.EN

Pre-set	Test Method	Unit	Typical Values		
			CC5™	CC8™	CC13™
Physical Properties					
Thickness	BS EN 1849-2	mm	5	8	13
Batch Roll Sizes		m	1.0x10	1.1x4.55	N/A
Area of CC per Batch Roll		m^2	10	5	N/A
Bulk Roll Sizes		m	1.0 x 200	1.1 x 114	1.1 x 73
Area of CC per Bulk Roll		m^2	200	125	80
Mass per Unit Area	BS EN 1849-2	kg/m^2	7	12	19
Density	BS EN 1849-2	kg/m^3	1430-1540		
Density Increase on Curing		% Increase	30-35		
Other Properties					
Peel Strength (strength of internal linking fibres)	BS EN ISO 13426-2	kN/m	4.0	4.5	5.0
Embodied CO_2 Saving (cradle to gate for CC8™ vs poured concrete)	ISO 14040 & EN 15804	% Saving	55		
Working Time from Hydration (refer to the CC Hydration Guide)		Hours	1 to 2		

Post-set (Hydrated by full immersion in accordance with ASTM D8030. Water:GCCM ratio of 0.33)	Test Method	Unit	Typical Values		
			CC5™	CC8™	CC13™
Mechanical Performance					
Compressive Strength of Cementitious Mix+					
- 24 Hour	BS EN 12390-3	MPa	50		
- 28 Day	BS EN 12390-3	MPa	80		
Flexural Strength at 24 Hours from Hydration					
- Initial Break (MD)	ASTM D8058	MPa	>4.0		
- Initial Break (MD)	ASTM D8058	N/m	750	1750	5000
- Final Break (MD)	ASTM D8058	MPa	>10	>6	>6
Static Puncture Resistance (mean ultimate puncture force)	BS EN ISO 12236	kN	2.0	4.0	4.0
Dynamic Puncture Resistance (depth of perforation)	BS EN ISO 13433	mm	0*		
Pyramid Puncture Resistance	BS EN ISO 14574	kN	4.0	7.0	12.5
Differential Ground Movement (strain to PVC failure)		%	>5	>5	>2
Coefficient of Thermal Expansion		α (mm/mk)	0.012-0.015		
Environmental Durability (minimum 120 year expected life - see BBA Cert 19/5685)					
Freeze - Thaw Resistance (retained Initial Flexural Strength after 250 cycles)	BS EN 12467	%	95		
Weathering Resistance (refer to CC Weather Resistance)	BS EN 12467	-	Passed		
Chemical Resistance (refer to CC Chemical Resistance)	BS EN 14414	-	Passed		
Root Resistance (refer to CC Root Resistance Testing)	DD CEN/TS 14416	-	Passed		
Reaction to Fire (refer to CC Fire Certification)	BS EN 13501	-	Euroclass B-s1, d0		
Hydraulic Performance					
Abrasion Resistance (cementitious barrier depth of wear)	ASTM C1353	mm/1000 Cycles	0.2		
Manning's Roughness Coefficient	ASTM D6460	n	0.011		
Recommended Permissible Velocity (intermediate fixings may be required - contact CC Ltd)		m/s	Application Dependent	<8.6	>8.6

+ Cube testing at Water:Powder ratio of 0.3 to correspond to GCCM hydration by immersion to ASTM D8030 * Probe did not make a full penetration through the product, therefore the depth of penetration is zero.

Occasionally there will be a Beam Fault (fabric imperfection under 100mm wide running across the width) in a Bulk Roll. This fault is unavoidable due to the manufacturing process and the fault will be clearly marked with a white tag, there will be a maximum of (1) one Beam Fault in any Bulk Roll. A joint may need to be made on site where there is a Beam Fault as the material at a fault will not reach the performance specified in this Data Sheet. The maximum un-useable material due to any Beam Fault will be 100mm. There are no beam faults in standard batched rolls. Roll dimension tolerances are typically +5%/-2.5%

Information is provided based on current test data and may be subject to change as new information becomes available. The versatile nature of Concrete Canvas® means that all application conditions cannot be anticipated. Concrete Canvas Ltd makes no warranties and assumes no liability in connection with this information. Project specific testing may be required to determine the suitability for Concrete Canvas® material use in a particular application.

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 19/5685

ISO 9001 CERTIFIED

CE

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2011.01.EN

CONCRETE CANVAS®
Concrete on a Roll

MADE IN UK



CONCRETE CANVAS®

Concrete on a Roll

USER GUIDE: JOINTING & FIXING

The Queen's Awards for Enterprise: International Trade 2019

Board of Trade Winner 2018

Ground Engineering Awards 2017 — Winner Technical Innovation Award

ice award winner — ICE Wales Cymru Project Awards — Innovation Award ICE Wales Cymru Awards 2017

BBA Approval Inspection Testing Certification — British Board of Agrément Certified

CPD Certified — The CPD Certification Service — Certified CPD Provider

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Concrete Canvas® is part of a revolutionary new class of construction materials called Geosynthetic Cementitious Composite Mats (GCCMs). It is a flexible, concrete filled geosynthetic, that hardens on hydration to form a thin, durable, water proof and fire resistant concrete layer. Essentially, it's concrete on a roll. The following guide provides useful information for installers, customers and specifiers of Concrete Canvas® GCCM (CC). It provides an overview of methods for jointing and fixing of CC material. The versatile nature of CC means that this document is not exhaustive and is intended for guidance purposes only.

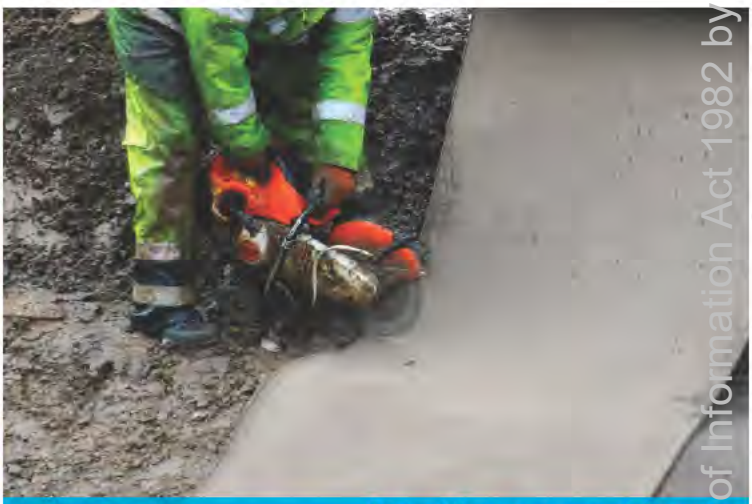
1.0 Cutting Concrete Canvas® GCCM

1.1 Cutting Unset CC

A 'snap-off blade' utility knife can be used for cutting CC before it is hydrated or set. When cutting unset CC a 15-20mm allowance should be left from the cut edge due to potential loss of fill. For larger projects where numerous cuts are required it is recommended to use a powered disc-cutter, angle grinder or a self sharpening fabric cutter. If cutting with a disc cutter, it is recommended to wet the cut beforehand to minimise dust generation.



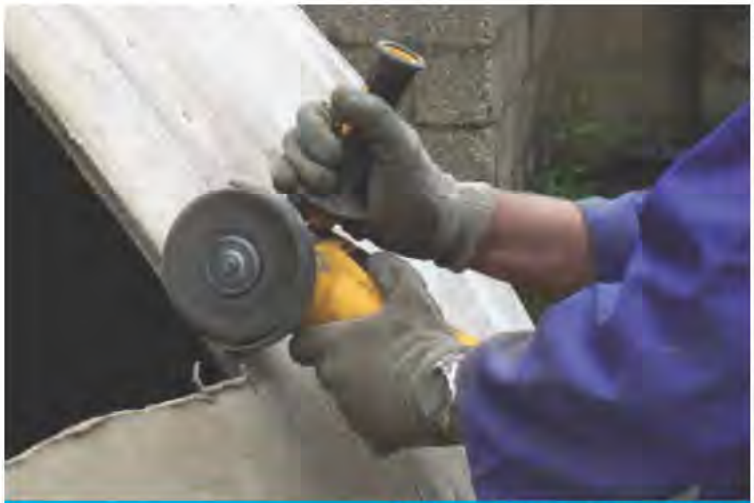
Cutting CC using a 'snap-off blade' utility knife



Cutting CC using a powered disc-cutter

1.2 Cutting Set CC

Set CC can be cut using the same tools used for cutting conventional concrete, such as disc cutters, angle grinders or good quality tile cutters. CC sheets can also be water-cut for applications where a high resolution is required such as for signage or sculptural works.



Cutting set CC using an angle grinder



Water-cut CC

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FOI 26-292 - Document 27

2.0 Fixing Specification

2.1 To Soil

Anchor Trench: Burying the perimeter edges of CC in an anchor trench is essential for the majority of installations. This will help prevent undermining from surface water and provide a neat edge termination. Used in conjunction with pegs or when back-filled with concrete an anchor trench provides an effective means of securing CC to the substrate. Typically anchor trenches are used at the crest and toe of a slope and along the shoulders of a channel and leading and trailing edges to prevent wind and water ingress. **We would therefore recommend anchor trenching the entire perimeter edge of CC wherever possible.**

Pegs: Galvanised steel J-pegs are available from Concrete Canvas® Ltd in lengths of 250mm and 380mm. Pegs may be sourced from alternate suppliers but must have a sufficiently sharp point to penetrate the CC and a head design that will capture the surface of CC. Peg length and spacing should be selected based on soil conditions and application. Pegs should be applied at joints where possible to secure adjacent layers together.

Soil Nails / Ground Anchors: For high load applications or where ground conditions are poor, such as with slope protection, slope stabilisation or for high flow applications, it is recommended to use CC in conjunction with soil nails, ground anchors or earth percussion anchors. The anchor plate design should be circular where possible or have radiused corners to avoid stress concentrations. The soil nail and anchor plate specification should be approved by a qualified geotechnical engineer.

2.2 To Concrete

Mortar: A suitable mortar can be used to join and seal CC to existing concrete infrastructure such as head walls and slabs. Most off-the-shelf mortars will bond well to the fibrous surface of CC. We recommend applying the mortar to the CC immediately after hydration or wetting the CC surface if applying post-set.

Masonry fixings (bolts/screw anchors): A range of conventional masonry fixings, such as stainless steel self-tapping masonry bolts, concrete screw anchors or stainless steel fixings with washers are recommended to fix CC to other concrete surfaces. We recommend a minimum washer/head diameter of 15mm or use a clamping plate to prevent pull-through.

2.3 To Rock

Rock Bolts: For use on hard or rocky substrates, the number and type of rock bolt should be selected based on the pull-out force requirement. A suitable head design should be selected to prevent stress concentrations. A minimum head diameter of 15mm is normally recommended and plates up to 150mm are often used.













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2.4 To Steel

Hog rings: Ideal for fixing CC to wire mesh, gabion baskets or fencing, hog-rings are available in a range of sizes and can be applied with a manual or powered hog-ringer. The hog rings should be applied to CC prior to hydration.



Tech-screws: Self-drilling screws such as tech-screws are suitable for fixing CC to sheet steel. A washer may be required to prevent pull-through.



2.5 To Wood

Screws / Staples / Nails / Adhesive: A range of conventional fixings can be used to fix CC to substrates such as wood. In its pre-hydrated form CC behaves like a thick geotextile and can be fastened with suitable screws, staples, nails or adhesives.

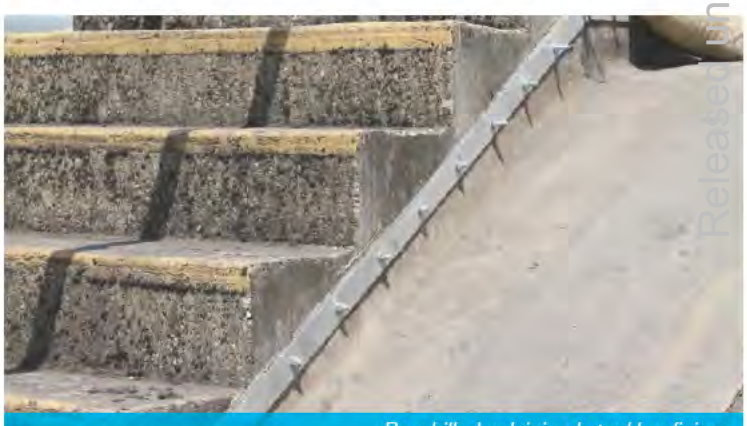


2.6 Other

The flexible nature of CC means that it can be jointed, sealed and fixed using a large selection of products available on the market. The 3 following listed joints (3.0) are suitable for the majority of applications and summarised in the table at the end of this document (5.0). Some other fixings which may be useful are also shown in the images below.



Clamping band fixing



Pre-drilled galvinised steel bar fixing

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FOI 26-292 - Document 27

3.0 Jointing Specifications

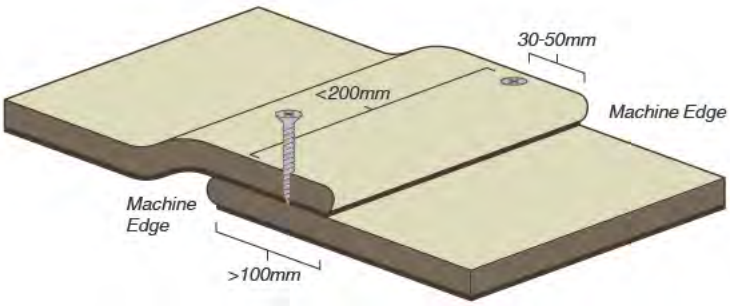


Fig 1. Standard Screwed Overlap Joint

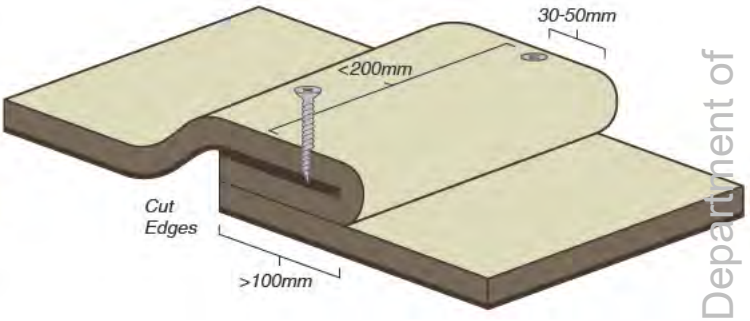


Fig 2. Screwed Knuckle Joint for Cut Edges of CC

3.1 Overlapped Joint

This joint is suitable for the majority of CC applications and involves overlapping adjacent sheets of CC by a minimum of 100mm, (see Fig.1.) For erosion control applications, care should be taken to position the overlap in the direction of water flow (like shingled roof tiles). When jointing cut edges of CC, the material can be folded back on itself to form a knuckle joint, (see Fig.2.) which covers the cut edge and improves the seal between layers. We would recommend securing the overlap with one of the following methods **- please note, it is important to hydrate the material under the overlap before fixing.**

3.2 Screws

Suitable for the majority of applications this joint is fast and simple to apply, it provides good mechanical strength but has limited impermeability. The screws should be applied at 200mm spacing (50mm for bund lining) and 30-50mm from the edge of the CC. The screws should be applied prior to setting but immediately after hydration (CC has 1-2 hours working time in a UK climate), so the concrete within CC will then set around the thread of the screws. For this reason it is important that the screws have a fully threaded shank and a minimum length equal to the full thickness of the joint. Collated screws allow for the use of an auto-fed screwdriver which provides a rapid means of creating a screwed joint. Suitable collated stainless steel screws are available from Concrete Canvas Ltd.



Stainless steel collated screws



CC joint fixed using an autofed screwdriver

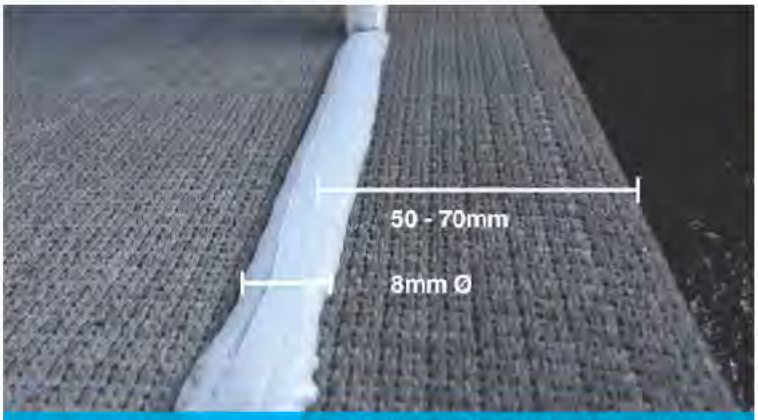
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3.3 Screws & Sealant

For applications where improved impermeability is required, CC can be jointed with a CC approved adhesive sealant using a caulking gun. This is applied as a single 8mm bead with the screws inserted through the sealant bead where possible to minimise leakage. An 8mm bead is equivalent to a coverage of 50g/m which is equivalent to 5.8m of joint for 290ml cartridge or 12m of joint from a 600ml cartridge. Suitable CC approved adhesive sealants are available from Concrete Canvas Ltd. 200mm screw spacing is suitable for most applications, 50mm is recommended for bund lining. **It is important to hydrate under the overlap prior to applying the adhesive sealant in order to remove excess dust, ensuring contact with the fibrous top surface of the bottom CC layer and to provide moisture for curing.** Surfaces may be damp during installation, but have no standing water.



Sealant applied to CC using caulking gun

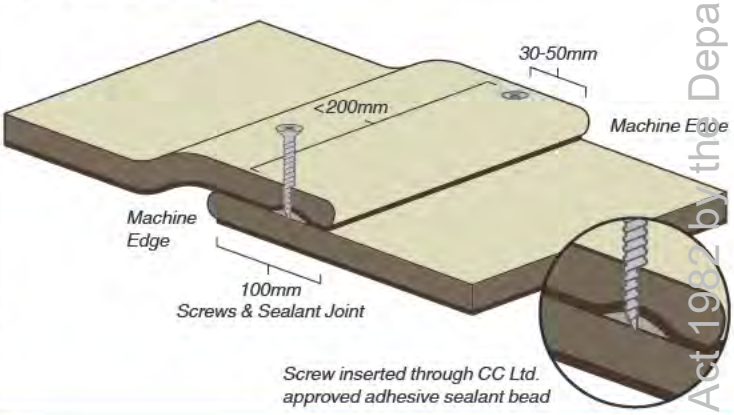


Diagram showing screw inserted through sealant bead

3.4 Hydration of the Overlap

In some circumstances for the above joints, it may not be possible to hydrate underneath the overlap prior to fixing. This is not generally advised, as the underlap material will only be partially hydrated, however it may be acceptable if certain conditions exist. For example, if the joint is going to be continually exposed to water due to the nature of the application, the underlap material will slowly hydrate through infiltration.

Please be aware, that in these instances, the joint strength may be compromised. For example a screwed joint relies on the CC setting around the thread of the screw to reach the strength values overleaf therefore the short-term strength will be significantly lower until full hydration is achieved. **Adhesive sealants also benefit from pre-hydration as this cleans the jointing surface of dry cement dust prior to the application of adhesive and helps to cure the adhesive during setting.** Joints will therefore typically achieve a long-term strength which is 30-40% lower than the published values if the underlap CC is not hydrated prior to jointing.


Automatic thermal welding machine


Handheld thermal welding machine

3.5 Thermal Bonding

Thermal Bonding can be used for applications where screws are not suitable, for example when applying CC onto a hard concrete substrate or geomembrane. The joint is formed using either a manual or automatic thermal welding machine to form a bond between the PVC backing of the CC and the polyester top surface.
Please refer to the *CC User Guide: Thermal Bonding* for more details.

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EQ1 26-282 - Document 27

4.0 Installation Principles

The unique material properties of Concrete Canvas (CC) mean that it can be used for a variety of applications. Following the Four Installation Principles below will help ensure a successful installation.



Avoid Voids

1. Avoid Voids

Prepare the substrate so it is well compacted, geotechnically stable and has a smooth and uniform surface.

- For soil substrates, remove any vegetation, sharp or protruding rocks and fill any large void spaces. Ensure the CC makes direct contact with the substrate to minimise soil bridging or potential soil migration under the layer.
- For concrete substrates, remove any loose or friable material, cut away any protruding exposed re-bar and fill any large cracks or voids.

2. Secure Canvas



Secure Canvas

It is important to ensure that the CC is **Jointed** at every overlap between layers and that those layers are **Fixed** to the substrate.

- **Jointing:** Overlapped CC layers should be securely jointed together, typically this is achieved using stainless steel screws applied with an auto-fed screw gun at regular intervals. Correct screw placement will help ensure intimate contact between CC layers, prevent washout of the substrate, and limit potential weed growth. An adhesive sealant can be applied between the layers to improve the joint impermeability.

  A non-penetrative method of jointing is to 'thermally bond' the CC layers together. This also improves joint impermeability. For more jointing options see above.
- **Fixing:** When fixing to a soil substrate, ground pegs (eg J-pegs) are typically used. On rock or concrete substrates, CC layers can be jointed together and fixed to the substrate using masonry bolts, percussion anchors or shot fired masonry nails. Stainless steel fixings with washers are recommended.



Prevent Ingress

3. Prevent Ingress

It is important to prevent water or wind ingress between the CC and the substrate, both around the perimeter of the installation and along the joints.

- For soil substrates, this is typically achieved by capturing the entire perimeter edge of the CC within an anchor trench.
- On rocky or concrete substrates, the perimeter edge should be sealed with a concrete fillet or an adhesive sealant.
- All overlapped CC layers should be lapped in the direction of water flow.

4. Hydrate Fully



Fully Hydrate

It is critical to properly hydrate CC, taking into account the quantity of material used and ambient temperature conditions.

- Always ensure hydration through the fibrous top surface.
- Ensure to hydrate any overlapped areas and anchor trenched material prior to backfilling.
- Spray the fibre surface with water until it feels wet to touch for several minutes after hydration (the 'Thumb Test').
- Follow the *CC User Guide: Hydration*.

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5.0 Comparison Table

	TENSILE SHEAR STRENGTH*			IMPERME-ABILITY*	INSTALLATION				Recommendation
					Speed	*Skill*	*Tools Required*	*When to use*	
Screwed (200mm spacing)	●●●○○			●○○○○	Fast	Low	Autofeed Screwdriver	Most common joint used on 95% of applications	>30mm stainless steel screws with 200mm spacing installed using autofeed screwdriver
	CC5™	CC8™	CC13™						
	2.0 kN/m	4.0 kN/m	5.0 kN/m						
Screwed and Sealed (200mm spacing)	●●●◐○			●●○○○	Med	Low	Autofeed Screwdriver and Caulking Gun	For applications where a level of impermeability is required	>30mm stainless steel screws with 200mm spacing. Sealed with a CC approved adhesive sealant
	CC5™	CC8™	CC13™						
	3.5 kN/m	5.0 kN/m	5.0 kN/m						
Screwed and Sealed (50mm spacing)	●●●●○			●●○○○	Med	Low	Autofeed Screwdriver and Caulking Gun	For bund lining applications or use in exposed areas prone to significant wind uplift forces	>30mm stainless steel screws with 50mm spacing. Sealed with a CC approved adhesive sealant
	CC5™	CC8™	CC13™						
	7.0 kN/m	13.0 kN/m	15.0 kN/m						
Thermal Bond	●●●●●			●●●○○	Med-Fast	Med-High	Manual or Automatic Thermal Welder and Power Supply	Used where screws are not suitable due to a concrete substrate etc under the CC**▲	Use automatic welder such as a Leister Twinny T or S (The Twinny T has data log-ging capability) or manual welder such as Leister TRIAC AT with a 60mm slot nozzle
	CC5™	CC8™	CC13™						
	10.5 kN/m	17.0 kN/m	17.0 kN/m						

* Joint strength and impermeability data is intended for guidance purposes only. Joint performance may vary depending on the quality of the installation and the application conditions. Strength data is based on the ultimate strength of a tensile shear test in laboratory conditions, test based on BS EN 12317 1:2000.

** For bund lining or when a level of impermeability is required, and/or when screws are not suitable due to a non-penetrable substrate beneath, such as concrete.

▲ For containment critical applications, CC Hydro™ should be used.

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See *CC Equipment List* for full details. *Dust hazard. Wear appropriate PPE. Consult CC & CCH SDS document.*

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CONCRETE CANVAS®
Concrete on a Roll

2010.01.EN

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CONCRETE CANVAS®

Concrete on a Roll

CC HYDRO™

Containment on a Roll

INSTALLATION GUIDE: BUND LINING

The Queen's Awards for Enterprise: International Trade 2019

Board of Trade Winner 2018

Ground Engineering Awards 2017 Winner Technical Innovation Award

ice award winner 2017 ICE Wales Cymru Project Awards Innovation Award ICE Wales Cymru Awards 2017

BBA Approval Inspection Testing Certification Certificate 15/5085 British Board of Agrément Certified

CPD Certified The CPD Certification Service Certified CPD Provider

IGS Corporate Member

Exporting is Great Britain & Northern Ireland Proud Supporter of Exporting is Great

RAIL ROAD MINING PETROCHEM AGRO PUBLIC WORKS UTILITIES DEFENCE DESIGN SHELTER

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1.0 Introduction

1.1 Background

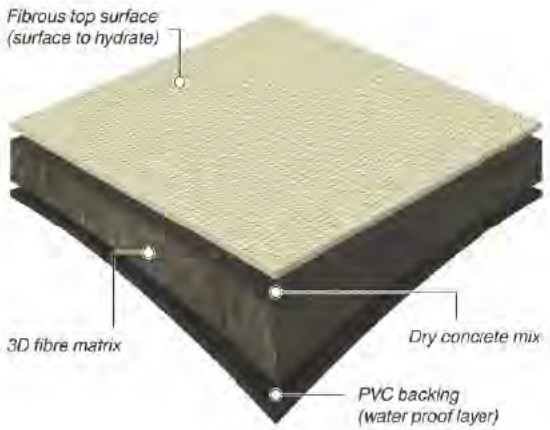
Concrete Canvas® (CC) is part of a revolutionary new class of construction materials called Geosynthetic Cementitious Composite Mats (GCCMs).

It is a flexible, concrete impregnated fabric that hardens on hydration to form a thin, durable, water proof and fire resistant concrete layer. Essentially, it can be described as 'concrete on a roll' and is used for a wide variety of applications including the rapid lining of bunds, water channels, providing slope protection, weed suppression, culvert repair and general concrete remediation.

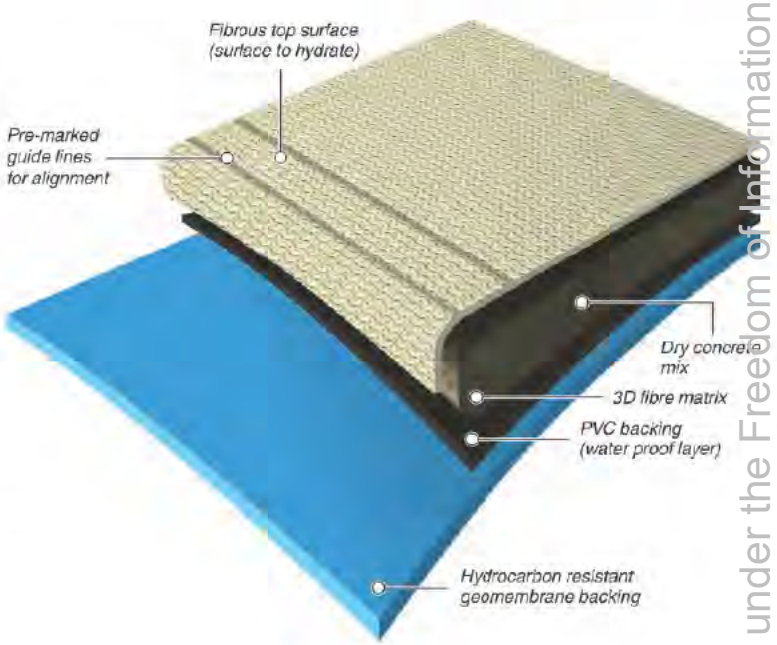
CC Hydro™ (CCH) Geosynthetic Cementitious Composite Barrier (GCCB), combines the company's concrete impregnated fabric technology with a high impermeability, chemically resistant geomembrane backing. The geomembrane provides a high performance liner with a testable joint for quality assured containment applications. The liner incorporates a hi-visibility welding strip allowing joints to be thermally bonded with a double or triple-track air channel for on-site testing.

CCH provides long term protection to the geomembrane from puncture, abrasion, weathering and UV degradation. This hard armour concrete surface effectively removes the need for concrete, soil or aggregate top cover, normally required with conventional liner systems.

Concrete Canvas® GCCM section



CC Hydro™ GCCB section



1.2 Scope

- This document provides guidance procedures for the installation of CC & CCH as **bund lining** in a manner that maximises safety, efficiency, and the physical integrity of the material and channel.
- This document provides useful information for installers, customers and specifiers of CC & CCH and provides an overview of installation techniques for the lining of bunds.
- The versatile nature of CC & CCH means that this document is not exhaustive and is intended for guidance purposes only. Exceptions to this guideline may be required to address site-specific and/or product-specific conditions.
- The performance of CC & CCH is highly dependent on the quality of the installation. It is the installer's responsibility to adhere to these guidelines where applicable and to the project specification and drawings.

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2.0 Specification and Installation Essentials

2.1 Specifying the correct Product

Concrete Canvas® (CC) is designed to be used for **Erosion Control** applications, for example as a capping layer for clay berms to provide protection against weathering, animal damage and prevent vegetation growth. CC should not be used as a replacement for clay or an impermeable liner.

CC Hydro™ (CCH) is designed to be used for **Containment** applications, for example as a replacement for clay or a geomembrane liner covered with a protective overburden. CC Hydro™ combines the durability of concrete with the impermeability of a geomembrane, significantly reducing earthworks through reduced excavations and importation of top cover fill.

2.2 Specifying the correct CC Thickness

CC is available in 3 thicknesses, CC5™ (5mm), CC8™ (8mm) and CC13™ (13mm). CC Hydro™ is available in 2 thicknesses, CCH5™ (5mm) and CCH8™ (8mm).

- CC5™ and CCH5™ are most commonly used to line secondary containment bunds where there is no requirement for trafficking, for example from maintenance contractors.
- CC8™, CC13™ and CCH8™ are recommended for use on areas exposed to high a degree of water flow such as flood protection bunds and water channels; or areas required to be lightly trafficked.

	GCCM Type	Thickness (mm)	Roll Width (m)	Dry Weight (kg/m²)	Batched Roll Coverage (m²)	Batched Roll Length (m)	Bulk Roll Coverage (m²)	Bulk Roll Length (m)
Concrete Canvas®	CC5™	5	1.0	7	10	10	200	200
	CC8™	8	1.1	12	5	4.55	125	114
	CC13™	13	1.1	19	N/A	N/A	80	73
CC Hydro™	CCH5™	5	1.0	8	N/A	N/A	150	150
	CCH8™	8	1.0	13	N/A	N/A	100	100

2.3 Specifying the correct CC Roll Format

CC and CCH are available in **Bulk Rolls**, CC is also available in smaller **Batched Rolls**.

- **Bulk Rolls** offer the quickest installation but must be deployed using heavy lifting equipment and a spreader beam. Bulk Rolls are generally more efficient to use than Batched Rolls, in terms of material use and transportation.
- For sites where this isn't suitable, man portable **Batched Rolls** can be installed without the need for plant and are well suited to smaller scale works in restricted access areas.
- CC is now also available in **Wide Rolls** of up to 4 times the standard roll width. Contact Concrete Canvas for further details.



CC Bulk Rolls and Batch Rolls



Wide Rolls of up to 4 times the standard roll width are now available

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2.4 Specifying the correct Fixing

Perimeter Fixings: The GCCM/GCCB must be firmly secured around the entire perimeter of the installation prior to hydration, in order to prevent movement during curing and wrinkling during subsequent thermal expansion. Perimeter fixing is also needed to eliminate wind ingress and wind actions which can result in sheet uplift. This can be achieved by capturing the GCCM/GCCB in a concrete anchor trench or by using ground pegs combined with an anchor trench backfilled with aggregate or soil. The fixing design should be sufficient to resist wind uplift. Alternatively, it can be secured to existing concrete infrastructure using mechanical fixings such as concrete anchor bolts (see images). Where only one face of the bund is to be covered, the GCCM/GCCB will also need to be secured to the crest to prevent wind from getting beneath the GCCM/GCCB and to resist wind actions.



Anchor trenched CC



CC captured within a poured curb



CC fixed to concrete headwall



CC fixed to concrete drainage channel

Intermediate Fixings: On large berms where wind uplift forces may be significant, intermediate fixings may be required to prevent uplift (calculation of wind loads can be obtained using the methodology described in BS EN 1991-1-4:2005) and the appropriate national annex. Intermediate fixings such as ground pegs, soil nails or earth percussion anchors can be used. Depending on the design wind loads in the location, bunds covered with CC5™ with a slope face length above 7m may require an intermediate fixing at the mid-point of the bund through the overlapped joints.[1] Suitable fixings will need to resist at least 50% of the net wind load perpendicular to the bund face.

When installing CC Hydro™ intermediate fixings will normally only be required for bund faces with a slope face length above 20m or in exceptionally exposed locations[1] (this is due to the high tensile strength of the CCH and welded joints). Contact Concrete Canvas Ltd for further advice and guidance including non-penetrative fixings.



CC being fixed with a ground peg



A Percussion Anchor fixed into place

1. Example given for guidance purposes only, based on BS EN 1991 wind speed data from the UK National Annex based on an installation in the Shetland Islands with typical bund geometry and infrastructure topology. Wind loading analysis should be conducted by the Project Engineer according to customer requirements and site-specific conditions.

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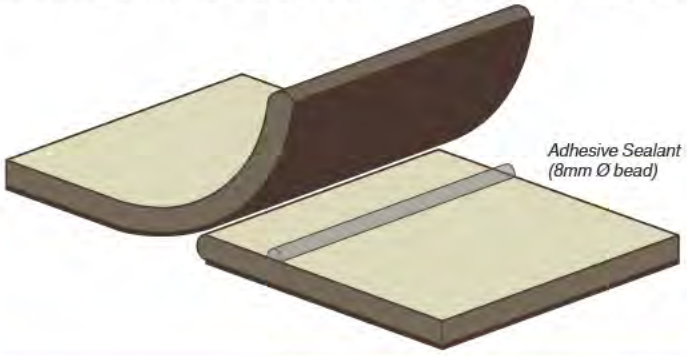
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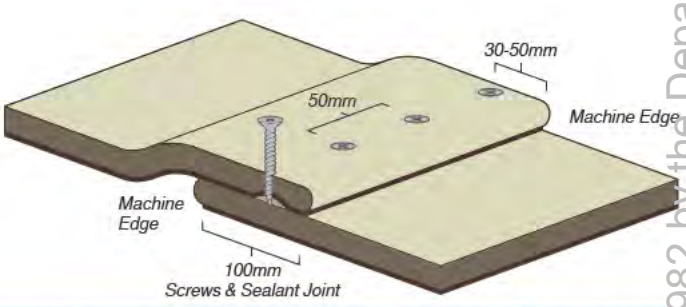
2.5 Specifying the correct Joints

- **Concrete Canvas should be overlapped by 100mm and jointed using either:**

Stainless steel screws at 50mm centres, positioned between 30-50mm from the edge of the joint, in addition to an 8mm diameter bead of a Concrete Canvas approved adhesive sealant, applied to the surface of the CC whilst wet and still flexible (see diagram). It is important that a compatible adhesive sealant is used, please contact Concrete Canvas to confirm compatibility. The joint should be clean and the adhesive sealant must be compressed to maximize the adhesive contact area. Once cured the concrete within CC will set around the thread of the screws.

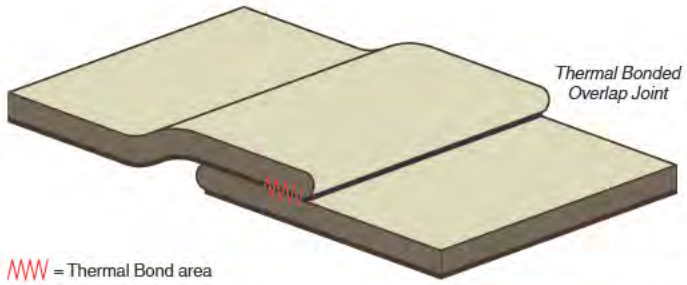


Adhesive sealant applied prior to screw jointing



Screws inserted at 50mm centers, 30-50mm in from machined edge

Thermal bonding - using a hand-held heat gun such as a Leister Triac AT with 60mm perforated slot nozzle, or an automatic welder such as a Leister Twinny 50mm combi-wedge (without test channel). Screws can also be used in conjunction with the thermal bonded joint for some applications. Please refer to *CC User Guide: Thermal Bonding*.



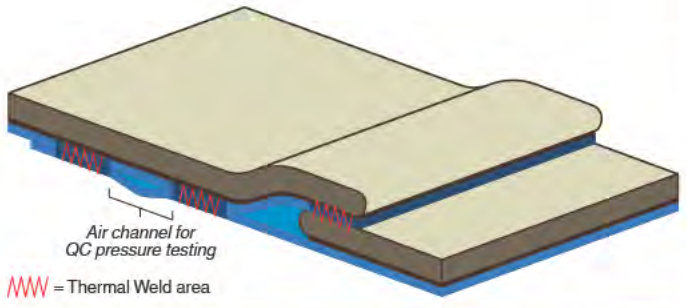
Thermally Bonded Overlap Joint



A hand-held slot nozzle heat gun in use

- **CC Hydro™ should be jointed using:**

An automatic thermal welder such as a Leister Twinny with a double or triple track combi-wedge (with test channel). Welding of CC Hydro™ should be carried out by a qualified thermal welding contractor in accordance with the design specification and *CC Hydro™: Thermal Welding Guide*.



CC Hydro™ double/triple-track weld



A Leister Twinny in use

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3.0 Four Key Installation Principles of CC

The unique material properties of Concrete Canvas (CC) mean that it can be used for a variety of applications. Following the Four Installation Principles below will help ensure a successful installation.



Avoid Voids

1. Avoid Voids

Prepare the substrate so it is well compacted, geotechnically stable and has a smooth and uniform surface.

- For soil substrates, remove any vegetation, sharp or protruding rocks and fill any large void spaces. Ensure the CC makes direct contact with the substrate to minimise soil bridging or potential soil migration under the layer.
- For concrete substrates, remove any loose or friable material, cut away any protruding exposed re-bar and fill any large cracks or voids.



Secure Canvas

2. Secure Canvas

It is important to ensure that the CC is **Jointed** at every overlap between layers and that those layers are **Fixed** to the substrate.

- **Jointing:** Overlapped CC layers should be securely jointed together, typically this is achieved using stainless steel screws applied with an auto-fed screw gun at regular intervals. Correct screw placement will help ensure intimate contact between CC layers, prevent washout of the substrate, and limit potential weed growth. An adhesive sealant can be applied between the layers to improve the joint impermeability.

  A non-penetrative method of jointing is to 'thermally bond' the CC layers together. This also improves joint impermeability. For more jointing options see the *CC User Guide: Jointing and Fixing*.
- **Fixing:** When fixing to a soil substrate, ground pegs (eg J-pegs) are typically used. On rock or concrete substrates, CC layers can be jointed together and fixed to the substrate using masonry bolts, percussion anchors or shot fired masonry nails. Stainless steel fixings with washers are recommended.



Prevent Ingress

3. Prevent Ingress

It is important to prevent water or wind ingress between the CC and the substrate, both around the perimeter of the installation and along the joints.

- For soil substrates, this is typically achieved by capturing the entire perimeter edge of the CC within an anchor trench.
- On rocky or concrete substrates, the perimeter edge should be sealed with a concrete fillet or an adhesive sealant.
- All overlapped CC layers should be lapped in the direction of water flow.



Fully Hydrate

4. Hydrate Fully

It is critical to properly hydrate CC, taking into account the quantity of material used and ambient temperature conditions.

- Always ensure hydration through the fibrous top surface.
- Ensure to hydrate any overlapped areas and anchor trenched material prior to backfilling.
- Spray the fibre surface with water until it feels wet to touch for several minutes after hydration (the 'Thumb Test').
- Follow the *CC User Guide: Hydration*.

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FOI 26-292 - Document 27

4.0 Installation Methodology

4.1 Bund Preparation

CC & CCH will conform closely to the underlying surface contours of a bund profile. The degree of ground preparation needed will depend on the bund construction and surface finish required. For best results it is recommended that loose soil, vegetation, soft ground and protruding rocks are removed and any voids filled. A suitable non-woven geotextile layer can be used to provide puncture protection to the geomembrane liner when laying CC Hydro™.



4.2 Laying

Unwrap the material, ensuring that the fibrous surface of the product is facing upwards and the membrane backing is in contact with the bund. Align the roll perpendicularly and simply unroll over the bund profile.



4.3 Positioning

Cut to length ensuring there is sufficient excess for the specified anchor trench.

When positioning subsequent CC rolls, ensure that there is at least a 100mm overlap between layers.

When positioning subsequent CC Hydro™ rolls ensure the layers are aligned within the pre-marked black guidelines.



4.4 Hydrating overlaps

If laying CC, the overlapped areas should be hydrated by spraying with water (sea water may be used). Fold back one edge to expose the overlapped section. Spray the fibre surface with water until it feels wet to touch for several minutes after spraying. **This applies to CC only and not CCH**.



4.5 Jointing

CC: The fastest and easiest method of jointing with CC is using stainless steel screws at 50mm spacing in addition to an 8mm bead of adhesive sealant. These can be applied using an auto-feed collated screw driver and the adhesive sealant applied with a caulking gun. Alternatively, a thermal bonded joint can be used with CC.

CCH: Joints are thermally welded – please refer to the *CC Hydro™ User Guide: Thermal Welding*.



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FOI 26-292 - Document 27

4.6 Hydration

Once in position and the joints secured, **the material should be hydrated as per the CC Hydration Guide**. Hydrate from crest to toe to ensure a uniform finish. An excess of water should be used as the material cannot be over hydrated (minimum ratio of water:CC is 1:2 by weight). Avoid trafficking wetted GCCM to prevent staining. Please note that you should not rely on precipitation to hydrate the material.



4.7 Junctions and Corners

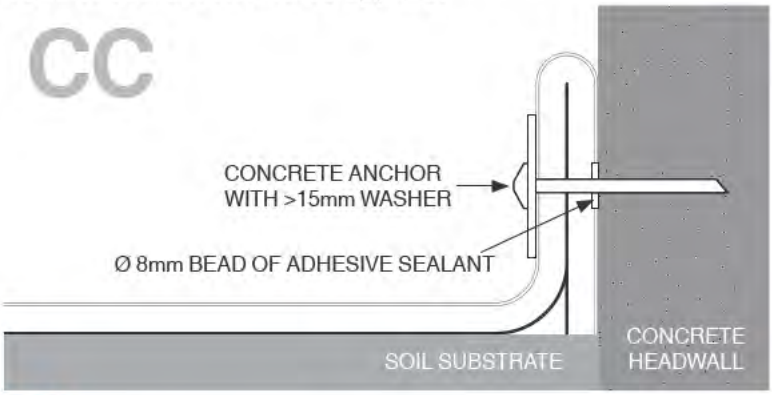
CC & CCH are very easy to shape before setting and layers can be laid in multiple directions to form junctions and corners or cut to create pie-welds when using CC Hydro™. **The perimeter edges of the material must be buried or securely fixed to existing concrete infrastructure to prevent wind and water ingress.**

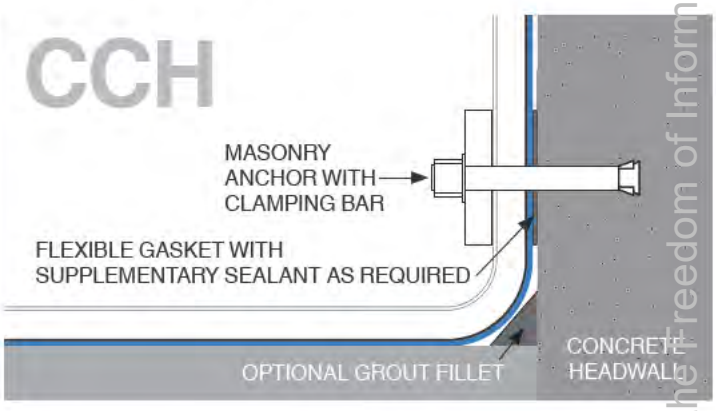


4.8 Terminations

CC:

Terminations into concrete headwalls or upstands can be achieved by folding the edge of the CC over by 50mm and fixing to the concrete substrate using concrete anchors. Where there are water ingress concerns at the termination a bead of sealant should be applied.





CCH:

Interfaces with concrete headwalls or upstands can be fixed using a steel batten and masonry anchors, sealed using neoprene gaskets (TWI suggests a 5x40mm batten with 12mm holes at 200mm centres). Please contact Concrete Canvas to request access to our library of CAD design details.

4.9 Setting

Once hydrated, the material remains workable for approximately 2 hours. In warm climates, working time may be reduced. CC & CCH will harden to 80% of their 28-day strength in 24 hours and are ready for use.



See *CC Equipment List* for full details. Dust hazard. Wear appropriate PPE. Consult *CC SDS* document.

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CONCRETE CANVAS®

EQUIPMENT LIST

Concrete Canvas® Required Equipment List — 1910.01.EN

Concrete Canvas® GCCM* (CC) does not require specialist contractors for the majority of applications. Installation is quick and easy, provided that installation guidelines are followed and the appropriate equipment is used.
Dust hazard. Wear appropriate PPE. Consult *CC SDS* document.

There are four simple steps to all CC installations which must be followed:
1. Deployment - 2. Fixing - 3. Hydration - 4. Jointing

Equipment needs will vary from project to project but the following list is designed to be suitable for the majority of installs. Most of the equipment below is available for hire or purchase from Concrete Canvas Ltd.

1. DEPLOYMENT

		REQUIRED EQUIPMENT		
Bulk rolls of CC weigh approximately 1.5T. Appropriate plant for handling and deployment of heavy goods is required on site.				
Delivery	A suitable means of offloading heavy goods from delivery vehicles is required, unless a hiab or tail-lift is requested in advance.	**2T rated forklift** (or similar)		☐
Deployment	Bulk rolls of CC are typically deployed via plant mounted spreader beams (rated to 2T SWL) in a similar fashion to conventional geosynthetics.	**2T rated spreader beam**		☐
Cutting (Small Projects < 100m²)	CC can be cut using basic hand tools. The cement dust within the material will blunt blades so replaceable or disposable knives are recommended.	**Snap-off-blade utility knife**		☐
OR				
Cutting (Larger Projects > 100m²)	For larger projects with numerous cuts required, a cutting power tool such as an angle grinder or disc cutter is recommended.	**Angle grinder / Disc Cutter** (cordless recommended)		☐

2. FIXING

		REQUIRED EQUIPMENT		
Following deployment it is required to secure the CC to the substrate to ensure the material is not displaced during use. The following fixings can be used depending on the substrate.				
Soil Substrates	CC should be fixed to the substrate along its length at regular intervals and through any overlaps using J-pegs. The leading edge of the CC (i.e. at the crest of a V-ditch) should be anchor trenched to a project specific depth, the excavation of which should form part of the subgrade preparation prior to install.	**Steel J-pegs** (Galvanised or stainless steel recommended)		☐
		Lump hammer (or similar)		☐
OR				
Concrete or Rock Substrates	When remediating existing concrete infrastructure, CC should be fixed to the concrete substrate using standard off-the-shelf concrete anchors or shot fired masonry nails in conjunction with a minimum >15mm washer. The frequency and length of fixings is project specific. A means of installing these mechanical fixings is also required.	**Fixings** (E.g. masonry bolts, nails, anchors or screws with >15mm washer)		☐
		Powder actuated nail gun (Hilti DX recommended)		☐

*Geosynthetic Cementitious Composite Mat

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CONCRETE CANVAS®

EQUIPMENT LIST

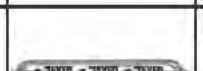
3. HYDRATION

Following deployment and fixing, it is required to hydrate CC. This must be proactively done and it is not advised to rely on hydration from rainfall. See the CC Hydration Guide.

		REQUIRED EQUIPMENT		
Mains Water Supply	A minimum volume of water equal to 50% of the material weight is required and an appropriate means of application.	**Mains water supply**		☐
		Adequate length hosing (spray nozzle recommended)		☐
OR				
Water Bowser	A water bowser can be used as an alternative means of hydration if access to a mains water supply is unavailable.	**Water bowser** (or similar alternative)		☐
		Petrol/diesel water pump		☐
		Adequate length hosing (spray nozzle recommended)		☐

4. JOINTING

Typically CC layers are overlapped by 100mm in the direction of water flow and jointed using any of the following options. Jointing methods are project specific and provide varying mechanical strengths and impermeability.

		REQUIRED EQUIPMENT		
Screws	This joint is suitable for the majority of applications and is fast and simple to apply. It provides good mechanical strength but with limited impermeability. The screws should be applied at 200mm spacing and 30-50mm from the edge of the CC. See the CC *Jointing and Fixing Guide*.	**Auto-fed screwdriver** (cordless recommended)		☐
		Collated screws (stainless steel recommended)		☐
OR				
Screws & Sealant	For applications where improved impermeability is required, CC can be jointed with a CC approved adhesive sealant using a caulking gun. This is applied as a single 8mm bead with the screws inserted through the sealant bead where possible to minimise leakage. Suitable CC approved adhesive sealants are available from Concrete Canvas Ltd. 200mm screw spacing is suitable for most applications, 50mm is recommended for bund lining. See the CC *Jointing and Fixing Guide* along with individual application user guides for further details.	**Caulking gun** (powered unit recommended)		☐
		Adhesive sealant cartridge (use a CC approved adhesive sealant)		☐
		Auto-fed screwdriver (cordless recommended)		☐
		Collated screws (stainless steel recommended)		☐
OR				
Thermal Bonding	For applications where a high degree of impermeability is required. The joint can be formed using hand tools or using an automatic thermal welding machine. The latter allows joints to be formed at a rate of 1-1.5m/min. See the *CC Thermal Bonding Guide*.	**Leister Twinny S or T** (T provides data-logging capability)		☑

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Four Key Installation Principles of CC

1912.01.EN

The unique material properties of Concrete Canvas® (CC) mean that it can be used for a variety of applications. Following the Four Installation Principles below will help ensure a successful installation.



Avoid Voids

1. Avoid Voids

Prepare the substrate so it is well compacted, geotechnically stable and has a smooth and uniform surface.

- For soil substrates, remove any vegetation, sharp or protruding rocks and fill any large void spaces. Ensure the CC makes direct contact with the substrate to minimise soil bridging or potential soil migration under the layer.
- For concrete substrates, remove any loose or friable material, cut away any protruding exposed re-bar and fill any large cracks or voids.

2. Secure Canvas

It is important to ensure that the CC is **Jointed** at every overlap between layers and that those layers are **Fixed** to the substrate.



Secure Canvas

- **Jointing:** Overlapped CC layers should be securely jointed together, typically this is achieved using stainless steel screws applied with an auto-fed screw gun at regular intervals. Correct screw placement will help ensure intimate contact between CC layers, prevent washout of the substrate, and limit potential weed growth. An adhesive sealant can be applied between the layers to improve the joint impermeability.

  A non-penetrative method of jointing is to 'thermally bond' the CC layers together. This also improves joint impermeability. For more jointing options see the *CC User Guide: Jointing and Fixing*.

- **Fixing:** When fixing to a soil substrate, ground pegs (eg J-pegs) are typically used. On rock or concrete substrates, CC layers can be jointed together and fixed to the substrate using masonry bolts, or concrete screw anchors. Stainless steel fixings with washers are recommended.



Prevent Ingress

3. Prevent Ingress

It is important to prevent water or wind ingress between the CC and the substrate, both around the perimeter of the installation and along the joints.

- For soil substrates, this is typically achieved by capturing the entire perimeter edge of the CC within an anchor trench.
- On rocky or concrete substrates, the perimeter edge should be sealed with a concrete fillet or an adhesive sealant.
- All overlapped CC layers should be lapped in the direction of water flow.

4. Hydrate Fully

It is critical to properly hydrate CC, taking into account the quantity of material used and ambient temperature conditions.



Fully Hydrate

- Always ensure hydration through the fibrous top surface.
- Ensure to hydrate any overlapped areas and anchor trenched material prior to backfilling.
- Spray the fibre surface with water until it feels wet to touch for several minutes after hydration (the 'Thumb Test').
- Follow the *CC User Guide: Hydration*.

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE 19/5685

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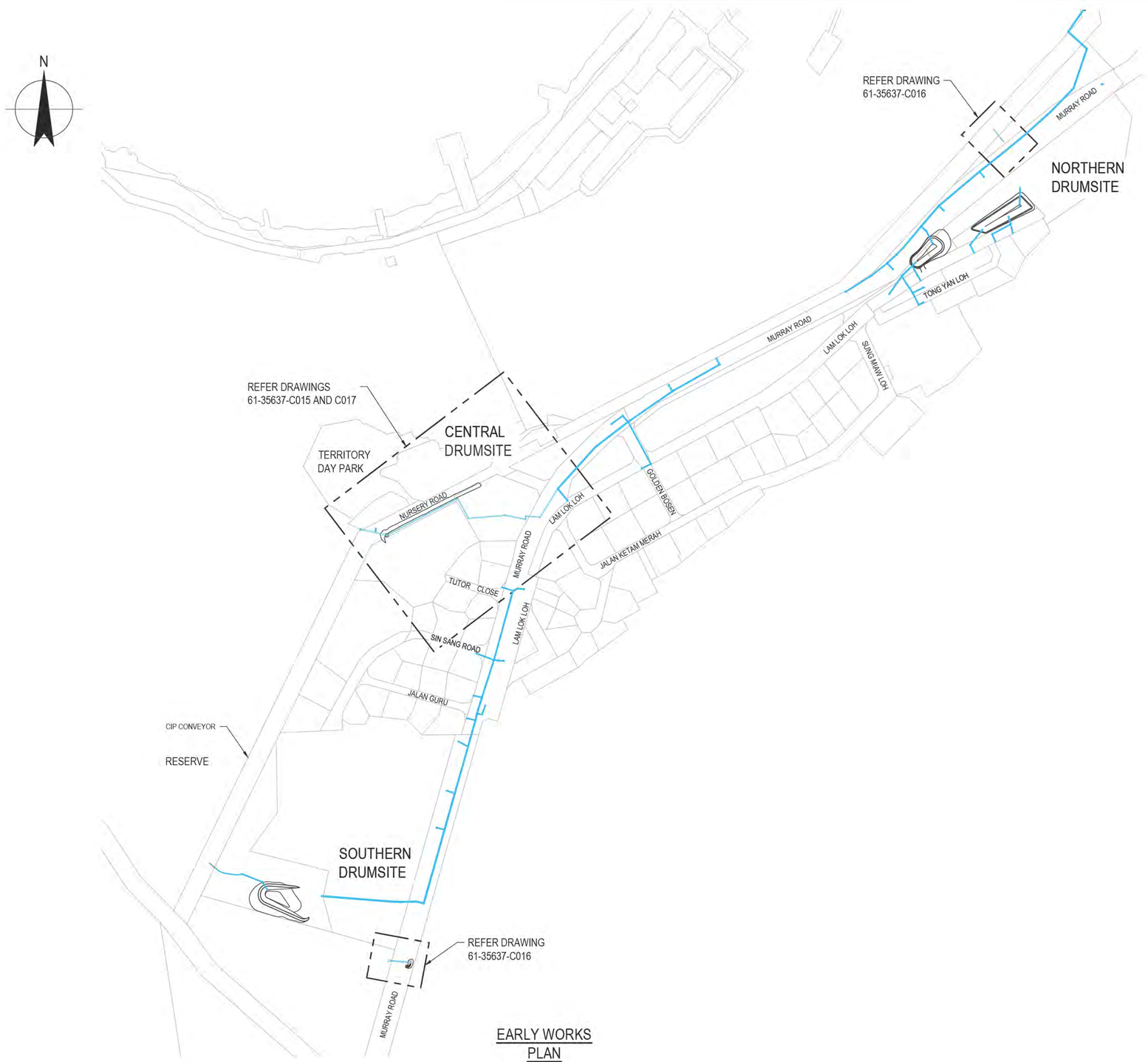
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Appendix D – Early Works Drawings

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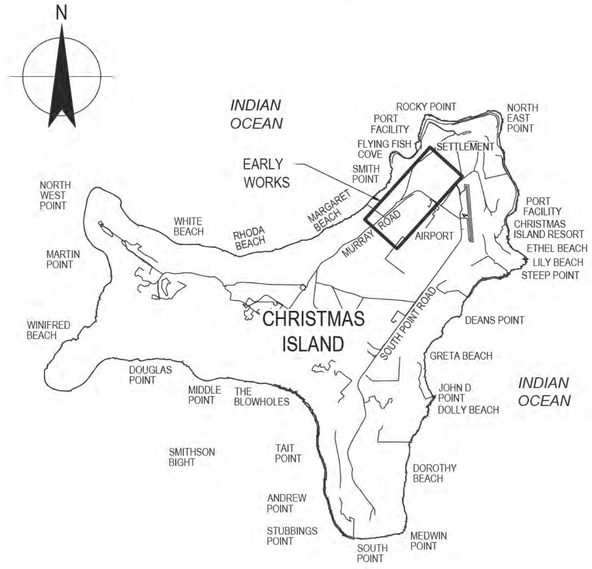
EARLY WORKS PLAN

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DRAWING LIST:

61-35637-C002	COVER SHEET, LOCALITY PLAN AND DRAWING LIST - EARLY WORKS
61-35637-C005	NORTHERN DRUMSITE WORKS - EXISTING SERVICES - PLAN - SHEET 1 OF 5
61-35637-C006	NORTHERN DRUMSITE WORKS - EXISTING SERVICES - PLAN - SHEET 2 OF 5
61-35637-C007	CENTRAL DRUMSITE WORKS - EXISTING SERVICES - PLAN - SHEET 3 OF 5
61-35637-C008	CENTRAL DRUMSITE WORKS - EXISTING SERVICES - PLAN - SHEET 4 OF 5
61-35637-C009	SOUTHERN DRUMSITE WORKS - EXISTING SERVICES - PLAN - SHEET 5 OF 5
61-35637-C013	CENTRAL DRUMSITE WORKS - PLAN - SHEET 2
61-35637-C015	CENTRAL DRUMSITE WORKS - PLAN & LONGITUDINAL SECTION - EARLY WORKS
61-35637-C016	NORTHERN & SOUTHERN DRUMSITE WORKS - PLANS & LONGITUDINAL SECTIONS - EARLY WORKS
61-35637-C017	CENTRAL DRUMSITE WORKS - PLAN & LONGITUDINAL SECTION - C01-14 TO C01-15 CULVERT - EARLY WORKS
61-35637-C028	CENTRAL DRUMSITE WORKS - BUND & DRAIN - PLAN, LONGITUDINAL SECTION & TYPICAL SECTIONS - EARLY WORKS
61-35637-C040	STRUCTURAL NOTES
61-35637-C041	CENTRAL DRUMSITE WORKS - TYPICAL DETAILS - PIT ADJACENT CONVEYOR CROSSOVER
61-35637-C042	CENTRAL DRUMSITE WORKS - TYPICAL DETAILS - OUTLET ADJACENT CONVEYOR CROSSOVER
61-35637-C049	DRAINAGE STRUCTURES - TYPICAL DETAILS - SHEET 1
61-35637-C050	DRAINAGE STRUCTURES - TYPICAL DETAILS - SHEET 2
61-35637-C051	DRAINAGE STRUCTURES - TYPICAL DETAILS - SHEET 3
61-35637-C052	DRAINAGE STRUCTURES - TYPICAL DETAILS - SHEET 4



LOCALITY PLAN

N.T.S

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Approved (Project Director)	*P.SEMAN		
Date	04/05/2018		
Scale	1:2500	This Drawing must not be used for Construction unless signed as Approved	

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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: COVER SHEET, LOCALITY PLAN & DRAWING LIST EARLY WORKS

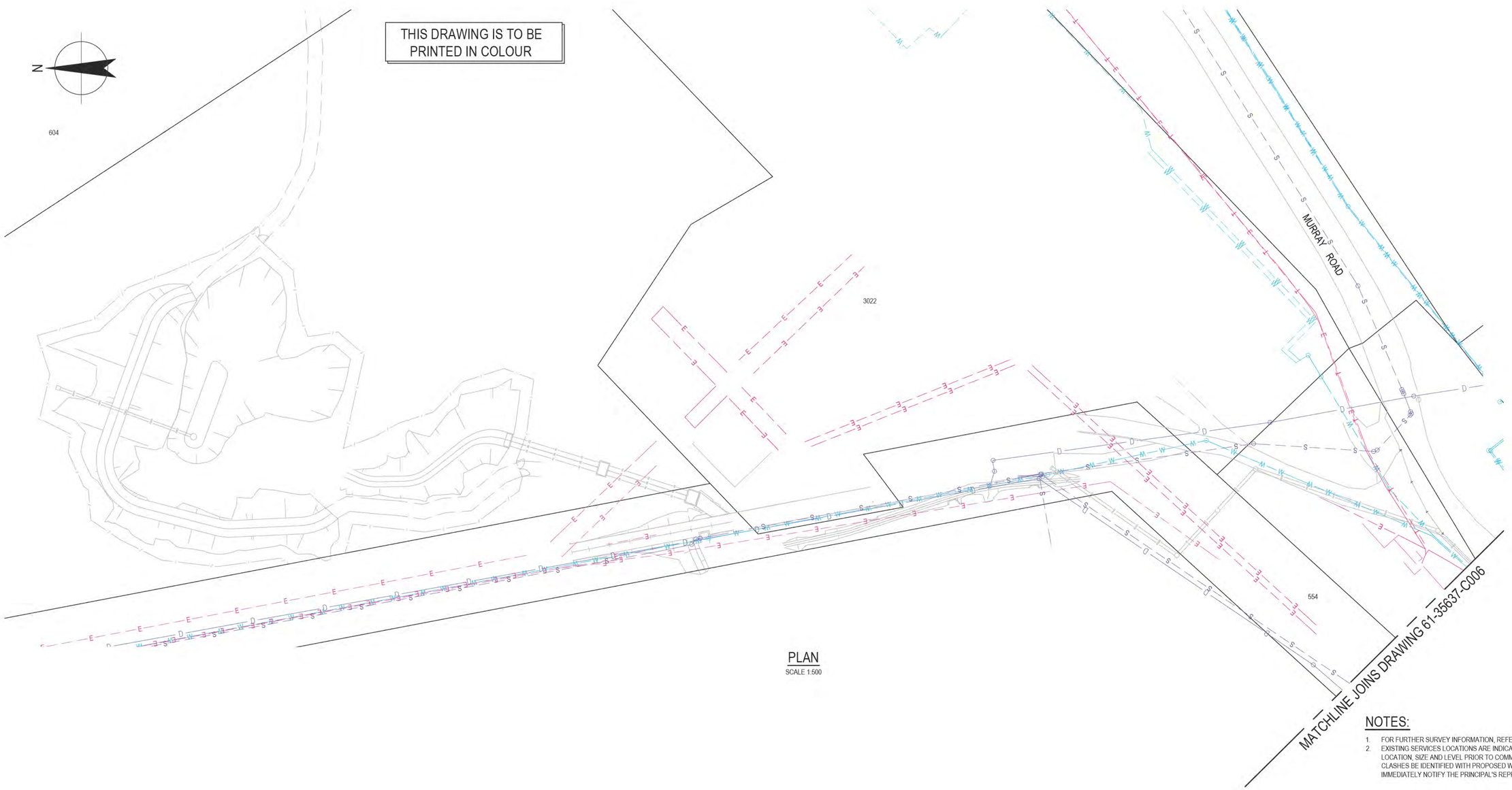
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Drawing No: 61-35637-C002
Rev: 0

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- EXISTING CADASTRAL BOUNDARY
- EXISTING DRAINAGE
- EXISTING ELECTRICAL CABLE
- EXISTING FUEL LINE
- EXISTING SEWER LINE
- EXISTING TELCO CABLE
- EXISTING WATER PIPE

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Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: NORTHERN DRUMSITE WORKS
EXISTING SERVICES - PLAN - SHEET 1 OF 5

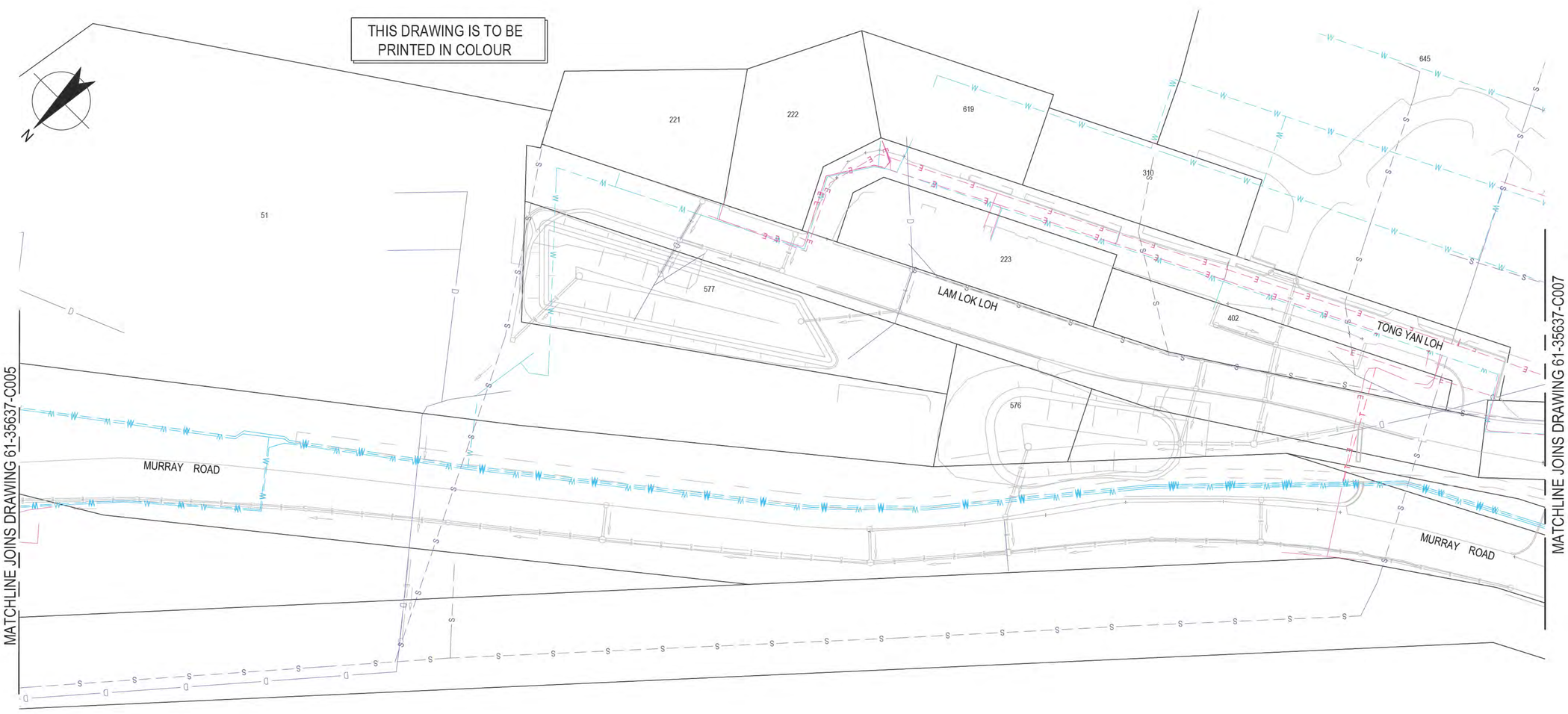
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- D — EXISTING DRAINAGE
- E — EXISTING ELECTRICAL CABLE
- F — EXISTING FUEL LINE
- S — EXISTING SEWER LINE
- T — EXISTING TELCO CABLE
- W — EXISTING WATER PIPE

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Date		
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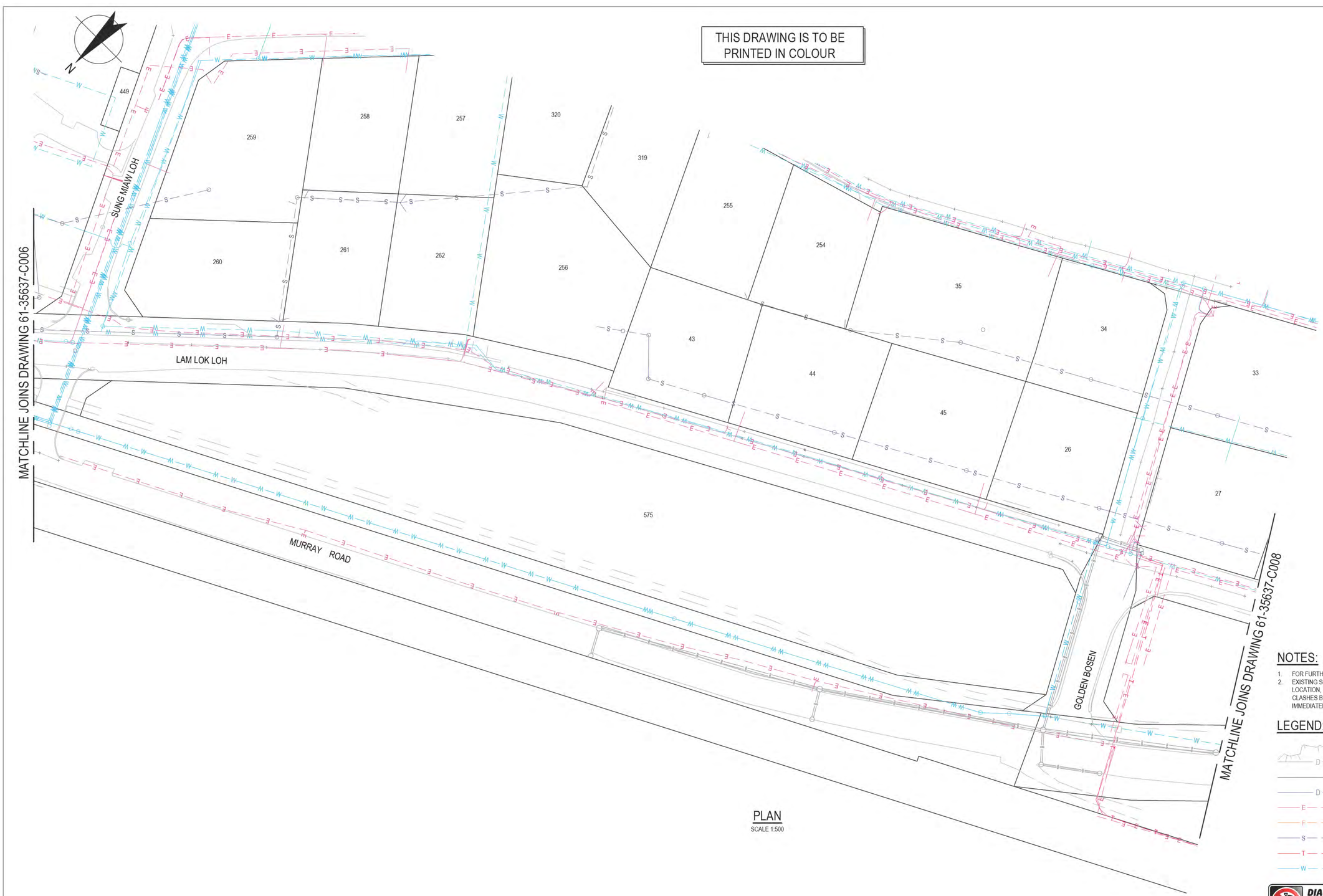
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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: NORTHERN DRUMSITE WORKS
EXISTING SERVICES - PLAN - SHEET 2 OF 5

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LEGEND:

- PROPOSED DRAINAGE
- EXISTING CADASTRAL BOUNDARY
- EXISTING DRAINAGE
- EXISTING ELECTRICAL CABLE
- EXISTING FUEL LINE
- EXISTING SEWER LINE
- EXISTING TELCO CABLE
- EXISTING WATER PIPE

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0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

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Approved (Project Director)			
Date			
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Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: CENTRAL DRUMSITE WORKS
EXISTING SERVICES - PLAN - SHEET 3 OF 5

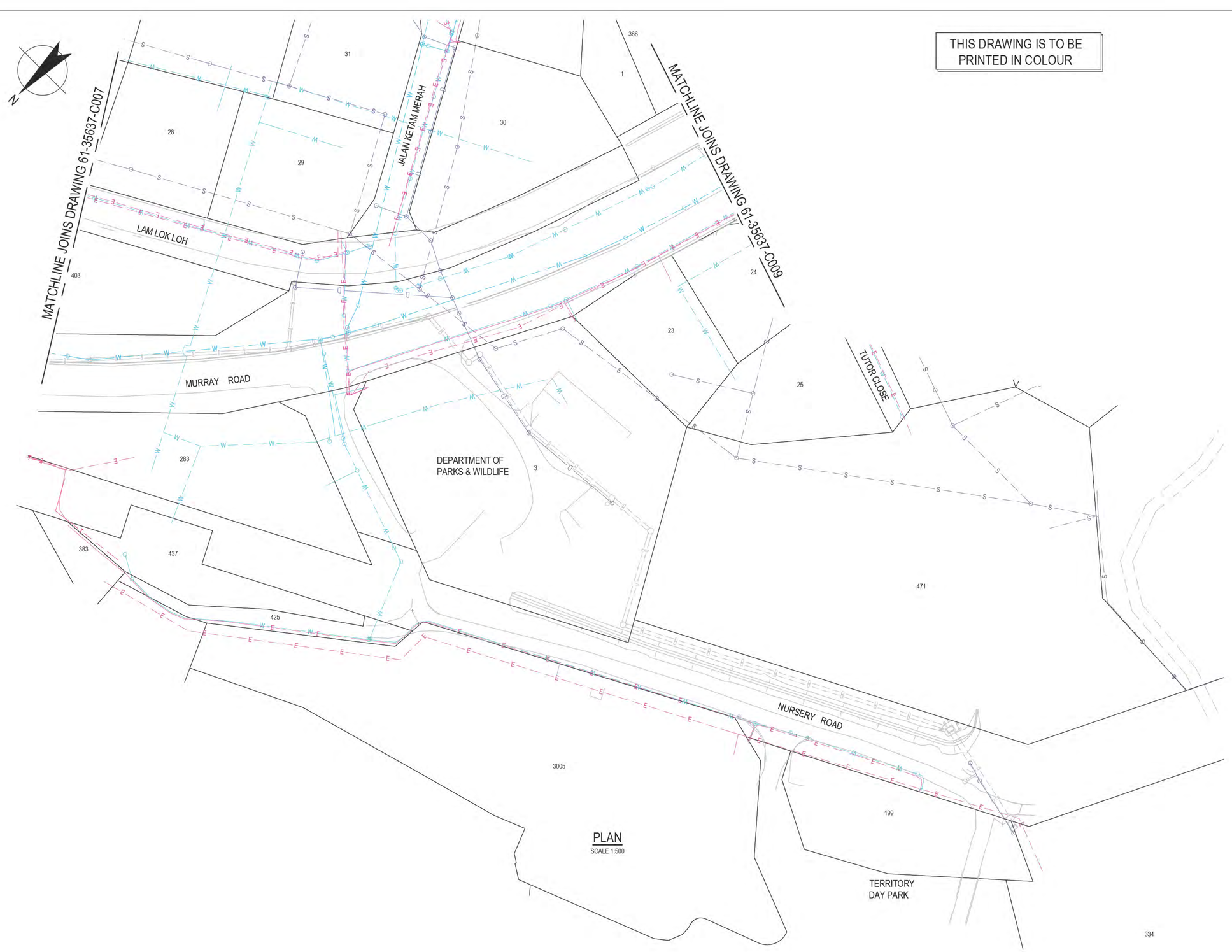
Original Size A1 | Drawing No: 61-35637-C007 | Rev: 0

Plot Date: 3 May 2018 - 1:03 PM | Plotted by: Jess Overheu | Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C007.dwg

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PLAN
SCALE 1:500

NOTES:

1. FOR FURTHER SURVEY INFORMATION, REFER TO DRAWINGS 61-35637-V01 SHEETS 1-3.
2. EXISTING SERVICES LOCATIONS ARE INDICATIVE ONLY. CONTRACTOR TO CONFIRM LOCATION, SIZE AND LEVEL PRIOR TO COMMENCING CONSTRUCTION, SHOULD ANY CLASHES BE IDENTIFIED WITH PROPOSED WORKS THE CONTRACTOR IS TO IMMEDIATELY NOTIFY THE PRINCIPAL'S REPRESENTATIVE.

LEGEND:

- PROPOSED DRAINAGE
- EXISTING CADASTRAL BOUNDARY
- EXISTING DRAINAGE
- EXISTING ELECTRICAL CABLE
- EXISTING FUEL LINE
- EXISTING SEWER LINE
- EXISTING TELCO CABLE
- EXISTING WATER PIPE

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SCALE 1:500 AT ORIGINAL SIZE

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
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Drafting Check		Design Check	
Approved (Project Director)			
Date			
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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: CENTRAL DRUMSITE WORKS
EXISTING SERVICES - PLAN - SHEET 4 OF 5

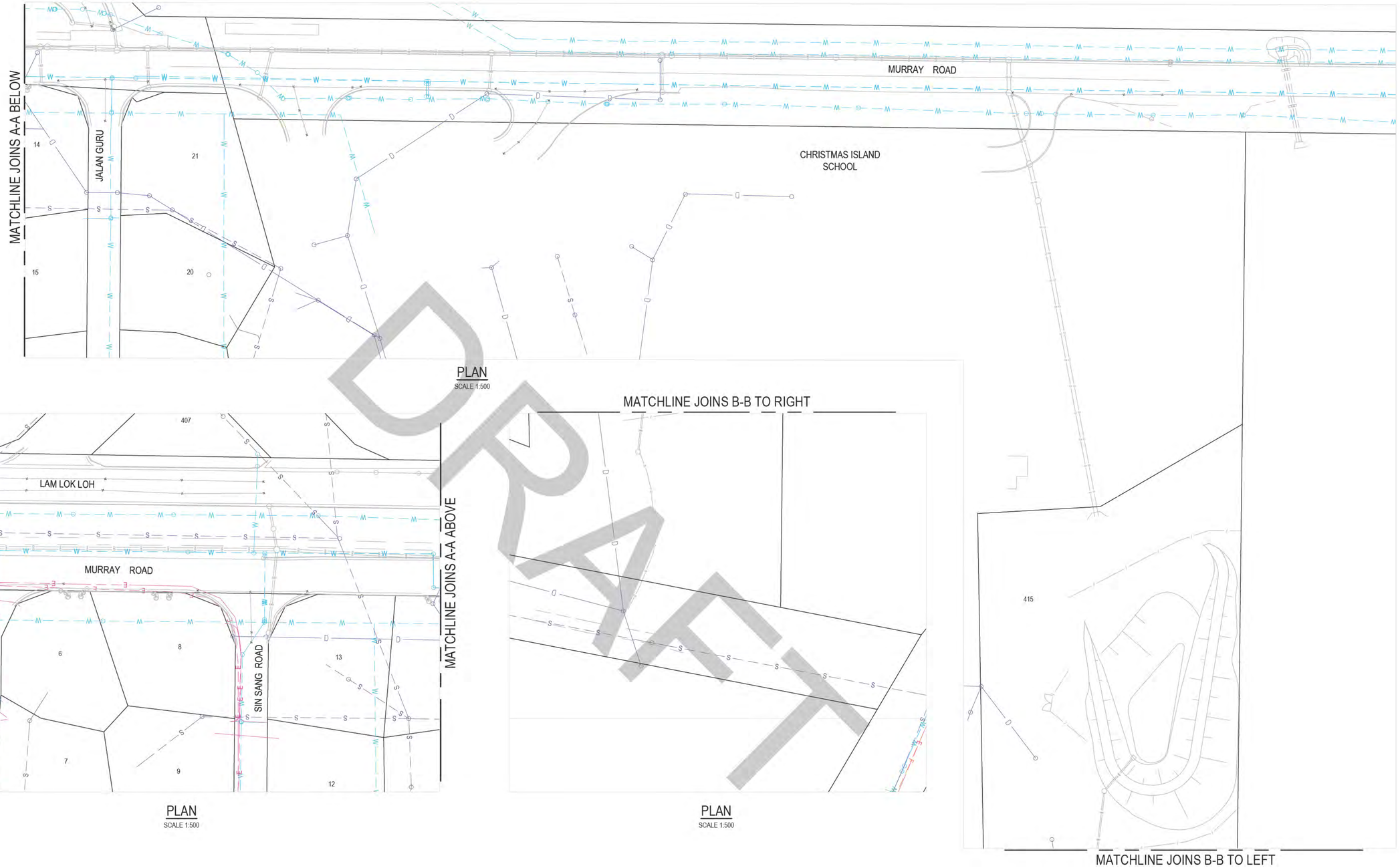
Original Size A1 | Drawing No: 61-35637-C008 | Rev: 0

Plot Date: 3 May 2018 - 1:04 PM | Plotted by: Jess Overheu | Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C008.dwg

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PLAN
SCALE 1:500

PLAN
SCALE 1:500

PLAN
SCALE 1:500

LEGEND:

- PROPOSED DRAINAGE
- EXISTING CADASTRAL BOUNDARY
- EXISTING DRAINAGE
- EXISTING ELECTRICAL CABLE
- EXISTING FUEL LINE
- EXISTING SEWER LINE
- EXISTING TELCO CABLE
- EXISTING WATER PIPE

NOTES:

1. FOR FURTHER SURVEY INFORMATION, REFER TO DRAWINGS 61-35637-V01 SHEETS 1-3.
2. EXISTING SERVICES LOCATIONS ARE INDICATIVE ONLY. CONTRACTOR TO CONFIRM LOCATION, SIZE AND LEVEL PRIOR TO COMMENCING CONSTRUCTION, SHOULD ANY CLASHES BE IDENTIFIED WITH PROPOSED WORKS THE CONTRACTOR IS TO IMMEDIATELY NOTIFY THE PRINCIPAL'S REPRESENTATIVE.

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0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

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Approved (Project Director)			
Date			
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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: SOUTHERN DRUMSITE WORKS
EXISTING SERVICES - PLAN - SHEET 5 OF 5

Original Size: A1
Drawing No: 61-35637-C009
Rev: 0

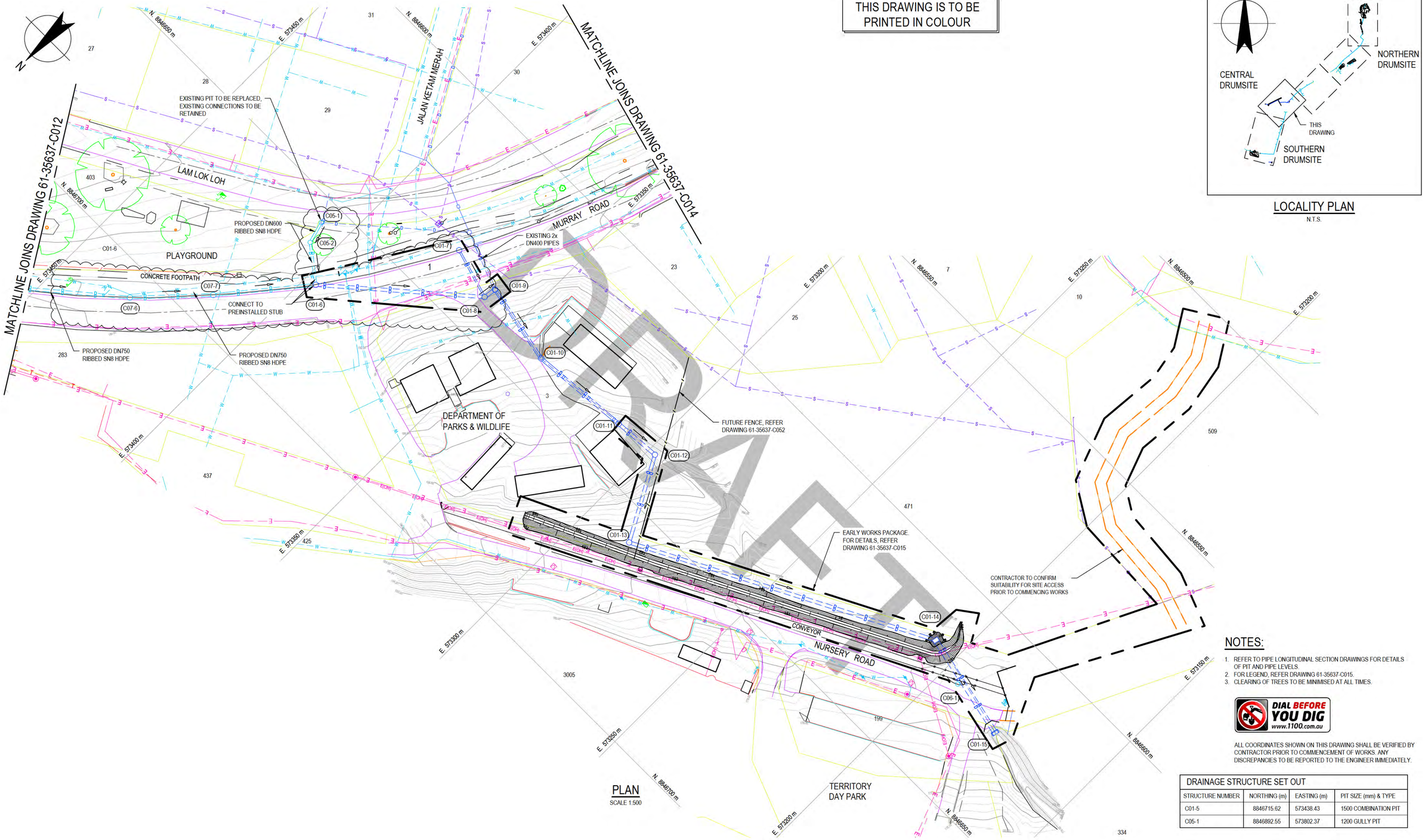
Plot Date: 3 May 2018 - 1:05 PM
Plotted by: Jess Overheu
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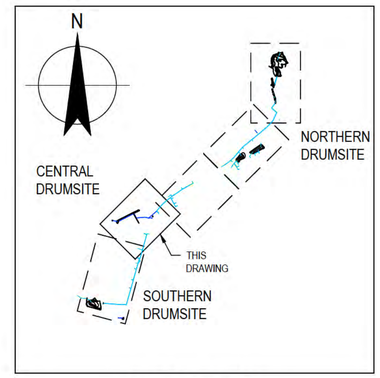
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LOCALITY PLAN
N.T.S.

PLAN
SCALE 1:500

NOTES:

1. REFER TO PIPE LONGITUDINAL SECTION DRAWINGS FOR DETAILS OF PIT AND PIPE LEVELS.
2. FOR LEGEND, REFER DRAWING 61-35637-C015.
3. CLEARING OF TREES TO BE MINIMISED AT ALL TIMES.

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DRAINAGE STRUCTURE SET OUT

STRUCTURE NUMBER	NORTHING (m)	EASTING (m)	PIT SIZE (mm) & TYPE
C01-5	8846715.62	573438.43	1500 COMBINATION PIT
C05-1	8846892.55	573802.37	1200 GULLY PIT

0 5 10 15 20 25m
SCALE 1:500 AT ORIGINAL SIZE

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
1	REVISED FOR CONSTRUCTION - 50□ DESIGN FOR CLIENT REVIEW		JO	JMK	PS	13/06/18
0	ISSUED FOR CONSTRUCTION		JO	*JMK	*PS	04/05/18

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Drafting Check	*S.HORTON	Design Check	*S.CLEARY
Approved (Project Director)	*P.SEMAN		
Date	04/05/2018		
Scale	1:500	This Drawing must not be used for Construction unless signed as Approved	

Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: CENTRAL DRUMSITE WORKS PLAN - SHEET 2

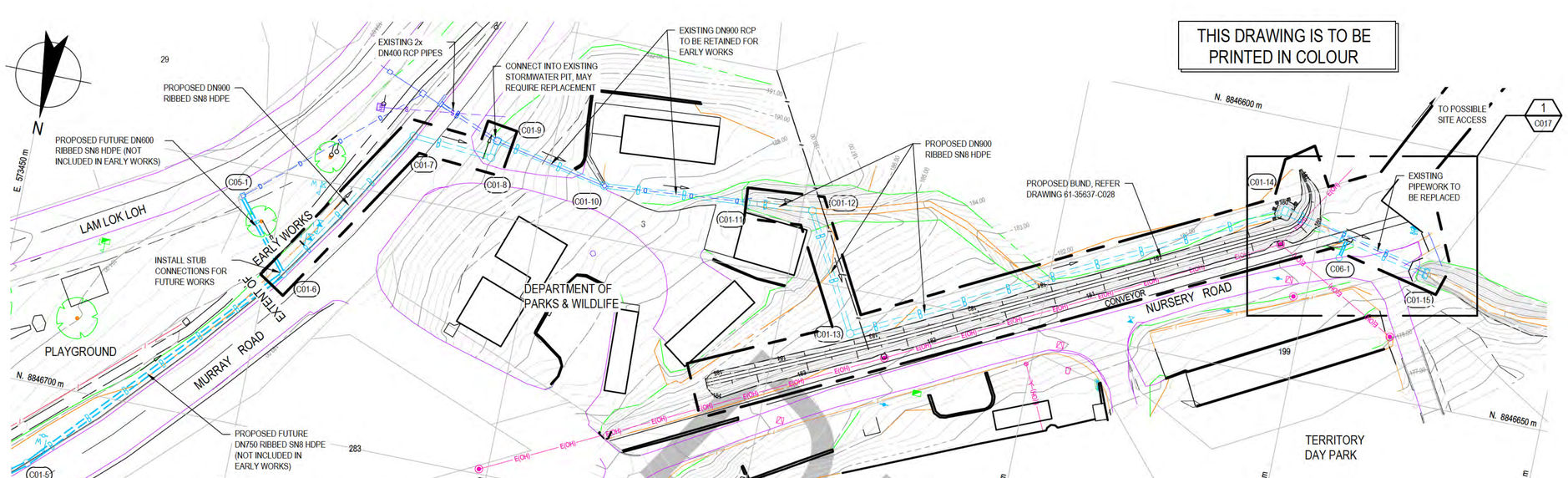
Original Size: A1
Drawing No: 61-35637-C013
Rev: 1

Plot Date: 15 June 2018 - 4:04 PM Plotted by: Jess Overheu Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C013.dwg

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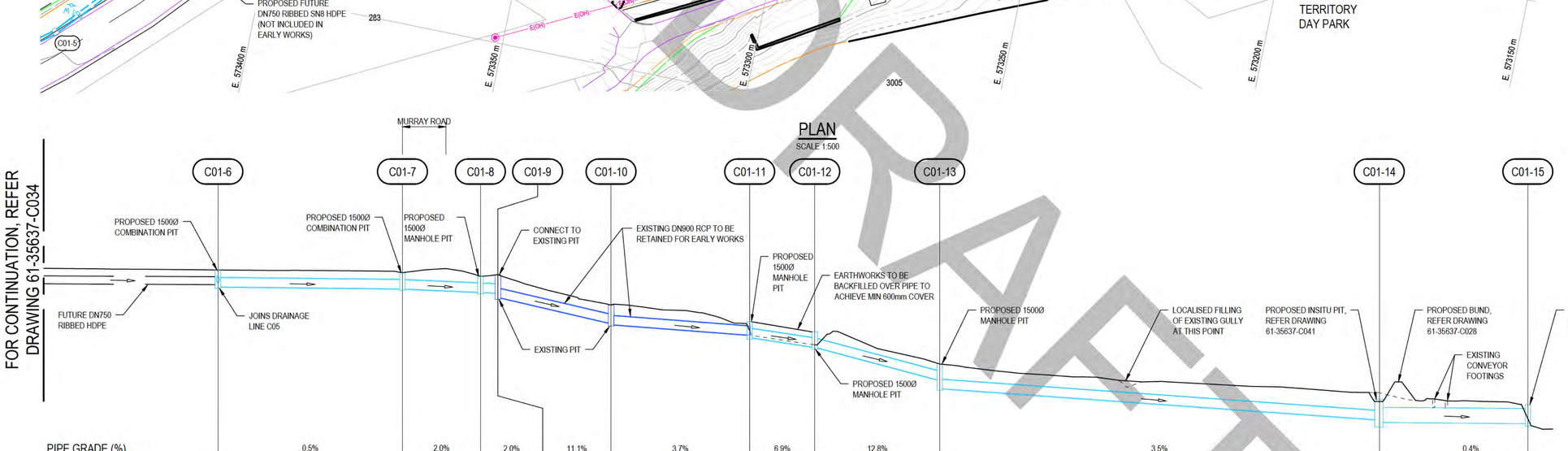
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PLAN

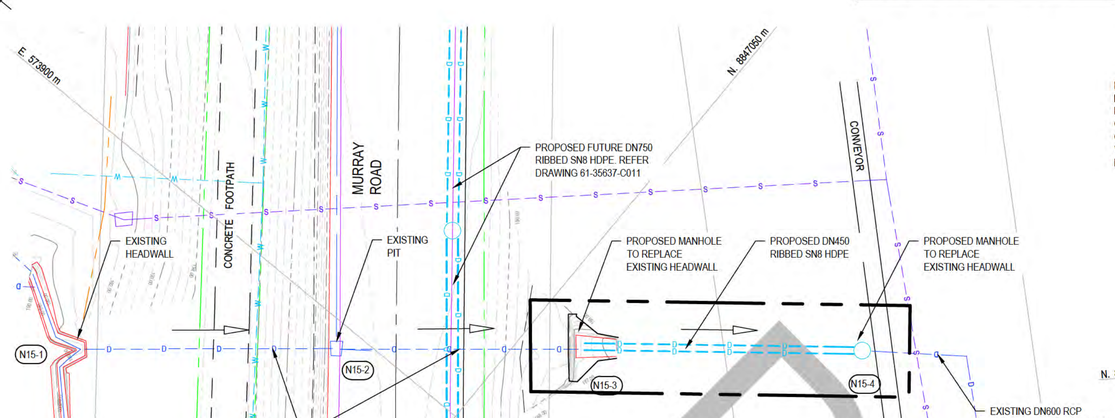
SCALE 1:500

FOR CONTINUATION, REFER DRAWING 61-35637-C034



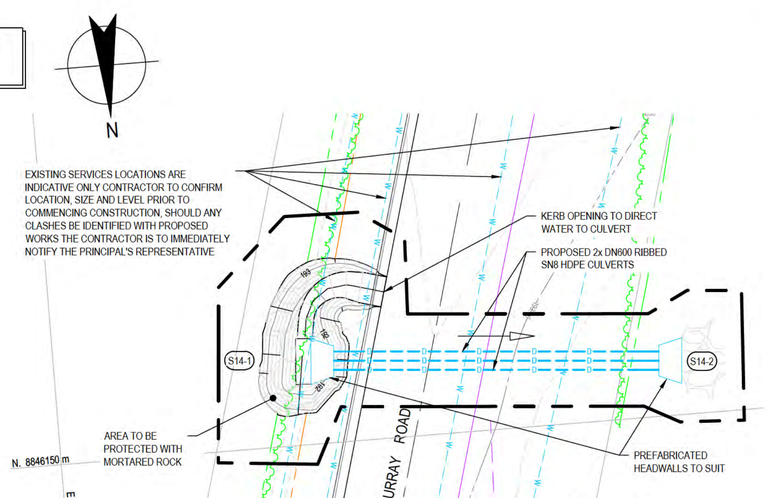
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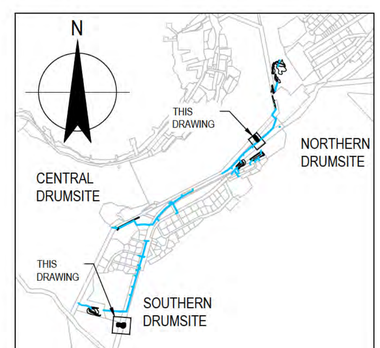
NORTH DRUMSITE - PLAN

SCALE 1:200



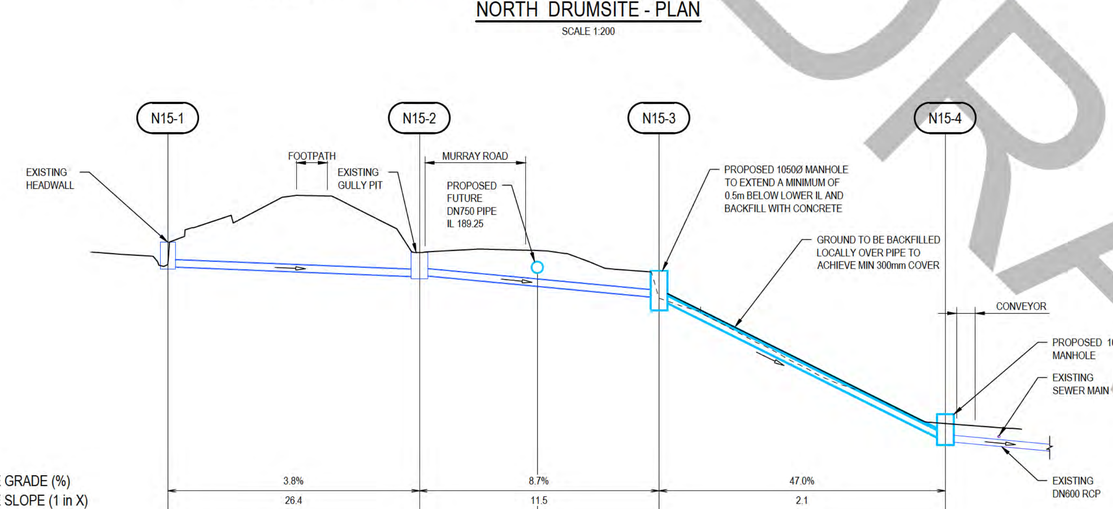
SOUTH DRUMSITE - PLAN

SCALE 1:200



LOCALITY PLAN

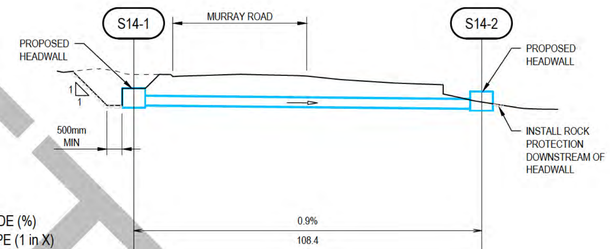
N.T.S.



PIPE GRADE (%)	3.8%	8.7%	47.0%	
PIPE SLOPE (1 in X)	26.4	11.5	2.1	
PIPE SIZE (mm)	450	450	450	
PIPE CLASS	RCP	RCP	RIBBED SN8 HDPE	
DATUM R.L. 168.0m				
DESIGN SURFACE LEVEL (m)	191.27	190.60	189.40	180.00
EXISTING SURFACE LEVEL (m)	189.80	190.60	187.60	179.40
INVERT LEVEL (m)	189.51 / 189.66	189.04 / 188.89 / 189.07 / 188.40	187.70 / 186.80 / 187.30	178.50 / 178.00
DEPTH TO INVERT FROM DESIGN SURFACE (m)	1.76 / 1.61	1.56 / 1.71 / 1.53	1.70 / 2.60 / 2.10	1.50 / 2.00
CHAINAGE (m)	0.0	16.5 / 16.5 / 15.7 / 7.72 / 32.2	18.7	50.9

DRAINAGE LINE N15 - LONGITUDINAL SECTION NORTHERN DRUMSITE

HORIZONTAL SCALE 1:200
VERTICAL SCALE 1:200



PIPE GRADE (%)	0.9%	
PIPE SLOPE (1 in X)	108.4	
PIPE SIZE (mm)	2x 600	
PIPE CLASS	RIBBED SN8 HDPE	
DATUM R.L. 176.0m		
DESIGN SURFACE LEVEL (m)	192.31	192.10
EXISTING SURFACE LEVEL (m)	193.24	191.42
INVERT LEVEL (m)	191.06 / 191.21	191.00 / 190.85
DEPTH TO INVERT FROM DESIGN SURFACE (m)	1.25 / 1.10	1.10 / 1.25
CHAINAGE (m)	0.0	22.8 / 22.8

DRAINAGE LINE S14 - LONGITUDINAL SECTION SOUTHERN DRUMSITE

HORIZONTAL SCALE 1:200
VERTICAL SCALE 1:200

NOTES:

1. FOR LEGEND, REFER DRAWING 61-35637-C015.
2. CLEARING OF TREES TO BE MINIMISED AT ALL TIMES.

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DRAINAGE STRUCTURE SET OUT		
STRUCTURE NUMBER	NORTHING (m)	EASTING (m)
N15-1	8847028.48	573912.05
N15-2	8847041.15	573901.53
N15-3	8847053.18	573891.46
N15-4	8847067.81	573879.74
S14-1	8846144.69	573231.68
S14-2	8846146.36	573210.47

0 2 4 6 8 10m
SCALE 1:200 AT ORIGINAL SIZE

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Approved (Project Director)			
Date			
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Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: NORTHERN & SOUTHERN DRUMSITE WORKS PLANS & LONGITUDINAL SECTIONS - EARLY WORKS

Original Size: A1
Drawing No: 61-35637-C016
Rev: 0

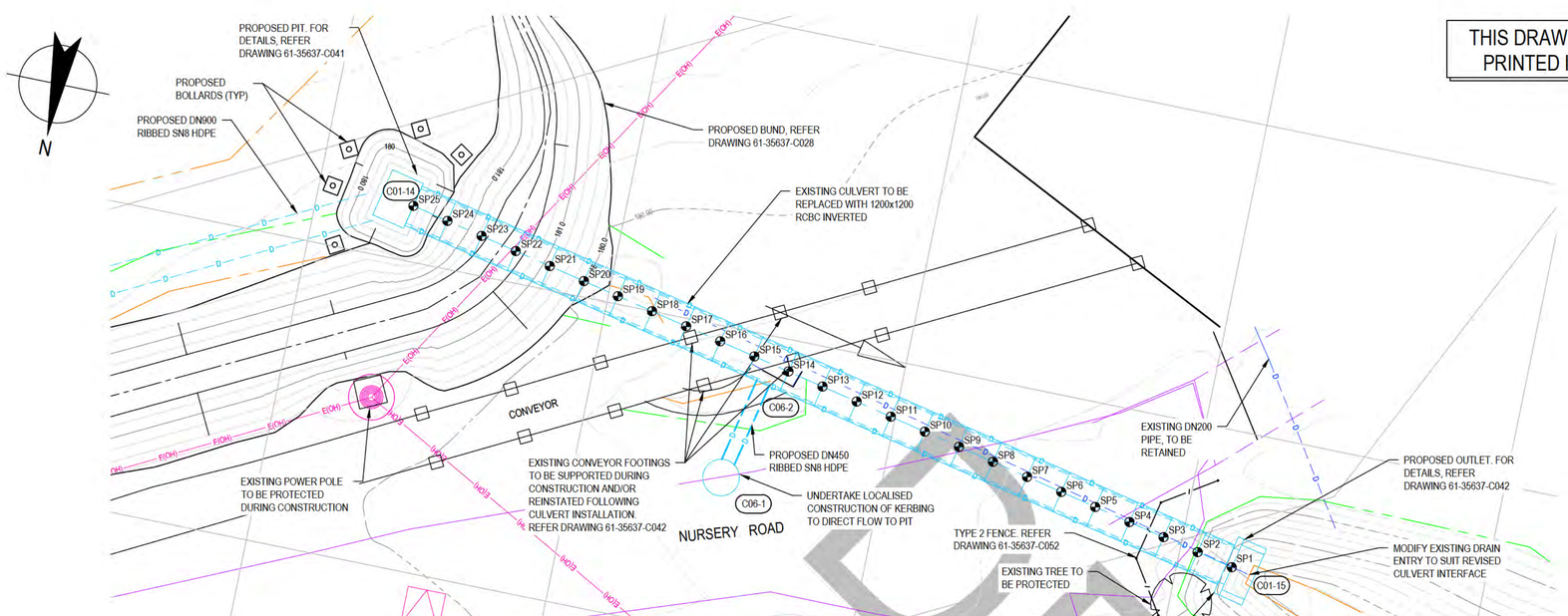
Plot Date: 3 May 2018 - 2:40 PM
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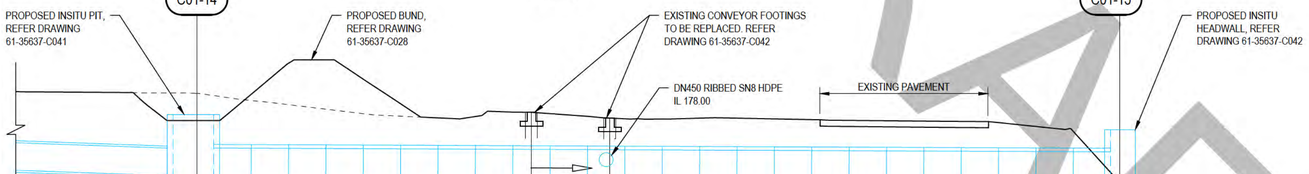
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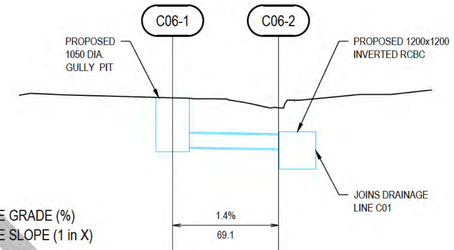
1 DETAIL
C015 SCALE 1 : 100

CULVERT SETOUT			
POINT	NORTHING (m)	EASTING	INVERT LEVEL
SP1	8846624.409	573178.223	177.280
SP2	8846624.150	573179.416	177.285
SP3	8846623.891	573180.608	177.289
SP4	8846623.631	573181.800	177.295
SP5	8846623.372	573182.992	177.299
SP6	8846623.113	573184.184	177.304
SP7	8846622.853	573185.376	177.309
SP8	8846622.594	573186.568	177.314
SP9	8846622.335	573187.760	177.319
SP10	8846622.076	573188.953	177.324
SP11	8846621.816	573190.145	177.329
SP12	8846621.557	573191.337	177.333
SP13	8846621.298	573192.529	177.338
SP14	8846621.038	573193.721	177.343
SP15	8846620.779	573194.913	177.348
SP16	8846620.520	573196.105	177.353
SP17	8846620.260	573197.297	177.358
SP18	8846620.001	573198.490	177.363
SP19	8846619.742	573199.682	177.367
SP20	8846619.483	573200.874	177.372
SP21	8846619.223	573202.066	177.377
SP22	8846618.964	573203.258	177.382
SP23	8846618.705	573204.450	177.387
SP24	8846618.445	573205.642	177.392
SP25	8846618.186	573206.834	177.400



PIPE GRADE (%)												0.4%														
PIPE SLOPE (1 in X)												250.8														
PIPE SIZE (mm)												1200x1200														
PIPE CLASS												INVERTED RCBC														
DATUM R.L. 170.0m																										
DESIGN SURFACE LEVEL (m)	179.70											179.77												179.58		179.20
EXISTING SURFACE LEVEL (m)	179.50																									177.79
INVERT LEVEL (m)	177.70	176.95	177.40									177.36												177.35		177.28	177.03
DEPTH TO INVERT FROM DESIGN SURFACE (m)	2.00	2.75	2.30																							1.92	2.17
CHAINAGE (m)	468.7											479.62												482.18	30.1	498.8	

DRAINAGE LINE C01 - LONGITUDINAL SECTION
CENTRAL DRUMSITE
HORIZONTAL SCALE 1:100
VERTICAL SCALE 1:100



PIPE GRADE (%)		1.4%	
PIPE SLOPE (1 in X)		69.1	
PIPE SIZE (mm)		450	
PIPE CLASS		RIBBED SN8 HDPE	
DATUM R.L. 172.0m			
DESIGN SURFACE LEVEL (m)	179.66		179.34
EXISTING SURFACE LEVEL (m)	179.66		179.34
INVERT LEVEL (m)	177.90	178.05	178.00 177.85
DEPTH TO INVERT FROM DESIGN SURFACE (m)	1.76	1.61	1.34 1.49
CHAINAGE (m)	0.0	3.5	3.5

DRAINAGE LINE C06 - LONGITUDINAL SECTION
CENTRAL DRUMSITE
HORIZONTAL SCALE 1:100
VERTICAL SCALE 1:100

NOTES:

1. FOR LEGEND, REFER DRAWING 61-35637-C015.

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0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
0	ISSUED FOR CONSTRUCTION		JO			

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Drafting Check		Design Check	
Approved (Project Director)			
Date			
Scale	1:100	This Drawing must not be used for Construction unless signed as Approved	

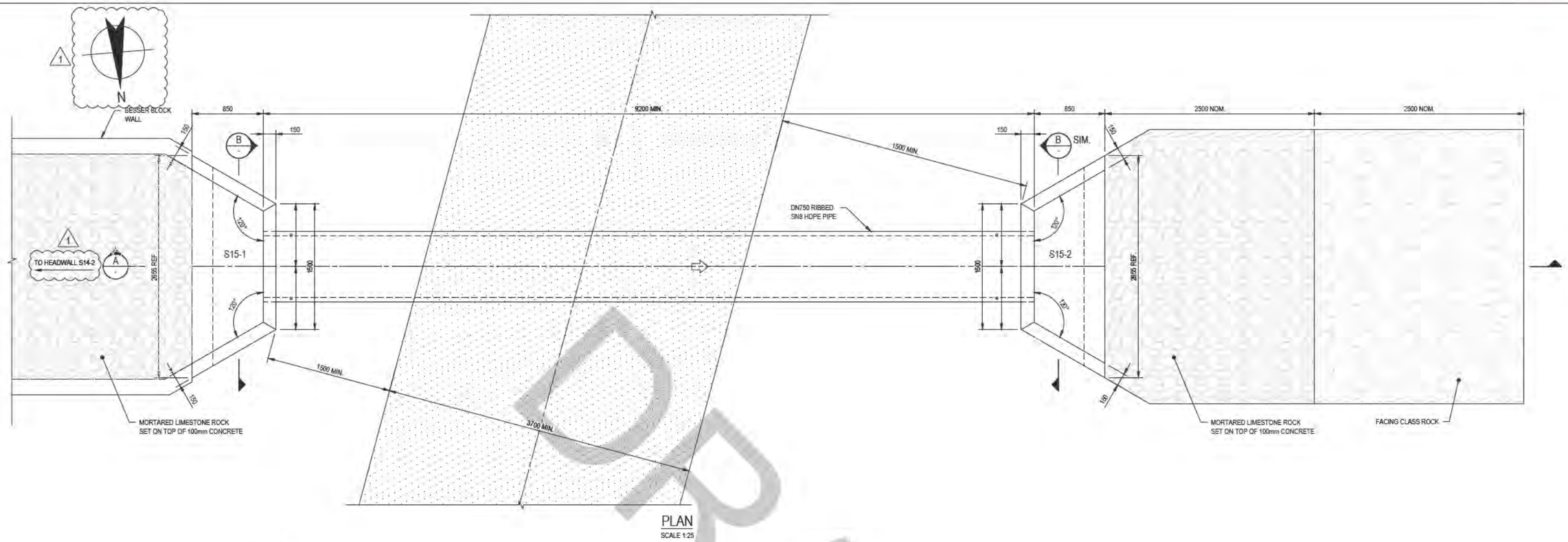
Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: CENTRAL DRUMSITE WORKS
PLAN & LONGITUDINAL SECTION - C01-14 TO C01-15 - EARLY WORKS

Original Size A1 | Drawing No: 61-35637-C017 | Rev: 0

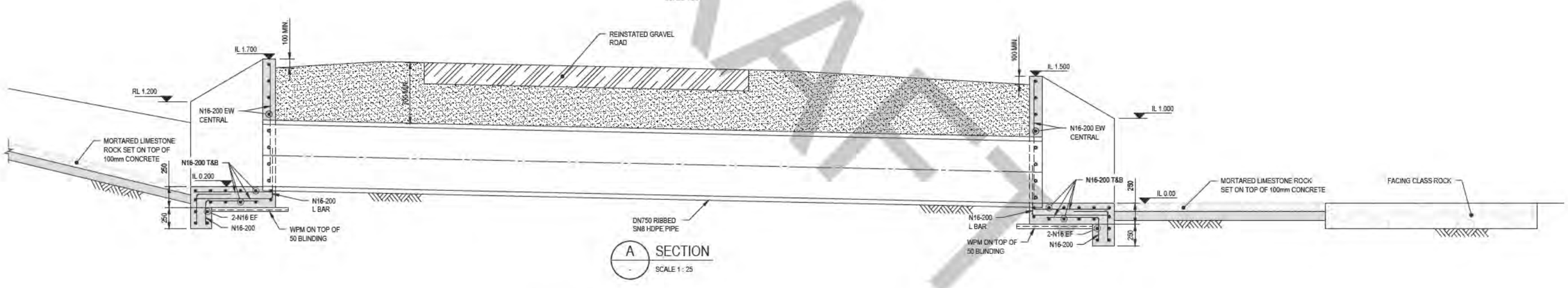
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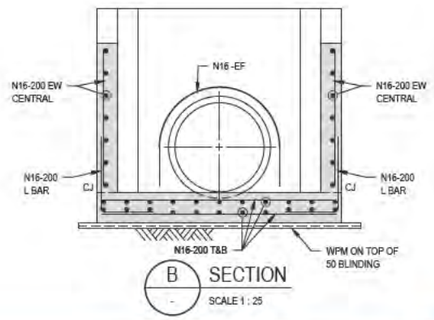
FOI 26-292 - Document 27



PLAN
SCALE 1:25



A SECTION
SCALE 1 : 25



B SECTION
SCALE 1 : 25

NOTES:

1. REFER DRG 61-35637-C040 FOR STRUCTURAL NOTES.
2. THE POSITION OF THE CULVERT IS SUBJECT TO CONFIRMATION ON SITE.
3. SURROUNDING LEVELS TO BE CHANGED TO MATCH IN WITH HEADWALLS.
4. ROCK PROTECTION DOWNSTREAM OF S15-2 TO BE LOCATED TO AVOID REMOVAL OF ANY EXISTING TREES. ROCK TO BE ADDED ON MIN. 150mm THICK BEDDING MATERIAL.

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
1	ISSUED FOR CONSTRUCTION - EDITED NOTES		GLB	SVC*	PS*	17/07/18
0	ISSUED FOR CONSTRUCTION		GLB	JMK*	PS*	16/07/18

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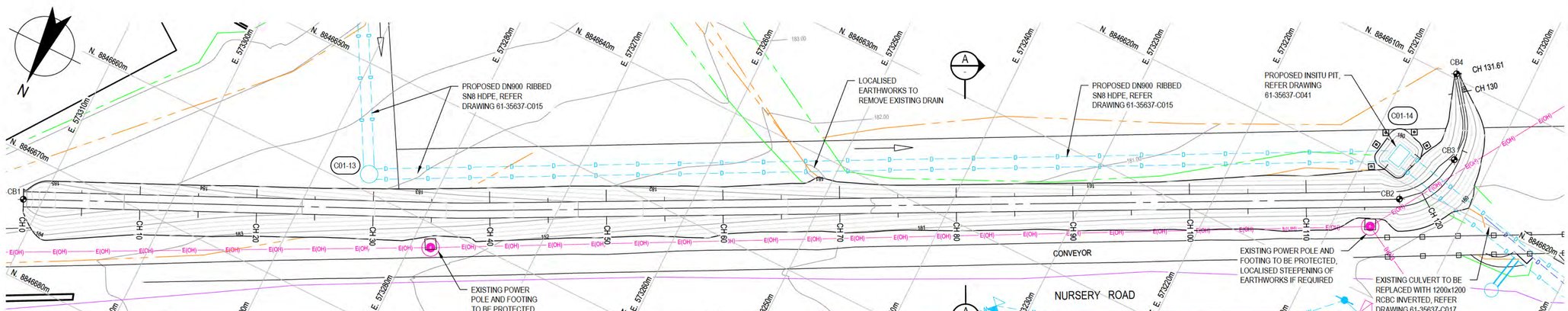
Drawn	G.BURTON	Designer	E.BOSUSTOW*
Drafting Check	L.ORREAL*	Design Check	T.MZUNGU*
Approved (Project Director)	P. SEMAN*		
Date	16/07/18		
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: SOUTHERN DRUMSITE WORKS
CIP ACCESS ROAD CULVERT DETAILS - EARLY WORKS

Original Size: A1
Drawing No: 61-35637-C018
Rev: 1

Plot Date: 17 July 2018 - 8:53 AM Plotted by: Gary Burton Cad File No: G:\61\35637\CADD\Drawings\61-35637-C018.dwg

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NOTES:

1. FOR LOCATION OF BUND, REFER DRAWING 61-35637-C015.
2. LAY GEOSYNTHETIC CEMENTITIOUS COMPOSITE MAT (GCCM) IN ACCORDANCE WITH MANUFACTURER'S GUIDELINES.
3. LAY GCCM PERPENDICULAR TO THE BUND.
4. EACH GCCM SEGMENT TO BE PINED IN ANCHOR TRENCH, MINIMUM 4 PINS PER SECTION.
5. 12-15% 100mm OVERLAP REQUIRED ON EACH SECTION. ALL JOINTS TO BE SCREWED AND SEALED AS PER DETAIL 1.
6. EARTH FILL COMPACTED TO NOM. 95% SMDD, VERIFIED BY METHOD SPEC.
7. EARTH FILL TO COMPRISE EXCESS TRENCH SPOIL PLACED AND COMPACTED IN LAYERS.
8. ANCHOR TRENCH TO HAVE SIMILAR MATERIAL AND COMPACTION TO BUND, REFER NOTES 6 AND 7.
9. EMBANKMENT SLOPES CAN INCREASE TO 1:1 LOCALLY TO AVOID EXISTING INFRASTRUCTURE.
10. SETOUT POINTS ARE FOR REFERENCE ONLY, REFER TO 12D MODEL.
11. FOR LEGEND, REFER DRAWING 61-35637-C010.
12. ALL DIMENSIONS ARE IN MILLIMETRES (m) UNO.
13. ALL RLs ARE IN METRES TO AUSTRALIAN HEIGHT DATUM (m AHD)
14. ALL WORKS SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE LATEST EDITION OF CURRENT STANDARDS, SPECIFICATIONS AND DRAWINGS.
15. DRAWINGS SHALL NOT BE SCALED.

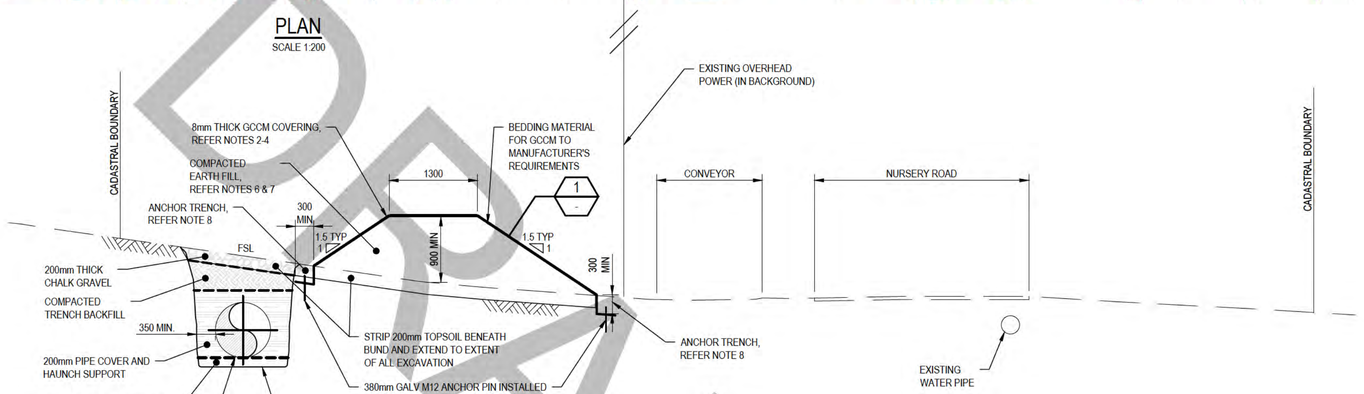
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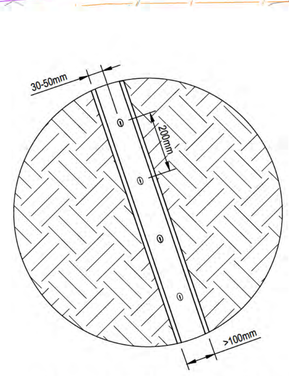
ALL COORDINATES SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

DRAINAGE STRUCTURE SET OUT		
SETOUT POINT	NORTHING (m)	EASTING (m)
CB1	8846673.56	573311.49
CB2	8846621.38	573205.71
CB3	8846616.28	573202.98
CB4	8846609.59	573206.05

THIS DRAWING IS TO BE PRINTED IN COLOUR

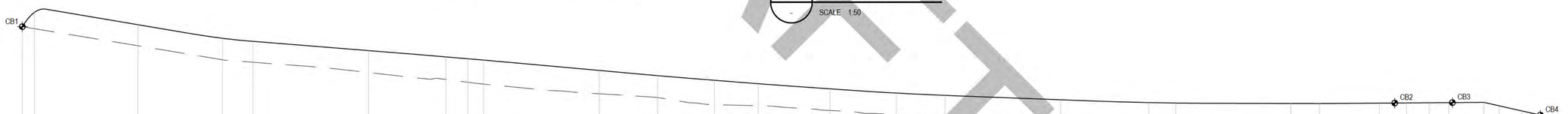
PLAN
SCALE 1:200





1 CONCRETE CANVAS SECONDARY CONTAINMENT BUND EDGE DETAIL
SCALE 1 : 10

A TYPICAL SECTION
SCALE 1:50



DATUM RL. 178.0m

| | | |

FOI 26-292 - Document 27

GENERAL

1. THESE DRAWINGS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS AND THE SPECIFICATION.

2. MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE RELEVANT AUSTRALIAN STANDARDS AND THE BYLAWS AND ORDINANCES OF RELEVANT AUTHORITIES.

3. ALL TRADES SHALL VERIFY ON SITE LEVELS AND DIMENSIONS BEFORE COMMENCING WORK.

4. DURING CONSTRUCTION THE STRUCTURE SHALL BE MAINTAINED IN A STABLE CONDITION.

CONCRETE

1. ALL CONCRETE SHALL COMPLY WITH AS 3600 AND THE SPECIFICATION.

2. CEMENT USED IN ALL CONCRETE SHALL BE NORMAL PORTLAND CEMENT (TYPE GP) EXCEPT 'N' GRADE MIXES.

3. CONCRETE QUALITY

LOCATION	GRADE (MPa)	MAX SIZE AGG (mm)	SLUMP (mm)
FOOTINGS	N32	20	80
PITS & SLABS ON GROUND	S40	20	80

4. NOTIFY THE ENGINEER AT LEAST 24 HOURS BEFORE PLACING CONCRETE

5. COMPACT CONCRETE BY USING APPROVED IMMERSION VIBRATORS (INCLUDING FOOTINGS).

6. CURE ALL CONCRETE BY KEEPING MOIST FOR 7 DAYS IN AN APPROVED MANNER.

REINFORCEMENT

1. UNLESS NOTED OTHERWISE MINIMUM LAPS ARE TO BE: FABRIC - 250mm, BARS - 40 DIAMETERS.

2. SUPPORT ALL REINFORCEMENT ADEQUATELY AND ACCURATELY ON APPROVED CHAIRS

3. CLEAR COVER TO REINFORCEMENT TO BE:

FOOTINGS	75 BOTTOM AND SIDES
PITS & SLABS ON GROUND	40 TOP

FORMWORK

1. FORMWORK SHALL COMPLY WITH AS 3610.

STRUCTURAL STEELWORK

1. STEEL SHALL COMPLY WITH AS 4100.

2. STEEL SHALL BE HOT-DIP GALVANISED TO AS/NZS 4680 AFTER FABRICATION.

3. STEEL WORK SHALL BE FABRICATED TO SUIT HOT-DIP GALVANISING REQUIREMENTS INCLUDING REMOVAL OF SHARP EDGES AND SURFACE IRREGULARITIES.

WELDING

1. STRUCTURAL STEELWORK WELDS TO BE MINIMUM 6mm, FULLY SEALED, CONTINUOUS FILLET, STRUCTURAL PURPOSE TO AS 1554.1

HOT-DIP GALVANISED CARBON/MILD STEEL FASTENERS

1. BOLTS, NUTS AND WASHERS SHALL COMPLY WITH AS/NZS 1252.

2. BOLTS AND NUTS SHALL BE HOT-DIP GALVANISED TO AS 1214 AND WASHERS SHALL BE GALVANISED TO AS/NZS 4680.

DRAFT

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
0	ISSUED FOR CONSTRUCTION		GLB			

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Drawn G.BURTON	Designer T.MZUNGU	
Drafting Check	Design Check	
Approved (Project Director)		
Date		
Scale N/A	This Drawing must not be used for Construction unless signed as Approved	

Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: STRUCTURAL NOTES

Original Size: A1
Drawing No: 61-35637-C040
Rev: 0

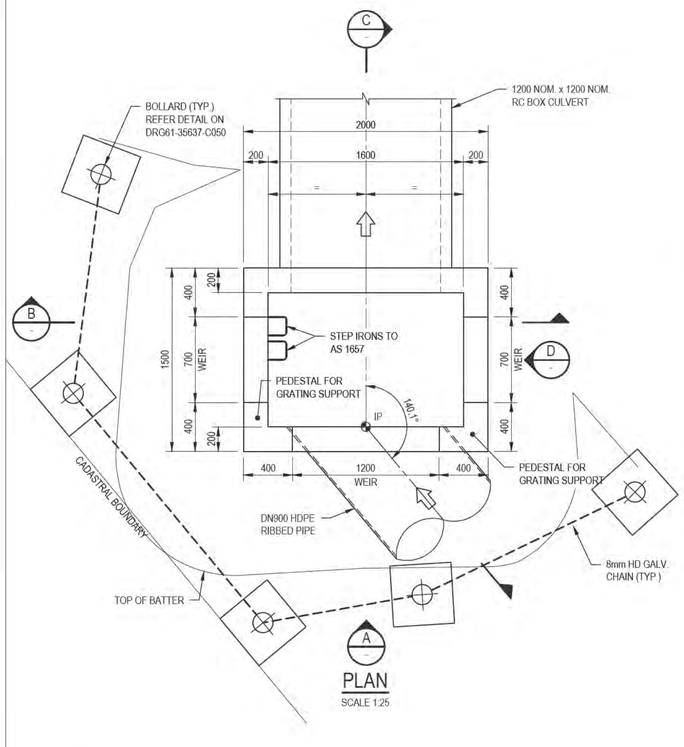
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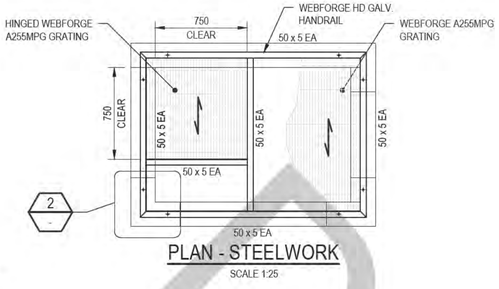
NOTES:

1. REFER DRG 61-35637-C015 FOR PIT LOCATION.
2. REFER DRG 61-35637-C040 FOR STRUCTURAL NOTES.
3. REFER DRG 61-35637-C042 FOR STEP IRON DETAILS



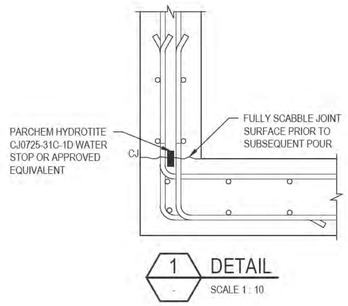
PLAN

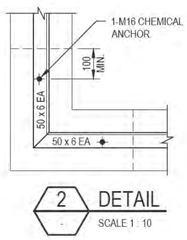
SCALE 1:25

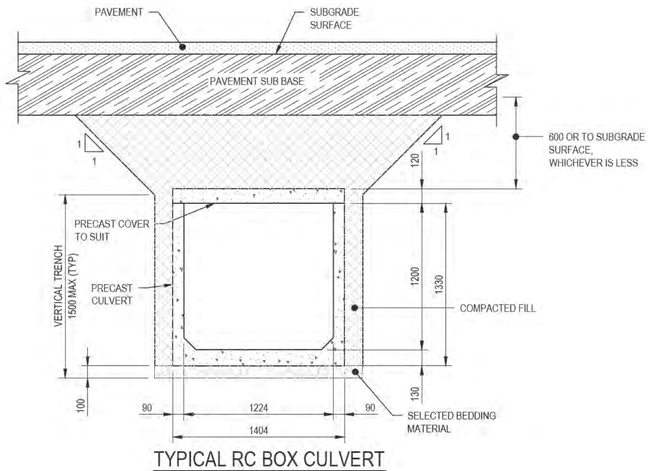


PLAN - STEELWORK

SCALE 1:25

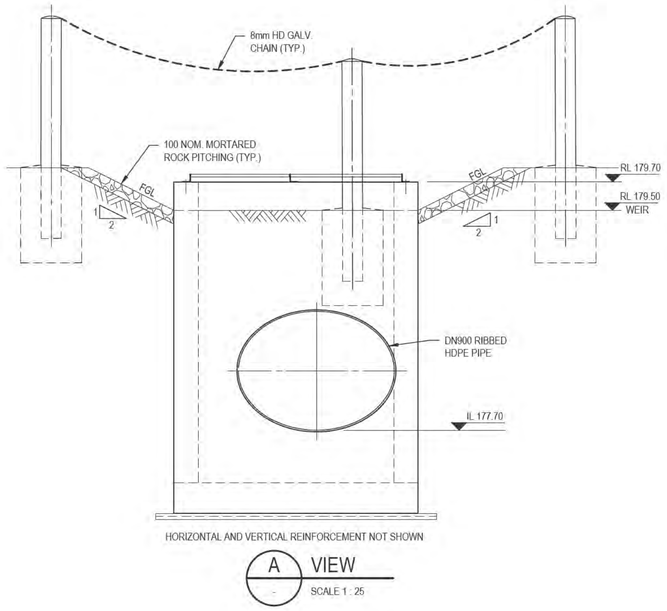


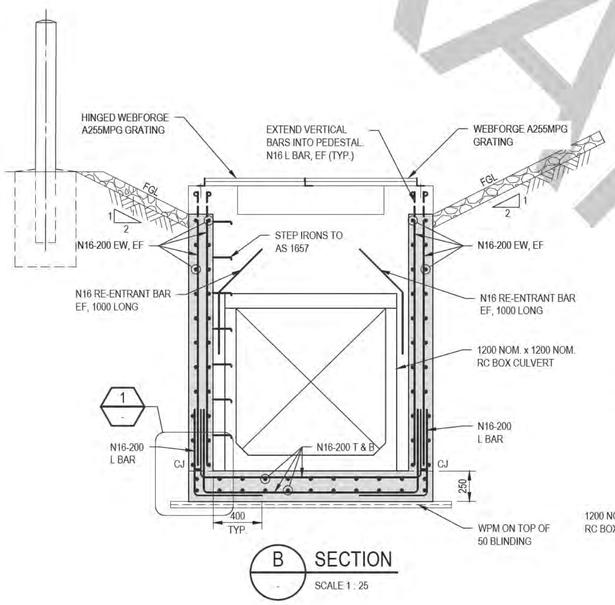


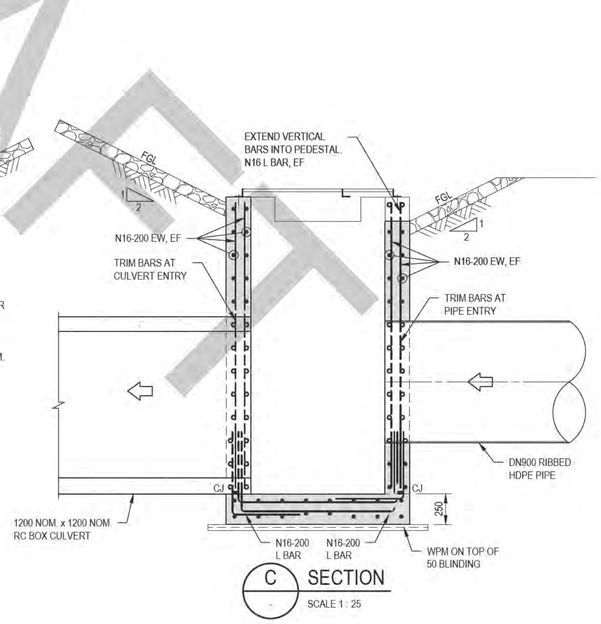


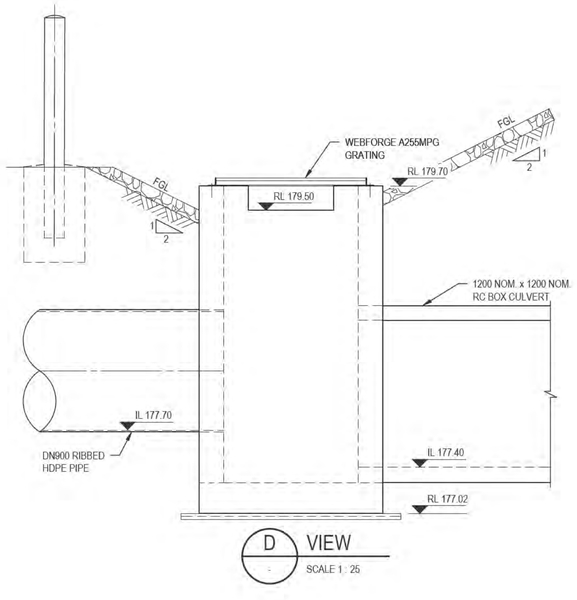
TYPICAL RC BOX CULVERT

SCALE 1:25









0 0.25 0.5 0.75 1.0 1.25m

SCALE 1:25 AT ORIGINAL SIZE

0 0.1 0.2 0.3 0.4 0.5m

SCALE 1:10 AT ORIGINAL SIZE

DRAFT

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Drafting Check	Design Check	
Approved (Project Director)		
Date		
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Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES

Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS

Title: TYPICAL DETAILS - CENTRAL DRUMSITE PIT ADJACENT CONVEYOR CROSSOVER

Original Size: A1

Drawing No: 61-35637-C041

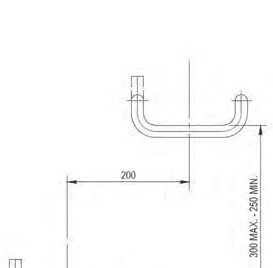
Rev: 0

Plot Date: 3 May 2018 - 1:19 PM Plotted by: Jess Overheu Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C041.dwg

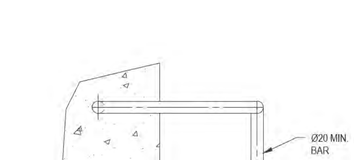
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NOTES:

1. REFER DRG 61-35637-C015 FOR PIT LOCATION.
2. REFER DRG 61-35637-C040 FOR STRUCTURAL NOTES.
3. STEP IRONS SHALL BE IN ACCORDANCE WITH AS 1657 AND HOT DIP GALVANISED AFTER BENDING.



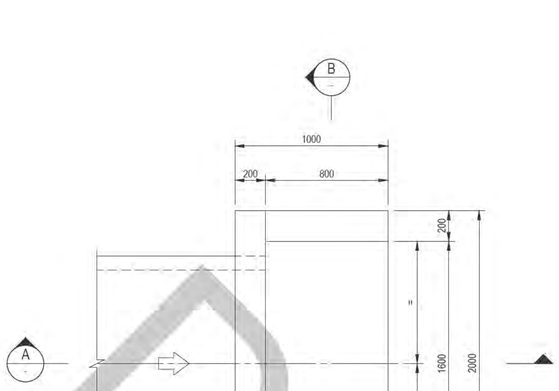
ELEVATION
SCALE 1:5



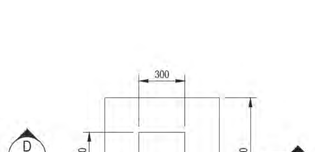
PLAN - STEP IRON
SCALE 1:5



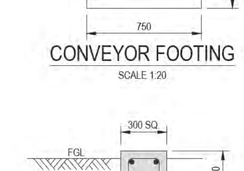
C SECTION
SCALE 1 : 5



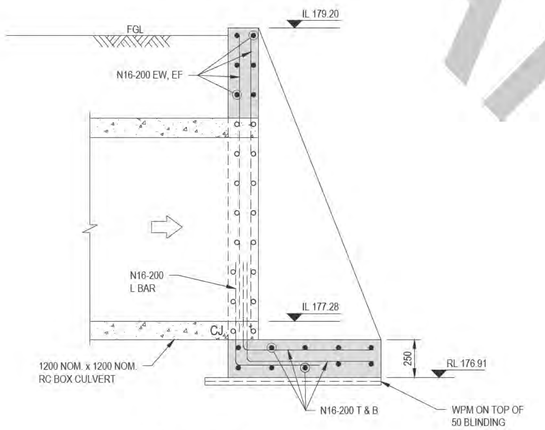
PLAN
SCALE 1:20



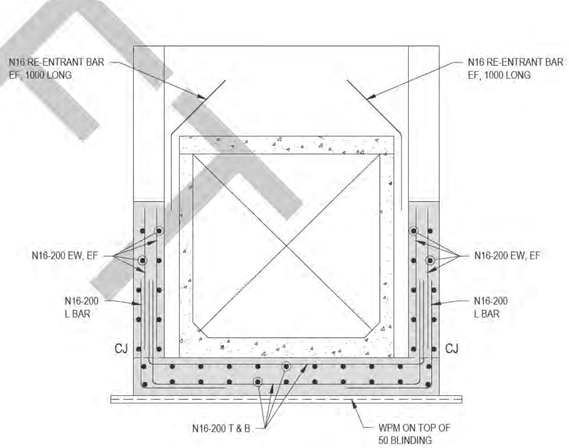
CONVEYOR FOOTING
SCALE 1:20



D SECTION
SCALE 1 : 20



A SECTION
SCALE 1 : 20



B SECTION
SCALE 1 : 20

0 0.2 0.4 0.6 0.8 1.0m
SCALE 1:20 AT ORIGINAL SIZE

0 0.05 0.1 0.15 0.2 0.25m
SCALE 1:5 AT ORIGINAL SIZE

DRAFT

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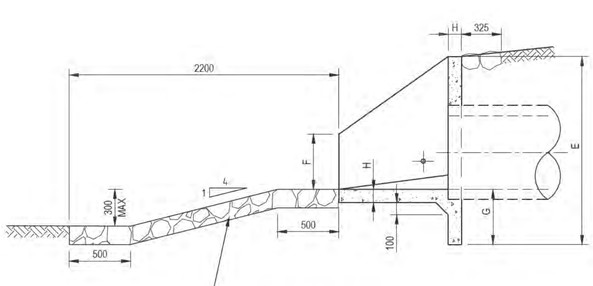
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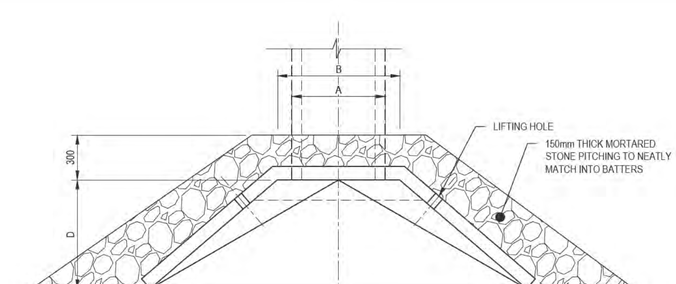
Drawn G.BURTON	Designer T.MZUNGU	Client DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Drafting Check	Design Check	Project CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Approved (Project Director)		Title TYPICAL DETAILS - CENTRAL DRUMSITE OUTLET ADJACENT CONVEYOR CROSSOVER
Date		
Scale AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	Original Size A1 Drawing No: 61-35637-C042 Rev: 0

Plot Date: 3 May 2018 - 1:21 PM Plotted by: Jess Overheu Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C042.dwg

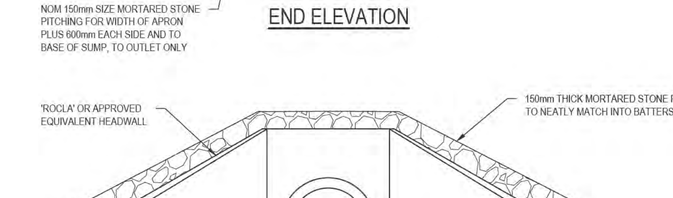


NOM 150mm SIZE MORTARED STONE PITCHING FOR WIDTH OF APRON PLUS 600mm EACH SIDE AND TO BASE OF SUMP, TO OUTLET ONLY

END ELEVATION



PLAN



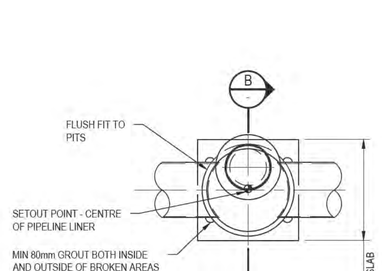
FRONT ELEVATION

HEADWALL SCHEDULE									
NOM. PIPE SIZE	MASS kg	DIMENSION IN (mm)							
		A	B	C	D	E	F	G	H
300	415	387	650	1850	600	920	270	250	65
375	400	450	650	1850	600	920	270	250	65
450	395	538	650	1850	600	920	270	250	65
525	690	620	800	2300	750	1070	320	250	75
600	680	702	800	2300	750	1070	320	250	75
675	1050	786	1000	3000	1000	1320	320	300	75
750	1030	870	1000	3000	1000	1320	320	300	75
900	940	1050	1060	2040	850	1340	570	360	100
1050	1325	1215	1225	2370	1005	1500	640	380	100

* FOR 825mm PIPE, USE 900 NOM PIPE SIZE HEADWALL

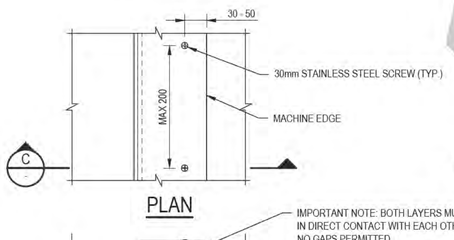
TYPICAL HEADWALL DETAILS

SCALE 1:25



PLAN

SCALE 1:50

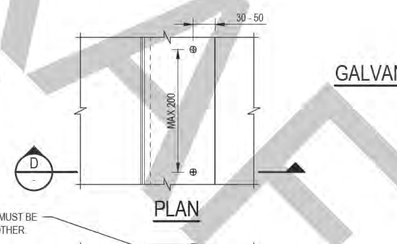


PLAN

C SECTION

CONCRETE CANVAS SCREWED OVERLAP JOINT

SCALE 1:5

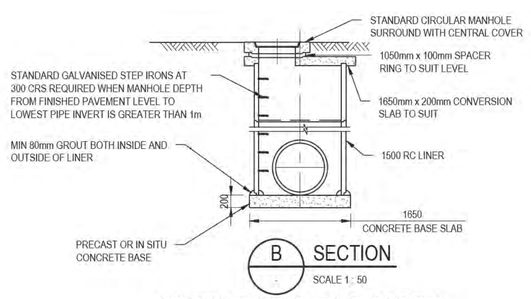


PLAN

D SECTION

CONCRETE CANVAS SCREWED KNUCKLE JOINT (FOR CUT EDGE ONLY)

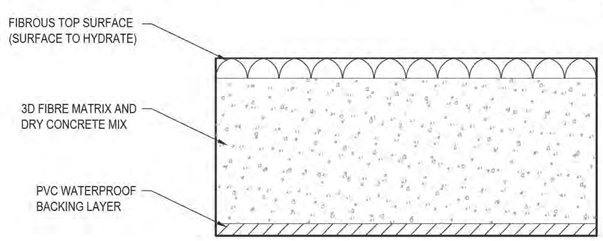
SCALE 1:5



B SECTION

SCALE 1 : 50

MANHOLE DETAIL TYPE 1500 DIA.



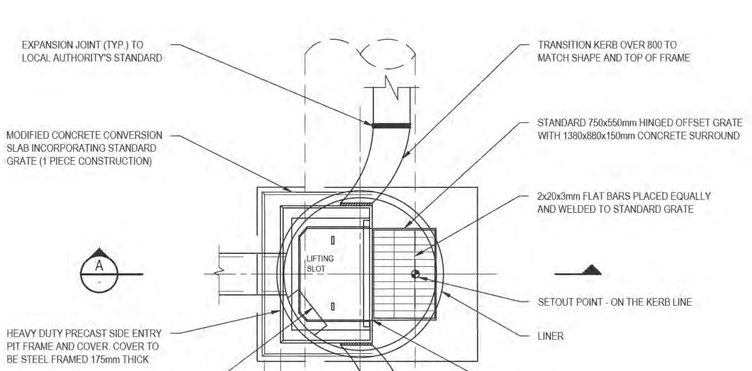
CONCRETE CANVAS CROSS SECTION

SCALE 1:5



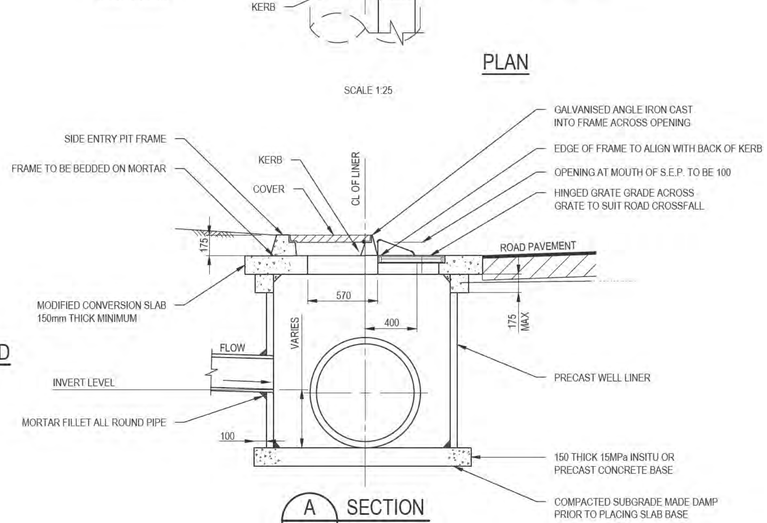
GALVANISED STEEL GROUND PEG DETAIL

SCALE 1:5



PLAN

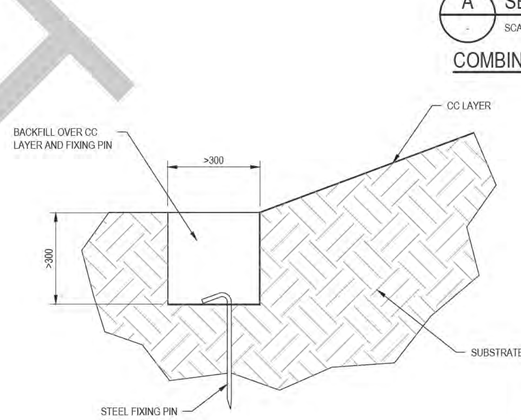
SCALE 1:25



A SECTION

SCALE 1 : 25

COMBINATION PIT



CONCRETE CANVAS ANCHOR TRENCH DETAIL

SCALE 1:10

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0 0.05 0.1 0.15 0.2 0.25m
SCALE 1:5 AT ORIGINAL SIZE

0 0.1 0.2 0.3 0.4 0.5m
SCALE 1:10 AT ORIGINAL SIZE

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

0 0.5 1.0 1.5 2.0 2.5m
SCALE 1:50 AT ORIGINAL SIZE

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Drafting Check		Design Check	
Approved (Project Director)			
Date			
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Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: DRAINAGE STRUCTURES
TYPICAL DETAILS - SHEET 1

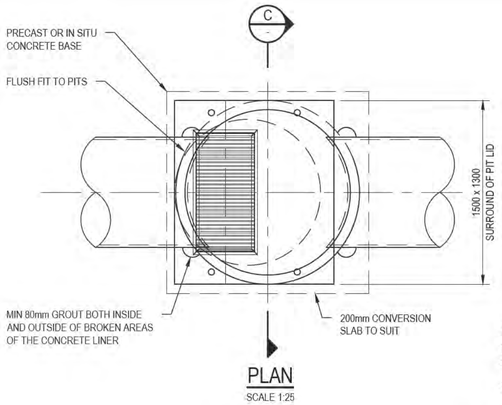
Original Size A1 | Drawing No: 61-35637-C049 | Rev: 0

Plot Date: 3 May 2018 - 2:54 PM | Plotted by: Jess Overheu | Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C049.dwg

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THIS DRAWING IS TO BE PRINTED IN COLOUR

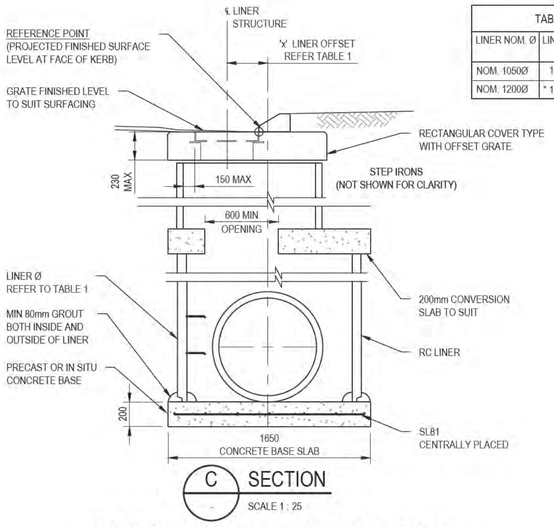


PLAN
SCALE 1:25

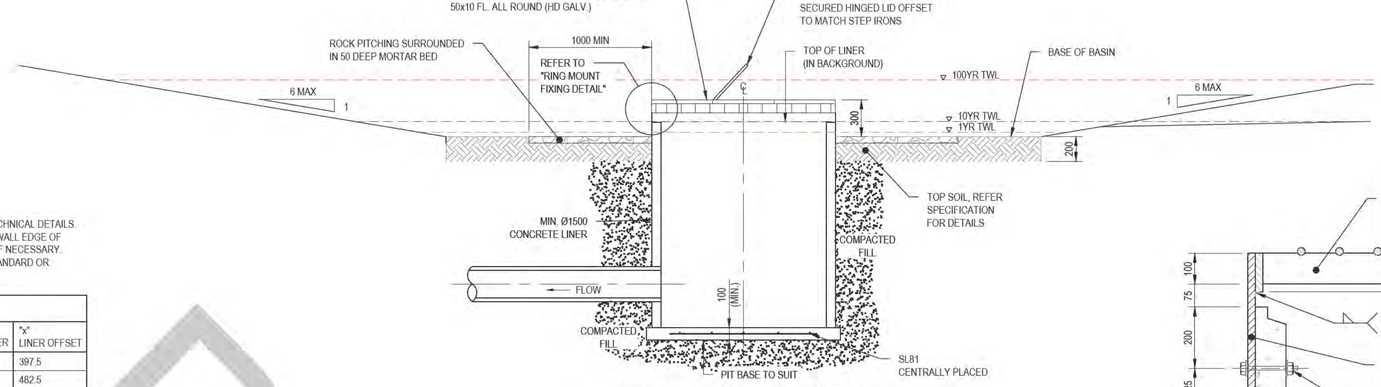
GRATED GULLY NOTES

1. REFER TO SPECIFICATION FOR FURTHER TECHNICAL DETAILS.
2. COVER TYPE EDGE MAY NOT QUITE COVER WALL EDGE OF LINERS GREATER THAN 1050Ø. GROUT GAP IF NECESSARY.
3. ALL GRATES ON PITS TO BE MAIN ROADS STANDARD OR SIMILAR.

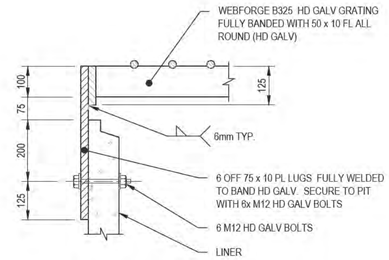
TABLE 1 - UPPER PIT DETAIL			
LINER NOM. Ø	LINER OUTSIDE Ø	MAX. Ø PIPE CONNECTING TO LINER	"x" LINER OFFSET
NOM. 1050Ø	1190Ø	NOM. 525Ø	397.5
NOM. 1200Ø	* 1360Ø	NOM. 600Ø	482.5



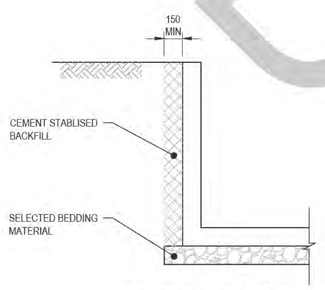
TYPICAL GULLY PIT DETAIL TYPE 1500 DIA.



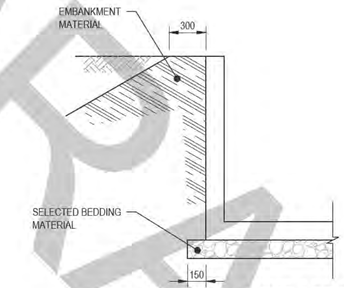
TYPICAL DETAIL - HIGH FLOW PIT
SCALE 1:25



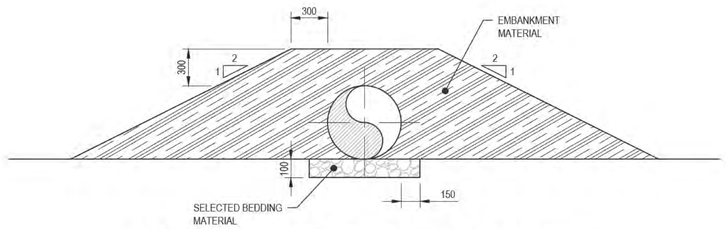
RING MOUNT FIXING DETAIL
SCALE 1:10



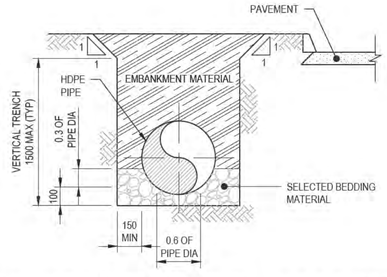
WINGWALLS AND APRON
N.T.S.
TRENCH METHOD



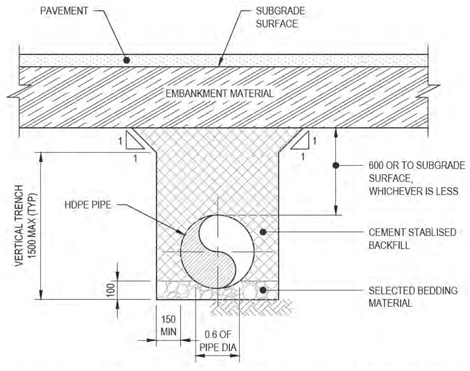
WINGWALLS AND APRON
N.T.S.
EMBANKMENT METHOD



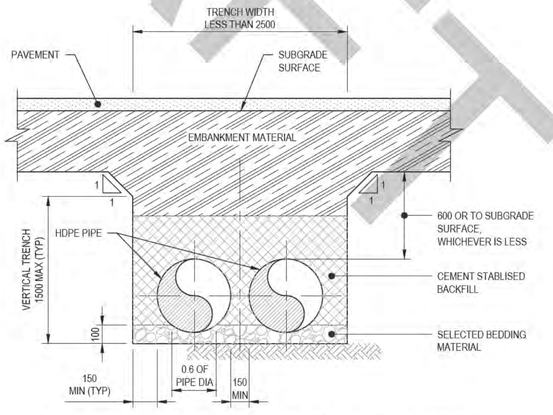
BACKFILL - EMBANKMENT METHOD - SINGLE BARREL
N.T.S.
APPLICABLE IN ALL TRAFFIC ENVIRONMENTS



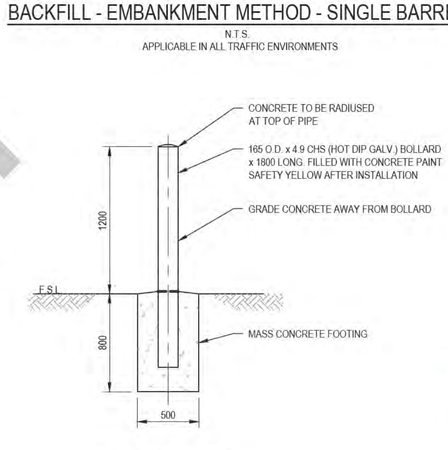
TRENCH METHOD (TRAFFICABLE) - SINGLE BARREL
N.T.S.



TRENCH METHOD (TRAFFICABLE) - SINGLE BARREL
N.T.S.



TRENCH METHOD (TRAFFICABLE) - MULTI BARREL
N.T.S.



BOLLARD DETAIL
SCALE 1:25

NOTES:

1. BEDDING MATERIAL, FOUNDATION COMPACTION AND BACKFILL COMPACTION TO BE AS PER SPECIFICATION.
2. CEMENT STABILISED BACKFILL MIX TO BE AS PER SPECIFICATION.
3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. COVER AND TOP OF PIPE MATERIAL DEPENDENT. REFER TO MANUFACTURER'S REQUIREMENTS.

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0 0.1 0.2 0.3 0.4 0.5m
SCALE 1:10 AT ORIGINAL SIZE

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

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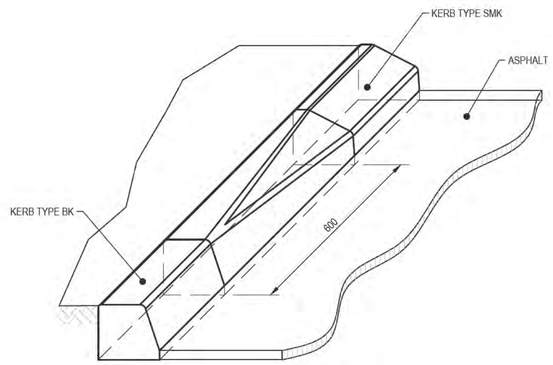
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Drafting Check		Design Check	
Approved (Project Director)			
Date			
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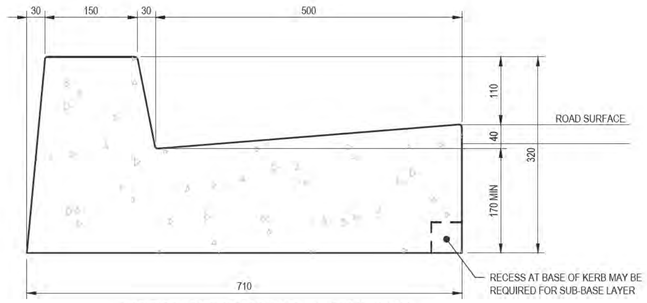
Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: DRAINAGE STRUCTURES TYPICAL DETAILS - SHEET 2

Original Size A1 | Drawing No: 61-35637-C050 | Rev: 0

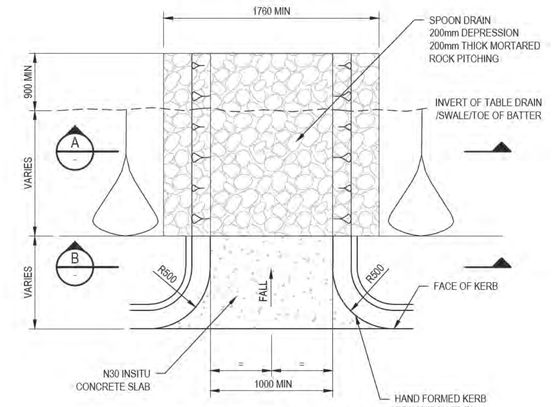
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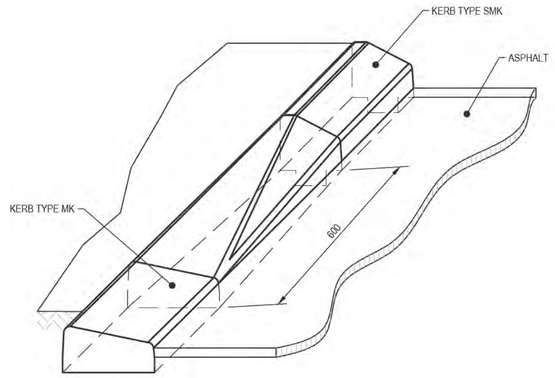
KERB TYPE BK TO SMK TRANSITION
SCALE 1:10



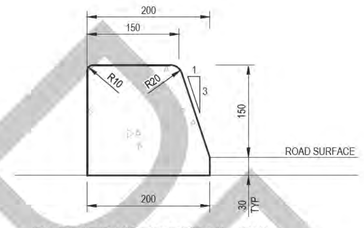
KERB AND CHANNEL DETAIL (KC)
N.T.S.



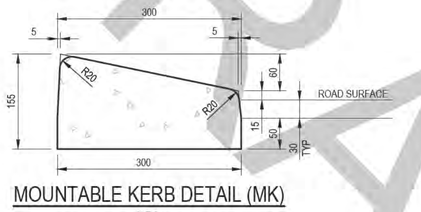
KERB OPENING DETAIL
SCALE 1:25



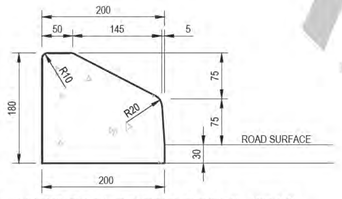
KERB TYPE MK AND KC TO SMK TRANSITION
SCALE 1:10



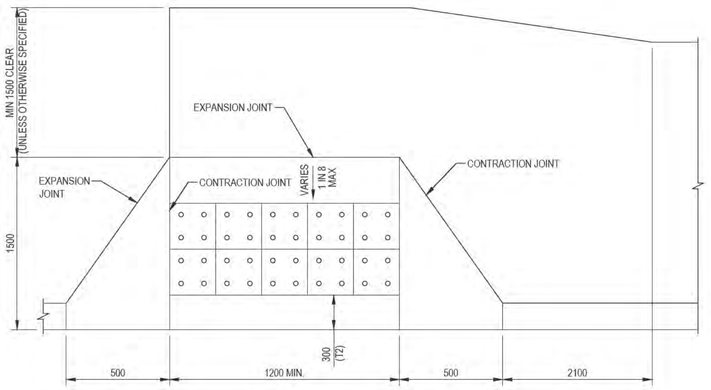
BARRIER KERB DETAIL (BK)
N.T.S.



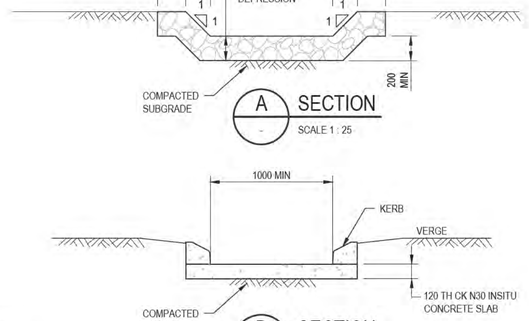
MOUNTABLE KERB DETAIL (MK)
N.T.S.



SEMI - MOUNTABLE KERB DETAIL (SMK)
N.T.S.

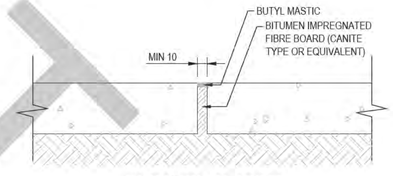


TYPICAL RAMP APRON DETAIL
N.T.S.

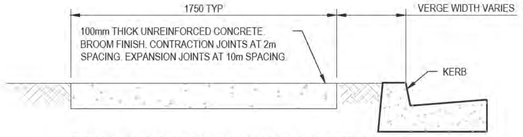


A SECTION
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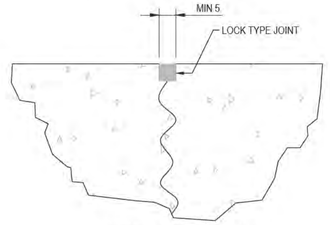
B SECTION
SCALE 1 : 25



EXPANSION JOINT
N.T.S.



TYPICAL CONCRETE FOOTPATH DETAILS
N.T.S.



CONTRACTION JOINT
N.T.S.

NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. PAVEMENT WIDENING TO BLEND SMOOTHLY TO EXISTING.
3. SURFACE OVERLAP TO BE CONFIRMED ON SITE BASED ON CONDITIONS OF EXISTING SOIL.
4. EDGE OF RAMP SHALL BE FLUSH WITH ROAD PAVEMENT (ASPHALT OR SEAL).
5. ALL CONCRETE SHALL CONTAIN WASHED AGGREGATE AND BE BROOMED FINISHED ACROSS THE DIRECTION OF PEDESTRIAN TRAFFIC TO PROVIDE A NON-SLIP SURFACE.
6. CONCRETE CLASS SHALL BE 25 MPa. NOMINAL THICKNESS 100mm MIN THICKNESS ON EDGES TO BE 150mm FOR PEDESTRIAN ACCESS AREAS.
7. ALL VERGE AREAS SURROUNDING PRAM RAMP (EG FOOTPATH, PAVING, GRASS) TO BE REINSTATED TO NEW LEVELS FLUSH WITH RAMP EDGES.
8. WINGS TO APRON TO BE A MAX SLOPE OF 1 IN 10. IF 1 IN 10 SLOPE NOT POSSIBLE DUE TO OBSTRUCTION, SLOPE CAN BE INCREASED WITH APPROVAL.
9. RAMP (INCLUDING WINGS) CONCRETE COLOUR SHOULD CONTRAST WITH SURROUNDING SURFACES.
10. ALL EXPOSED EDGES TO BE ROUNDED TO 5mm RADIUS MAXIMUM UNLESS NOTED OTHERWISE.
11. REFER TO SPECIFICATION FOR MATERIAL AND CONSTRUCTION DETAILS.

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0 0.1 0.2 0.3 0.4 0.5m
SCALE 1:10 AT ORIGINAL SIZE

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

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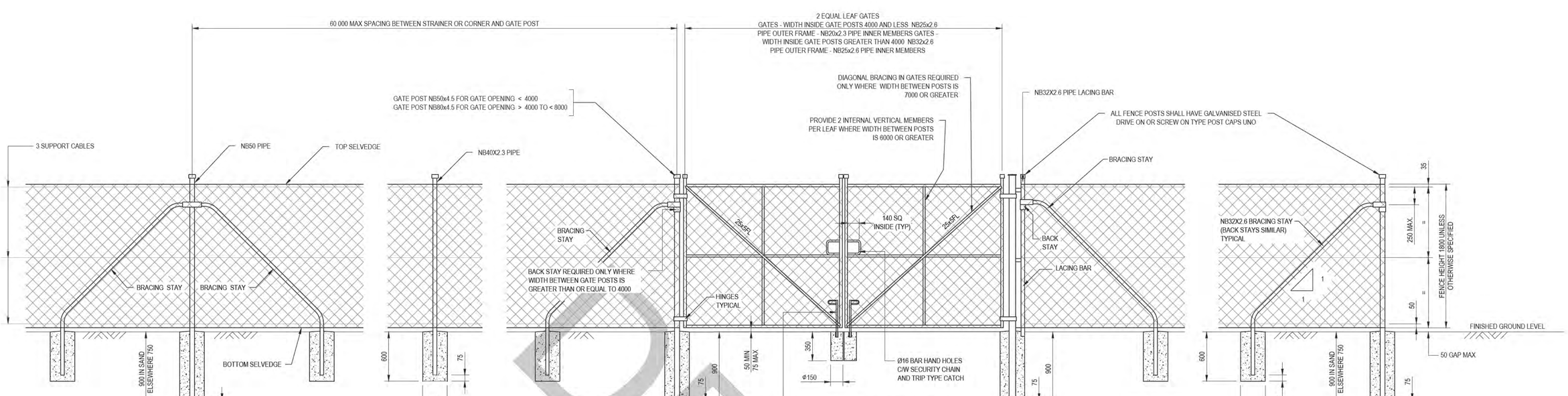
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Drawn J.OVERHEU	Designer J.OVERHEU	Client	DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Drafting Check	Design Check	Project	CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Approved (Project Director)		Title	DRAINAGE STRUCTURES TYPICAL DETAILS - SHEET 3
Date			
Scale AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	Original Size A1	Drawing No: 61-35637-C051 Rev: 0

Plot Date: 3 May 2018 - 2:57 PM Plotted by: Jess Overheu Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C051.dwg

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STRAINER POST
REQUIRED AT EACH CHANGE OF DIRECTION OR GRADE GREATER THAN 10° OR 60 000 MAX SPACING SHALL NOT BE USED IMMEDIATELY ADJACENT TO ROADS

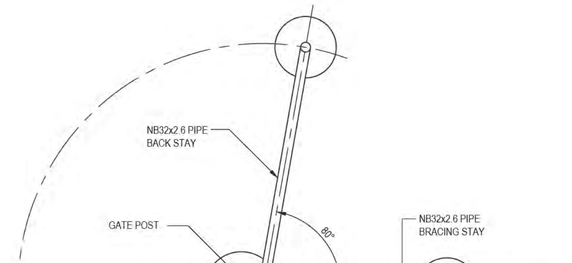
INTERMEDIATE POST
4000 MAX SPACING BETWEEN POSTS EVENLY SPACED

GATE POST
TYPICAL ARRANGEMENT FOR OTHER THAN DN50 GATE POST

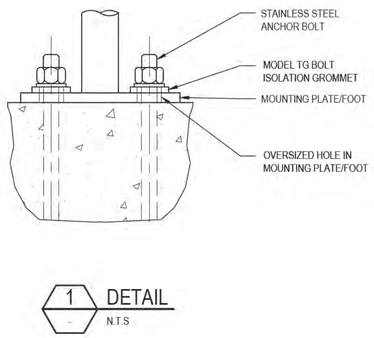
DOUBLE GATES
FOR VEHICLE ACCESS

GATE POST
TYPICAL ARRANGEMENT FOR DN80 GATE POST

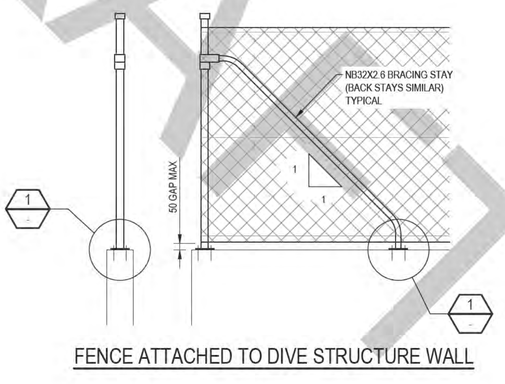
CORNER POST



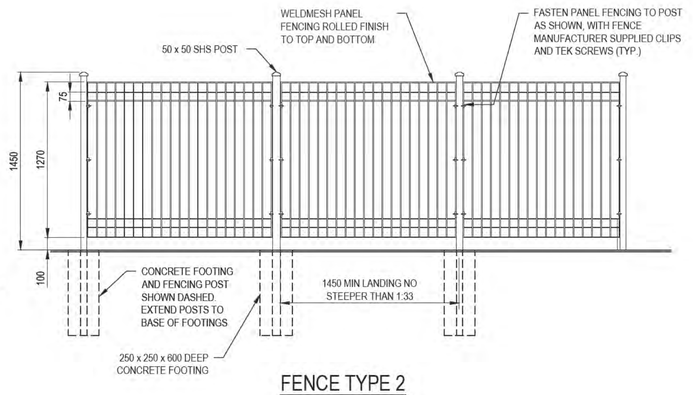
PLAN OF GATE POST
NTS



1 DETAIL
N.T.S



FENCE ATTACHED TO DIVE STRUCTURE WALL



FENCE TYPE 2

NOTES
1. FENCING MESH TO BE BLACK PLASTIC COATED AND POSTS TO BE BLACK POWDERCOATED.
2. FENCING AND GATES TO BE SUPPLIED AND INSTALLED IN ACCORDANCE WITH AS1725.1
3. TOP OF ALL FOOTINGS TO HAVE A FALL AWAY FROM PIPE OF 10mm
4. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
5. CONTRACTOR TO PHYSICALLY CONFIRM THE LOCATION OF ALL EXISTING SERVICES PRIOR TO THE COMMENCEMENT OF ANY WORKS ON SITE.
6. ALL GALVANISED STEELWORK FENCING AND CONCRETE TO BE IN ACCORDANCE WITH SPECIFICATION.

DIAL BEFORE YOU DIG www.1100.com.au

ALL COORDINATES SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

0 0.25 0.5 0.75 1.0 1.25m
SCALE 1:25 AT ORIGINAL SIZE

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
0	ISSUED FOR CONSTRUCTION		JO	*JMK	*PS	04/05/18

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Drafting Check	*S.HORTON	Design Check	*S.CLEARY
Approved (Project Director)	*P.SEMAN		
Date	04/05/2018		
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

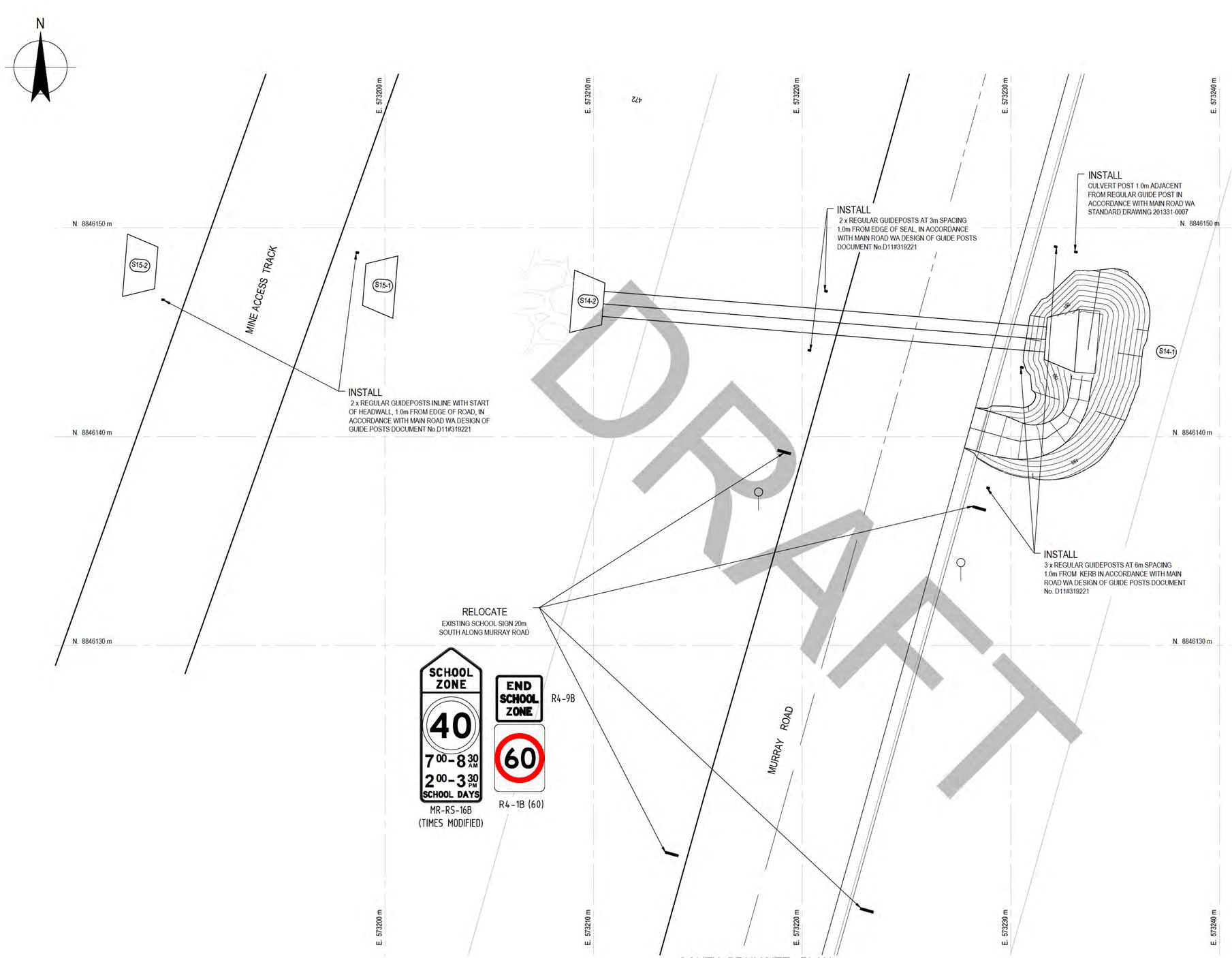
Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: DRAINAGE STRUCTURES TYPICAL DETAILS - SHEET 4

Original Size A1 | Drawing No: 61-35637-C052 | Rev: 0

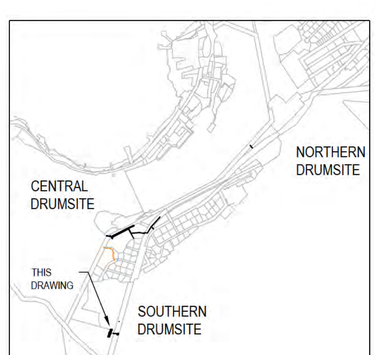
Plot Date: 4 May 2018 - 3:40 PM | Plotted by: Jess Overheu | Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\CADD\Drawings\61-35637-C052.dwg

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FOI 26-292 - Document 27



SOUTH DRUMSITE - PLAN
SCALE 1:100



LOCALITY PLAN
N.T.S.

NOTES:

1. LOCATION OF S15 CULVERT TO BE CONFIRMED ON SITE, POSITION SHOWN IS APPROXIMATE.

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ALL COORDINATES SHOWN ON THIS DRAWING SHALL BE VERIFIED BY CONTRACTOR PRIOR TO COMMENCEMENT OF WORKS. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

0 1 2 3 4 5m
SCALE 1:100 AT ORIGINAL SIZE

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
0	ISSUED FOR CONSTRUCTION		YV	JM*	PS*	05/10/18

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Drafting Check	S HORTON *	Design Check	S CLEARY *
Approved (Project Director)	P SEMAN *		
Date	05/10/18		
Scale	1:100	This Drawing must not be used for Construction unless signed as Approved	

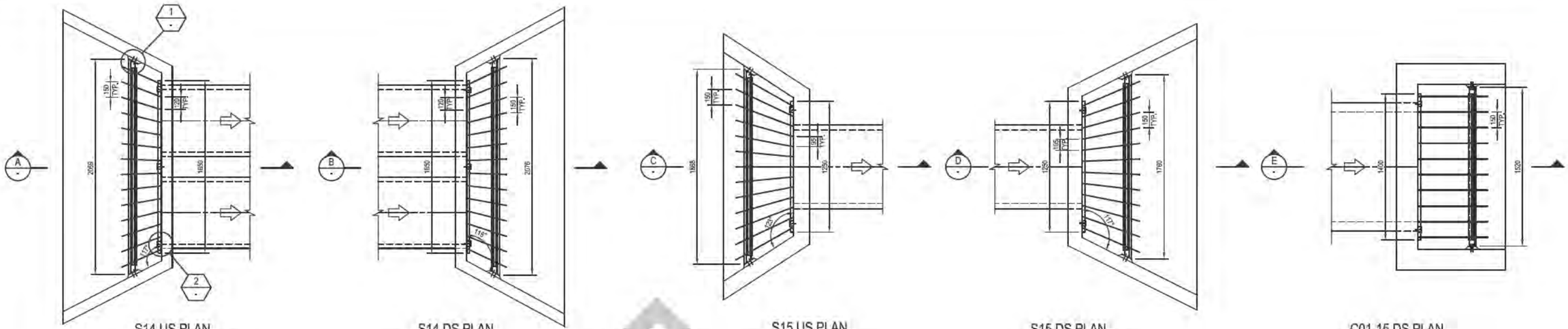
Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: SOUTHERN DRUMSITE WORKS
ROAD SIGNS AND GUIDEPOSTS - EARLY WORKS

Original Size A1 | Drawing No: 61-35637-C101 | Rev: 0

Plot Date: 5 October 2018 - 12:49 PM | Plotted by: Yvonne Vermaak | Cad File No: G:\61\35637\CADD\Drawings\61-35637-C101.dwg

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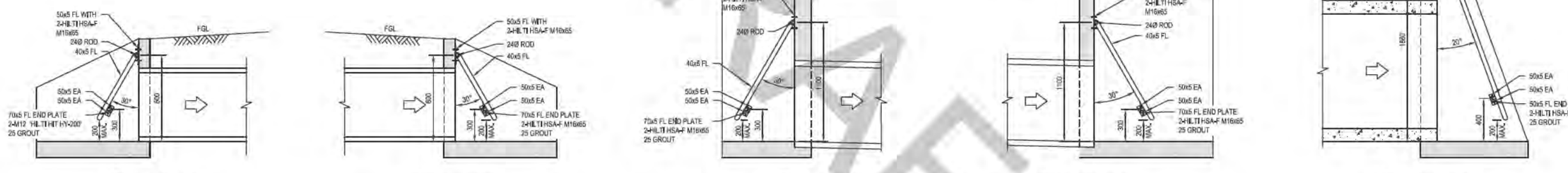
S14 US PLAN
SCALE 1:20

S14 DS PLAN
SCALE 1:20

S15 US PLAN
SCALE 1:20

S15 DS PLAN
SCALE 1:20

C01-15 DS PLAN
SCALE 1:20



A SECTION
SCALE 1:20

B SECTION
SCALE 1:20

C SECTION
SCALE 1:20

D SECTION
SCALE 1:20

E SECTION
SCALE 1:20

GENERAL

G1. THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL OTHER DRAWINGS, THE SPECIFICATIONS AND WITH OTHER SUCH WRITTEN INSTRUCTIONS AS MAY BE ISSUED DURING THE COURSE OF THE WORKS. ANY DISCREPANCIES OR VARIATIONS SHALL BE REFERRED TO THE SUPERINTENDENT FOR RESOLUTION BEFORE PROCEEDING WITH THE AFFECTED WORK.

G2. ALL DIMENSIONS RELEVANT TO SETTING OUT AND OFF-SITE WORK SHALL BE VERIFIED BY THE CONTRACTOR BEFORE CONSTRUCTION AND FABRICATION IS COMMENCED.

G3. DIMENSIONS SHALL NOT BE DETERMINED FROM THE DRAWINGS BY SCALING.

G4. ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS, CHAINAGES AND CO-ORDINATES ARE EXPRESSED IN METRES, UNLESS STATED OTHERWISE.

G5. DURING CONSTRUCTION THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE STRUCTURES IN A STABLE CONDITION AND ENSURING NO PART SHALL BE OVER STRESSED UNDER CONSTRUCTION ACTIVITIES. TEMPORARY BRACING, PROPPING OR OTHER TEMPORARY WORKS SHALL BE PROVIDED BY THE CONTRACTOR AS REQUIRED. WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE RELEVANT CODES.

G6. PROVIDE ADEQUATE TEMPORARY PROPPING AND/OR BRACING TO ALL PARTS OF THE WORK, WHETHER SHOWN ON THE DRAWINGS OR NOT, DURING ALL STAGES OF CONSTRUCTION AS REQUIRED. CHECK WITH THE SUPERINTENDENT IF THERE ARE ANY QUERIES REGARDING WORK THAT MAY REQUIRE TEMPORARY PROPPING/BRACING/ SHORING ETC.

G7. PROVIDE WATER AND CORROSION RESISTANT PADLOCKS IDENTICALLY KEYED TO DIRDC REQUIREMENTS BETWEEN THE FRAMING AND SUPPORT MEMBERS TO LOCK SCREENS CLOSED. LOCKS TO BE INSTALLED BETWEEN THE LAST 2 SCREENING BARS ON EACH SIDE.

STEELWORK

S1. WORKMANSHIP AND MATERIALS TO COMPLY WITH AS4100, AS/NZS4600 AND AS/NZS1554.

S2. STEEL SHALL BE THE FOLLOWING GRADE UNLESS NOTED OTHERWISE:
- PLATE TO AS3678 ..... C250
- UNIVERSAL BEAMS, COLUMNS, PARALLEL FLANGE CHANNELS AND ANGLES TO AS3679.1 ..... GRADE 300 or 8HP GRADE 300 Plus
- SQUARE AND RECTANGULAR HOLLOW SECTIONS TO AS1163 ..... C350/C450.
- CIRCULAR HOLLOW SECTIONS TO AS1163 ..... C350/C250

S3. STRUCTURAL STEEL WORK WELDS TO BE MINIMUM 5mm, FULLY SEALED, CONTINUOUS FILLET, STRUCTURAL PURPOSE TO AS1554.1.

S4. USE BOLT LENGTHS SO THAT PROJECTION BEYOND NUT IS AT LEAST TWO THREADS, AND NOT MORE THAN 10mm.

S5. PROVIDE DOCUMENTARY EVIDENCE (INCLUDING TEST RESULTS) OF COMPLIANCE WITH RELEVANT AUSTRALIAN STANDARD FOR EACH BATCH OF FASTENERS USED.

S6. HOT DIP GALVANISE BOLTS, SCREWS, NUTS AND WASHERS TO AS1214. TAP GALVANISED NUTS 0.4 mm OVERSIZE TO SUIT GALVANISED THREADS TO AS1214 AND OIL FOR PROTECTION. INSTALL WASHERS UNDER BOLT HEAD AND NUT. USE TAPERED WASHERS AS REQUIRED.

S7. DRILL BOLT HOLES FULL SIZE OR REAM TO FULL SIZE AFTER SUB-DRILLING OR SUB-PUNCHING. FLAME CUTTING OF HOLES IS NOT PERMITTED. BOLT HOLE SIZE TO BE:
- BOLT DIAMETER PLUS 2mm FOR STEEL TO STEEL CONNECTIONS.
- BOLT DIAMETER PLUS 4mm FOR STEEL TO CONCRETE CONNECTIONS.

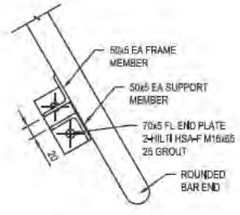
S8. PREPARE WORKSHOP DRAWINGS TO SHOW RELEVANT DETAILS OF EACH ASSEMBLY, COMPONENT AND CONNECTION, TOGETHER WITH INFORMATION RELATIVE TO FABRICATION, SURFACE TREATMENT AND ERECTION, INCLUDING IDENTIFICATION, STEEL TYPE AND GRADE, DIMENSIONS OF ITEMS, REQUIRED CAMBER (WHERE APPLICABLE), LOCATION, TYPE AND SIZE OF WELDS OR BOLTS, WELD CATEGORIES AND BOLTING CATEGORIES, SURFACE PREPARATION METHODS AND COATING SYSTEM, VENT/DRAIN HOLES FOR HOT DIP GALVANISING, PROPOSED JOINTS IN STEEL MEMBERS, etc.

S9. IT IS RECOMMENDED THAT SHOP DRAWINGS BE REVIEWED BY THE DESIGN ENGINEER. ALLOW 14 DAYS FOR REVIEW. REVIEW DOES NOT INCLUDE CHECKING OF DIMENSIONS, AND DOES NOT RELIEVE THE CONTRACTOR OF THEIR RESPONSIBILITY FOR COMPLIANCE WITH DRAWINGS AND SPECIFICATIONS.

S10. AFTER COMPLETION OF FABRICATION, PREPARATION FOR SURFACE TREATMENT TO BE: ROUND OFF ROUGH WELDS, SHARP EDGES, BURRS, ARRISES. WELD SPLATTER AND SLAG, etc. REMOVE GREASE, OIL AND OTHER CONTAMINANTS TO AS1627.1. REMOVE RUST, MILLSCALE, OXIDE DEPOSITS, OLD PAINT FILMS, etc. BY ABRASIVE BLAST CLEANING TO AS1627.4. REMOVE ALL DUST BY BRUSHING OR VACUUM CLEANING.

S11. ALL STEELWORK SHALL BE HOT DIP GALVANISED IN ACCORDANCE WITH AS4680. MINIMUM COATING TO BE 600g/m².

S12. GROUT BASE PLATES, HOLDING-DOWN BOLTS BEFORE COLUMNS ARE LOADED. USE AN APPROVED HIGH-STRENGTH SHRINKAGE COMPENSATED PRE-MIXED GROUT.



1 DETAIL
SCALE 1:5



2 DETAIL
SCALE 1:5

0 50 100 150 200 250mm
SCALE 1:5 AT ORIGINAL SIZE

0 200 400 600 800 1000mm
SCALE 1:20 AT ORIGINAL SIZE

No	Revision	Drawn	Job Manager	Project Director	Date
0	ISSUED FOR CONSTRUCTION	TM*	JM*	PS*	22.10.18

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Drafting Check	K. BYRNE*	Design Check	S. CLEARY*
Approved (Project Director)	P. SEMAN*		
Date	22.10.18		
Scale	AS SHOWN	This Drawing must not be used for Construction unless signed as Approved	

Client: DEPARTMENT OF INFRASTRUCTURE, REGIONAL DEVELOPMENT & CITIES
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: TYPICAL DETAILS - EARLY WORKS PROTECTIVE SCREENS

Original Size: A1
Drawing No: 61-35637-C102
Rev: 0

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Appendix E – Survey Drawings

DRAFT

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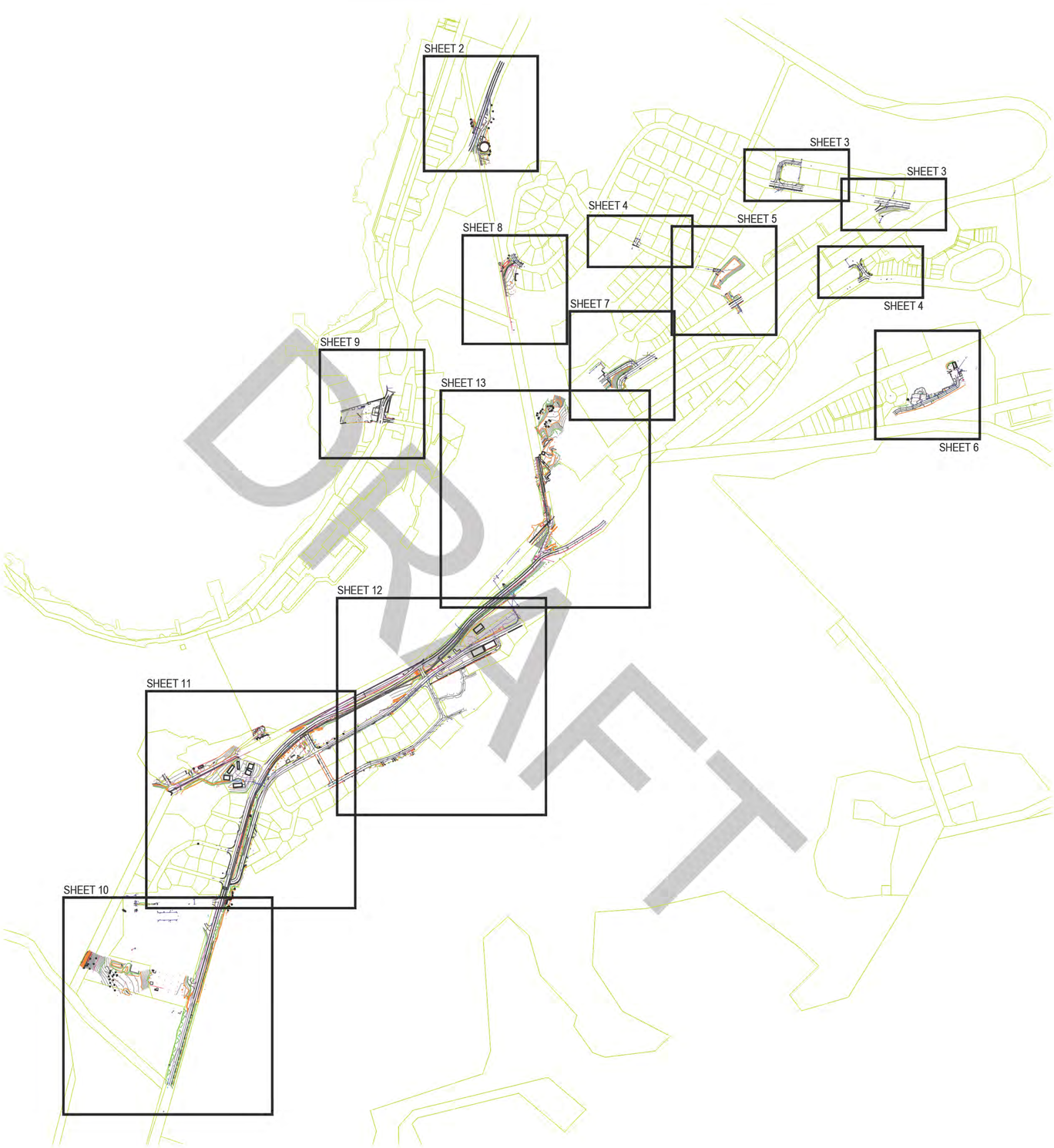
LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
- LITTER BIN
- STOP VALVE
- DEPTH OF PIPE
- SOFFIT LEVEL
- BUS STOP
- ANCHOR
- SEWER IO
- FLOOR LEVEL
- SEWER INVERT
- SSB ANTENNA
- OBVERT
- INVERT
- ELECTRONIC DETECTOR
- TRAFFIC CONTROL
- FIRE REEL
- GROUND FLOOD LIGHT
- ON ROAD
- SCOUR VALVE
- GULLY
- HYDRANT PILLAR
- SEWER IS
- DRAINAGE MANHOLE
- DISTRIBUTION BOARD
- UNKNOWN MANHOLE
- LARGE TREE
- HOUSE POWER POLE
- POWER METER BOX
- TAP
- COMM ANTENNA
- BOLLARD
- WATER METER
- ELECTRICAL PIT
- HYDRANT AT GROUND LEVEL
- ELECTRIC CABLE BOX
- SMALL TREE
- WATER MAIN MARKER POST
- CENTRE OF ROAD
- MEDIUM TREE
- ELECTRIC CABLE DOME
- NATURAL SURFACE
- VALVE
- POWER POLE
- GUIDE POST
- COMM CABLE MARKER
- COMM PIT
- BORE HOLE
- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

N

0 50 100 150 200 250m

SCALE 1:5000 AT ORIGINAL SIZE



DRAFT

NOTES:

1. CADASTRAL BOUNDARIES SHOWN ARE SUBJECT TO SURVEY. ALL CADASTRAL INFORMATION HAS BEEN PROVIDED BY LANDGATE OCTOBER 2020. THE ACCURACY OF BOUNDARY DEFINITION IS TO THE ASSOCIATED ACCURACY STATEMENTS PROVIDED BY LANDGATE.
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6. LEVELS ON SERVICES ARE AT TOP OF SERVICE UNLESS INDICATED OTHERWISE. "@ GL" DENOTES SERVICE DIRECTION ONLY, LEVEL TAKEN ON GROUND SURFACE AS DEPTH UNOBTAINABLE.

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Checked	Approved	Date
0	ISSUED FOR INFORMATION - MASTER SURVEY					

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Drafting Check	KSJ	Surveyor	GHD/DSS
Datum	CIHD	Field Book	*
Grid	MGA 94 Zone 48	Level Book	*
Approved	S. CLEARY		
Date			

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Client: DEPT OF INFRASTRUCTURE, TRANSPORT, REGIONAL DEVELOPMENT & COMMUNICATIONS

Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS

Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY BASE PLAN - SHEET 1 OF 13

Original Size A1

Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\Survey\Cadd\61-35637-Master_Survey_Data_MGA48.dwg

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LEGEND OF FEATURES

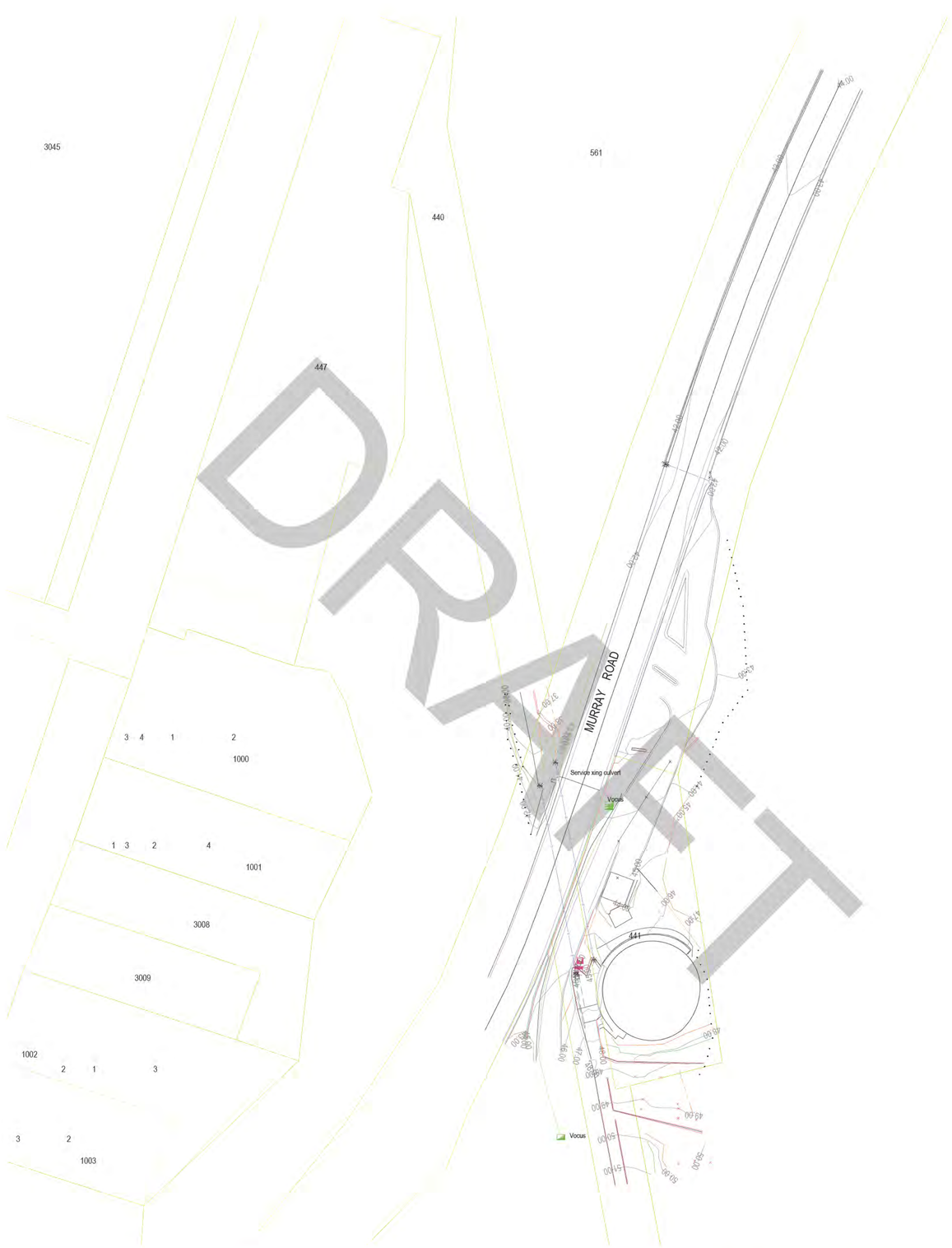
- BUSH
- AIR VALVE
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- GUIDE POST
- COMM CABLE MARKER
- COMM PIT
- BORE HOLE
- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

COMM CABLE MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



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4. DRAWING SHOWS ONLY SERVICES REQUESTED AT TIME OF SURVEY. IT IS NOT A COMPLETE DEPICTION OF SERVICES FOR ANY PORTION OF THE SITE/CORRIDOR.
5. ALIGNMENT OF UNDERGROUND SERVICES SHOWN ARE INDICATIVE ONLY AND HAVE BEEN STRUNG FROM MEASURED POINTS AS INDICATION ONLY.
6. LEVELS ON SERVICES ARE AT TOP OF SERVICE UNLESS INDICATED OTHERWISE. "@ GL" DENOTES SERVICE DIRECTION ONLY, LEVEL TAKEN ON GROUND SURFACE AS DEPTH UNOBTAINABLE.

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0	ISSUED FOR INFORMATION - MASTER SURVEY					

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Drafting Check	KSJ	Surveyor	GHD/DSS
Datum	CIHD	Field Book	*
Grid	MGA 94 Zone 48	Level Book	*
Approved	S. CLEARY		
Date			

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Client: DEPT OF INFRASTRUCTURE, TRANSPORT, REGIONAL DEVELOPMENT & COMMUNICATIONS
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 2 OF 13

Original Size A1
Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM
Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\Survey\Cadd\61-35637-Master_Survey_Data_MGA48.dwg

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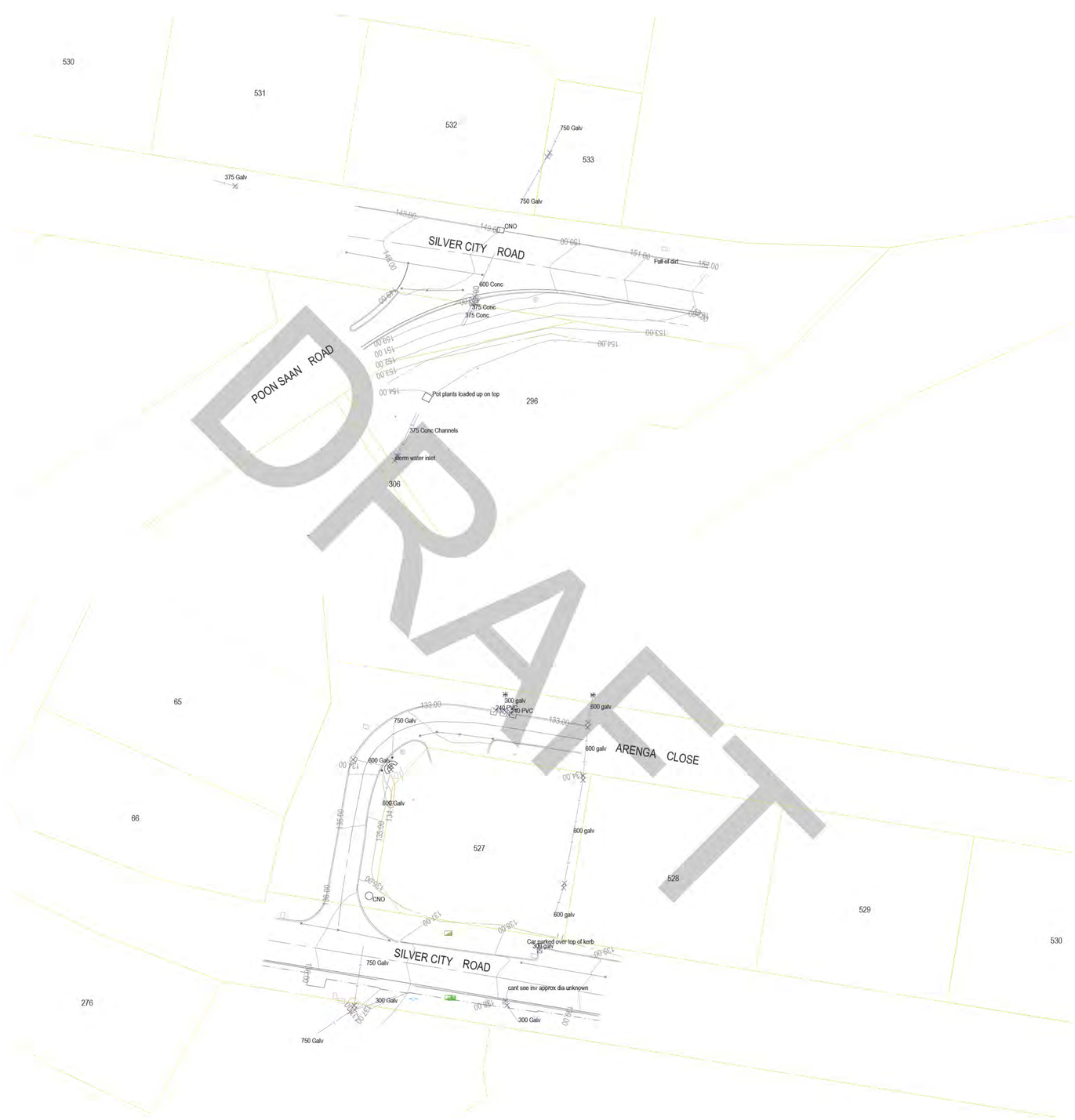
LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
- LITTER BIN
- STOP VALVE
- DEPTH OF PIPE
- SOFFIT LEVEL
- BUS STOP
- ANCHOR
- SEWER IO
- FLOOR LEVEL
- SEWER INVERT
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- OBVERT
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- COMM PIT
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- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



NOTES:

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Level 10, 999 Hay Street Perth WA 6000
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Datum	CIHD	Field Book	*
Grid	MGA 94 Zone 48	Level Book	*
Approved	S. CLEARY		
Date			

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Client: DEPT OF INFRASTRUCTURE, TRANSPORT, REGIONAL DEVELOPMENT & COMMUNICATIONS
Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 3 OF 13

Original Size A1
Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM
Cad File No: \\ghdnet.internal\ghd\AU\Perth\Projects\61\35637\Survey\Cadd\61-35637-Master_Survey_Data_MGA48.dwg

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FOI 26-292 - Document 27

LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
- LITTER BIN
- STOP VALVE
- DEPTH OF PIPE
- SOFFIT LEVEL
- BUS STOP
- ANCHOR
- SEWER IO
- FLOOR LEVEL
- SEWER INVERT
- SSB ANTENNA
- OBVERT
- INVERT
- ELECTRONIC DETECTOR
- TRAFFIC CONTROL
- FIRE REEL
- GROUND FLOOD LIGHT
- ON ROAD
- SCOUR VALVE
- GULLY
- HYDRANT PILLAR
- SEWER IS
- DRAINAGE MANHOLE
- DISTRIBUTION BOARD
- UNKNOWN MANHOLE
- LARGE TREE
- HOUSE POWER POLE
- POWER METER BOX
- TAP
- COMM ANTENNA
- BOLLARD
- WATER METER
- ELECTRICAL PIT
- HYDRANT AT GROUND LEVEL
- ELECTRIC CABLE BOX
- SMALL TREE
- WATER MAIN MARKER POST
- CENTRE OF ROAD
- MEDIUM TREE
- ELECTRIC CABLE DOME
- NATURAL SURFACE
- VALVE
- POWER POLE
- GUIDE POST
- COMM CABLE MARKER
- COMM PIT
- BORE HOLE
- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



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Grid	MGA 94 Zone 48	Level Book	*
Approved	S. CLEARY		
Date			

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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 4 OF 13

Original Size A1
Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM
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LEGEND OF FEATURES

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- AIR VALVE
- SEWER MANHOLE
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- SOFFIT LEVEL
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- ANCHOR
- SEWER IO
- FLOOR LEVEL
- SEWER INVERT
- SSB ANTENNA
- OBVERT
- INVERT
- ELECTRONIC DETECTOR
- TRAFFIC CONTROL
- FIRE REEL
- GROUND FLOOD LIGHT
- ON ROAD
- SCOUR VALVE
- GULLY
- HYDRANT PILLAR
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- BOLLARD
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- ELECTRIC CABLE BOX
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- WATER MAIN MARKER POST
- CENTRE OF ROAD
- MEDIUM TREE
- ELECTRIC CABLE DOME
- NATURAL SURFACE
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- GUIDE POST
- COMM CABLE MARKER
- COMM PIT
- BORE HOLE
- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 5 OF 13

Original Size A1
Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM
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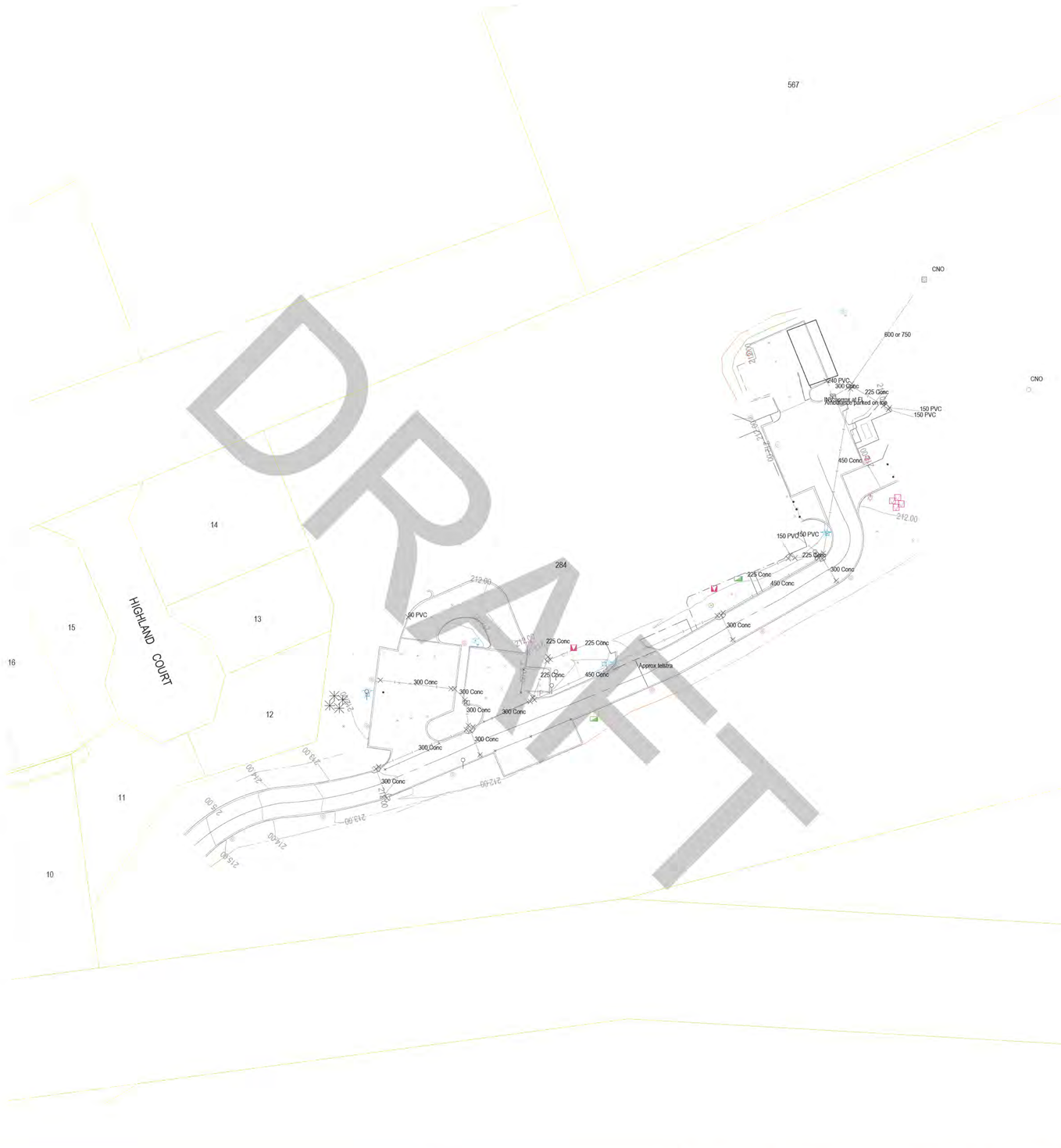
LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
- LITTER BIN
- STOP VALVE
- DEPTH OF PIPE
- SOFFIT LEVEL
- BUS STOP
- ANCHOR
- SEWER IO
- FLOOR LEVEL
- SEWER INVERT
- SSB ANTENNA
- OBVERT
- INVERT
- ELECTRONIC DETECTOR
- TRAFFIC CONTROL
- FIRE REEL
- GROUND FLOOD LIGHT
- ON ROAD
- SCOUR VALVE
- GULLY
- HYDRANT PILLAR
- SEWER IS
- DRAINAGE MANHOLE
- DISTRIBUTION BOARD
- UNKNOWN MANHOLE
- LARGE TREE
- HOUSE POWER POLE
- POWER METER BOX
- TAP
- COMM ANTENNA
- BOLLARD
- WATER METER
- ELECTRICAL PIT
- HYDRANT AT GROUND LEVEL
- ELECTRIC CABLE BOX
- SMALL TREE
- WATER MAIN MARKER POST
- CENTRE OF ROAD
- MEDIUM TREE
- ELECTRIC CABLE DOME
- NATURAL SURFACE
- VALVE
- POWER POLE
- GUIDE POST
- COMM CABLE MARKER
- COMM PIT
- BORE HOLE
- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 6 OF 13

Original Size A1
Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM
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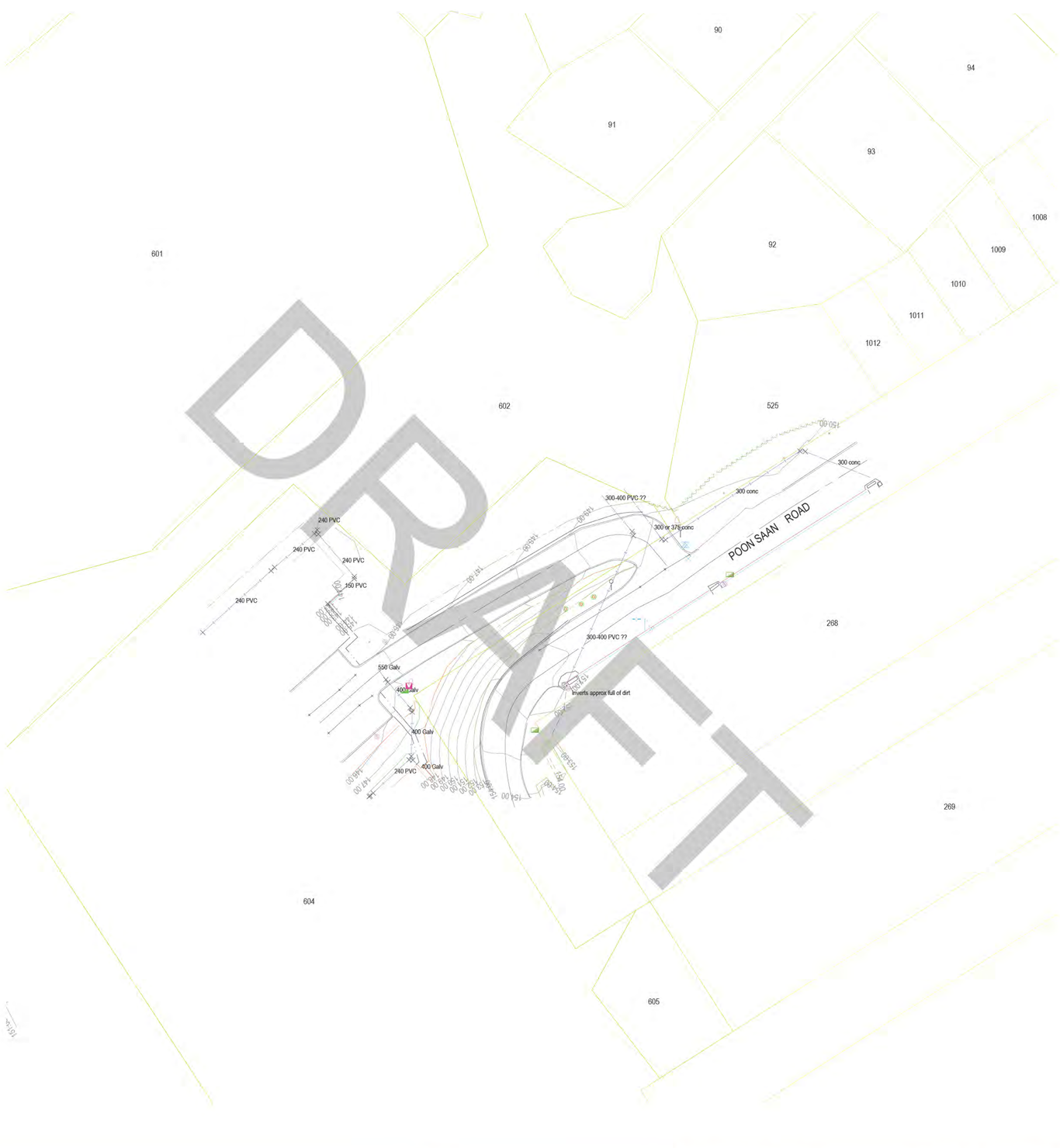
LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
- LITTER BIN
- STOP VALVE
- DEPTH OF PIPE
- SOFFIT LEVEL
- BUS STOP
- ANCHOR
- SEWER IO
- FLOOR LEVEL
- SEWER INVERT
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- OBVERT
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- TRAFFIC CONTROL
- FIRE REEL
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- ON ROAD
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- GUIDE POST
- COMM CABLE MARKER
- COMM PIT
- BORE HOLE
- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
- U/G POWER HIGH TENSION MARKER
- CABLE DIRECTION MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



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Approved	S. CLEARY		
Date			

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Project: CHRISTMAS ISLAND STORMWATER REMEDIAL WORKS
Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 7 OF 13

Original Size A1 | Drawing No: 61-35637-Master_Survey_Data | Rev: 0

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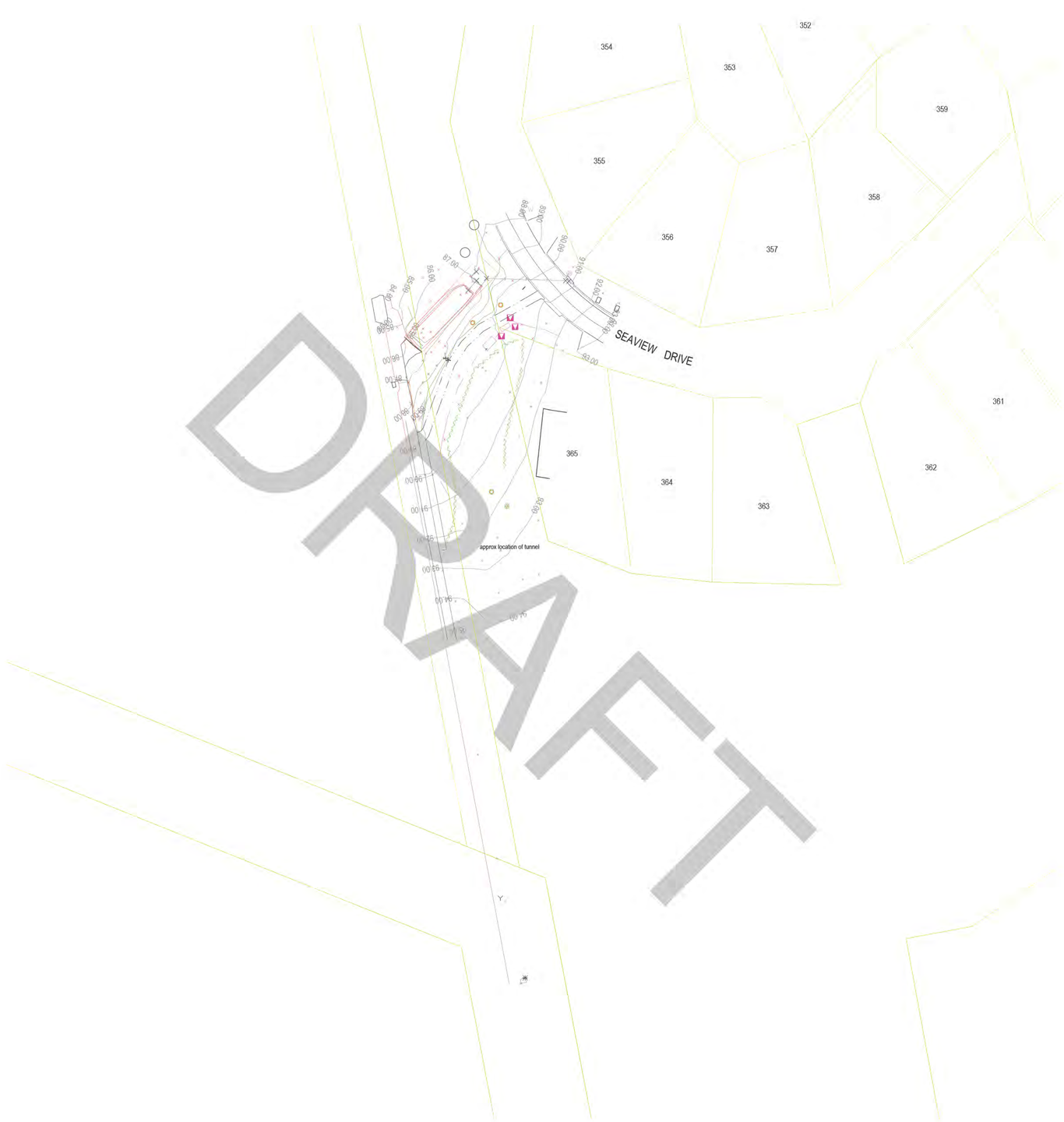
LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
- LITTER BIN
- STOP VALVE
- DEPTH OF PIPE
- SOFFIT LEVEL
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- EARTH PIT
- LIGHT POLE (ONLY)
- SIGN
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- CABLE DIRECTION MARKER

N

0 5 10 15 20 25m

SCALE 1:500 AT ORIGINAL SIZE



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Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 8 OF 13

Original Size A1
Drawing No: 61-35637-Master_Survey_Data Rev: 0

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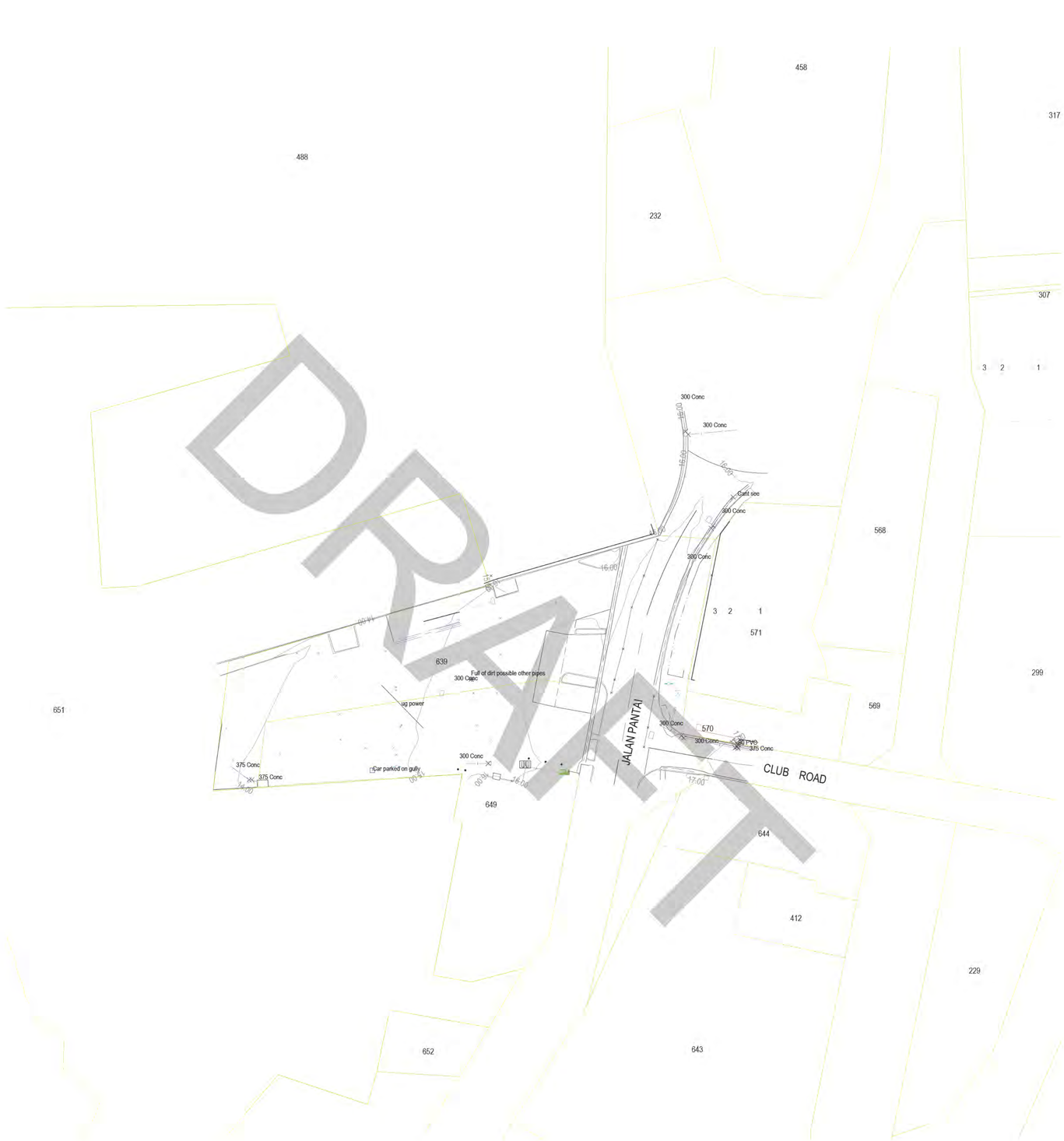
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N

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Date			

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Title: FEATURE AND LEVEL SURVEY - MASTER SURVEY SHEET 9 OF 13

Original Size A1

Drawing No: 61-35637-Master_Survey_Data Rev: 0

Plot Date: 9 November 2020 - 10:14 AM

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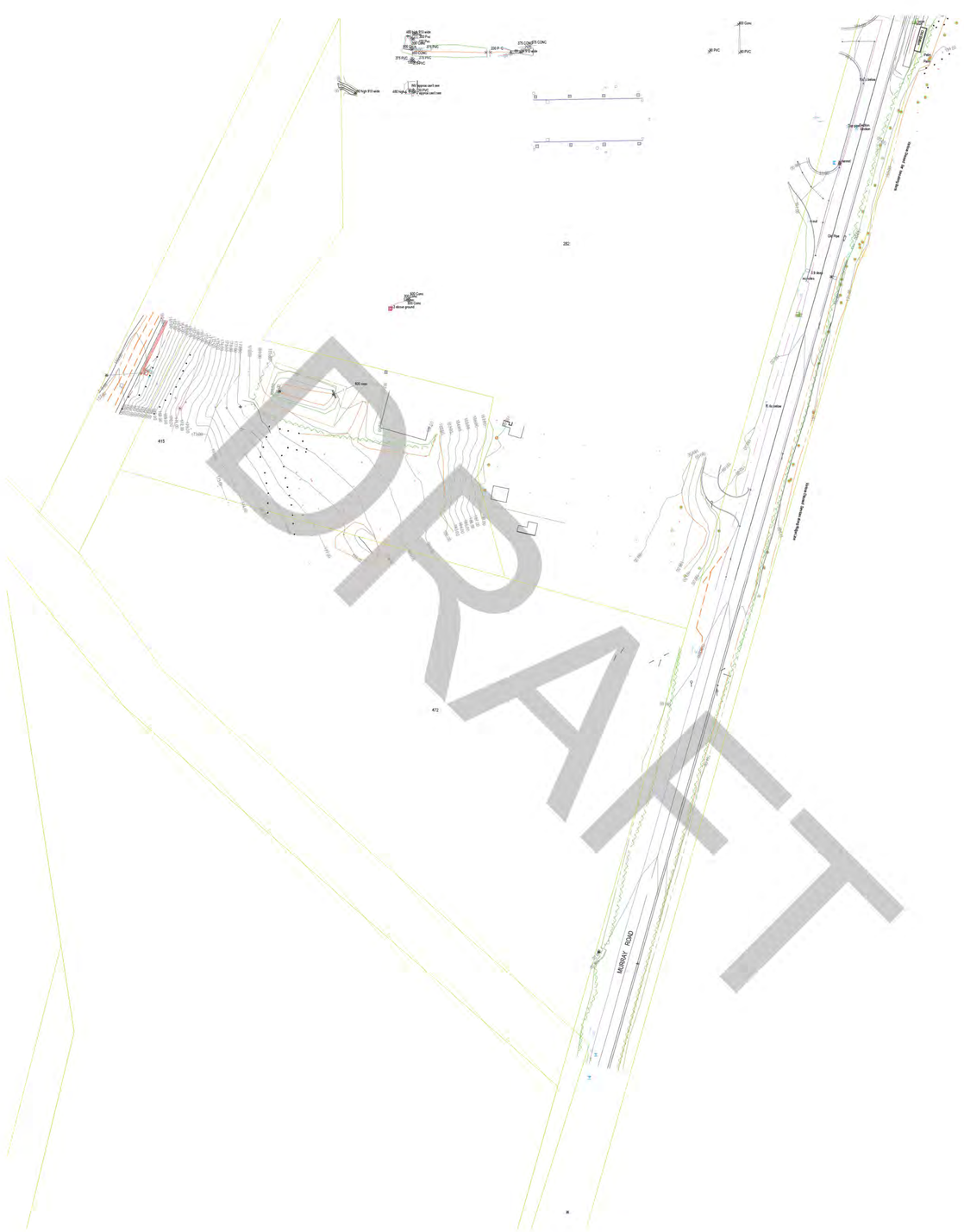
LEGEND OF FEATURES

- BUSH
- AIR VALVE
- SEWER MANHOLE
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- STOP VALVE
- DEPTH OF PIPE
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- BUS STOP
- ANCHOR
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- LIGHT POLE (ONLY)
- SIGN
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SCALE 1:1000 AT ORIGINAL SIZE



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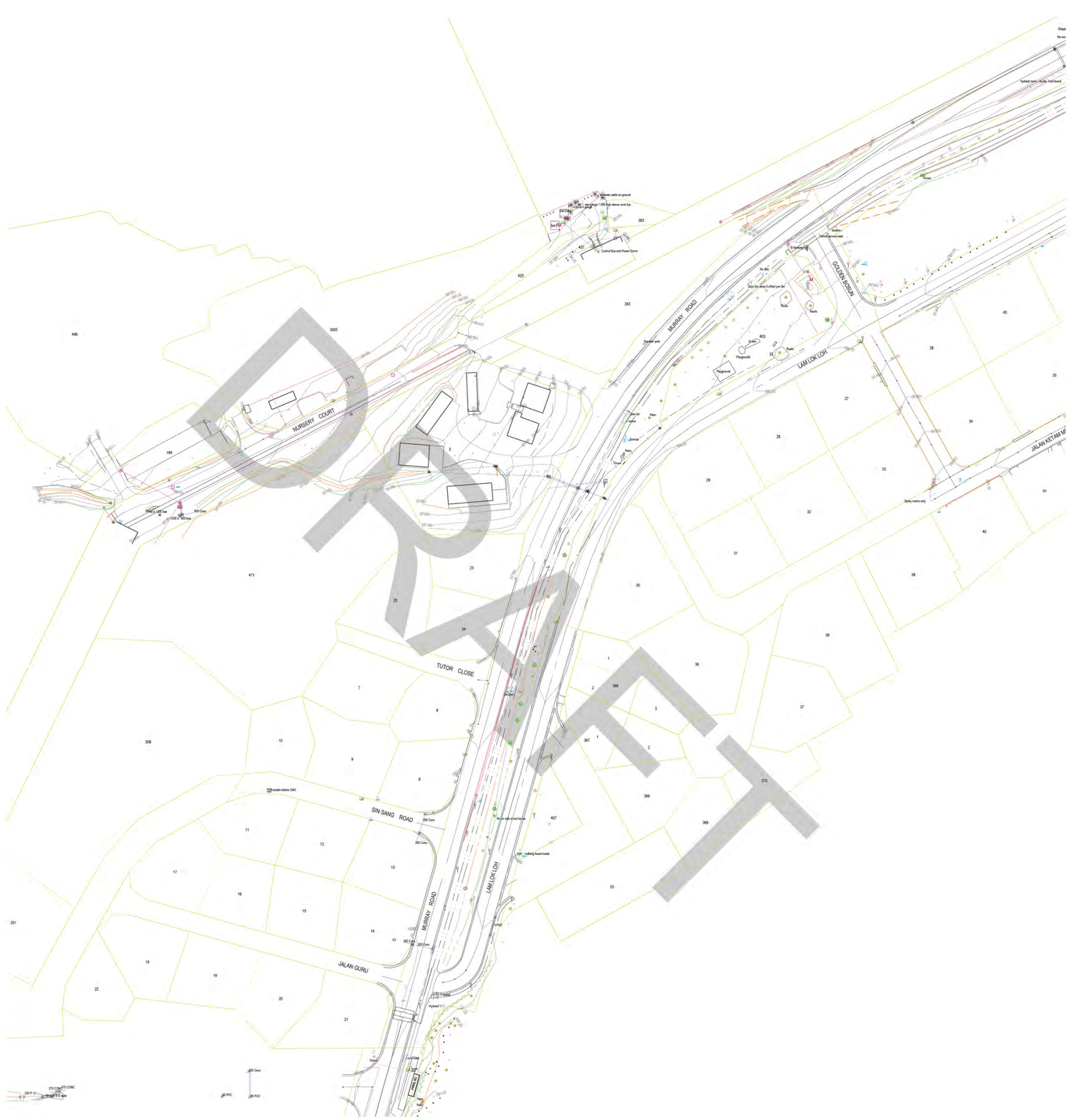
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Original Size A1

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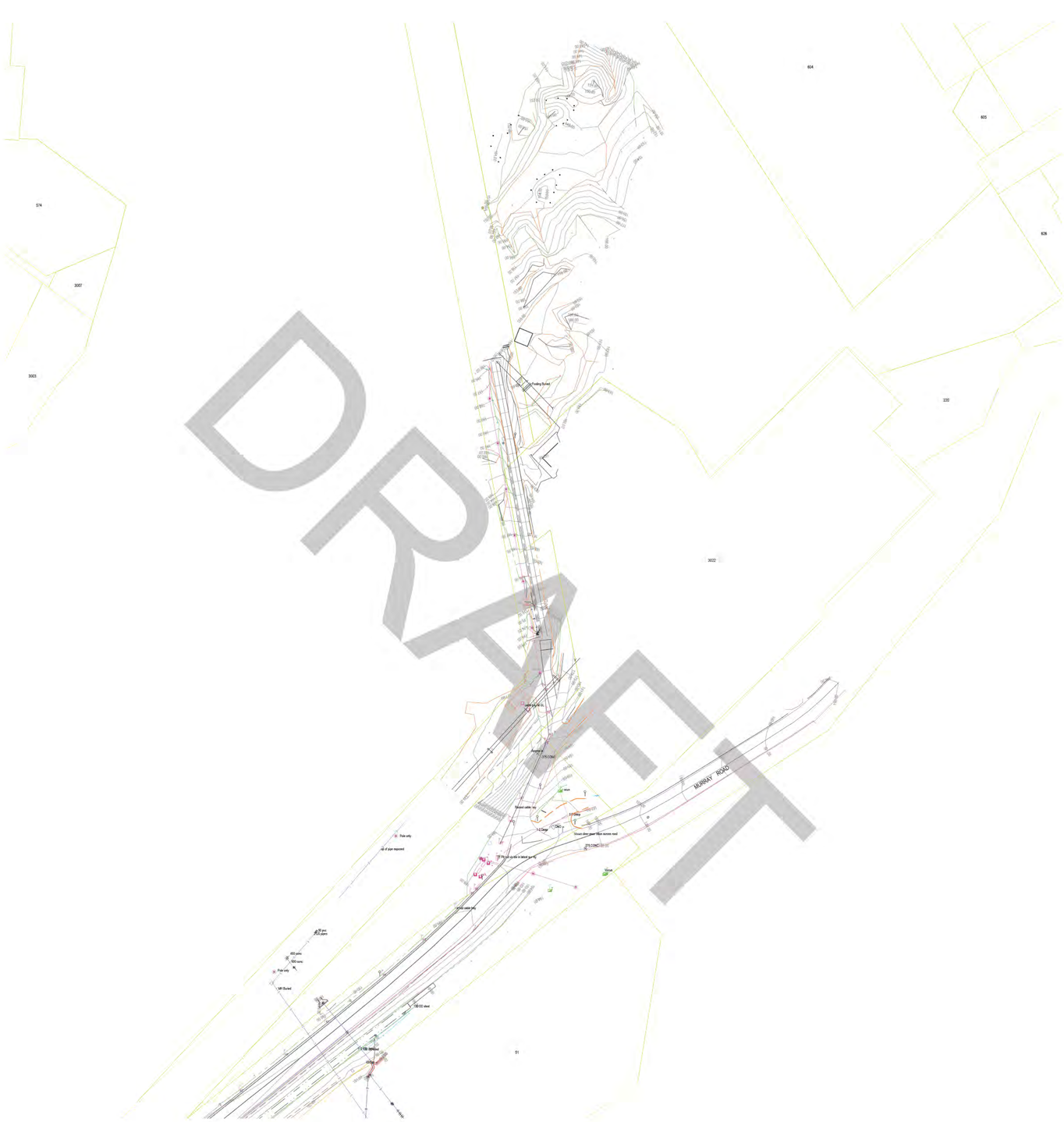
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SCALE 1:1000 AT ORIGINAL SIZE


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574
3007
3003
220
3022
MURRAY ROAD
Footing Buried
Pole only
SP Buried
Wire
Wood cable rail
Wood door gate Wire across road
Wood cable rail
Pole only
Wire
Wire
Wire

FOI 26-292 - Document 27

Appendix F – Permits

DWER Clearing Permit

Commonwealth Decision Documentation

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GOVERNMENT OF WESTERN AUSTRALIA

CLEARING PERMIT

Granted under section 51E of the Environmental Protection Act 1986

Purpose Permit number:	CPS 8472/1
Permit Holder:	Department of Infrastructure, Regional Development and Cities
Duration of Permit:	23 September 2019 to 23 September 2024

The Permit Holder is authorised to clear native vegetation subject to the following conditions of this Permit.

PART I – CLEARING AUTHORISED

1. **Purpose for which clearing may be done**
   Clearing for the purpose of upgrading of existing drainage infrastructure

2. **Land on which clearing is to be done**
   Murray Road reserve - 11831914, Christmas Island
   Murray Road reserve - 11831915, Christmas Island
   Murray Road reserve - 11831916, Christmas Island
   Murray Road reserve - 11344302, Christmas Island
   Lot 282 on Plan 218258, Christmas Island
   Lot 415 on Plan 192160, Christmas Island
   Lot 472 on Plan 219656, Christmas Island
   Lot 554 on Plan 221294, Christmas Island
   Lot 604 on Plan 74724, Christmas Island
   Lot 606 on Plan 74724, Christmas Island
   Unallocated Crown Land - 1190061, Christmas Island

3. **Area of Clearing**
   The Permit Holder must not clear more than two hectares of native vegetation within the area cross-hatched yellow on attached Plan 8472/1.

4. **Application**
   This Permit allows the Permit Holder to authorise persons, including employees, contractors and agents of the Permit Holder, to clear native vegetation for the purposes of this Permit subject to compliance with the conditions of this Permit and approval from the Permit Holder.

PART II – MANAGEMENT CONDITIONS

5. **Avoid, minimise and reduce the impacts and extent of clearing**
   In determining the amount of native vegetation to be cleared authorised under this Permit, the Permit Holder must have regard to the following principles, set out in order of preference:
   (a) avoid the clearing of native vegetation;
   (b) minimise the amount of native vegetation to be cleared; and
   (c) reduce the impact of clearing on any environmental value.

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6. **Weed control**
When undertaking any clearing or other activity authorised under this Permit, the Permit Holder must take the following steps to minimise the risk of the introduction and spread of *weeds*:
(a) clean earth-moving machinery of soil and vegetation prior to entering and leaving the area to be cleared;
(b) ensure that no known *weed*-affected soil, *mulch*, *fill* or other material is brought into the area to be cleared; and
(c) restrict the movement of machines and other vehicles to the limits of the areas to be cleared.

PART III – RECORD KEEPING AND REPORTING

7. **Record keeping**
The Permit Holder must maintain the following records in relation to the clearing of native vegetation authorised under this Permit:
(a) the location where the clearing occurred, recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Eastings and Northings or decimal degrees;
(b) the date(s) that the area was cleared;
(c) the size of the area cleared (in hectares);
(d) actions taken to avoid, minimise and reduce the impacts and extent of clearing in accordance with condition 5 of this Permit; and
(e) actions taken to minimise the risk of the introduction and spread of *weeds* in accordance with condition 6 of this Permit.

8. **Reporting**
The Permit Holder must produce the records required under condition 7 of this Permit when required by the *CEO*.

DEFINITIONS

The following meanings are given to terms used in this Permit:

CEO means the Chief Executive Officer of the Department responsible for the administration of the clearing provisions under the *Environmental Protection Act 1986*;

fill means material used to increase the ground level, or fill a hollow;

mulch means the use of organic matter, wood chips or rocks to slow the movement of water across the soil surface and to reduce evaporation;

weed/s means any plant -
(a) that is a declared pest under section 22 of the *Biosecurity and Agriculture Management Act 2007*; or
(b) published in a Department of Biodiversity, Conservation and Attractions species-led ecological impact and invasiveness ranking summary, regardless of ranking; or
(c) not indigenous to the area concerned.

Samara Rogers
MANAGER
NATIVE VEGETATION REGULATION

Officer delegated under Section 20
of the Environmental Protection Act 1986

19 August 2019

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FOI 26-292 - Document 27

Plan 8472/1



Legend

- CPS areas approved to clear
- Cadastre
- Roads
- Local Government Authorities

Image

N

300 0 300 m

MGA 94
Geocentric Datum of Australia 1994

Samara Rogers
2019.08.19 14:40:38 +08'00'

Officer with delegated authority under Section 20 of the Environmental Protection Act 1986

GOVERNMENT OF WESTERN AUSTRALIA

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Government of Western Australia
Department of Water and Environmental Regulation

Clearing Permit Decision Report

1. Application details

1.1. Permit application details

Permit application No.: 8472/1
Permit type: Purpose Permit

1.2. Applicant details

Applicant's name: Department of Infrastructure, Regional Development and Cities
Application received date: 18 April 2019

1.3. Property details

Property:
Murray Road reserve - 11831914, Christmas Island
Murray Road reserve - 11831915, Christmas Island
Murray Road reserve - 11831916, Christmas Island
Murray Road reserve - 11344302, Christmas Island
Lot 282 on Plan 218258, Christmas Island
Lot 415 on Plan 192160, Christmas Island
Lot 472 on Plan 219656, Christmas Island
Lot 554 on Plan 221294, Christmas Island
Lot 604 on Plan 74724, Christmas Island
Lot 606 on Plan 74724, Christmas Island
Unallocated Crown Land - 1190061, Christmas Island

Local Government Authority: Shire of Christmas Island
Localities: Christmas Island

1.4. Application

Clearing Area (ha)	No. Trees	Method of Clearing	Purpose category:
2		Mechanical Removal	Drainage

1.5. Decision on application

Decision on Permit Application: Grant
Decision Date: 19 August 2019
Reasons for Decision: The clearing permit application has been assessed against the clearing principles, planning instruments and other matters in accordance with section 51O of the *Environmental Protection Act 1986* (EP Act). It has been concluded that the proposed clearing may be at variance to principle (h), and is not likely to be at variance to the remaining principles.

It has been determined that the proposed clearing may impact the environmental values of adjacent vegetation through the introduction or spread of weeds.

In determining to grant a clearing permit, the Delegated Officer determined that potential impacts to adjacent vegetation and conservation areas can be adequately minimised and/or avoided by imposing weed management measures.

2. Site Information

Clearing Description The application is to clear two hectares of native vegetation within Murray Road reserve (PINs 11831914, 11831915, 11831916 and11344302), Lot 282 on Deposited Plan 218258, Lot 415 on Deposited Plan 192160, Lot 472 on Deposited Plan 219656, Lot 554 on Deposited Plan 221294, Lot 604 on Deposited Plan 74724, Lot 606 on Deposited Plan 74724 and unallocated Crown land (PIN 1190061), Christmas Island, for the purpose of upgrading of existing drainage infrastructure. The application area is described as three distinct areas in this assessment, distinguished as the 'school site – drainage basin area, 'school site – Murray Road area' and as Silver City Area (basin and incline)' (figure 1).

Vegetation Description The vegetation within the application area is mapped as:
School site (both at the proposed basin and along Murray Road): predominantly 'Regrowth' with some minor areas of 'Mixed weed and pioneer species';
Silver City (proposed basin): predominantly contain '*Leaucanea leucocephala* dominant' with some areas of 'Regrowth'; and
Silver City (along the incline): 'Mixed weed and pioneer species' and some small areas of 'Regrowth' (GeoScience Australia, 2011-2014, as referenced in GHD, 2019).

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A vegetation and fauna assessment/survey of the application area undertaken on 20-21 February 2019 recorded the application area to comprise the following vegetation types:

School site – drainage basin area: the vegetation is marginal rainforest and consists of a range of forest tree species up to 30 metres high, over lower level trees and palms, with a very limited understorey. At the outer edges of the forest, adjacent to the school, a number of weed shrub and herb species are present, in a dense layer at the base of the trees;

School site – Murry Road area: Only a few semi-mature trees of the marginal rainforest vegetation type are present in the survey area, with much of the vegetation being mown weeds or introduced shrubs (the latter in a strip 2-3 metres wide). Included were a non-native palm and an introduced, unidentifiable small tree/shrub from the Fabaceae family;

Silver City area (including incline): What remains of the native vegetation consists of scattered trees and shrubs of marginal rainforest. The majority of the plants are introduced shrubs and small trees in disturbed soils, dominated by the introduced species, *Leucaena leucocephala* (GHD, 2019).

Vegetation Condition

Good; Vegetation structure significantly altered with obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate (Keighery, 1994);
To
Degraded; Basic vegetation structure severely impacted by disturbance, scope for regeneration but not to a state approaching good condition without intensive management (Keighery, 1994).

Soil type

The soils within the application area are described as:
School site – drainage basin area: The vegetation is on an upper/middle terrace of the Island, in relatively shallow soils over some areas of outcropping limestone boulders and sheets;
School site – Murry Road area: The vegetation is on an upper/middle terrace of the Island, in sandy soils;
Silver City area (including incline): The vegetation is on an upper/middle terrace of the Island. Much of the area has been previously excavated for drainage and/or soil borrow, which has exposed outcropping limestone and boulders (GHD, 2019).



Figure 1: Application area

3. Minimisation and mitigation measures

The applicant has minimised the clearing of native vegetation by choosing locations which have been historically cleared and those close to previously cleared areas. Additionally the areas disturbed have been located in places where the drainage will be the most functional, thereby minimising the impact of major, uncontrolled drainage flows over other areas of native vegetation, which in the past have resulted in some landslides, damaging vegetation (GHD, 2019).

The applicant has also committed to limiting construction works to those times outside of crab migration, as advised by Christmas Island National Parks (GHD, 2019).

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4. Assessment of application against clearing principles

(a) Native vegetation should not be cleared if it comprises a high level of biodiversity.

Proposed clearing is not likely to be at variance to this Principle
Christmas Island has over 240 native flora species, with at least 18 known to be worldwide endemics. About half of the non-endemic native species are not known to occur anywhere else in Australia or its Territories. Exotic species now comprise a major component of the island's flora, with at least 390 exotic species known and 221 of these identified as posing a current or potential weed threat (Director of National Parks, 2014).

No priority flora species are listed for Christmas Island.

Christmas Island is home to three threatened flora species, being; *Asplenium listeri* (Christmas Island Spleenwort), *Tectaria devexa* var. *minor* and *Pneumatopteris truncate*. A survey of the application area did not record any conservation significant flora species within the application area (GHD, 2019).

No state or federally listed priority or threatened ecological communities (TEC) are located on Christmas Island.

During the 2019 surveys, GHD identified two fauna species of conservation significance, *Turdus poliocephalus erythropleurus* (the Christmas Island thrush) and *Ninox natalis* (the Christmas Island hawk owl), both of which are highly mobile species. The Christmas Island thrush was observed within the application area during the survey, as well as throughout other locations on the island. The Christmas Island hawk owl was heard within proximity of the school site during the survey, however no potential nesting hollows were observed within the application area (GHD, 2019). The adjacent intact vegetation in the rain forests contains more suitable habitat for these two species. The proposed clearing is also not expected to cause any fragmentation of habitats due to their extent and locations, therefore is not likely to have a minimal impact on migration pathways for red crabs (GHD, 2019). Fauna is discussed in more detail under principle (b).

Noting that parts of the application area have been previously cleared and does not contain a high level of biodiversity when compared to remnant forest which covers approximately 65 per cent of the island, the proposed clearing is not likely to be at variance to this principle.

(b) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna.

Proposed clearing is not likely to be at variance to this Principle
Christmas Island provides habitat for several species of fauna indigenous to the island including fourteen native bird species and nine species of seabird which use the island for breeding. Four seabird taxa and nine land bird taxa are endemic to the island. A further 108 migratory or vagrant bird species have been recorded on the island. Six of the island's endemic birds are listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Based on available databases, the application area is likely to support suitable habitat for *Chalcophaps indica Natalis* (Christmas Island emerald dove), *Turdus poliocephalus erythropleurus* (the Christmas Island thrush) and *Ninox natalis* (the Christmas Island hawk owl). A field survey by GHD identified the Christmas Island thrush within the application area and heard the Christmas Island hawk owl within proximity of the school site (GHD, 2019).

The Christmas Island thrush is listed as Endangered under the EPBC Act. This species is confined to Christmas Island, where it is considered to be widespread. The extent of occurrence is estimated to be 137 kilometres squared (DotEE, 2019a).

The Christmas Island hawk owl is confined to Christmas Island and occupies permanent territories in all forest types on the island, with highest densities in primary forest and lowest in post-mining regrowth (DotEE, 2019b). The Christmas Island hawk owl was heard within proximity of the school site during the survey, however no potential nesting hollows were observed within the application area (GHD, 2019).

Both these species are highly mobile and therefore the proposed clearing is not likely to significantly impact upon these species. In addition, approximately 63 per cent of the island is National Park which provides better quality habitat for these species.

In addition to the above two threatened species, five other conservation significant fauna species were observed during the flora survey, being; robber crab (*Birgus latro*), red crab (*Gecarcoidea natalis*), Christmas Island white eye (*Zosterops natalis*), Christmas Island imperial pigeon (*Ducula whartoni*) and tree sparrow (*Passer montanus*) (GHD, 2019).

The Christmas Island white eye, Christmas Island imperial pigeon and the tree sparrow are widespread and highly mobile and therefore the proposed clearing is not likely to significantly impact upon these species. In addition, approximately 63 per cent of the island is National Park which provides better quality habitat for these species.

Red crabs are most common in the moist environment of the rainforest, however also inhibit a variety of other habitats. The only habitat they are not found in are the areas cleared of rainforest and stripped of soil for phosphate mining. Current estimates of population size are about 50-60 million (Orchard, 2015). At the beginning of the wet season (around October to December) every year adult red crabs migrate from the forest to the coast, to breed and spawn. Red crabs were observed at the school site, but were not seen at the other sites (GHD, 2019). The application areas are not located within important migration pathways for the red crab. The proposed clearing is also not expected to cause any fragmentation of habitats due to their extent and locations, therefore is not likely to have a minimal impact on migration pathways for red crabs (GHD, 2019). The applicant has also committed to limiting construction works to those times outside of crab migration, as advised by Christmas Island National Parks (GHD, 2019).

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Christmas Island supports the world's largest population of the world's largest terrestrial invertebrate, the robber crab. Robber crabs have a wide distribution across many Indian and Pacific oceanic islands but in most of their range they are now scarce, heavily hunted and in serious decline. Although abundant on Christmas Island their exact conservation status is unknown (DotEE, 2019c). Robber crabs were observed at the school site, but were not seen at the other sites (GHD, 2019). Noting their distribution on Christmas Island and noting that the majority of the application area is in degraded condition, the application area is not likely to support significant habitat for the robber crab.

Noting the above, the proposed clearing is not likely to be at variance to this principle.

(c) Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, threatened flora.

Proposed clearing is not likely to be at variance to this Principle
Christmas Island is home to three species listed as threatened under the EPBC Act. These three species are *Asplenium listeri* (Christmas Island Spleenwort), *Tectaria devexa* var. *minor* and *Pneumatopteris truncata*.

Tectaria devexa var. *minor* is described as growing in shaded positions in the primary rainforest on the plateau, usually in areas of deep soil, where it may be the only forest floor species (Butz, 2004a).

Asplenium listeri (Christmas Island Spleenwort) is a fern endemic to Christmas Island, where it is known from a very small number of localities growing among rocks and on cliffs of exposed limestone outcrops (Butz, 2004b).

Pneumatopteris truncata grows colonially on permanently moist sites, in marginal rainforest and in shaded areas, between 50 and 140 metres above sea-level (DotEE, 2019d).

Flora surveys of the application areas did not identify any of the abovementioned species (GHD, 2019).

Given the above, the proposed clearing is not likely to be at variance to this principle.

(d) Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.

Proposed clearing is not at variance to this Principle
No TECs have been recorded on Christmas Island.

Therefore, the propose clearing is not at variance to this principle.

(e) Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.

Proposed clearing is not likely to be at variance to this Principle
Christmas Island retains approximately 75 per cent native vegetation, of which 84 per cent (63 per cent of total island area) is protected as National Park.

The application area contains vegetation in good (Keighery, 1994) to degraded (Keighery, 1994) condition and does not contain significant habitat for indigenous fauna. Also given the amount of vegetation remaining on Christmas Island it is not a significant remnant in an area that has been extensively cleared.

Therefore, the proposed clearing is not likely to be at variance to this principle.

(f) Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.

Proposed clearing is not at variance to this Principle
The proposed clearing is not growing in or is associated with a watercourse or wetland.

Perennial surface water features on Christmas Island are limited to spring fed streams on coastal or sloping areas of the island.

The proposed clearing is not at variance to this principle.

(g) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.

Proposed clearing is not likely to be at variance to this Principle
Christmas Island has a high annual rainfall of approximately 2000 millimetres per year. Despite this, the island has very little in the way of natural running water. Approximately 70 per cent of the rainfall is taken up by the island's plants and the remaining infiltrates through the soil to recharge the groundwater. The soil and underlying limestone rock is very porous and there is very little runoff except during torrential wet season downpours (GHD, 2007).

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The project is considered necessary to improve the stormwater and drainage infrastructure on the island due to a number of landslip events and increasing erosion. This is a result of flooding events which have caused significant damage to down-gradient infrastructure. The most significant areas currently affected are located in between the Drumsite and Flying Fish Cove and specifically along the Kampong residential area. The flooding events and consequent high levels of erosion are causing major damage to vegetation in the area. The proposed clearing to upgrade the drainage infrastructure in this area is anticipated to significantly reduce the number of flooding events and associated erosion and therefore will have a positive impact for land degradation (GHD, 2019).

The proposed clearing is not likely to be at variance to this principle.

(h) Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.

Proposed clearing may be at variance to this Principle

Two Ramsar listed wetlands (Honsie's Spring and The Dales) are located on Christmas Island. Both of these conservation areas are located within the National Park. At its closest point, the application area is located approximately 4500 metres northwest of Honsie's Spring. The Dales are approximately 12 kilometres southwest of the application area. Given the distance to these Ramsar sites the proposed clearing is not likely to impact on the environmental value of these areas.

Christmas Island retains approximately 75 per cent native vegetation, of which 84 per cent (63 per cent of total island area) is protected as National Park. The majority of the National Park is uncleared primary rainforest.

The majority of weeds on Christmas Island cannot survive in primary rainforest mainly due to low light and consumption by crabs. Potential plant invaders of intact rainforest must possess two key traits: the ability to establish and grow under heavy shade, and the ability of both seeds and seedlings to tolerate, evade, or resist consumption by red crabs (Green et al., 2003). The majority of weeds on Christmas Island do not have these key traits are therefore unable to penetrate primary rainforest. However, there are some shade tolerant species that can spread into forested areas.

Weed management practices should be sufficient to ensure that the environmental values of the National Park are not compromised.

The proposed clearing may be at variance to this principle.

(i) Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.

Proposed clearing is not likely to be at variance to this Principle

The proposed clearing is not growing in or is associated with a watercourse or wetland.

Due to high infiltration rates on Christmas Island, erosion and sedimentation is generally localised to compacted areas such as roads and stockpiles. Therefore, the proposed clearing is not likely to cause deterioration in the quality of surface water.

Christmas Island retains approximately 75 per cent native vegetation and therefore the clearing of two hectares of vegetation will not result in an increase in groundwater salinity.

The proposed clearing is not likely to be at variance to this principle.

(j) Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

Proposed clearing is not likely to be at variance to this Principle

The proposed clearing will not increase the incidence or intensity of flooding due to the porous nature of the soils and the underlying rock structures on Christmas Island.

The proposed clearing is not likely to be at variance to this principle.

Planning instruments and other relevant matters.

The Shire of Christmas Island advised that the Shire has no objection to the proposed clearing (Shire of Christmas Island, 2019)

The proposed clearing has also been referred to the Department of the Environment and Energy to be assessed under the Environment Protection and Biodiversity Conservation Act 1999 (Reference 2019/8467).

The clearing permit application was advertised on the DWER website on 30 May 2019 with a 21 day submission period. The application was also advertised in The Islander on 7 July 2019. No public submissions have been received in relation to this application.

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FOI 26-292 - Document 27



FIGURE 2

FIGURE 3

LEGEND

Proposed Clearing Extent

Paper Size ISO A3

0 50 100 150

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: CIG94

N

GHD

Department of Infrastructure, Regional Development and Cities
Christmas Island
Stormwater Remediation Project

Overview

Project No. 61-35637
Revision No. 0
Date 10 Apr 2019

FIGURE 1

G:\61\35637\GIS\Maps\Working\Clearing Areas\61\35637_001_Fig1ClearingExtentOverviewMap_Rev0.mxd
Print date: 10 Apr 2019 - 15:59

Data source: GHD: Proposed clearing extent, Proposed drainage - 2018; DIRD: Imagery; Google Earth: Inset imagery Created by: afeeney

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Paper Size ISO A3

0 20 40 60 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: CIG94

N

GHD

Department of Infrastructure,
Regional Development and Cities
Christmas Island
Stormwater Remediation Project

Proposed Clearing Area

Project No. 61-35637
Revision No. 0
Date 12 Apr 2019

FIGURE 2

G:\61\35637\GIS\Maps\Working\Clearing Areas\61135637_002_Fig2ProposedClearing_Rev0.mxd
Print date: 12 Apr 2019 - 10:40

Data source: GHD: Proposed clearing extent, Proposed drainage - 2018; DIRD: Imagery. Created by: afeeney

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LEGEND

Proposed Drainage Pits and Pipes

Proposed Clearing Extent

Paper Size ISO A3

0 10 20 30 40 50

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 48

N

GHD

Department of Infrastructure, Regional Development and Cities
Christmas Island
Stormwater Remediation Project

Proposed Clearing Area

Project No. 61-35637
Revision No. 0
Date 10 Apr 2019

FIGURE 3

G:\61\35637\GIS\Maps\Working\Clearing Areas\61135637_003_Fig3ProposedClearing_Rev0.mxd
Print date: 10 Apr 2019 - 16:03

Data source: GHD: Proposed clearing extent, Proposed drainage - 2018; Geoscience Australia: Christmas Island Vegetation and Clearing Map - May 2014; DIRD: Imagery. Created by: afeeney

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Australian Government

Department of Agriculture, Water and the Environment

Notification of

REFERRAL DECISION – not controlled action
Christmas Island Stormwater Remediation Project (EPBC 2019/8467)

This decision is made under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Proposed action

Person proposing to take the action	Department of Infrastructure, Transport, Regional Development and Communications ABN 86 267 354 017
proposed action	Upgrading and expanding the existing stormwater management system and drainage infrastructure in existing urban areas on Christmas Island [See EPBC Act referral 2019/8467].
Referral decision:	**Not a controlled action**
status of proposed action	The proposed action is not a controlled action.

Person authorised to make decision

Name and position	Gregory Manning Assistant Secretary Assessments (WA, SA, NT), Post Approvals and Policy Branch
signature	
date of decision	17 March 2020

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FOI 26-292 - Document 27

Australian Government
Department of the Environment and Energy

COMPLIANCE MONITORING AND AUDITING

This fact sheet provides an overview of the compliance monitoring and auditing program in place for projects referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and permits granted under the *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act).

What is the EPBC Act?

The EPBC Act is Australia's key national environment law. Under the EPBC Act, proposals which are likely to have a significant impact on matters of national environmental significance must be referred, assessed, and a decision made by the Minister or his delegate on whether to approve the proposal.

What is the Sea Dumping Act?

The Sea Dumping Act regulates the loading and dumping of waste at sea. The Sea Dumping Act fulfils Australia's international obligations under the London Protocol to prevent marine pollution by dumping of wastes and other matter. Permits are required from the Department for all ocean disposal activities.

What is compliance monitoring and auditing for?

The Department has implemented a program to monitor and audit projects that have been referred under the EPBC Act and the Sea Dumping Act to ensure they are complying with their approval/permit conditions or particular manner requirements and the legislation.

Compliance monitoring activities, including inspections and audits, aim to ensure projects with the potential to impact on nationally protected matters are implemented as planned. Monitoring and audits help the Australian Government to understand how well conditions or requirements are being understood and applied, and contribute to improving the effectiveness of the Department's operations.

All compliance monitoring activities, and any subsequent enforcement activities, are conducted in accordance with the Department's Compliance and Enforcement Policy.

What is a monitoring inspection?

Approved projects are subject to monitoring inspections to ensure and verify compliance with the conditions or requirements of the approval or permit. Projects are selected for a monitoring inspection based on a risk-based process informed through a number of factors, including sector, location, compliance history and the potential impact on listed matters (such as threatened species and ecological communities).

What is a compliance audit?

A compliance audit is an objective assessment of a project's compliance against selected criteria. Projects are audited against conditions or requirements. A compliance audit usually takes the form of a desktop document review and may include a site inspection, if necessary. In some cases, the document review provides the Department with enough information to verify that a project is compliant.

Projects can be chosen for audit based on a random selection process or a risk-focused selection process. If your project is selected for an audit, you will be contacted by a Departmental officer who will explain the process. All audit report summaries are posted on the Department's website. The results of audits may also be publicised through the general media.

Further information

For further information on the compliance monitoring and auditing program, please visit the Department's website at www.environment.gov.au or contact:

The Director, Monitoring and Assurance Section
Department of the Environment and Energy
GPO Box 787 CANBERRA ACT 2601
Telephone: (02) 6274 1111
Email: EPBCmonitoring@environment.gov.au



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FOI 26-292 - Document 27

Appendix G – Water Corporation Documents

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FOI 26-292 - Document 27

WATER CORPORATION

MODULAR SPECIFICATION SECTION 'COM'

COMMISSIONING

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Revision Status

Nexus # 58570963

REVISION STATUS The revision status of this specification is shown by section below. Note that all sections have been revised and no vertical lines have been used in the left margin for identifying changes in this version of the COM Modules.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.1	10/02/16	All	Initial version	Sup Eng Const Support (PMB)	Sup Eng Const Support (PMB)
All	1.2	1/11/19	All	Revised to reflect updated Commissioning Guidelines	Team Lead – Commissioning (AMS)	Sup Eng Const Support (PMB)
All	2.0	29/10/20	All	Simplified and inclusion of key activities table	Team Lead – Commissioning (AMS)	Manager, Asset Management Services (AMS)

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FOI 26-292 - Document 27

Contents

COM1 APPLICATION OF SECTION 1
COM2 STANDARDS, CODES AND REGULATIONS 1
COM3 LIST OF ACTIONS (DELIVERABLES) 1
COM4 COMMISSIONING REQUIREMENTS 2
COM4.1 Planning 2
COM4.2 Commissioning Plan 3
COM4.3 Personnel 3
COM4.4 Commissioning Plan and Schedule Approval 3
COM4.5 Commissioning Communications 4
COM5 COMMISSIONING PROCESS 4
COM5.1 Testing and Commissioning 4
COM5.2 Supply & Construction Verification (Inspections and Tests) 4
COM5.3 Pre-commissioning 4
COM5.4 Regulatory Inspections and Tests 4
COM5.5 Integration Commissioning 5
COM5.6 Performance Testing / Equipment Commissioning 5
COM5.7 Proof Testing / Reliability Testing 5
COM5.8 Commissioning Report: 5
COM5.9 Key Deliverable Documentation: 5
COM5.10 Training 6

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COM COMMISSIONING

COM1 APPLICATION OF SECTION

This section specifies the requirements for Commissioning. Items in relation to Commissioning specific to this contract will be identified in the relevant section of the Project Specific Preliminaries section and in the Commissioning Plan (if provided).

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

COM2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

The Specification takes precedence over the Australian Standards.

Water Corporation Specifications and Guidelines

Asset Commissioning Guideline

COM3 LIST OF ACTIONS (DELIVERABLES)

Table COM3.1 summarises the various actions required throughout section COM. The actions listed in table COM3.1 are not the only actions required and the table is not a substitute for familiarisation with section COM, the project specific Commissioning Plan and the PSP.

Record of actions noted in table COM3.1 need to be included in the MDR.

Table COM3.1: List of actions

Reference	Description	Timeframe
COM4.4 Commissioning Plan & Schedule Approval	Commissioning Plan, including Commissioning Schedule* and Commissioning Risk Register*,to be submitted to the Superintendent for approval. *Note. These may be commissioning specific OR fully detailed in the Project Schedule/Risk Register	Within eight (8) weeks of design completion (D&C) or six (6) weeks prior to commencement of Pre-Commissioning, whichever is sooner.
COM4.5 Commissioning Workshop	Commissioning Workshop to be held (with both Principal and Contractor key staff)	Two (2) weeks prior to commencement of commissioning work or as defined in the Preliminary Commissioning Plan, whichever is sooner

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COM 5.2 Supply & Construction Verification	Supply and Construction Verification shall be complete and evidence, as per the Quality Plan and PQR, shall be available to the Superintendent	Two (2) weeks Prior to commencing pre-commissioning
COM 5.2 Supply & Construction Verification	Factory acceptance test plans / ITPs for vendor packages / test plans for major equipment shall be submitted to Principal's Commissioning Manager	Three (3) weeks prior to scheduled testing
COM5.3 Pre-commissioning	Pre-Commissioning verification evidence shall be complete, and available to the Superintendent.	prior to commencing commissioning
COM5.4 Regulatory Inspections and Tests:	Regulatory verification evidence of compliance shall be submitted to the Superintendent	One (1) week prior to commencing commissioning of these assets
COM5.5 Integration Commissioning	Integration test plans & procedures shall be submitted to Superintendent for approval	Three (3) weeks prior to scheduled integration.
COM5.6 Performance / Equipment Testing	Performance test plans, procedures and proposed test records shall be submitted to Superintendent for approval	Three (3) weeks prior to scheduled testing.
COM5.7 Proof / Reliability Testing	Proof test plans, procedures and proposed test records shall be submitted to Superintendent for approval	Three (3) weeks prior to scheduled testing.
COM5.8 Commissioning Report	Report to be complete and submitted for approval to the Superintendent	Within four (4) weeks of completion of commissioning works (incl. analysis of results)

COM4 COMMISSIONING REQUIREMENTS

Commissioning of *the Works* shall be completed as specified in the Project Specific Commissioning Plan approved by the Principal. The required review and approval process for the Commissioning Plan is described in this specification. This shall be undertaken in conjunction with the specification and drawings and any requirements detailed in the PSP Project Specific Preliminaries.

COM4.1 Planning

A Commissioning Plan shall be prepared to document the requirements for Commissioning of the *WUC* as detailed in the specification.

The plan shall detail, as a minimum:

a) Scope,

b) Commissioning procedures and methodology,

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c) Quality records required to verify commissioning activities,

d) Roles and responsibilities,

e) Schedule dates and durations for all planned activities, having due regard to specified time and other constraints,

f) Identification and management of the OSH, Environmental, Quality and Operational risks that may be associated with planned *test* and commissioning activities.

g) Witness and Hold Points,

h) Reporting Requirements.

The plan shall be duly updated as commissioning and testing of the work proceeds.

COM4.2 Commissioning Plan

Where the Commissioning Plan is provided by the *Principal*, the *Contractor* shall undertake the commissioning requirements as detailed in the *Principal* approved commissioning plan. The *Superintendent* will nominate a Commissioning Manager to represent the *Principal's* interest in commissioning related activities and outcomes on site. The Contractor shall review and update the Preliminary Commissioning Plan (or Template) issued as part of the contract.

If a Commissioning Plan has not been provided by the *Principal* the *Contractor* shall prepare a Commissioning Plan as specified. This Commissioning Plan is be submitted to the *Superintendent* for review and approval of the *Principal* no later than four (4) weeks prior to the commencement of commissioning work.

COM4.3 Personnel

The *Contractor* shall nominate the personnel proposed to undertake the commissioning, for review by the *Superintendent*. The *Contractor's* commissioning personnel shall be available to operate *the Works* for the duration of the specified commissioning phase working hours.

The *Contractor* shall provide the services of qualified technical manufacturer's representative(s) to provide advice and to assist and/or witness commissioning of equipment.

Agreed key commissioning personnel shall be available to support the *Principal's* process operations during a specified operation and maintenance support period, as may be directed.

The *Superintendent* will nominate the Principal's personnel who will participate in the *Works* Commissioning.

Contractor Commissioning Personnel, including their roles and responsibilities are to be nominated in the Commissioning Plan for approval of the Superintendent.

COM4.4 Commissioning Plan and Schedule Approval

The Commissioning Plan shall be submitted to the Superintendent for approval of the Principal's Commissioning Manager within eight (8) weeks of completion of design (if a D&C contract) or no later than six (6) weeks prior to the commencement of Commissioning Work. Commissioning work shall not proceed until approval is received (ie Commissioning Plan is "approved for Construction"), this shall be a Hold Point in the contract schedule.

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COM4.5 Commissioning Communications

During the construction phase of the contract, progress against the Commissioning Plan, Commissioning Schedule and Project Quality Register (PQR) will be discussed and minuted at the progress meeting chaired by the Superintendent.

Further Commissioning Communication will be required on completion of pre-commissioning work, this shall be as detailed in the Commissioning plan.

The contractor shall conduct a Commissioning Workshop to present the commissioning plan and schedule to all key stakeholders (Principal and Contractor), this is to be held no later than 2 weeks prior to commencing Commissioning Work or as defined in the Preliminary Commissioning Plan (whichever is sooner).

COM5 COMMISSIONING PROCESS

Commissioning activities, associated procedures and performance objectives shall be as per the Commissioning Plan. The commissioning works commences at witnessing of pre-commissioning tests, with the exception of factory testing of vendor packages or complex equipment, which shall be considered commissioning works.

COM5.1 Testing and Commissioning

A Water Corporation representative shall be invited to witness different stages of testing and commissioning as specified in the commissioning plan or directed by the *Superintendent*. At least one (1) week notice shall be provided for witnessing

The *Contractor* shall provide and maintain a suitable commissioning schedule incorporating pre-commissioning and commissioning activities, hold points and milestones as per the Commissioning plan.

The *WUC* shall be tested and commissioned by the *Contractor* who shall complete all in accordance with the drawings and specification and as defined in the Commissioning Plan.

COM5.2 Supply & Construction Verification (Inspections and Tests)

Supply and Construction Verification shall be complete, and evidence, as per the Quality Plan and PQR, shall be available to the Superintendent prior to commencing pre-commissioning of subject equipment / works.

Factory acceptance test documents / ITPs for vendor packages / major equipment shall be submitted to Principal's Commissioning Manager at least three (3) weeks prior to scheduled testing for endorsement and to enable booking of resources to witness the tests (in the case of control systems and SCADA evidence of pre-FAT testing shall also be submitted prior to FAT).

COM5.3 Pre-commissioning

Pre-commissioning is to be undertaken in accordance with the Quality Plan in a planned and coordinated manner. Verification evidence shall be complete, and available to the Superintendent as a prerequisite to commencing commissioning work.

COM5.4 Regulatory Inspections and Tests

There is a legal requirement for certain classes of high risk assets to be inspected and/or tested for regulatory compliance prior to use, these are to be defined as Hold Points in the contract / commissioning schedule. Verification evidence of compliance shall be submitted to the Superintendent at least one (1) week prior to commencing commissioning of these assets.

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COM5.5 Integration Commissioning

The contractor shall undertake integration commissioning (where applicable) to test the functionality of the new assets within the Principal's operational systems (e.g. A boosting pump station within a water conveyance system).

The Integration commissioning shall demonstrate the full operation of the assets delivered by the contract as part of, and/or connected to a larger water system or treatment plant under the specified conditions and operational modes.

Integration test procedures and proposed test records shall be submitted to Superintendent for approval at least three (3) weeks prior to scheduled testing.

COM5.6 Performance Testing / Equipment Commissioning

The Contractor shall undertake performance testing of the new assets. Testing consists of a series of production and/or functional tests designed to demonstrate the capability of the newly constructed assets. If applicable, the minimum performance testing requirements are described in the PSP (Project Specific Preliminary Specification), these are to be referenced in the Commissioning Plan and further described in Performance Test Plans and Procedures.

Performance test plans, procedures and proposed test records shall be submitted to Superintendent for approval at least three (3) weeks prior to scheduled testing.

COM5.7 Proof Testing / Reliability Testing

The Contractor shall undertake proof testing / reliability testing of the new assets. Testing consists of tests designed to demonstrate the reliability of the newly constructed assets in the full range of normal service. The minimum proof testing requirements are described in the PSP (Project Specific Preliminary Specification), these are to be referenced in the Commissioning Plan and further described in Proof Test Plans & Procedures.

Proof test plans, procedures and proposed test records shall be submitted to Superintendent for approval at least three (3) weeks prior to scheduled testing.

COM5.8 Commissioning Report:

The Contractor shall prepare a Commissioning Report summarising all completed commissioning activities required by the Commissioning Plan, this shall reference the results of all completed inspections and tests and detail any deficiencies, exceptions or issues.

The Commissioning Report shall be submitted to the *Superintendent* for approval by the Principal's Commissioning Manager within Four (4) weeks of completion of commissioning work (commissioning works shall include analysis of test results).

COM5.9 Key Deliverable Documentation:

Key documentation is required to be delivered to stakeholders prior to certain commissioning activities occurring. These documents are listed in the PSP (Project Specific Preliminary Specification) – Commissioning Documentation Section.

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COM5.10 Training

Specified training of the Principal's Operating and Maintenance staff shall be delivered prior to commencing proof testing of the Works.

Training dates will need to be included in the contract schedules.

Training dates and training format are to be discussed and agreed with the Superintendent during pre-commissioning.

END OF SECTION

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FOI 26-292 - Document 27

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WATER CORPORATION
SPECIFICATION SECTION 'CPP'

CORROSION PROTECTION PIPELINES

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FOI 26-292 - Document 27

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Revision Status

Nexus ID 58574551

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REVISION STATUS The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.0	10/02/16	All	Initial version	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP3.2	1.1	09/03/16	2	Added requirements for steel work and appurtenances closer than 1km to coast	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.1	1.1	09/03/16	2	Added "Unless otherwise specified"	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.3	1.1	09/03/16	2	Removed "Coating of Ductile Iron Pipeworks and Fittings"	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.3	1.1	09/03/16	2	Was CPP4.4	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.4	1.1	09/03/16	3	Was CPP4.5 Referred to relevant SPS and added specifications for repairs	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.5	1.1	09/03/16	3	Was CPP4.6	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.6	1.1	09/03/16	6	New Section "DICL Fittings"	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.7	1.1	09/03/16	6	Removed "Ductile Iron Cement Lines (DICL) Pipelines"	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.7	1.1	09/03/16	6	Was CPP4.8	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.
CPP4.8	1.1	09/03/16	7	Was CPP4.9	Mgr Welding & Corrosion Cont (MESB)	Principal Eng. Water Conv.

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Section 'CPP' – Corrosion Protection Pipelines
Nexus ID 58574551 Rev2.0

	2.0	11/09/18		Title Page - Removed reference to 3 party CPP1 – amended to cover 2 party		Senior Principal Eng Water Conveyance
CPP4.4	2.0	11/09/18		New clause Flange isolation required for dissimilar metals	Team Leader Asset Durability	Senior Principal Eng Water Conveyance
CPP4.2 and CPP4.6.4	2.0	11/09/18	3, 6	Inclusion of UCC Petrolatum 4 step system	Team Leader Asset Durability	Senior Principal Eng Water Conveyance
CPP2	3.0	04/07/19	1	Updated referenced to other standards and documents.	Team Leader Asset Durability	Senior Principal Eng. Water Conveyance
CPP3			1-2	Added section.		
CPP4.1			2	Non-APAS to be approved by and ITPs to be sent to Superintendent. ~~Field joints to be~~ minimized. AS4020 requirement added.		
CPP4.2			2	Relocated section on ~~repair to CPP6.~~		
CPP5.1			2	Amended stainless bolt requirements to A4.		
CPP4.5.1			3	Relocated section on ~~repair to CPP6.~~		
CPP4.5.2			3	Relocated section on ~~repair to CPP6.~~		
CPP5.6.1			3	Correct MSCL lining from concrete to mortar.		
CPP5.6.3			3-4	Approvals by Superintendent instead of Principal.		
CPP5.6.5			5	Added section.		
CPP4.6.6			6	Relocated section on ~~repair to CPP6.~~		
CPP4.7			6	Removed section.		
CPP6			7	New section consolidating repair requirements.		

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FOI 26-292 - Document 27

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Contents

CPP1	**APPLICATION OF SECTION**	**1**
CPP2	**STANDARDS, CODES AND REGULATIONS**	**1**
CPP3	**LIST OF ACTIONS**	**1**
CPP4	**GENERAL**	**2**
CPP4.1	General	2
CPP4.2	Structural Steelwork and Appurtenances	2
CPP5	**PIPELINES**	**2**
CPP5.1	Flange Bolts	2
CPP5.2	Flange Protection	3
CPP5.3	Coupling Joints	3
CPP5.4	Dissimilar Metal Flange Protection	3
CPP5.5	Valves	3
CPP5.6	MSCL Pipeline	3
CPP5.7	PVC Pipelines	6
CPP5.8	PE Pipeline	6
CPP6	**REPAIR OF COATINGS**	**7**
CPP6.1	Repair of Cement Mortar Lining	7
CPP6.2	Repair of Galvanised items	7
CPP6.3	Repair of Damaged Sintakote or Heat Shrink Sleeves	7
CPP6.4	Repair of Damaged Ultra High Build Epoxy Coating	7
CPP6.5	Repair of Thermal-bonded polymeric coatings	7

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FOI 26-292 - Document 27

CPP CORROSION PROTECTION

CPP1 APPLICATION OF SECTION

This section applies to the coating and coating repair of water and wastewater conveyance pipelines and associated platforms and structures. This section is not intended to cover 'plant' pipework within pump stations or treatment plants. For cathodic protection of pipelines refer to section CATP.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

CPP2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS 1214	Hot dip galvanized coatings on threaded fasteners
AS 1281	Cement mortar lining of steel pipes and fittings
AS 1627	Metal Finishing – Preparation and Pretreatment of Surfaces
AS 3894	Site testing of protective coatings
AS/NZS 4020	Testing of products for use in contact with drinking water
AS/NZS 4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

Water Corporation Standards, Specifications and Documents

DS95	Standard for the Selection, Preparation, Application, Inspection and Testing of Protective Coatings on Water Corporation Assets

CPP3 LIST OF ACTIONS

Table CPP3.1 summarises various actions required throughout section CPP of the specification. The actions listed in table CPP3.1 are not the only actions required and the table is not a substitute for familiarization with section CPP in its entirety.

Record of actions noted in table CPP3.1 need to be included in the MDR.

Table CPP3.1: List of actions

Reference	Description	Timeframe
CPP4.1 General	Approval to use non APAS approved product	Before use of product.
CPP4.1 General	Submission of coating quality assurance documentation.	10 days before commencement of work.
CPP5.6.6 Coating and Wrapping Applicator and Testing Requirements	Witnessing of spark testing of all coatings, wrappings, and shrink sleeves by Superintendent.	Before backfilling.

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FOI 26-292 - Document 27

CPP5.6.7 Coating Defects Survey of Buried Welded Pipe	Notification of all coating defects found during DCVG survey.	As soon as practicable.
CPP5.6.7 Coating Defects Survey of Buried Welded Pipe	Approval of DCVG survey contractor	Before DCVG survey

CPP4 GENERAL

CPP4.1 General

Where a suitable Australian Paint Approval Scheme (APAS) approved product is available it shall be used. If a suitable APAS approved product is not available, then an equivalent non-APAS approved product may be used subject to approval by the *Superintendent*.

Coating specifications inclusive of datasheets, coating application method statements and ITP's shall be submitted to the *Superintendent* for approval at least ten (10) working days prior to commencement of work.

The coating applicator, supervisor and inspector shall be competent and qualified. All personnel engaged in the application of coatings shall have received relevant training from the product supplier. The Applicator's Coating Supervisor and Inspector shall possess as a minimum one of the following certifications:

a) ACA - Corrosion Inspector; or

b) NACE - CIP Level I Coating Inspector.

Additional qualifications may be required for some coatings as detailed in the relevant technical specification.

As far as practical, The *Contractor* shall plan shop fabrication work so as to minimize field jointing.

All products in contact with drinking water, including those used for coatings and repairs, shall pass AS4020 testing at an exposure level meeting or exceeding the anticipated product exposure level to drinking water. Proof of current AS4020 compliance shall be provided to the *Superintendent*.

CPP4.2 Structural Steelwork and Appurtenances

Unless otherwise specified, structural steelwork and appurtenances shall be hot dip galvanised in accordance with Water Corporation Technical Specification H2 – Galvanised coating of steel structures.

Unless otherwise specified, structural steelwork and appurtenances within 1km of the coast or within 50m of an estuary or salt lake shall be coated in addition to being hot dip galvanized in accordance with A3 – Surface Preparation for the application of protective coating on galvanized steel and E4 – Epoxy mastic, Polyurethane top coat on galvanized steel.

CPP5 PIPELINES

CPP5.1 Flange Bolts

Unless otherwise specified, all nuts, bolts and washers are to be hot dip galvanised in accordance with AS/NZS1214.

Where stainless steel is specified, the bolts, nuts and flat washers shall be grade A4-70 for sizes M30 and below, and A4-80 for sizes larger than M30 steel, to the standards and properties specified in DS38.02.

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FOI 26-292 - Document 27

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CPP5.2 Flange Protection

All buried metallic flanged joints, nuts and bolts on fittings, valves, mechanical joints, tapping bands, shall be wrapped using UCC or Denso Petrolatum 4 step system in accordance with Water Corporation Specification L1 - Tape Wrapping Procedure, System "B".

CPP5.3 Coupling Joints

Mechanical Coupling joints, Straub Coupling or similar shall be coated in accordance with Water Corporation Specification M4 – Coating Procedure for Coupling Jointed Pipes.

CPP5.4 Dissimilar Metal Flange Protection

Flanged joints connecting dissimilar metals shall be isolation joints as per the Flange Installation Section.

CPP5.5 Valves

Valves shall be supplied with coating in accordance with the relevant SPS.

CPP5.6 MSCL Pipeline

CPP5.6.1 Internal Lining

MSCL pipes shall be cement mortar lined internally.

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The internal cement mortar lining reinstatement of all pipe joints on MSCL pipelines shall be made in accordance with Water Corporation Standard Drawing No AY58-19-1.

The cement mortar lining thickness shall comply with AS/NZS1281. Field joint reinstatement and repairs shall be carried out using Parchem Renderoc HB40® pre-mix cement mortar and Nitobond HAR® primer and in accordance with the Water Corporation's specification M8 – Cement Mortar Lining Requirement. Personnel engaged in the application of cement mortar lining reinstatement shall be trained and certified by Parchem, the product supplier.

Grouting of convex banded joints as specified in the project drawings shall be performed using Parchem Conbextra GP® grout or an equivalent that has potable water (AS/NZS 4020) approval. Grouting shall be carried to the manufacturer's recommendation and the Corporation technical specification M9 - Grouting Convex Bands in Pipelines.

CPP5.6.2 Buried Pipework

Unless otherwise specified MSCL pipes for below ground applications should be coated with fusion bonded polyethylene coating (Sintakote®).

CPP5.6.3 Fittings (Buried Pipework)

The coating systems that shall be used for fabricated fittings are listed in Table CPP5.1.

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FOI 26-292 - Document 27

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Table CPP5.1

FITTING TYPE	COATING	NOTE
Straight Section Joints & Segmented Bends (Fabricated from Sintakote Pipe or rolled plate)	Fusion bonded polyethylene coating (Sintakote®)	If Sintakote® Coating is not available, then Heat Shrink Sleeves in accordance with Specification L2 may be used upon approval by the *Superintendent*.
Flanged Connections (straight section)	Water Corporation Specification L1 – System B (Petrolatum 4 step System)	
Crotch Plated Tees	Fusion bonded polyethylene coating (Sintakote®)	If Sintakote® Coating is not available, then Ultra High Build Epoxy in accordance with Water Corporation Technical Specification D4, may be used upon approval by the *Superintendent*
Valve to Pipe Flanges	Water Corporation Specification L1 – System B (Petrolatum 4 step System)	
Access / Inspection Opening	Fusion bonded polyethylene coating (Sintakote®)	If Sintakote® Coating is not available, then Ultra High Build Epoxy in accordance with Water Corporation Technical Specification D4, may be used upon approval by the *Superintendent*
Air Valve Off-take / spigot	Fusion bonded polyethylene coating (Sintakote®)	If Sintakote® Coating is not available, then Ultra High Build Epoxy in accordance with Water Corporation Technical Specification D4, may be used upon approval by the *Superintendent*
Scours Off-take / spigot	Fusion bonded polyethylene coating (Sintakote®)	If Sintakote® Coating is not available, then Ultra High Build Epoxy in accordance with Water Corporation Technical Specification D4, may be used upon approval by the *Superintendent*

Pipework assemblies that are coated with Sintakote or Heat Shrink Sleeve and where the period of storage on site exceeds 6 months shall be adequately protected against ultraviolet and direct sunlight to prevent the coating systems from deterioration. Petrolatum coated fittings shall not be exposed to direct sunlight, preference is to bury the fitting as soon as practicable.

If an Ultra High Build Epoxy coating has been specified, it shall be applied in accordance with the Water Corporation Technical Specification A1 - Surface Preparation for the Application of Protective Coating on Steel or Cast Iron and D4 - Ultra High Build Epoxy Coating on Steel or Cast Iron. UHB coating shall overlap Sintakote coatings on pipe sections by 100 mm and 50 mm on pre-coated valves.

CPP5.6.4 Wrapping of Site Installed Fitting and Joints (Buried Pipework)

The relevant system that shall be used for coating different types of fittings in situ are listed in Table CPP5.2.

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FOI 26-292 - Document 27

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Prior to application of the protective coating system, minimum surface preparation requirements shall be degreasing and mechanical wire brushing to obtain Class 2 cleanliness in accordance with AS1627 Part 2.

Temporary lifting lugs shop welded to assist with manufacture and transportation of pipe fittings shall be removed and dressed back prior to field coating / wrapping.

Table CPP5.2

FITTING TYPE	COATING
Straight Section Joints & Segmented Bends (Fab. from Sintakote Pipe or rolled plate)	Heat Shrink Sleeve in accordance with Water Corporation Specification L2
Flanged Connections	Tape Wrapping in accordance with Water Corporation Specification L1 – System B
Valve To Pipe Flanges	Tape Wrapping in accordance with Water Corporation Specification L1 – System B
Access / Inspection Opening	Tape Wrapping in accordance with Water Corporation Specification L1 – System B
Air Valve & Off-take / Spigot	Tape Wrapping in accordance with Water Corporation Specification L1 – System B
Scour Off-take / Spigot	Tape Wrapping in accordance with Water Corporation Specification L1 – System B
Magflow Meter Flanges (Only)	Same as for Valve assembly spooling
Field Patch Repairs	Heat Shrink Sleeve in accordance with Water Corporation Specification L2

Where tape wrapping or heat shrink-wrap is specified, the area with abrupt profile changes shall be filled with mouldable mastic to obtain a smooth even profile or alternatively a moldable PVC skirt can be used with the Canusa - CPS® product.

All other buried fittings not listed in this specification shall be wrapped using UCC or Denso Petrolatum 4 step system in accordance with Water Corporation Technical Specification L1 - Tape Wrapping Procedure, System "B".

CPP5.6.5 Coating of above ground metallic Pipework

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Where MSCL pipelines are to be installed above ground, they shall be Sintakote coated. For short section of pipework incorporating many fittings, such as in valve complexes, the short section of pipework may be coated in accordance with A1 and C2.

Unless otherwise stated, a top coat shall be applied to above ground Sintakote. The top coat shall be applied in accordance with A7 and E5.

Above ground joints and fittings shall be coated in accordance with M2.The transition between below and above ground pipework shall be coating in accordance with M1.

CPP5.6.6 Coating and Wrapping Applicator and Testing Requirements

Heat shrink sleeves shall only be installed by Canusa® accredited and trained applicators. Heat shrink sleeves shall be applied in accordance with Corporation's Technical Specification L2 - Heat Shrink Sleeve Requirements.

All coating, wrappings, and shrink sleeves shall be spark tested by the *Contractor* and witnessed by the *Superintendent* using high voltage brush methods to AS3894.1 prior to backfilling. Spark testing equipment shall be within two (2) years of calibration. Spark testing voltage parameters shall be as per Table CPP5.3.

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FOI 26-292 - Document 27

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Table CPP5.3: Spark Testing Parameters

Coating Process	Test Voltage	AS/NZS Standard
Fusion Bonded Medium Density PE Coating (Sintakote®)	12 kV	Per AS 3894.1
Heat Shrink Sleeves	12 kV	Per AS 3894.1
Ultra High Build Epoxy Coating	11 kV	Per AS 3894.1
Densopol 80 (Wrapping)	12 kV	Per AS 3894.1
Petrolatum 4 Step System	NA	NA

CPP5.6.7 Coating Defects Survey of Buried Welded Pipe

A Direct Current Voltage Gradient survey (DCVG) shall be carried out as specified in the Pipelaying Module.

The *Superintendent* shall be notified of the number and location of all the defects found. Defects located shall be excavated and repaired to the acceptance of the *Superintendent*.

The DCVG survey work shall be carried out by the *Contractor* using an approved qualified corrosion consultant acceptable by the *Superintendent*.

CPP5.6.8 Exposed/ Above Ground Pipework

Where pipes and fittings are to be installed above ground, they shall be either:

1. Clean-skin pipe coated in accordance with Water Corporation Specification M3 – Coating procedure for clean skin pipe permanently exposed to atmosphere
2. Fusion Bonded Medium Density Polyethylene coated (Sintakote®) coated in accordance with Water Corporation specification M2 – Coating procedure for Sintakote pipe and steel pipe joint.

CPP5.6.9 Pipework Transition from above to below Ground

For below ground to above ground pipe transitions the coating application shall be in accordance with the Corporation's coating specification M1 – Coating Procedure for Pipe Transition (Below to Above Ground).

CPP5.6.10 Pipework at Concrete Interface

Steel pipework that is to be installed at the interface to concrete should be coated in accordance with Water Corporation Specification M5 – Coating Procedure for Steel Pipe at the Concrete Interface, Steel pipe at the concrete interface and connected to Sintakote coated pipe should be coated in accordance with Water Corporation Specification M6 – Coating Procedure for Sintakote Pipe at the Concrete Interface & Joint.

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CPP5.7 PVC Pipelines

CPP5.7.1 General

Unless otherwise specified on the drawings or by the *Superintendent*, below ground PVC pipe and fittings shall not be coated. Above ground PVC pipe shall be coated in accordance with Water Corporation Technical Specification K1.

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CPP5.7.2 Coating for Below Ground

Bolted flange connections shall be wrapped in accordance with Water Corporation Technical Specification L1 – system B.

CPP5.8 PE Pipeline

CPP5.8.1 General

Unless otherwise specified on the drawings or by the *Superintendent*, PE pipe and fittings shall not be coated.

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FOI 26-292 - Document 27

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CPP5.8.2 Coating for Flange Backing Rings

Unless otherwise noted, Flange backing rings shall be hot dipped galvanised in accordance with AS/NZS 4680. Bolted flange connections shall be wrapped in accordance with Water Corporation Technical Specification L1 – system B.

CPP6 REPAIR OF COATINGS

CPP6.1 Repair of Cement Mortar Lining

Cement Mortar Lining repairs shall be carried out using Parchem Renderoc HB40® pre-mix cement mortar and Nitobond HAR® primer and in accordance with the Water Corporation's specification M8 – Cement Mortar Lining Requirement. Personnel engaged in the application of cement mortar lining reinstatement shall be trained and certified by Parchem, the product supplier.

CPP6.2 Repair of Galvanised items

Galvanised items that are damaged shall be repaired in accordance with the Water Corporation coating specification H1 – Repair of Galvanised Coating.

CPP6.3 Repair of Damaged Sintakote or Heat Shrink Sleeves

Damaged Sintakote pipe coatings and or heat shrink sleeves shall be repaired using the Canusa CRP® (Coating Repair Patches), patch repairs shall be applied to the manufacturers recommended practice and the Water Corporation Technical Specification L1 - Tape Wrapping Procedure, System "C".

CPP6.4 Repair of Damaged Ultra High Build Epoxy Coating

Damaged UHB epoxy coating shall be repaired using the same products and procedures as used in the workshop manufacturing process.

The classification of and allowable number of coating defects shall be based on the coating system standard specified in the relevant strategic product specification and to which it was coated.

All repairs and recoating shall be undertaken in accordance with the coating manufacturer's recommendations and the area re-tested for acceptance.
Repair coatings that are to be in contact with potable shall comply with AS/NZS 4020.

CPP6.5 Repair of Thermal-bonded polymeric coatings

Defective Thermal-bonded polymeric coating allowance shall be in accordance with Table 3.3 of AS/NZS 4158.

All repairs and recoating shall be undertaken in accordance with the coating manufacturer's recommendations and retested upon full cure for acceptance in accordance with AS/NZS 4158.

Repair coatings that are to be in contact with potable shall comply with AS/NZS 4020.

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SECTION ‘EP’

EXCAVATION FOR PIPELINES

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FOI 26-292 - Document 27

Revision Status

Nexus ID 58581972

REVISION STATUS The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.0	10/02/16	All	Initial version	Principal Eng. Water Conv.	Principal Eng. Water Conv.
EP5.1	1.1	2/03/2016	3	Moved last paragraph of PL3.2.4 to EP5.1	Principal Eng. Water Conv.	Principal Eng. Water Conv.
EP4.1	1.2	12/04/2016	1	Corrected Reference to GP19.2.1	Principal Eng. Water Conv.	Principal Eng. Water Conv.
EP1	2.0	19/03/2019	1-2	Title Page - Removed reference to 3 party. EP1 – amended to cover 2 party.	Snr Principal Eng. Water Conv.	Snr Principal Eng. Water Conv.
EP3			2	Added new section EP3. Renumbered subsequent sections		
EP4.2			2	Amended reference to "this section" to "this section EP".		
EP5.1			2	Amended Site clearing requirement to refer to "legislative requirements" and requirements of all of the contract		
EP5.1.1			3	Clarified stockpile locations are to be agreed with Superintendent		

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EP5.1.2	2	19/03/2019	3	Clarified the contractor can elect to undertake trenchless techniques but at its convenience and in accordance with the relevant specifications and design standards	Snr Principal Eng. Water Conv.	Snr Principal Eng. Water Conv.
EP6.1			4	Clarified maximum length of open trench Require all service identified to be located and protected Added trench planning requirements with regards to other services, stability and erosion		
EP7			4	Amended pipe underlay compaction and material requirements		
EP9.2			5	Amended backfill requirements for over excavations		
EP10.3.3			7	Clarified payment limit if no bedding is required		

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FOI 26-292 - Document 27

Contents

EP1 APPLICATION OF SECTION 1
EP2 STANDARDS, CODES AND REGULATIONS 1
EP3 LIST OF ACTIONS 1
EP4 GENERAL 2
EP4.1 General 2
EP4.2 Measurement and Payment 2
EP5 CLEARING, SURFACE STRIPPING AND STOCKPILING 2
EP5.1 *Site* Clearing 2
EP5.2 Stripping Of Surfaces 3
EP6 EXCAVATION 4
EP6.1 Excavation General 4
EP7 MATERIAL/COMPACTION AT BASE OF EXCAVATION 4
EP8 TRENCH/EXCAVATION SHORING 4
EP9 TRENCH DIMENSIONS 5
EP9.1 Trench Width 5
EP9.2 Trench Depth and Over-Excavation 5
EP10 EXCAVATED MATERIAL CLASIFICATION 5
EP10.1 Common Excavation 5
EP10.2 Rock Excavation 5
EP10.3 Method of Measurement/Payment 6
EP11 DEWATERING OF EXCAVATIONS 7
EP12 HAND PLONKING OF SEWERS 8

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

EP EXCAVATION FOR PIPELINES

EP1 APPLICATION OF SECTION

This Section applies to the *Site* preparation and excavation for pipelines. For Trenchless Techniques refer to the TT module.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

EP2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

The Specification takes precedence over the Australian Standards.

Australian Standards

AS2566.2 Buried Flexible Pipelines – Part 2: Installation

AS1289 Methods of testing soils for engineering purposes

AS2187 Explosives - Storage, transport and use

Water Corporation Standards, Specifications and Documents

Safety

Government of Western Australia – Code of Practice – Excavation – 2005

EP3 LIST OF ACTIONS

Table EP3.1 summarises various actions required throughout section EP of the specification. The actions listed in table EP3.1 are not the only actions required and the table is not a substitute for familiarization with section EP in its entirety.

Record of actions noted in table EP3.1 need to be included in the MDR.

Table EP3.1: List of actions

Reference	Description	Timeframe
EP5.1 *Site* Clearing	Approval to remove or prune shrubs, trees, and other fixtures	Before commencement of pruning or removal
EP5.1.2 Shrubs and Trees	Confirmation of additional trees to be preserved	Before commencement of Works
EP5.2.3 Established Lawns (including sprinklers and reticulation systems)	Agreement of existing condition of reticulation systems	Before work within property affected

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EP6.1 Excavation General	Approval to open up trench more than maximum allowable on any one pipe laying front	Approval to open up trench more than maximum allowable on any one pipe laying front
EP6.1 Excavation General	Identification and location of all services	5 working days prior to commencement of proposed excavation
EP6.1 Excavation General	Notification of clashes with design	5 working days prior to commencement of proposed excavation
EP6.1 Excavation General	Approval to leave open excavations during extended breaks in work	Before breaks in the works.
0 MATERIAL/COMPACTION AT BASE OF EXCAVATION	Confirmation of extent of removal of unsuitable trench material	Whenever unsuitable trench material is encountered
EP9.2 Trench Depth and Over-Excavation	Notification of inadequate cover for installation of valves.	Before excavation for the relevant section of pipe
EP10.2 Rock Excavation	Approval for excavators with in excess of 130 kW power.	Before excavator's arrival to site
EP11 DEWATERING OF EXCAVATIONS	Submission of dewatering management plan	10 working days prior to dewatering

EP4 GENERAL

EP4.1 General

The *Contractor* shall ensure that a competent person supervises excavation work as per Sections 3 of the Government of Western Australia – Code of Practice – Excavation – 2005. When working on multiple excavations simultaneously, a nominated competent person shall be required at each excavation location.

Trenches shall be maintained in a stable condition to prevent movement or collapse.

Reusable material shall be deposited in an area causing the least interference to vehicular or pedestrian traffic, to the approval of the *Superintendent*.

Excavation shall be in accordance with AS2566.2 'Buried Flexible Pipelines Part 2: Installation', unless otherwise specified.

The *Contractor* shall comply with the relevant Construction Environmental Management Framework and Plan (CEMF and CEMP).

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FOI 26-292 - Document 27

EP4.2 Measurement and Payment

All *WUC* addressed in this section EP is deemed to be included in the lump sum or rate per metre of pipe as identified in the schedule of prices.

Should the schedule of prices allow payment items such as rock excavation and disposal, ASS management, or dewatering and the activity be approved by the *Superintendent*, the limits for payment are defined in this section.

EP5 CLEARING, SURFACE STRIPPING AND STOCKPILING

EP5.1 *Site* Clearing

Any *site* clearing shall be undertaken in accordance with the *legislative requirement*s and with the requirements specified in the *Contract*.

The extent of clearing for the pipeline route shall be the practicable minimum. Clearing shall only be undertaken with the relevant clearing permit. The *Contractor* shall ensure that damage to trees, shrubs and gardens is minimised. Trees, shrubs and permanent fixtures shall not be damaged, pruned or removed without the prior written approval of the *Superintendent*.

EP5.1.1 Structures and Paving (Including Driveways)

Fences, brick paving, concrete slabs, transportable structures, garden beds, walls, footpaths etc. shall be removed only as necessary to allow for excavation works. Cleared materials to be salvaged for re-use shall be stacked neatly in location agreed by the *Superintendent* to prevent damage to the surrounding area.

Materials that are damaged during clearing operations shall be removed from the *site* and replaced with equivalent new materials.

EP5.1.2 Shrubs and Trees

Shrubs and trees that are permitted to be removed shall be cleared and disposed of off-*site*. Wherever trimming of existing trees, shrubs, roots or foliage proves necessary, it shall be carried out using recognised arboriculture pruning techniques under the supervision of a qualified tree surgeon to minimise damage to the plants. Tunnelling or thrust boring of pipelines shall be used to construct pipelines where shown on the Drawings, otherwise the *Contractor* may elect, for its convenience, to use such techniques in lieu of open trenching, in order to minimise damage to trees. Tunneling or thrust boring shall comply with the relevant Water Corporation design standards and specifications as provided by *the Superintendent*.

Shrubs and trees that are identified for retention or preservation on the Drawings shall be suitably protected from damage.

The *Contractor* shall walk the route of all pipelines in road verges, public open space and private properties with the *Superintendent* to determine any additional trees to be preserved at the *Superintendent's* discretion.

EP5.2 Stripping Of Surfaces

EP5.2.1 Ungrassed Areas (including verges, properties)

The topsoil shall be stripped to the underside of any existing grass/vegetation roots (a nominal depth of 200 mm) and shall be stockpiled separately from the remainder of the excavated materials to avoid contamination.

EP5.2.2 Grassed Surfaces (apart from established lawns)

Where rough or sparse grass exists, the existing surface topsoil shall be stripped and stockpiled as for ungrassed areas. The stockpiled material should be kept moist until respreading.

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FOI 26-292 - Document 27

EP5.2.3 Established Lawns (including sprinklers and reticulation systems)

Lawns shall be stripped of turf, which shall be stockpiled adjacent to the trench and kept sufficiently moist to prevent the turf dying. Topsoil shall be stripped and stockpiled as for ungrassed areas.

Existing reticulation systems shall be dismantled as necessary to accommodate *WUC* and stored so as to prevent damage or loss. The *Contractor* shall formally agree with the property owner as to the condition of the reticulation system prior to disturbance by *WUC*.

Pipelines supplying the reticulation system shall be kept live whenever required by the property owner/occupier.

EP5.2.4 Bituminous Road Pavements, Kerbs, Concrete Paving (including cross overs)

Kerbing, pavements, and concrete paving to be removed shall be marked out and saw-cut prior to excavation work. The saw cuts shall be in straight lines parallel to the pipe centre line. The *Contractor* shall saw-cut to the full depth of the existing pavement to help confine the disturbance during excavation.

The surface materials shall be stripped to the subgrade level, removed and disposed off-*site*.

EP6 EXCAVATION

EP6.1 Excavation General

Existing road surfaces shall be protected with a minimum of 200 mm thick layer of sand or a mat of rubber tyres prior to movement of tracked machines.

Trenches shall be opened in advance of pipe laying, sufficient only to enable work to proceed without delay. The length of trench opened up ahead of pipe laying shall be as short as practicable and shall adhere to the construction environmental management plan. The length of open trench available for pipe laying, per pipe laying front, at any time shall not exceed the maximum allowable in the environmental approvals, or elsewhere in the *Contract*, or 50m (whichever is less) unless authorised in writing by the *Superintendent*.

All Services identified by any means including drawings, Dial Before You Dig, onsite pits, or markers, shall be located, surveyed, and protected ahead of the trench excavation. Conflicts with the design shall be notified to the *Superintendent* a minimum of five (5) working days ahead of proposed excavation for pipelaying.

Trenches/excavations shall be excavated to the depths and widths necessary to allow safe installation of the pipeline to the levels, grades and covers specified.

Excavations shall not disturb pipes, building, or other assets in the zone of influence. Safe excavation planning shall take into account the potential of pipes in the zone of influence to leak.

Excavations shall be planned with regard to local site conditions, and current and predicted weather conditions. The *Contractor* shall take steps to ensure no trench instabilities or erosion occurs.

Excavations shall not be left longer than allowable in the environmental approvals, or elsewhere in the contract and in no case during breaks in the works exceeding 3 days unless approved otherwise by the Superintendent.

EP7 MATERIAL/COMPACTION AT BASE OF EXCAVATION

Where the density of in situ material at the base of trench excavations is less than 95% of the modified maximum dry density it shall be compacted to at least 95% of modified maximum dry density.

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FOI 26-292 - Document 27

Where unsuitable in situ material, such as silt, organic material, or expansive clay exists at the base of trench excavations it shall be removed to the extent directed by the *Superintendent* and replaced with pipe embedment material as per section ETF of the specifications compacted to 95% of modified maximum dry density.

EP8 TRENCH/EXCAVATION SHORING

Shoring/Trench Boxes, when used, shall remain in place until backfilling is commenced. During backfilling, the *Contractor* shall remove shoring in such a manner so as to provide adequate support for the full depth of the unfilled trench at all times, maintain stability of the trench walls and protect or support any adjacent pipelines and structures.

For some trenches, particularly where adjacent to structures/walls, the *Contractor* may elect to use jarrah timbering and leave it permanently in the trench/excavation. No timbering shall be left within 1.20 m of the finished surface.

The *Contractor* shall not be required to leave shoring timber in place, but will bear full responsibility for all damage and injury due to collapse, undermining or other disturbance of adjacent foundations.

EP9 TRENCH DIMENSIONS

EP9.1 Trench Width

Minimum trench widths shall comply with the greater of either the respective pipe manufacturer's requirements or the requirements of AS2566. Trench widths shall be wide enough to facilitate the compaction to the specification. Pipe trench width shall be the measured width at the level of the underside of the pipe. The minimum trench width shall be 600 mm.

The *Contractor* shall make due allowance for widening and deepening of trenches at pipe joints, to accommodate pipe coupling sockets, flanges, valves, pits, meters, chambers, pipeline fittings or joint work inclusive of on-*site* access for welding and corrosion protection work and inspection and testing thereof.

Where timbering or other shoring is necessary, the width shall be increased sufficiently to maintain clearances between face of timbering/shoring and pipes as specified in the standards above.

EP9.2 Trench Depth and Over-Excavation

All trenches shall be neatly excavated to provide full support for the pipe and pipe grade. Pipe trenches shall be excavated to depths sufficient to achieve designed invert levels and specified underlay depths unless the bottom of the trench at underside of pipe level consists of material suitable for use as pipe underlay as determined by the *Superintendent*.

The *Contractor* shall, prior to excavation, check the design pipeline invert level against actual ground level at the location of valves (including air valves) to confirm the cover is adequate to accommodate the valve or air valve to be installed. All cases of inadequate cover for the item to be installed shall be reported to the *Superintendent* prior to excavating for that section of the pipeline.

Over-excavated trench foundations shall be backfilled with pipe embedment material as per section ETF of the specification, and shall be compacted in layers not exceeding 300 mm loose thickness to achieve a density of 95% of the maximum modified dry density in accordance with AS 1289.5.4.1 or meeting the requirements of a Clegg Impact Test in accordance with AS1289.6.9.1 achieving a Clegg Impact Value of 35 or greater. Unless additional excavation is directed by the *Superintendent*, refilling of over excavations shall be at the *Contractors* expense.

Excavations for pits and access chambers shall be taken to the depth below the underside of the concrete base necessary to provide for the type of access chamber foundation detailed on the drawings.

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FOI 26-292 - Document 27

EP10 EXCAVATED MATERIAL CLASIFICATION

EP10.1 Common Excavation

Common excavation shall be excavation of all material other than rock as defined below.

Wherever practicable, excavation shall be carried out using mechanical excavation equipment and hand tools that are not power-operated.

EP10.2 Rock Excavation

Rock shall be defined as massive hard conglomerate material of volume greater than 0.5 m^3 and of such hardness and texture that:

a) for pipelines equal or smaller than DN900, cannot be excavated by a 125 kW excavator, in good condition, with a rock bucket of maximum width of 800 mm or;
b) for pipelines greater than DN900, cannot be excavated by a 175 kW excavator, in good condition, with a rock bucket of maximum width of 800 mm or;
c) Requires the use of rock breaking techniques to enable removal; or
d) As separately defined for sewer pipes of DN250 mm or smaller.

For sewer pipelines DN250 or smaller, rock shall be defined as massive hard conglomerate material divided into separate classifications depending on *site* accessibility and plant size, refer Table EP10.1

Table EP10.1: Rock Classification, Sewers DN 250 mm and smaller

Rock Classification No.	*Site* Accessibility	Classification Material is classified as Rock if it:
1	Limited Access	Is only able to be excavated by power, pneumatically or hydraulically hand operated impact tools or a rock hammer attached to an excavator of less than 75 kW flywheel power.
2	Unlimited Access	Is only able to be excavated by hydraulically operated impact tools (including a rock hammer attached to an excavator of greater than 75 kW flywheel power).

Rock shall include individual cobbles or boulders which exceed 0.5 m^3 each in volume.

The use of excavators larger than 130 kW flywheel power on-*site* shall only be permitted with the approval of the *Superintendent*. They shall not be permitted for use in areas where undue damage may be caused to the existing surroundings.

Rock excavation shall be carried out by appropriate power, pneumatically or hydraulically operated impact tools (e.g. rock breakers) or blasting having due regard to public safety and amenity and the integrity of the environment.

Blasting or the use of explosives shall not be used in developed urban areas and shall only be permissible with the written permission from the *Superintendent* for each separate length of trench where blasting is necessary. All blasting shall comply with AS2187 and all local authority and statutory requirements.

Rock classification shall be approved and agreed with the *Superintendent* before this work commences on-*site*. The rock profile is to be agreed with the *Superintendent* before rock excavation commences. At the *Superintendent's* discretion, surveyed profiles of the rock

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FOI 26-292 - Document 27

shall be submitted by the *Contractor* to enable the *Superintendent* to assess the accurate measurement of rock.

EP10.3 Method of Measurement/Payment

EP10.3.1 Method of Measurement

Except as noted below, rock excavation will be measured in its original position by taking the difference between the rock surface at the time the trench is excavated and that after the excavations are complete. Before starting any rock excavation, the *Contractor* shall notify the *Superintendent* so that elevations and measurements of *the Work* may be obtained. Any work done prior to such notification will not be paid for. Payment limits shall be as described hereinafter.

EP10.3.2 Horizontal Payment Limits

Except as noted below, payment lines shall be vertical and shall be the width to which the material is actually removed, except that in no case, even though the actual excavation is wider, shall the width or height between payment lines be more than the following:

a) 600 mm greater than the nominal diameter of the pipe, for diameters less than 750 mm.
b) 900 mm greater than the nominal diameter of the pipe for diameters that are 750 mm or greater.

For access chambers and valve pits, payment lines shall be vertical and 600 mm outside of the neat lines of the foundations in each direction horizontally.

In case it is necessary to excavate to a greater width than that specified above on account of the removal of existing structures, such additional excavation will be considered as trench excavation and will be measured and paid for as such.

For the removal of underground obstructions such as pipelines, tanks, drainage structures, etc., payment lines shall be vertical and 600 mm outside of the underground item measured horizontally in each direction.

If rock is encountered, the *Contractor* shall strip it of sufficient overlying material to allow for proper measurement and shall then notify the *Superintendent* that the rock surface is ready for measurement. If the *Contractor* shall fail to give such notice, the *Superintendent* shall presume that the measurements taken at the time the *Superintendent* first saw the material in question will give the true quantity of excavation.

EP10.3.3 Vertical Payment Limits

Where pipe bedding is used, the lower vertical payment limit will be to 200 mm below the underside of the pipeline, otherwise the lower vertical payment limit will be the underside of the pipeline.

EP11 DEWATERING OF EXCAVATIONS

Pipe trenches and excavations, where the groundwater rest level is above the bottom of the trench/excavation, shall be dewatered to provide stable foundations for bedding materials and to enable pipeline construction in the dry.

Groundwater control shall be maintained at all times. The *Contractor* shall prevent the flotation or displacement of pipes. Dewatering shall continue until the trenches/excavations have been refilled to a sufficient depth to prevent flotation of the pipes.

Where acceptable to the *Superintendent* aggregate that complies with the bedding specification, may be used as the bedding material for lengths of trench requiring extensive dewatering.

Aggregate bedding shall be made impervious to the siltation of sand into the voids in the bedding matrix by wrapping the aggregate bedding in A14 type geotextile fabric capable

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of preventing migration of sand into the aggregate, with 500 mm overlap of the edges of geotextile

Aggregate shall be compacted in layers not exceeding 150 mm loose thickness by a minimum of two (2) passes of a 60 kg vibrating plate compactor.

Groundwater shall not be permitted to enter the pipeline.

Proposals for the discharge of all dewatered products shall be submitted in a detailed Dewatering Management Plan, including disposal of dewatering products contaminated by exposure to Acid Sulphate Soil (ASS), for consideration and acceptance by the *Superintendent* at least ten (10) working days prior to any dewatering work.

Each proposal shall detail the location and size of stilling or recharge basins to be used for settlement of solids and turbidity prior to a final discharge of clarified effluent into a receiving water body.

The *Contractor* shall not discharge or cause to be discharged into any drain, lake, river or other receiving waters any dewatered products which contain levels of salt, organic material, hydrocarbons, detergents or sediments which are incompatible with the receiving water body.

EP12 HAND PLONKING OF SEWERS

Hand plonking is acceptable where open excavation is not considered practical such as:

a) Under sheds that cannot be relocated
b) In the vicinity of significant trees
c) When there are a number of existing services close together
d) Crossovers or power poles
e) Or where otherwise directed by the *Superintendent*

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION SPECIFICATION SECTION 'ET'

TESTING OF FOUNDATION, EMBEDMENT, TRENCHFILL AND EARTHWORKS

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Revision Status

Nexus #58578574

REVISION STATUS The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
Title	2.0	5/06/19	-	Removed reference to 3 party.	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.
ET1			1	Amended to cover 2 party.		
ET2			1	Specification only takes precedence over AS when specifically noted.		
ET3			2	Added section ET3.		
ET5.2			2	Reference to AS1289.5.8.4.		
ET6.2			3	Clarified correlation to be used modified or standard compaction as required.		
ET6.4.1			3	Clarified minimum compliance testing frequency.		
ET6.4.2			4	NDM to be used whenever a Perth Sand Penetrometer is unsuitable.		
ET6.5			4-5	Clarified testing frequencies.		
ET9			6	Removed redundant last sentence (re-testing and remedial work at contractor's cost is a general condition of contract)		
All	2.1	14/10/20	All	Updated for formatting consistency	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.

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ET6.3	2.1	14/10/20	3	Contractor to provide Perth Sand Penetrometer complying to AS1289.6.3.3, certificate of standardisation not required	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.
ET6.4.1			3	NATA compliance testing frequencies apply unless otherwise agreed with the Superintendent	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.

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FOI 26-292 - Document 27

Contents

ET1 APPLICATION OF SECTION 1
ET2 STANDARDS, CODES AND REGULATIONS 1
ET3 GENERAL 2
ET3.1 General 2
ET4 MEASUREMENT AND TESTING EQUIPMENT 2
ET4.1 General 2
ET4.2 Nuclear Moisture/Density Meters 2
ET4.3 Perth Sand Penetrometer 2
ET5 TEST METHODS 2
ET5.1 Testing 2
ET5.2 Use of Perth Sand Penetrometer 3
ET5.3 Compliance Testing by *Contractor's Site* Personnel 3
ET5.4 *Contractor's* Nata Registered Compliance Testing 3
ET5.5 Sampling and Frequency of *Contractor's* Testing 4
ET6 AUDIT TESTING BY *SUPERINTENDENT* 5
ET6.1 General 5
ET6.2 Audit Penetrometer Testing By *Superintendent* of Sand Backfill 5
ET6.3 Audit Testing By the *Superintendent* of Backfill Materials Other Than Sands 6
ET7 CONFORMANCE OF WORK 6
ET8 FAILED COMPACTION TESTS IN BACKFILL 6
ET9 REPORTING OF TEST RESULTS 6

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FOI 26-292 - Document 27

ET TESTING OF FOUNDATION, EMBEDMENT TRENCHFILL AND EARTHWORKS

ET1 APPLICATION OF SECTION

This section specifies the testing requirements for embedment and trench fill. The embedment and trench fill terminology aligns with WSAA codes and AS2566.

This section is applicable where payment for all *WUC* associated with this module specification is deemed to be included in a lump sum or a $/m length of pipeline.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

ET2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS2566.2 Buried Flexible Pipelines – Part 2: Installation

AS1289 Methods of testing soils for engineering purposes

Safety

Government of Western Australia – Code of Practice – Excavation – 2005

ET3 LIST OF ACTIONS

Table ET3.1 summarises various actions required throughout section ET of the specification. The actions listed in table ET3.1 are not the only actions required and the table is not a substitute for familiarization with section ET in its entirety.

Record of actions noted in table ET3.1 need to be included in the MDR.

Table ET3.1: List of actions

Reference	Description	Timeframe
ET5.2 Nuclear Moisture/Density Meters	Approval of Nuclear Moisture/Density Meter Calibration Certificate	Prior to use of Nuclear Moisture/Density Meter for conformance testing of *WUC*.
ET6.1 Testing	Determination of Dry Density/Moisture Content Relationship	At each change of material that is tested for field density
ET6.2 Use of Perth Sand Penetrometer	Submission of Penetrometer Site calibration testing	Prior to use of the Penetrometer.
ET6.3 Compliance Testing by *Contractor's Site* Personnel	Compliance testing of compaction by Contractor's Site Personnel (where Penetrometer is used)	As per Table ET6.1

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FOI 26-292 - Document 27

ET6.4.1 *Contractor's* Nata Registered Compliance Testing	Compliance testing of compaction by Contractor's independent NATA registered Laboratory (where Penetrometer is used)	As per Table ET6.1
ET6.4.2 Use of Nuclear Density Meters (NDM's)	Compliance testing of compaction by Contractor's independent NATA registered Laboratory (where Nuclear Moisture/Density Meter is used)	As per Table ET6.1
ET10 REPORTING OF TEST RESULTS	Submission of satisfactory written test results	Within 7 working days of the test being carried out.

ET4 GENERAL

ET4.1 General

The term 'backfill' is used to describe either or both of embedment and trench fill.

ET5 MEASUREMENT AND TESTING EQUIPMENT

ET5.1 General

Measurement and test equipment shall include all equipment necessary for the proper setting out and for production and conformance testing of *WUC*.

Calibration and certification of test equipment shall comply with National Association of Testing Authorities (NATA) stipulations.

ET5.2 Nuclear Moisture/Density Meters

Nuclear Moisture Density Meters (NDM) shall be calibrated in accordance with AS 1289.5.8.4 on standard blocks for the range of densities specified in the *Contract*. A current NATA endorsed calibration certificate shall be supplied to the *Superintendent* for approval prior to the NDM being used for conformance testing of *WUC*. The NDM shall have current density calibrations for the 50 mm, 65 mm, 100 mm, 150 mm, 200 mm and 300 mm direct transmission (DT) modes.

The direct transmission mode (depth of probe) to be used for each insitu density test undertaken shall be stated in the appropriate quality assurance certificates. The depth of probe shall be the maximum depth of the 6 calibrations listed above that can be accommodated by the layer to be tested, taking tolerances into account (eg. 65 mm for a 75 mm basecourse layer).

ET5.3 Perth Sand Penetrometer

The Perth Sand Penetrometer shall conform to the dimension, mass and tolerances given in AS1289.6.3.3. The use of a Perth Sand Penetrometer is limited to testing non cohesive materials with a maximum particle size of two (2) mm.

ET6 TEST METHODS

ET6.1 Testing

In situ density shall be measured using a Nuclear Density Meter in accordance with AS1289.5.8.1 or Perth Sand Penetrometer where appropriate.

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FOI 26-292 - Document 27

Compaction shall be tested to determine the Modified Dry Density Ratio in accordance with AS1289.5.4.1 or AS1289.5.4.2. Where assigned values are used under AS1289.5.4.2, the validity of the assigned Maximum Dry Density and Optimum Moisture Content shall be verified for conformance with the standard on a continual basis. Where the materials tested are too variable to produce an assigned value complying with the limits specified in AS1289.5.4.2, testing shall be carried out to AS1289.5.4.1.

The laboratory Dry Density/Moisture Content Relationship shall be determined at each change of material that is tested for field density determination or as required by the *Superintendent*.

ET6.2 Use of Perth Sand Penetrometer

When the Perth Sand Penetrometer can be calibrated and is suitable for the particular soils on the *Site*, it shall be used as the test for the purpose of conformance judgement of bulk earthworks, subgrade and trench fill (sand).

The method used to determine the penetration resistance of the soil using a Perth Sand Penetrometer shall be in accordance with AS1289.6.3.3.

Prior to the use of the Penetrometer, the *Contractor* shall submit to the *Superintendent* the results of *Site* calibration testing performed by a NATA registered laboratory. The testing shall show the correlation between in situ density expressed as a percentage of the maximum dry density, using standard and/or modified compactive effort as required, and the number of blows per 300 mm penetration of the in situ compacted backfill/fill layers by the penetrometer rod for the different fill material types on the *Site* (at optimum moisture content).

ET6.3 Compliance Testing by *Contractor's Site* Personnel

The Contractor shall provide standard Perth Sand Penetrometers, which complies with AS1289.6.3.3. A separate standard penetrometer shall be provided for each trench work front and an employee is to be designated from each crew to carry out penetrometer testing during construction.

Personnel using the penetrometer are to have proven experience in its use and application.

Compliance testing by *Contractor's Site* personnel shall be carried out with a minimum frequency as specified in Table ET6.1 and be recorded and submitted on a Quality Assurance System Checklist approved by the *Superintendent*.

Additional random compliance penetrometer tests shall be carried out by the *Contractor* at the *Superintendent's* direction.

ET6.4 *Contractor's* Nata Registered Compliance Testing

ET6.4.1 *Contractor's* NATA Registered Compliance Testing

The *Contractor* shall also arrange and allow for check penetrometer testing of his sand backfill using an independent NATA registered laboratory, unless otherwise agreed with the Superintendent:

1. A minimum of 20 random check penetrometer tests,
2. At a minimum frequency of two visits to Site per week (on average over the duration of backfill works), and
3. On random days.

The thickness of layers tested shall be the maximum possible (up to 1650mm).

A minimum of half the number of the penetrometer tests shall be taken in the bottom half of the trench backfill. The results of such compliance testing are to be reported direct to the *Superintendent* from the *Contractor's* testing authority.

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FOI 26-292 - Document 27

The *Superintendent* may direct amendments to the *Contractor's* system of check penetrometer testing at its discretion.

ET6.4.2 Use of Nuclear Density Meters (NDM's)

Where backfill material is predominantly of a cohesive type or otherwise deemed unsuitable to be tested with the Perth Sand Penetrometer, then the density shall be measured in situ by a NATA registered technician by use of a nuclear density meter calibrated to the densities of the various backfill material types on *WUC*, as necessary and tests shall be carried to a minimum frequency as specified in Table ET6.1.

The *Contractor* shall include the necessary associated maximum dry density tests as required by Australian Standards AS 1289. A minimum of half the number of nuclear density meter tests, shall be taken, at the bottom half of the trench backfill.

ET6.5 Sampling and Frequency of *Contractor's* Testing

Sampling methods shall be unbiased and either random or systematic in concept or as specified or directed by the *Superintendent*. For testing of road pavement refer to Roadworks section of the Specification. The frequency of tests shall at all times be adequate to demonstrate *WUC* conformance with the Specification. The minimum frequency of compaction tests shall be as listed in the Table ET6.1.

Table ET6.1: Frequency and Method of Testing Backfill

Process	Testing Method	Minimum Testing frequency
1. Trench - Sand Backfill (All areas trafficable and non - trafficable)	Penetrometer (By *Contractor's* personnel)	Equivalent to a) 1 test for the full depth of backfill per 20 m of trench, plus a test over the full depth of backfill adjacent to each access chamber / Maintenance shaft. b) Adjacent Buildings/walls - 1 test over full depth of backfill every 10 m of trench. c) Road crossings (transverse) and cross overs - 1 test for each carriage way over the full depth of backfill.

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FOI 26-292 - Document 27

2. Trench - Material unsuitable for penetrometer	NDM	a) In trenches, 1 test per: 1) 60m in private properties, or 2) 30m in all other trenches b) In addition, 1 test next to each valve pits or structure. or as directed by the *Superintendent*
3. Other than trenches **a) Sand** **b) Other than sand**	Penetrometer (by *Contractor's* personnel). NDM	1 full-depth test per 75 m² of backfill and testing at least every metre of vertical fill. As above or as directed by the *Superintendent*

ET7 AUDIT TESTING BY *SUPERINTENDENT*

ET7.1 General

The *Superintendent* will be responsible for and arrange its own independent NATA registered laboratory audit testing (both penetrometer and Nuclear Density Meter) of trench and excavation backfill.

This audit testing will generally take place at the frequency of approximately every 150 m to 300 m of pipe excavated or at least once a week or on a random basis at the discretion of the *Superintendent*.

The NATA test results will be reported directly to the *Superintendent* and will be made available to, the *Contractor*, at the *Superintendent's* discretion.

Any audit testing by the *Superintendent* is not to be regarded as fulfilling (or partly fulfilling) the *Contractor's* testing obligations as specified elsewhere in the Specification, however the results of audit testing shall be deemed to be holding upon the *Contractor*.

The *Contractor* shall provide access and any necessary assistance, plant and labour, to the audit tester including excavation and backfill for the testing of lower layers. If the audit results confirm that the compaction was achieved, then the *Principal* will pay all costs associated with the audit testing.

ET7.2 Audit Penetrometer Testing By *Superintendent* of Sand Backfill

Sand backfill may be audited by penetrometer testing by the *Superintendent* using its NATA registered technician. The penetrometer shall be calibrated to correlate with densities of backfill layers of each of the soil types up to 1650 mm maximum thickness (this allows for 150 mm bedding of the penetrometer plus testing of five (5) layers of 300 mm compacted thickness). Audit testing will be at random locations and all backfill placed to a layer depth in excess of 0.4 m loose thickness above the pipe overlay or the level of a previous tested layer, shall be deemed to have been compacted and access immediately available for audit testing by the *Superintendent*.

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FOI 26-292 - Document 27

Where the *Contractor* reasonably indicates a test *site* is not ready for testing, the audit will ignore the results for the top 400 mm/600 mm, as appropriate, of the backfill layer tested.

ET7.3 Audit Testing By the *Superintendent* of Backfill Materials Other Than Sands

Audit testing of backfill materials, other than sand, may be carried out by a NATA registered laboratory using a nuclear density meter correlated to the densities of the various soil types at locations determined by the *Superintendent*.

ET8 CONFORMANCE OF WORK

The conformance of any section of the work with the density requirements shall be judged on the basis that the modified dry density ratio results for tests taken at all locations within the section of work tested shall comply with the requirements of the Specification.

ET9 FAILED COMPACTION TESTS IN BACKFILL

Should any audit testing or *Contractor's* testing reveal a failed test at any level of the backfill layers then additional tests shall be carried out by the *Contractor's* NATA registered technician as necessary to isolate the failed section of backfill. The *Contractor* shall remove and re-compact all backfill material at or above the level of failed test(s), for the full section of trench in the area of the failed tests. Alternatively additional compaction may be carried out and the full section re-tested (if the thickness of the failed section of backfill is less than 600 mm).

Re-testing of the remedial Works shall be at locations as directed by the *Superintendent* at a frequency not greater than that specified in Table ET6.1 using the *Contractor's* NATA registered testing *Subcontractor*.

ET10 REPORTING OF TEST RESULTS

The *Contractor* shall notify the *Superintendent* verbally upon request of all test results within two (2) working days of tests occurring and submit satisfactory written test results to the *Superintendent* within seven (7) working days of the tests being carried out on-*site*. Failure to submit written test results for specific sections of work shall render that work incomplete in regards to measurement for payment.

Test results for each penetrometer testing shall include the number of blows per 300 mm penetration in that specific material equivalent to the relevant specified modified maximum density ratio compaction requirement in each case. The written results from the *Contractor's* compliance penetrometer testing by *Site* Personnel shall be available on *Site* for inspection by the *Superintendent* immediately after each separate test has been completed.

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SECTION 'ETF'

EMBEDMENT AND TRENCH FILL

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FOI 26-292 - Document 27

Revision Status

Nexus ID # 58577640

The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.0	10/02/16	All	Initial version	Principal Eng. Water Conv.	Principal Eng. Water Conv.
ETF7 ETF8 ETF9	1.1	2/03/2016	3-5	Referred to table ETF9.1 to remove duplication	Principal Eng. Water Conv.	Principal Eng. Water Conv.
Title Page	2	15/04/2019	-	Title Page - Removed reference to 3 party.	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.
ETF1			1	Amended to cover 2 party		
ETF3			1	Added section ETF3		
ETF4			2	Relocated (to this clause) specification material and compaction around fitting, pits, etc Added diagrams showing zone of backfill		
ETF5			3	Added requirement to submit grading analysis		
ETF5.1			3	Updated table reference		
ETF5.2 ETF5.3			4	Relocated sections (ETF8, ETF8.1, and ETF8.2) to be sub-section of ETF5. Removed redundant text in each clause by referring to table ETF6.1		
ETF7			6	Clarified payment limit is 150mm below pipe only where imported bedding is used		

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ETF8	2	15/04/2019	6	Improved grammar of text	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.

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FOI 26-292 - Document 27

Contents

ETF1 APPLICATION OF SECTION 1
ETF2 STANDARDS, CODES AND REGULATIONS 1
ETF3 LIST OF ACTIONS 1
ETF4 GENERAL 2
ETF5 MATERIAL 3
ETF5.1 Coarse Aggregate for Dewatering 3
ETF5.2 Pipe Embedment 4
ETF5.3 Trench Fill 4
ETF6 COMPACTION 4
ETF7 IMPORTED EMBEDMENT MEASUREMENT FOR PAYMENT 5
ETF8 TRENCH CLASSIFICATION 6
ETF9 REPLACEMENT OF UNSUITABLE TRENCH FILL MATERIAL 6
ETF10 SUPPORT TO PIPES AND STRUCTURES ACROSS TRENCHES 6
ETF11 CEMENT STABILISED PIPE TRENCH FILL 7

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FOI 26-292 - Document 27

ETF EMBEDMENT AND TRENCH FILL

ETF1 APPLICATION OF SECTION

This section is intended for use with flexible pipes including PVC, PE and MSCL. The embedment and trench fill terminology aligns with WSAA codes and AS2566.

This section is applicable where payment for all *WUC* associated with this specification is deemed to be included in a lump sum or a $/m length of pipeline, as identified in the schedule of prices.

Should the schedule of prices allow payment for imported fill and the use of imported fill be approved, the limits for payment are defined in this section.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal.*

ETF2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS2566.2 Buried Flexible Pipelines – Part 2: Installation

AS1289 Methods of testing soils for engineering purposes

AS1141.4 Methods for sampling and testing aggregates - Bulk density of aggregate

Safety

Government of Western Australia – Code of Practice – Excavation – 2005

ETF3 LIST OF ACTIONS

Table ETF3.1 summarises various actions required throughout section ETF of the specification. The actions listed in table ETF3.1 are not the only actions required and the table is not a substitute for familiarization with section ETF in its entirety.

Record of actions noted in table ETF3.1 need to be included in the MDR.

Table ETF3.1: List of actions

ETF5 MATERIAL	Approval to import material	Before importing material
ETF5 MATERIAL	Submission of grading curve of coarse aggregate for dewatering	Before works using course aggregate for dewatering commences
ETF9 REPLACEMENT OF UNSUITABLE TRENCH FILL MATERIAL	Approval for replacement of unsuitable trench fill material	Before disposal of unsuitable trench fill material
ETF11 CEMENT STABILISED PIPE TRENCH FILL	Approval to use flowable controlled strength backfill material	Before use of flowable backfill material

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FOI 26-292 - Document 27

ETF4 GENERAL

Unless otherwise specified, embedment and trench fill shall be to AS2566.

Embedment comprises the bedding, side support and overlay.

Bedding is the portion of the embedment zone between the foundation and the bottom of the pipe.

Pipelines shall be constructed on a continuous stable bedding of minimum thickness 150mm, extending for the full width of the trench as shown in the pipe trench zoning detail in the Drawings.

Where the bottom of the trench consists of material suitable for bedding, the pipe bedding shall be the undisturbed or compacted bottom of the trench.

Side support is the portion of the embedment zone to the side of the pipe between the bottom and top of the pipe

Overlay is the portion of the embedment zone that is directly over the top of the pipe

The overlay shall be installed to a thickness of 0.15m for DN900 or smaller, 0.2m for pipes larger than DN900, above the top of the pipe, as shown in the pipe trench zoning detail in the Drawings.

Care shall be taken to prevent damage to, or movement of, the pipe during these works.

All exposed surfaces of trenches/excavations shall be uniform and free of excessive gouging, overhangs and cavities to enable uniform compaction of the embedment and trench fill.

Pipelines shall not be subjected to heavy static or impact loads capable of causing damage to the pipes.

Material and compaction around pipe fittings, valves, pits and access chambers shall meet the same requirements as for the pipe.

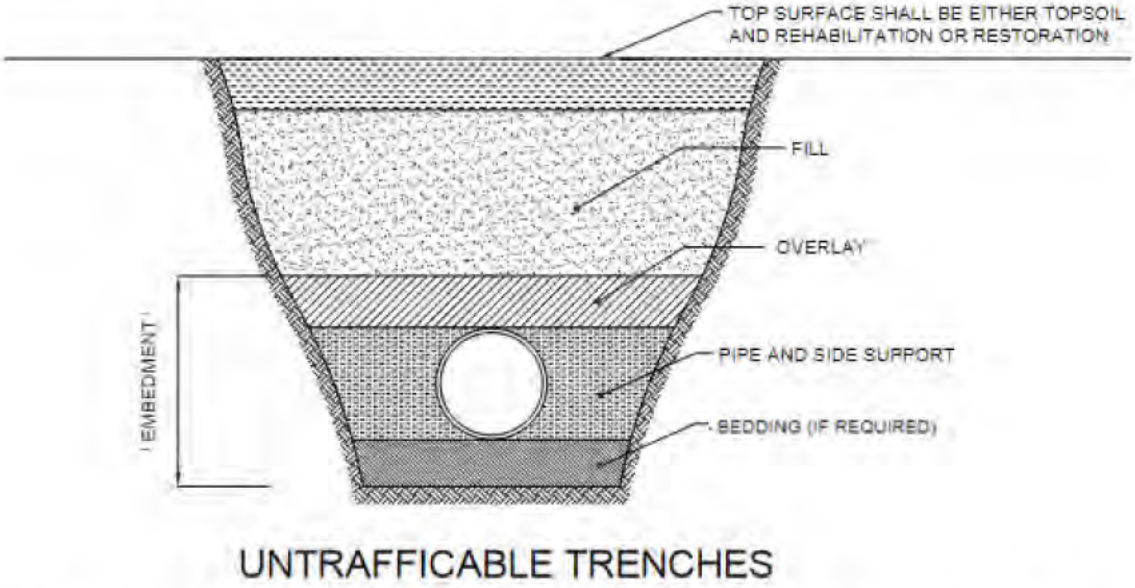


Figure ETF4.1: Diagram of trench backfill in non-trafficable areas (Trench safety and stability not considered in diagram)

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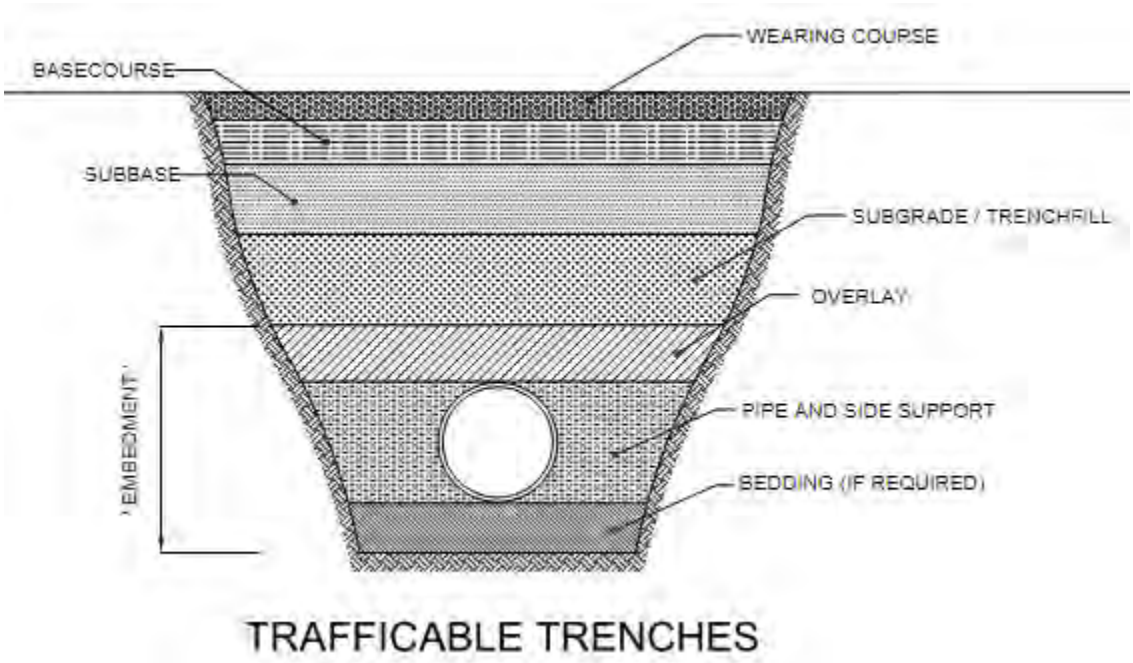


Figure ETF4.2: Diagram of trench backfill in trafficable areas (Trench safety and stability not considered in diagram)

ETF5 MATERIAL

Material for embedment shall be free of contamination and comply with the requirements of

Imported material shall only be used when the excavated material is proven unsuitable for use. Imported material shall not be used without the prior approval of the *Superintendent*.

Imported material shall be from an authorised source having the necessary approval of landowners and Authorities.

Beach sand, or other salt laden material, shall not be used. Material with sharp edges, including by-products of rock crushing operations sometimes referred to as 'crusher dust' shall not be used.

The *Contractor* shall submit a grading analysis of the embedment, and coarse aggregate in accordance with AS 1141.4 before work commences.

ETF5.1 Coarse Aggregate for Dewatering

Where approved by the *Superintendent*, coarse aggregate may be used as the bedding material for lengths of trench requiring extensive dewatering. Aggregate bedding shall be made impervious to the siltation of sand or fines into the voids in the bedding matrix by wrapping the aggregate bedding in A14 type geotextile fabric capable of preventing migration of sand into the aggregate, with 500 mm overlap of the edges of the geotextile.

Coarse aggregate shall be 14mm nominal size graded aggregate complying with Table ETF5.1. The aggregate shall be placed in a minimum compacted thickness of 80 mm.

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FOI 26-292 - Document 27

Table ETF5.1: Coarse Aggregate

Sieve Size (mm)	% Passing Range
19.00	100
13.20	85 - 100
9.50	60 - 85
6.70	25 - 55
4.75	10 - 35
2.36	0 - 10
1.18	0 - 3

ETF5.2 Pipe Embedment

Embedment material shall be in accordance with .

ETF5.3 Trench Fill

Trench fill is the refilling of trenches/excavations from the top of the pipe overlay to ground level in non-trafficable areas or to sub-grade level in trafficable areas, as shown in the pipe trench zoning detail in the Drawings.

Trench fill material shall be in accordance with .

ETF6 COMPACTION

All Trench material shall be compacted to meet the requirements of .

Table ETF6.1: Pipe Embedment and Trenchfill

Zone	Material	Compaction
Pipe embedment	Embedment materials, except for coarse aggregate for dewatering, shall be 'acker" crushed limestone or sand and shall: a) be free of organic materials; b) be free of materials that would be harmful to a pipe or its protective coating; c) not contain particles larger than 19 mm; d) not contain more than 12% fines by weight; e) have an optimal moisture content equal to ± 2% f) be imported if the above criteria cannot be met.	Pipe embedment materials and valve pit foundations shall be compacted to a density ratio of not less than 92% of maximum modified dry density as determined by AS1289.5.2.1, AS1289.5.8.1 and AS1289.5.4.1. Alternatively compaction testing shall being undertaken using the Clegg Impact Test in accordance with AS1289.6.9.1 so as to achieve a minimum Clegg Impact Value (CIV) of 35

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Zone	Material	Compaction
Trench Fill (Trafficable areas)	Trench fill shall be shall be 'acker" crushed limestone or sand and shall:: g) be free of organic materials; h) not contain particles larger than 37.5 mm; i) not contain more than 12% fines by weight; j) have a optimal moisture content equal to ± 2% k) be imported if the above criteria cannot be met.	Trench fill shall be placed in loose layers not exceeding 250 mm thickness and shall be compacted to a density ratio of not less than 95% of maximum modified dry density as determined by AS1289.5.2.1, AS1289.5.8.1 and AS1289.5.4.1. Base-course and sub-base materials shall be reinstated and compacted to a minimum modified density ratio of 95%. Alternatively compaction testing shall being undertaken using the Clegg Impact Test in accordance with AS1289.6.9.1 so as to achieve a minimum Clegg Impact Value (CIV) of 40.
Trench Fill (Non-trafficable areas)	Trench fill shall be silt clay or clayey sand and shall: a) be free of organic materials; b) not contain particles or clay lumps larger than 200 mm; c) have and optimum moisture content equal to ± 2% d) be imported if the above criteria cannot be met. Excavated material (including clay/clayey soils) shall be deemed unsuitable due to its moisture content, unless otherwise directed by the *Superintendent.*	Trench fill shall be placed in loose layers not exceeding 300 mm thickness for clay/cohesive materials or 400mm loose thickness for sand/gravel/cohesionless material and shall be compacted to a minimum density ratio of 92% of maximum modified dry density as determined by AS1289.5.2.1, AS1289.5.8.1 and AS1289.5.4.1. Alternatively compaction testing shall being undertaken using the Clegg Impact Test in accordance with AS1289.6.9.1 so as to achieve a minimum Clegg Impact Value (CIV) of 10 The final 200 mm of backfill material in parks, gardens and bushland shall be the topsoil material removed and stockpiled during stripping.

ETF7 IMPORTED EMBEDMENT MEASUREMENT FOR PAYMENT

Claims for imported embedment material will be based on theoretical dimensions around the pipe, as if the pipe is continuous. The theoretical dimension is irrespective of the actual volume of imported material required and irrespective of local changes to the

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FOI 26-292 - Document 27

embedment volume for valves, pits, chambers, pipe joints, thrust restraints and other pipe fittings.

a) Horizontal Payment Limits:
Payment lines shall be vertical and shall be the width as follows:
1) 600 mm greater than the nominal diameter of the pipe, for diameters less than 750 mm.
2) 900 mm greater than the nominal diameter of the pipe for diameters that are 750 mm or greater.

b) Vertical Payment Limits:
Where imported pipe bedding is used, the lower vertical payment limit will be to 150 mm below the underside of the pipeline. The higher vertical payment limit will be 200 mm above the top of the pipe.

ETF8 TRENCH CLASSIFICATION

Trafficable areas shall be as follows:

a) All excavations with a pipeline centreline within 0.50 m beyond each edge of the existing roadway, pavement area (including gravel limestone pavements), or back of kerb.
b) Excavations as in (a) above, which are deeper than 3.0 m within 0.70 m beyond each edge of the existing roadway, pavement area, or back of kerb.
c) Excavations across existing driveway cross-overs, paths in road reserves, public open spaces and paved areas in private properties including 0.50 m beyond each edge of the driveway, path, or paved areas.
d) Sections of trenches or excavations with the pipe centreline within 4.0 m of a residence, building or wall.
e) Sections of trenches/excavations within 4 m of the centerline of any road reserve which has no pavement in place

Non-trafficable areas shall be all trenches and excavations not included above.

ETF9 REPLACEMENT OF UNSUITABLE TRENCH FILL MATERIAL

Replacement of unsuitable material shall be directed (and measurement agreed) by the *Superintendent* before work commences for each specific operation. For unsuitable replacement under trafficable areas, the *Contractor* shall provide grading test results to show that the excavated materials are unsuitable.

Excavated material unsuitable for trench fill shall be removed, disposed of off-site, and replaced as necessary with suitable trench fill material either from on-site excavations or imported from a suitable source (if a suitable material is not available from on-site excavations).

The *Contractor* shall employ appropriate earthworks management practices to maximise the re-use of the available suitable excavated material.

ETF10 SUPPORT TO PIPES AND STRUCTURES ACROSS TRENCHES

Existing pipes/structures or other services crossing or impinging a trench shall be supported at all times.

Where an existing service main pipe crosses, or an existing structure impinges on a trench, unless otherwise agreed by the *Superintendent*, it shall be supported by sand compacted to 95% modified dry density ratio (in accordance with AS 1289.5.4.1) and extending for a distance of 1m along the trench on both sides. Where it is impracticable to compact material under the service/structure, the *Contractor* shall use weak cement sand slurry (approx. 4% cement) vibrated under and encasing the lower third of the existing service main/structure. A protective overlay/surround of sand of 150 mm

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thickness shall then be placed over the service main before completing the trench filling of the trench.

No additional payment will be made for the support of existing pipes or structures.

ETF11 CEMENT STABILISED PIPE TRENCH FILL

Cement stabilised pipe trench fill shall be used where nominated on the drawings or specified in the preliminaries. Cement stabilisation shall be carried out for the full depth of embedment and trench fill up to the underside of road sub-base material using ordinary Portland cement mixed into the backfill material.

Cement shall be incorporated in the backfill material at a rate of 5% by weight or a minimum of 67.5 kg/cubic metre of uncompacted backfill material, whichever is the greater.

Cement shall be thoroughly mixed into the backfill material by a purpose designated stabilising machine or rotary hoe. Stabilisation shall not be undertaken under high wind conditions where there is risk of cement material being lost from the backfill during spreading and mixing.

Cement shall be thoroughly and evenly worked through the backfill such that there are no excessive concentrations of cement, and mixing is complete. Only sufficient water shall be mixed with stabilised material to facilitate compaction.

Compaction of the stabilised fill shall be to not less than 95% modified dry density and shall be completed within 90 minutes of the commencement of mixing. Alternatively compaction testing shall being undertaken using the Clegg Impact Test in accordance with AS1289.6.9.1 so as to achieve a minimum Clegg Impact Value (CIV) of 40 for the same time constraints

Unless otherwise specified, the use of stabilised soils and aggregates shall be in accordance with the Appendix of AS/NZS 2566.2.

Flowable controlled strength backfill material shall only be used with the approval of the *Superintendent*. The *Contractor* shall submit a work methodology for consideration by the *Superintendent*. The methodology shall include the proposals and supporting calculations for protection of the pipe from flotation.

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SUPERINTENDENT ADMINISTERED
3 PARTY CONTRACT
MODULAR SPECIFICATION SECTION 'FI'

FLANGE INSTALLATION

DRAFT

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Revision Status

Aquadoc # 10060343

REVISION STATUS The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	0.1	6/01/2014	All	Initial draft, Combined from Water Dist and Infil Specs and edited duplications	Prin Eng Water Conveyance	Prin Eng Water Conveyance
FI6	1.1	9/03/2016	5-8	Removed reference to grade 4.6 bolts. All bolts will be 8.8	Prin Eng Water Conveyance	Prin Eng Water Conveyance
Table FI5.1	1.1	9/03/2016	3	Revised table	Prin Eng Water Conveyance	Prin Eng Water Conveyance

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FOI 26-292 - Document 27

Contents

FI1 APPLICATION OF SECTION 1
FI2 FSTANDARDS, CODES AND REGULATIONS 1
FI3 DEFINITIONS 2
FI4 MATERIALS AND GRADES 2
FI4.1 Frequently used flange arrangements 2
FI4.2 Gaskets 2
FI5 INSTALLATION 2
FI5.1 Flanged Joint Preparation 2
FI5.2 Gaskets 2
FI5.3 Fasteners 2
FI5.4 Fastener Lubrication 4
FI5.5 Flange Fastening Procedure 4
FI5.6 Isolating Joint Integrity 5
FI6 BOLTING TORQUES AND GASKET SIZING 5
FI6.1 Elastomeric Gasket Bolting Torques 5
FI6.2 Compressed Fibre (CF) Gasket Bolting Torques 6

DRAFT

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FOI 26-292 - Document 27

FI FLANGE INSTALLATION

FI1 APPLICATION OF SECTION

This section covers the installation of steel and ductile iron flanged joints for pipework used in Corporation infrastructure. The section is based on AS 4087, EN 1092 and Corporation-designed flange standards for pressure ratings PN 6 to PN 40 in the size range DN 50 to DN 2000. The scope of the Specification excludes the use of O-ring and flat segmented flange sealing gaskets.

Where proprietary equipment and fittings are specified with flanges that cannot be obtained to the requirement of this section, the flange Supplier's designated flange standard and joining requirements shall apply.

The flange type and standard shall be as shown on the drawings or as specified in the Project Specific section. Unless otherwise specified, gasket and bolts shall be selected in accordance with DS38-02 and flange installation to be in accordance with DS38-02.

NOTES: Reference should be made to AS 4087 for copper-alloy flange requirements which are not addressed in this Specification. O-rings required for replacement in existing joints, should be either NBR or EPDM, in accordance with AS 4087 and WSA 109.

FI2 FSTANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

The Specification takes precedence over the Australian Standards.

Australian Standards

AS1111.1	ISO metric hexagon bolts and screws - Product grade C - Bolts
AS1214	Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS/NZS 4087	Metallic flanges for waterworks purposes
AS 4291.1	Mechanical properties of fasteners made of carbon steel and alloy steel - Bolts, screws and studs
AS/NZS 4291.2	Mechanical properties of fasteners - Nuts with specified proof load values - Coarse thread

Industry Standards

EN1092-1	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges
EN1092-2	Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Cast Iron flanges

Water Corporation Documents

Corporation Standards and Specifications and Australian and International Standards referred to in the DS 30 Standard series are listed in full in Appendices A and B of DS 30-01.

AY58-17-1 - Pipe Fittings Standard – DS65 – Flange Bolt Tightening Sequence

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FOI 26-292 - Document 27

FI3 DEFINITIONS

Flange Types

The various flange attachment configurations designated in AS 4087 and EN1092 can be found in DS38-02.

NOTE: The flange type numbers assigned for ease of identification are as defined in EN 1092.

FI4 MATERIALS AND GRADES

FI4.1 Frequently used flange arrangements

Where PN16 flanges, up to and including DN300 to AS4087 are specified:

a) Elastomeric (NBR, EPDM or Viton) gaskets; 3 mm thick, hardness between 55 and 75 IRHD, and complying with AS4087; shall be used.

b) Bolts shall be 8.8 grade to AS1111.1

c) Bolts shall be hot dipped galvanized to AS1214, except where used in sewer pumps station or coastal locations where 316 stainless steel to AS1111.1, shall be used.

For all other flange types, sizes and pressure ratings the gasket material, thickness and size; bolt size, type and torque settings shall be in accordance with DS38-02.

FI4.2 Gaskets

Flanges gaskets shall be in accordance with DS38-02.

Flange gaskets used shall be new, unused, undamaged and shall be clean without distortion in any plane.

Gaskets shall be dimensioned such that the ID does not protrude into the bore of the pipe.

Note:

a) Where seal-on-body valves are used no gasket is required, with the exception of insulated flanged joints.

b) Full face gaskets shall be used for insulated flange joints.

c) For gaskets to be used at inspection manholes refer to Water Corporation Pipe Fitting Manual, Drg AY58-4-2.

FI5 INSTALLATION

FI5.1 Flanged Joint Preparation

Torqueing equipment shall be calibrated in accordance with the equipment calibration requirements and shall be maintained in clean condition.

Flange faces and sealing components shall be clean and free from defects that could potentially impair joint service life expectancy.

FI5.2 Gaskets

Where a narrow face gasket is used, the gasket may be fixed in place by small points of silicon sealant or adhesive tape.

FI5.3 Fasteners

The flange fastener used shall be free from material and coating defects. The capacity of nuts to run freely on the threads shall be verified prior to installation.

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FOI 26-292 - Document 27

Where Hot-dip galvanised nuts are subject to tapping, nut threads shall be oiled for corrosion protection in accordance with Clause 5.1 of AS 1214.

Bolt lengths shall be so as to permit a minimum of 2 and a maximum of 5 threads to protrude past the nut after installation.

Two washers shall be used for each bolt assembly. One washer shall be fitted under the bolt head and one washer under the nut for each flanged joint.

Unless otherwise specified, fastener materials shall be in accordance with Table FI5.1.

Table FI5.1: Flange Fastener Material and Flange Protection

Flange Location	Fastener Material	Flange Protection
Inside a dry building	Hot Dip Galvanised	Coated (Painted)
Within a pit or inside a damp building	Hot Dip Galvanised	Wrapped
Buried	Hot Dip Galvanised	Wrapped
Exterior, more than 1 km from the coast.	Hot Dip Galvanised	Coated
Exterior, less than 1 km from the coast or less than 50 m from salt lake or estuary	316 Stainless steel	316 SS Flange - No Wrapping Other flange types, coated and wrapped as per CPP
Waste water pump station – wet well	316 Stainless steel	316 SS Flange - No Wrapping, Otherwise refer CA01-1-3
Waste water air valve pit., Air valve flange only	316 Stainless steel	316 SS Flange - No Wrapping

Table Notes:

Exterior refers to flange locations that are not buried and not in a pit or building.

Bolts and nuts shall be in marked in accordance with the fastener marking requirements of AS 4291.1 and AS/NZS 4291.2. Bolts shall have the property class and manufacturers trademark, to AS 4291.1, marked on the top of the bolt head. Nuts shall have the property class and manufacturers trademark, to AS/NZS 4291.2, marked on nut side, bearing surface or chamfer.

When requested, the *Contractor* shall provide valid certification, issued by a certification body accredited by JAS-ANZ, certifying that the flange fasteners comply with relevant Australian (or international) standards.

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FOI 26-292 - Document 27

FI5.4 Fastener Lubrication

During assembly of flanged joints, fasteners and bearing surfaces shall be lubricated (in addition to factory applied lubricants) as specified below. Contamination of flange and gasket faces with fastener lubricant shall be avoided.

Flange fastener and bearing surface lubricants selected for use in drinking and non-drinking water applications shall comply with AS/NZS 4020, using a scaling factor of 0.05.

The minimum lubrication required shall be light oiling. Grease shall not be used.

The oily residue on black mild steel and high tensile bolts may suffice as a lubricant, but additional lubrication shall be applied to hot-dip galvanized fasteners and contiguous bearing surfaces.

Nickel based lubricants shall not be used as they emit carcinogenic fumes when burnt (e.g. oxy-cutting bolts).

A high quality solid type lubricant such as molybdenum disulphide shall be used for stainless steel bolts.

Fasteners for isolation joints shall be lightly oiled with a non-conductive lubricant such as Chemsearch Thread-Eze Ultra.

FI5.5 Flange Fastening Procedure

The procedural sequence and mechanics of flange fastener installation are critical elements in the assembly of fit for purpose flange joints intended for long term service life. Flange installation shall be undertaken as described below:

FI5.5.1 Fitting Fasteners

Flange fastener installation procedures shall be as follows:

a) Flange bolt holes shall be numbered by marker pen or other suitable means in accordance with the sequence shown in AY58-17-1 for the designated number of flange bolts in order to enable identification during the fastener tightening sequence.

b) Flange mating holes shall be lined up to facilitate insertion of flange bolts without excessive tightening force.

c) A thin uniform coating of lubricant shall be applied to fastener threads and to bolt, nut and washer bearing surfaces.

d) One flat washer shall be placed under the bolt head and one under the nut.

FI5.5.2 Joint Tightening

Fasteners shall be tightened in the sequence as marked in AY58-17-1. During assembly and tensioning, bolt heads shall be held fast. Tightening should be achieved using a minimum of 5 passes as detailed in the following:

1st Pass

Tighten each nut loosely by hand in the first instance and then to snug tight using a spanner with an even effort in accordance with the tightening sequence.

a) Check during tightening that the flanges are being pulled together parallel by measuring the distance between the flange faces at the 3, 6, 9 and 12 o'clock positions around the circumference of the flanges.

b) Check the final seating is uniform and in correct alignment.

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2nd Pass

Proceed to further tighten the nuts using a preset manual torque wrench. Torque the bolts to a maximum of 30% of the full torque requirement shown in the relevant bolt torque table for the first time around, in accordance with the tightening sequence.

a) Check that the flanges are bearing uniformly on the gasket.

3rd Pass

Torque the bolts to a maximum of 60% of the full torque requirement in accordance with the tightening sequence.

4th Pass

Torque to the full torque requirement in accordance with the tightening sequence.

5th Pass

Conduct a final pass at full torque, in a clockwise direction on all adjacent fasteners.

FI5.6 Isolating Joint Integrity

Where electrical isolation is required, continuous insulation testing shall be carried out during assembly and tensioning using Tinkor or Rasor flange insulation checkers.

Full face gaskets shall be fitted to all insulated joint types, regardless of whether flat or raised face flanges are used. The gasket shall be 3 mm thick compressed material such as the Klinger C-4430, Novus HDS-1, or equivalent. The dielectric strength of the gasket shall be at least 16 kV/mm (wet and compressed).

Flange cathodic protection isolation shall be achieved by the use of Klinger or Novus insulating flange kits (or approved equivalent), and installed in accordance with the Manufacturer's recommendations. A flange insulating kit includes an insulating gasket, one full length insulating sleeve per bolt and two insulating washers per bolt

The insulating sleeve material shall be polyester resin (Mylar or equivalent). It shall be sized to fit the entire length of the exposed fastener in the joint. The insulating washer material shall be G10 glass epoxy laminate.

All isolation joints shall be tested for acceptance by a Principal's testing Officer prior to any joint wrapping and burial that may be required.

FI6 BOLTING TORQUES AND GASKET SIZING

The tables below define the required bolt torques for commonly used standard flange sizes and pressure ratings. Bolt torques for proprietary items of equipment, shall be in accordance with the Manufacturer's guidelines.

FI6.1 Elastomeric Gasket Bolting Torques

Table FI6.1: Elastomeric Gasket Bolting Torques for AS 4087 PN 16 Flanges

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque (Nm)
80	82	185	146	4	M16	120
100	100	215	178	4	M16	150
150	154	280	235	8	M16	120
200	250	335	292	8	M16	150
250	259	405	356	8	M20	251
300	310	455	406	12	M20	184

NOTES:

a) Full face joint only.

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b) Assumed friction factor: μ = 0.11-0.14

c) Elastomeric gasket material: EPDM rubber, thickness 3 mm, allowable gasket stress of 8 MPa @ 20 ºC

d) Grade 8.8 bolts for sizes up to DN300.

Table FI6.2: Elastomeric Gasket Bolting Torques for EN 1092 PN 16 Flanges

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque – (Nm)
80	82	200	160	8	M16	73
100	100	220	180	8	M16	70
150	154	285	240	8	M20	153
200	250	340	295	12	M20	134
250	259	405	355	12	M24	213
300	310	460	410	12	M24	228

NOTES:

a) Full face joint only.

b) Assumed friction factor: μ = 0.11-0.14

c) Elastomeric gasket material: EPDM rubber, thickness 3 mm, allowable gasket stress of 8 MPa @ 20 ºC

FI6.2 Compressed Fibre (CF) Gasket Bolting Torques

FI6.2.1 AS 4087 flanges

Table FI6.3: CF Gasket Bolting Torques for AS 4087 PN 16 Flanges

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque (Nm)
400	392	580	521	12	M24	682
500	494	705	641	16	M24	682
600	594	825	756	16	M27	998
700	695	910	845	20	M27	998
800	795	1060	984	20	M33	1845
900	896	1175	1092	24	M33	1845
1000	996	1255	1175	24	M33	1845
1200	1197	1490	1410	32	M33	1845

NOTES:

a) Assumed friction factor: μ = 0.11-0.14

b) Raised face joint only.

c) Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 1.5 mm, allowable gasket stress of 135 MPa @ 20 ºC

d) Grade 8.8 bolts

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FOI 26-292 - Document 27

Table FI6.4: CF Gasket Bolting Torques for AS 4087, PN21/PN35 Flanges

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque (Nm)
80	82	205	165	8	M16	196
100	100	230	191	8	M16	196
150	154	305	260	12	M20	395
200	250	370	324	12	M20	395
250	259	430	381	12	M24	682
300	310	490	438	16	M24	682
400	392	610	552	20	M27	998
500	594	735	673	24	M30	1356
600	695	850	781	24	M33	1845
700	795	935	857	24	M33	1845
800	896	1060	984	28	M33	1845
900	908	1185	1105	32	M36	2369
1000	996	1275	1194	36	M36	2369
1200	1197	1530	1441	40	M39	3066

NOTES:

a) Assumed friction factor: μ = 0.11-0.14

b) Raised face joint only.

c) Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 1.5 mm, allowable gasket stress of 135 MPa @ 20 ºC

d) Grade 8.8 bolts.

FI6.2.2 EN 1092 Flanges

Table FI6.5: CF Gasket Bolting Torques for EN 1092 PN 16 Flanges

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque – (Nm)
400	392	580	525	16	M27	998
500	494	715	650	20	M30	1356
600	594	840	770	20	M33	1845
700	695	910	840	24	M33	1845
800	795	1025	950	24	M36	2369
900	896	1125	1050	28	M36	2369
1000	996	1255	1170	28	M39	3066
1200	1197	1485	1390	32	M45	4748

NOTES:

1. Assumed friction factor: μ = 0.11-0.14

2. Raised face joint only.

3. Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 1.5 mm, allowable gasket stress of 135 MPa @ 20 ºC

4. Grade 8.8 bolts

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Table FI6.6: CF Gasket Bolting Torques for Flanges to EN 1092, PN 25

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque (Nm)
80	82	200	160	8	M16	196
100	100	235	190	8	M20	395
150	154	300	250	8	M24	682
200	250	360	310	12	M24	682
250	259	425	370	12	M27	998
300	310	485	430	16	M27	998
400	392	620	550	16	M33	1356
500	494	730	660	20	M33	1356
600	594	845	770	20	M36	2369
700	***Refer Water Corporation Flange Designs***					
800						
900						
1000						
1200						

NOTES:

a) Assumed friction factor: μ = 0.11-0.14

b) Raised face joint only.

c) Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 1.5 mm, allowable gasket stress of 135 MPa @ 20 ºC

d) Grade 8.8 bolts.

e) Maximum bolt yield under full hydrostatic pressure = 75%

Table FI6.7: CF Gasket Bolting Torques for Flanges to EN 1092, PN 40

Flange Size	Gasket ID (mm)	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts	Bolt /torque (Nm)
80	82	200	160	8	M16	196
100	100	235	190	8	M20	395
150	154	300	250	8	M24	682
200	250	375	320	12	M27	998
250	259	450	385	12	M30	1356
300	310	515	450	16	M30	1356
400	392	660	585	16	M36	2369
500	494	755	670	20	M39	3066
600	594	890	795	20	M45	4748
700	***Refer Water Corporation Flange Designs***					
800						
900						
1000						
1200						

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FOI 26-292 - Document 27

NOTES:

a) Assumed friction factor: μ = 0.11-0.14

b) Raised face joint only.

c) Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 1.5 mm, allowable gasket stress of 135 MPa @ 20 ºC

d) Grade 8.8 bolts

e) Maximum bolt yield under full hydrostatic pressure = 75%

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SUB-SECTION 'PE'

POLYETHYLENE PIPELINES

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FOI 26-292 - Document 27

Revision Status

Nexus #58585004

REVISION STATUS The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
Title	3.0	05/06/19	-	Removed Reference to 3 party	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.
PE1			1	Amended to cover 2 Party		
PE2			1	The standard now only takes precedence over AS when specifically noted.		
PE3			1-2	Added section PE3		
PE4			2	Added reference to AS2566		
PE5			2	In drinking water PE to be PE100 HSCR.		
PE6			2	Added reference to SPS125 and AS4130 Fittings are not specified in WS-2		
PE6.1			2-3	Added section PE6.1		
PE9.1			3-4	PE pipe lengths to be as long as possible. At least two slings required to lift (not two exactly)		
PE9.2			4	Removed acceptance of well rounded gouges.		
PE11.3			5-6	Removed sub-section that do not actually add new requirements to WS-2		
All	3.1	30/09/20	All	Updated for formatting consistency.	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.

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FOI 26-292 - Document 27

PE5	3.1	30/09/20	2	Updated requirements of PE resin for use in chlorinated water applications	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.

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FOI 26-292 - Document 27

Contents

PE1 APPLICATION OF SECTION 1
PE2 STANDARDS, CODES AND REGULATIONS 1
PE3 GENERAL 2
PE4 PE PIPE MATERIAL 2
PE5 FITTINGS FOR PE PIPE 2
PE6 HDPE MANUFACTURE 3
PE7 PIPE COLOUR 3
PE8 TRANSPORTATION, HANDLING AND STORAGE 3
PE8.1 Transportation and Handling 3
PE8.2 Pipe Inspection upon Delivery 4
PE8.3 Storage 5
PE9 CONSTRUCTION OF THE PIPELINE 5
PE9.1 General 5
PE9.2 Thermal Expansion 5
PE9.3 Bends and Curves 5
PE10 WELDING REQUIREMENTS 5
PE10.1 General 5
PE10.2 Water Corporation Panel of PE Welders 5
PE10.3 Additional Requirements to Water Corporation Specification WS-2 6

DRAFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

PE POLYETHYLENE PIPES

PE1 APPLICATION OF SECTION

The Polyethylene Pipelines section contains items relevant to Polyethylene pipelines and Polyethylene pipelaying. It is to be read as a sub-section of the Pipes and Pipe Laying section of the specification.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal.*

PE2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS 1646	Elastomeric seals for waterworks purposes
AS/NZS 2033	Installation of polyethylene pipe systems
AS/NZS 2566	Buried flexible pipelines
AS/NZS 4129	Fittings for polyethylene (PE) pipes for pressure applications
AS/NZS 4130	Polyethylene pipes for pressure applications
AS/NZS 5065	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications

Plastic Industry Pipe Association of Australia (PIPA) Industry Guidelines

POP004	Polyethylene Pipe and Fittings Compounds

Water Corporation Standards, Specifications and Documents

SPS 106	Ductile Iron Pipe Fittings for Pressure Applications
SPS 125	Polyethylene and Polypropylene Pipe and Pipe Fittings
WS-2	Welding Joining Specification Thermoplastics

PE3 LIST OF ACTIONS

Table PE3.1 summarises various actions required throughout section PE of the specification. The actions listed in table PE3.1 are not the only actions required and the table is not a substitute for familiarization with section PE in its entirety.

Record of actions noted in table PE3.1 need to be included in the MDR.

Table PE3.1: List of actions

Reference	Description	Timeframe
PE7 HDPE MANUFACTURE	Notification of planned pipe manufacture.	At least 2 weeks before pipe manufacture.
PE7 HDPE MANUFACTURE	Provision of all pipe manufacture QA.	Prior to pipe dispatch of pipe from factory.
PE9.1 Transportation and Handling	Approval to use shorter lengths of PE pipe.	Before manufacture of the pipe.

DRAFT

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FOI 26-292 - Document 27

PE9.1 Transportation and Handling	Approval of alternative means to protect open pipe ends.	Before use of alternative pipe material.
PE11.3.1 Pre-qualifying Test Welds	Completion of Pre-qualifying test welds.	Before construction welding.
PE11.3.1 Pre-qualifying Test Welds	Acceptance of pre-qualifying test weld results.	Before construction welding.
PE11.3.9 Welding Quality Assurance – Weld Testing	Provision of test report for all test welds.	Within 5 working days from the date of the test weld

PE4 GENERAL

The *Contractor* shall install PE pipe as described on the Drawings, in accordance with the Water Corporation's strategic product specification 'SPS 125 Polyethylene and Polypropylene Pipe and Pipe Fittings', AS/NZS 2566, and AS/NZS 4130.

PE5 PE PIPE MATERIAL

Polyethylene (PE) pipes for pressure applications shall comply with AS / NSZ 4130 – Polyethylene (PE) pipes for pressure applications. The nominated pipe shall withstand installation and long term service loads.

PE pipes and fittings for chlorinated water applications, regardless of installation technique, shall be manufactured from a pre-compounded PE resin:

1. That has been assessed as HSCR in accordance with POP 016 and duly listed as such in POP 004, and
2. That has been assessed by the Water Corporations as Disinfectant Resistant in accordance with SPS125 and listed as such in the Strategic Product Register.

The pipe manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials to AS / NSZ 4130 – Polyethylene (PE) pipes for pressure applications.

PE pipe for non-pressure applications shall comply with AS/NZS 5065 and shall be supplied with integral joint sockets that assure long term installed pipe and jointing system integrity and service performance in buried service applications. Joint seals for AS/NZS 5065 PE pipelines in non-pressure applications shall be EPDM or NBR in accordance with AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4) for the nominated elastomer IRHD hardness and shall be supplied by the original pipe or fittings manufacturer.

PE6 FITTINGS FOR PE PIPE

Unless otherwise specified, up to and including DN300, flanged DI fitting shall be used.

All PE fittings shall have a certified manufactured pressure rating and be approved by the Water Corporation for use.

All manufactured fittings shall have a pressure rating, after application of the manufacture/fabrication de-rating, not less than the rated pressure of the adjoining pipeline.

PE fittings shall comply with SPS125. PE fittings for pressure application shall also comply with AS/NZS4130. PE fittings for non-pressure application shall also comply with AS/NZS 5065

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FOI 26-292 - Document 27

PE6.1 DI Fittings

Ductile iron fittings shall be specified according to SPS 106.

DI pipe fittings shall be in accordance with SPS106, and AS/NZS 2280 including compliance with the requirements of AS/NZS 4158 for thermal-bonded polymeric coating externally and lining internally. Fittings shall comply with AS/NZS 4020 for use in contact with drinking and recycled water and to SPS 106.

The *Contractor* shall provide documentary evidence regarding the coating system thickness and continuity and verification of the coating system applicator license.

The *Contractor* shall provide for the on-*site* sampling of each batch of coated pipe fittings and for *site* testing of the coating system continuity and thickness in accordance with AS 3894.1. The acceptance limits for continuity testing shall be as per AS 4158.

The thermal bonded polymeric coating on valves and fittings shall be in accordance with the Water Corporation coating specification G2.

PE7 HDPE MANUFACTURE

HDPE pipe shall be manufactured and factory tested in accordance with the requirements of AS/NZS 4130.

Pipes shall be manufactured from new (not recycled) material and, if possible, in one batch.

The *Contractor* shall notify the *Superintendent* at least two (2) weeks in advance of pipe manufacture together with full details of the source of the PE materials and the quality assurance proposed for pipe manufacture.

The pipe manufacturer shall carry out the following tests on each batch of pipes: -

a) Oxygen Induction Time – samples (3) (Pipe wall outside, middle, inside)

b) Melt Flow Index.

The *Superintendent* may arrange for independent resin grade verification. For resin grade verifications, the *Superintendent* shall choose 2 pipe samples which shall, if possible, be cut from different batches. Each sample shall weigh 1 kg and be supplied by the *Contractor*; the resin grade verification shall be at no cost to the contractor. The *Superintendent* may arrange for independent witnessing of the pipe manufacture and require samples of the manufactured pipe for additional and independent testing at no cost to the *Contractor*.

A copy of all the QA documentation from the pipe manufacturer shall be provided to the *Superintendent* for review prior to the acceptance and dispatch of the pipe from the factory.

PE8 PIPE COLOUR

The colour of the pipe shall be as specified in Clause 2.2 of SPS 125.

PE9 TRANSPORTATION, HANDLING AND STORAGE

PE9.1 Transportation and Handling

HDPE pipes shall be manufactured and transported in lengths chosen to minimise the number of field welds required. Where possible pipes shall be supplied in coils, if not possible pipe lengths shall be at least 20m unless otherwise approved by the *Superintendent*.

a) Ensure that the pipe is not cut, kinked or otherwise damaged during transportation. All materials found during inspection or during the progress of works to have

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cracks, flaws or other defects shall be rejected and removed from the job without delay.

b) Pipe shall be handled in such a manner to ensure that the pipe is not damaged by dragging it over sharp objects. Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used.

c) At least two slings spread apart shall be used for lifting each length of pipe. Slings for handling the pipeline shall not be positioned at butt-fused joints.

d) No pipe or fitting shall be dropped for any distance during loading or unloading operations.

e) Open ends of pipe lengths shall be protected from the entry of foreign material using end caps and in accordance with clause 10.1.4 WS-2 or other means as approved by the *Superintendent*.

f) Open ends of pipe section joined and/ or installed shall be plugged at night to prevent animals or foreign material from entering the pipe. Waterproof nightcaps of an approved design may be used but they shall be constructed to prevent the entrance of natural precipitation into the pipe and will be fastened to the pipe in such a manner that the wind cannot blow them loose. Cloth or paper "stuffing" of pipe ends is not acceptable.

g) Where possible, the pipe shall be raised and supported at a suitable distance back from the open end such that the open end will be below the level of the pipe at the point of support.

PE9.2 Pipe Inspection upon Delivery

The *Superintendent* shall immediately be informed of any damage to the pipe and pipe fittings.

On delivery of the pipes to site the *Contractor* shall inspect pipes for damage. This inspection shall include:

Visual inspection of the pipe material for conformity on the external and inner surfaces and damage to the pipe and pipe ends.

Any damage to the pipes determined from the above inspection shall be recorded on the appropriate inspection forms and, where appropriate, record photographs taken and attached to that report.

Acceptability of Damaged Pipe and or Materials

a) Pipe wall thickness loss of more than 10%

Sections of pipe with cuts or gouges that reduce the wall thickness by more than 10% and kinked pipe or pipe fitting sections shall be cut out, discarded and the remaining pipe ends shall be rejoined. Pipe fittings with cuts and gouges that reduce the wall thickness by more than 10% shall be discarded. Repair of cuts and gouges in pressure pipes that reduce the wall thickness by more than 10% shall not be permissible.

b) Pipe wall thickness loss of between 2% and 10%

Pipe scratches or notches that extend into the pipe wall by more than 2% but less than 10% of its thickness and are less than 100 mm in length shall be repaired by extrusion welding where the notch is sharp and has a clear potential to initiate failure. Sharp scratches and notches longer than 100 mm in length shall be treated as in a) above.

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FOI 26-292 - Document 27

PE9.3 Storage

Pipes shall be stored on level ground, preferably sand, free of sharp objects which could damage the pipe and in accordance with SPS 125. Stacking of PE pipe shall be limited to a height that will not cause excessive deformation to the bottom layer of pipe under anticipated temperature conditions. Adhere to the storage methods and stacking heights recommended by the pipe manufacturer.

Pipe fittings shall be stored above ground on suitably constructed pallets.

Storage sites shall be selected with a view to protecting the pipe from damage, including the risk of fire.

PE10 CONSTRUCTION OF THE PIPELINE

PE10.1 General

All PE pipes shall be cut, fabricated and installed in strict conformance with the pipe manufacturer's recommendations. Joining and laying of PE pipe shall be undertaken by personnel experienced in working with PE pipe.

Install PE pipelines in accordance with AS/NZS 2033 and AS/NZS 2566.2.

PE10.2 Thermal Expansion

Allowances shall be made for pipe movement due to temperature changes during installation and commissioning.

Unless otherwise advised by the *Superintendent*, a final service water temperature of 20°C should be assumed. Pipe lengths, bend locations etc. should be adjusted for changes in lengths that will occur when the pipe temperature stabilises at 20°C.

To minimise residual stress in the pipeline, the pipeline shall be allowed to stabilise at approximately the service temperature before final connection and backfilling.

PE10.3 Bends and Curves

Wherever feasible on pipeline deflections and curves, construct curves by deflecting the pipe in the trench, evenly and without kinking, at the minimum radius specified on the Drawings.

Where bends are shown on the Drawings, provide a welded PE sweep bend or the combination of a welded sweep bend and a curve to change the pipeline direction.

PE11 WELDING REQUIREMENTS

PE11.1 General

The *Contractor* shall develop and agree with the *Superintendent* a welding methodology for the welding of the PE pipelines in accordance with the Drawings, this Section and Water Corporation Specification WS-2.

PE11.2 Water Corporation Panel of PE Welders

The *Principal's* manages a Panel of approved thermoplastic welding providers. A list of appropriate Panel members to undertake the PE welding is in the Project Specific Preliminaries. Should the *Contractor* choose not to nominate a member of the Panel to undertake the PE welding it will be on the understanding that it will take a minimum of six weeks to assess the capability of the proposed welding provider. It is not guaranteed that the *Contractor's* nominated welding provider will be approved. All time and cost associated with the assessment of the proposed welding provider will be the *Contractor's* responsibility and there will be no opportunity to claim any *EOTs* or *variations* related to the assessment process.

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FOI 26-292 - Document 27

PE11.3 Additional Requirements to Water Corporation Specification WS-2

PE11.3.1 Pre-qualifying Test Welds

Refer to Section 11.1.1 of WS-2. The following requirements shall also apply:

a) Before any construction welding is undertaken the *Contractor* shall complete Pre-Qualifying test welds,

b) The test welds shall be carried out under site conditions using the welding equipment and the qualified welding operators proposed to be used,

c) Test welds shall be carried out for all welding machines on site,

d) Where welding machines are different then each welding operator shall be required to qualify on all machines they will operate, and

e) Test welds shall be marked in the machine before being cut out for testing.

The HDPE pipe installation shall not begin until all the above data has been reviewed and the results accepted by the *Superintendent*.

PE11.3.2 Sampling of Construction Welds

Refer to Section 11.2.2 of WS-2. The following requirement shall also apply:

The *Superintendent* may instruct which welds shall be removed for testing. In the absence of instruction from the *Superintendent* concerning sampling of construction welds for testing the conditions stated in WS-2 shall apply.

PE11.3.3 Cutting the Pipe

The *Contractor* shall nominate the proposed method to cut the pipe.

Petrol driven chainsaws or chainsaws with oil lubrication shall not be used.

PE11.3.4 Welding Parameters

Welding parameters shall be equivalent to ISO 21307 and WS-2.

PE11.3.5 Access of *Superintendent's* Welding Inspector

The *Superintendent* will have a Welding Inspector on-site to observe welding operations. The *Contractor* shall provide safe access to the Welding Inspector to enable inspection of any weld.

PE11.3.6 Cleaning of Welding Equipment

All welding equipment shall be kept clean. Cleaning of cutter plates and heater plates shall be by isopropanol and clean, lint free cloths as specified in WS-2. Cleaning cloths shall be used once and discarded.

PE11.3.7 Cleaning of Pipe Ends

Refer to Section 10.1.8 of WS-2. The following requirements shall also apply:

a) Each pipe to be joined shall be cleaned internally to remove any foreign material;

b) Where the outside of the pipe is soiled, the pipe shall be cleaned so that the pipe clamps can effectively and securely grip the pipe.

c) Heavily caked pipe shall be cleaned with water and rags first.

d) The pipe ends shall be thoroughly cleaned inside and outside. Cleaning shall extend at least 50 mm back from the cut end of the pipe. Cleaning shall continue until there is no evidence of contamination on the wipes.

PE11.3.8 Weld De-beading

Weld de-beading shall only be carried out as specified in the project specific preliminaries or the drawings.

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FOI 26-292 - Document 27

PE11.3.9 Welding Quality Assurance – Weld Testing

Copies of the test reports for all test welds shall be provided to the *Superintendent.* Copies of the test results shall be made available to the *Superintendent* within 5 working days from the date of the test weld. Pipe work will not be counted in progress claims until formal test reports confirming that the welds are in compliance have been supplied to the *Superintendent*.

In addition to the items required to be reported by WS-2, all weld test reports shall have attached a graph of load versus extension. These graphs are useful for confirming and recording ductility.

PE11.3.10 Field Welds

The *Contractor* shall provide weld records for each weld. The minimum required information to be supplied on each weld is provided on the templates provided in Appendix B of WS-2. In addition, the output of electronic data logging should include the following details:

a) A graph of time versus pressure

b) A graph of time versus heater plate temperature (if possible)

Where heater plate data is not possible the welder shall manually record the heater plate temperature at four locations on each side the plate.

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION SPECIFICATION SECTION 'PL'

PIPES AND PIPE LAYING

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FOI 26-292 - Document 27

Revision Status

Nexus ID # 58570978

The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.0	10/02/16	All	Initial version	Principal Eng. Wastewater Conv.	Principal Eng. Water Conv.
PL3.2.4	1.1	02/03/16	2	Elaborated on 50m open trench limitation	Principal Eng. Wastewater Conv.	Principal Eng. Water Conv.
Title	2.0	30/05/19	-	Title Page - Removed reference to 3 party.	Principal Eng. Wastewater Conv.	Principal Eng. Water Conv.
PL1			1	amended to cover 2 party.		
PL3			1	Added section PL3		
PL4.1			2	Clarified sealant cannot be used to remedy leakage		
PL4.2.3			2	Correct plastic welding panel name		
PL4.2.4			3	Added section PL4.2.4		
PL4.2.5			3	Contractor to check complete layout of existing pipework before construction		
PL4.4.1			4	Brought section PL4.4.1 in line with DS50		
PL4.4.3			5	Roundness tolerance checking method to be submitted prior to commencing Works		
PL4.7			5	Removed "according to manufacturer's specification".		

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FOI 26-292 - Document 27

Contents

PL1 APPLICATION OF SECTION 1
PL2 STANDARDS, CODES AND REGULATIONS 1
PL3 LIST OF ACTIONS 1
PL4 GENERAL 2
PL4.1 General 2
PL4.2 Prequalification for Pipelaying 2
PL4.3 Flotation Control 3
PL4.4 Pipelaying Tolerance 3
PL4.5 Connection to *Principal's* Assets 5
PL4.6 Thrust Blocks 5
PL4.7 Marker Posts 5
PL4.8 Tracer Tape 5

DRAFT

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FOI 26-292 - Document 27

PL PIPES AND PIPE LAYING

PL1 APPLICATION OF SECTION

This section specifies Pipes and Pipe Laying requirements for flexible pipes (PVC, Steel and Polyethylene) for the conveyance of fluids for water, recycled water and wastewater. This section which covers the general aspects of pipes and pipe laying must be included along with the applicable material section (Steel Pipelines, PVC Pipelines and/or Polyethylene Pipelines) depending on which type of pipe is specified for the project.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

PL2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS 1646	Elastomeric seals for waterworks purposes
AS 1741	Vitrified clay pipes and fittings with flexible joints - sewerage quality
AS/NZS 2032	Code of Practice for installation of UPVC pipe systems
AS/NZS 2544	Grey iron pressure fittings
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2638	Sluice valves for waterworks purposes
AS3571	Glass filament reinforced thermosetting (GRP) plastics pipes - Polyester based - water supply, sewerage and drainage applications
AS3572	Plastics - glass filament reinforced plastics (GRP) - methods of test
AS/NZS 3725	Loads on buried concrete pipes
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)

Water Corporation Standards, Specifications and Documents

WS-1	Welding Specification Metal Arc Welding
WS-2	Welding Joining Specification Thermoplastics

PL3 LIST OF ACTIONS

Table PL3.1 summarises various actions required throughout section PL of the specification. The actions listed in table PL3.1 are not the only actions required and the table is not a substitute for familiarization with section PL in its entirety.

Record of actions noted in table PL3.1 need to be included in the MDR.

Table PL3.1: List of actions

Reference	Description	Timeframe
PL4.2.5 Setting Out Control	Notification of discrepancy in levels and locations of existing pipe.	1 Week prior to commencement of construction, in each case
PL4.2.5 Setting Out Control	Notification of obstruction or inadequacies in design	Immediately

DRAFT

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FOI 26-292 - Document 27

PL4.4.3 Pipe Roundness Tolerance	Methodology of checking pipe roundness tolerances	Prior to commencement of works
PL4.6 Thrust Blocks	Notification of interference with thrust block location or of unsuitable material for thrust block	Immediately

PL4 GENERAL

PL4.1 General

Pipeline systems shall be loaded, transported, unloaded, stacked and handled using the methods, materials, tools and equipment in accordance with the Manufacturer's and/or Suppliers instructions and recommendations, and to the relevant Australian Standards unless otherwise specified.

All pipeline components used in *the Works* shall be as specified on the drawings and also be selected from products listed on the relevant Water Corporation's Strategic Products Registers, Design Standards and Strategic Product Specifications.

All Products and Materials shall be supplied in accordance with the relevant Water Corporation Strategic Product Specification. Flexible pipes shall be installed to AS/NZS 2566.2 unless otherwise specified.

Pipes shall be kept clean, sealed to keep dirt and animals out.

The construction works shall be fenced adequately to OSH standards.

The use of sealants or similar products to remedy leakage in constructed pipes is not acceptable.

PL4.2 Prequalification for Pipelaying

PL4.2.1 Steel Pipelayers

Prior to mobilisation to *site*, pipelaying crew supervisor(s) and pipelayer(s) shall have satisfactorily completed the one day SINTAKOTE Pipelines Program "Supervisor and Pipelayers Handling and Installation Workshop" conducted by Steel Mains Pty Ltd. Other employees responsible for the handling and unloading of PE coated steel pipes and fittings on *site* shall have satisfactorily completed the half-day "Handling and Unloading Workshop" course. The supervisor needs to be competent to NWP 233A/02 (National Training Accreditation).

PL4.2.2 PVC Pipelayers

The *Contractor* shall employ at least one person in each PVC pipelaying crew on the *Contract* who is accredited in PVC pipelaying. Prior to mobilisation to *site*, each nominated pipelayer shall have completed the 'Install PVC plastic pressure pipelines' (PMBWELD308B) course or similar approved. Notwithstanding the successful accreditation of the pipelayers, the pipelines constructed shall comply with the standard of workmanship contained in the PVC Pipelaying Accreditation Course, the requirements of this section and AS/NZS 2032.

PL4.2.3 PVC and PE Welders

Prior to mobilisation to *site*, each PVC and PE pipe or structure welder shall comply to the personnel training and qualification requirements of the Water Corporation's WS-2. Welders must be selected from the appropriate category of the Water Corporations' Plastic Welding Services panel.

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FOI 26-292 - Document 27

PL4.2.4 MSCL Welders

Prior to mobilisation to *site*, each MSCL pipe or fitting welder shall comply with the personnel training and qualification requirements of the Water Corporation's WS-1. Welders must be selected from the appropriate category of the Water Corporations' Metal Fabrication and Welding Works Panel.

PL4.2.5 Setting Out Control

The positions of pipes, access chambers, maintenance shafts, pipeline structures, and connections shall be set out from the control and cadastral boundaries as established by the *Contractor*. The *Contractor* shall set out *the Works*, check the levels, position, and orientation of the existing pipes at the join-ons and shall notify the *Superintendent* of any discrepancies at least one week prior to commencing construction, in each case.

The set out length ahead of the working front shall be of a sufficient distance to allow a minimum of five (5) working days of time till the excavation and pipelaying front reaches the set out position.

All services, structures, significant trees or any other obstacle to the completion of *the Works* shall be identified ahead of the set out by potholing and surveying.

Any obstruction/s or inadequacies to the design affecting *the Works* shall immediately be brought to the attention of the *Superintendent*.

The set out length shall be maintained for the duration of construction as a minimum and allow the *Superintendent* at least five (5) working days to implement design changes if required.

PL4.3 Flotation Control

The *Contractor* shall prevent flotation of pipes.

Where trench dewatering is necessary dewatering shall continue until the trenches/excavations have been filled sufficiently to prevent flotation of the pipes.

PL4.4 Pipelaying Tolerance

The *Contractor* shall maintain minimum cover as detailed in the Drawings.

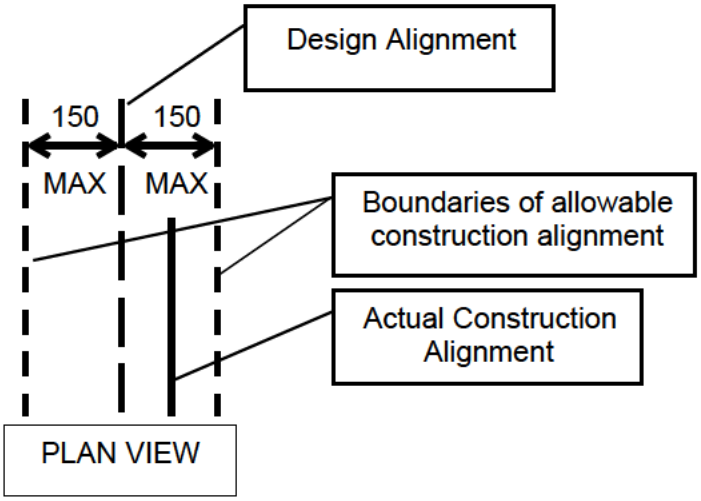
The *Contractor* shall construct pipes and associated structures to the lines and levels shown on the Drawings within the following tolerances:

PL4.4.1 Gravity Sewer Tolerance

Gravity Sewer construction alignment shall be offset a maximum of 150mm horizontally from the design alignment. The construction alignment offset shall be constant between access chambers.

The maximum deviation from the construction alignment for gravity sewers shall be the lesser of 35mm or 10% of the pipe diameter.

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The displacement of any gravity sewer pipeline levels shown on the design drawings shall be such that:

i. The invert level of any part of a constructed sewer pipeline shall not vary by more than 10mm from the designed invert level as shown or as calculated from the information on the design drawings.

ii. The vertical shift or deviation in a sewer grade shall not result in a grade which will be flatter than 1.1 times the grade shown on the design drawings.

iii. No part of a constructed sewer pipeline shall have a grade in the reverse slope direction to that shown on the design drawings.

Where a sewer crosses over existing services, the sewer shall be supported as required by the other service provider.

PL4.4.2 Pressure Pipe Tolerance

a) Horizontal Tolerances

1) Pressure mains and in-line structures

i) Pipelines - 100 mm lateral displacement from the design alignment.

ii) Appurtenances and structures – lateral displacement as for the pipelines, and 200 mm displacement (from the design position) along the pipeline axis.

2) Property services and meters

i) Property services – 200 mm displacement along pipeline axis from the position as specified.

ii) Water meters – 100 mm displacement from the position as specified.

b) Vertical Tolerances

1) Pressure mains, property connections and structures
The inverts of sewer mains, new water mains, property connections and structures shall not deviated from the specified design level (or interpolated design level) by more than 50 mm higher or lower.

2) Verticality ("plumb")
For hydrant risers, access chambers, shrouds and aqueduct piers, the tolerances at any point on the pipe or structure shall not be exceeded:

i) 30 mm deviation (from vertical) per metre rise in any direction; and

DRAFT

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FOI 26-292 - Document 27

ii) limited to a maximum 50 mm cumulative deviation (from vertical) in any one particular direction for distances greater than 5 m.

PL4.4.3 Pipe Roundness Tolerance

Pipeline sizes that allow personnel entry shall be measured in their final location within excavated trenches both before and after placing and compaction of backfill to ensure that they comply with the roundness tolerance as specified by the pipe manufacturer. The method of checking the pipe roundness tolerances shall be submitted by the *Contractor* for approval by the *Superintendent* prior to the commencement of works. Pipes shall be checked for roundness at three points equidistant along their length. The roundness check at each point, as above, shall be made at 45 degree locations around the pipe circumference and include horizontal and vertical measurements.

Diametral deflection measurements should be conducted according to AS/NZS 2566.2 for flexible pipes. Pipe deflection will be in accordance with AS/NZS 2566.2 – Buried Flexible Pipelines Table 5.6 and Table 6.2. Maximum allowable pipe deflection will be minimum of the AS/NZS 2566.2 Table 5.6 and the pipe manufacturer's recommendations.

Each pipe laid under roads and every tenth pipe laid elsewhere or at other locations as directed by the *Superintendent* shall be checked by the *Contractor* and the information provided to the *Superintendent*. Pipes that are beyond the specified roundness tolerance as specified by the pipe manufacturer shall be re-laid or replaced by the *Contractor*.

PL4.5 Connection to *Principal's* Assets

The work involved in direct connection to, or operations in live assets shall be carried out by the *Principal's* nominated subcontractor, unless otherwise approved and shall be arranged by the *Contractor*.

PL4.6 Thrust Blocks

Rubber ring jointed pressure pipelines shall be anchored by means of concrete thrust blocks, dimensioned and constructed as detailed on the Drawings. Thrust blocks shall be provided at all bends, tees, blank ends, reducers, valves and valved ends. Suitable temporary thrust blocks shall be provided at temporary blank ends for pressure testing. Each thrust block shall be constructed between the pipeline and the undisturbed face of the trench. The thrust block should not interfere with any other services. Trench excavations shall be hand trimmed so as to present undisturbed soil surfaces to the concrete thrust blocks.

Where thrust block interference, peat or other low strength material unsuitable for thrust block construction is encountered the *Contractor* shall immediately advise the *Superintendent* and request confirmation that the standard detail is suitable.

Bolts, nuts, flanges or joints shall not be encased in the concrete. All bolts shall be installed with the head facing away from the concrete block. Joints shall not be encased in the concrete blocks, but be protected by foam or similar blockouts or other approved means. A suitable bond breaker shall be provided between the fitting and the concrete (PVC film or approved equivalent).

PL4.7 Marker Posts

Marker posts shall be installed as indicated on the Drawings to show pipeline locations and alignment and valve locations.

PL4.8 Tracer Tape

Tracer tape mains and property services shall be installed as indicated on the Drawings according to manufacturer's specifications, 300 mm above the pipeline.

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SECTION ‘PT’

PIPE PRESSURE TESTING ~~AND~~

NA ~~DISINFECTION~~

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FOI 26-292 - Document 27

Revision Status

The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
PT4.2	3.1	05/06/19	2-3	Section length limit 5km. Contractor to verify performance of isolating equipment.	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.
PT4.3			3	Pipeline to be emptied no later than 36hours after disinfection start. Contractor to provide bacto sampling points. Contractor to prepare disinfection and sampling plan.		
PT4.3.1			3-4	Reworded second paragraph to improve clarity.		
PT4.6			4	Relocated from PT5.		
PT5			5	Renamed. Now apply to all pipes other than PE. Reinforced no make-up water requirement.		
PT6			5	Changed standard reference to AS2566.		
PT7			5	Added section PT7.		
PT8			6-7	Added section PT8.		
All	3.2	13/10/20	All	Update for formatting consistency	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.
PT4.2			2	Referred to Pressure gauges in plural	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.

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FOI 26-292 - Document 27

PT4.3	3.2	13/10/20	3	Increase minimum notice period for bacteriological testing to 8 working days (up from 5) Noted Principal will only undertake bacteriological sampling and minimum 2 working days required for return of results	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.
PT4.4			4	Clarified number of pressure gauges shall comply with AS2566 requirements.	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.
PT5.2			5	Corrected spelling errors	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.

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FOI 26-292 - Document 27

Contents

PT1 APPLICATION OF SECTION 1
PT2 STANDARDS, CODES AND REGULATIONS 1
PT3 LIST OF ACTIONS 1
PT4 GENERAL 2
PT4.1 General 2
PT4.2 Preparation for Pressure Test 2
PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains 3
PT4.4 Test Equipment 4
PT4.5 Pipeline Filling 4
PT4.6 Non-Pressure Pipe Testing 4
PT4.7 Measurement and Payment 4
PT5 PIPELINES OTHER THAN POLYETHYLENE 4
PT5.1 Scope 4
PT5.2 Pressure Pipe Testing 5
PT6 POLYETHYLENE PIPELINES 5
PT6.1 Scope 5
PT6.2 Pressure Pipe Testing 5
PT7 TEST RECORDS 5
PT8 PIPEWORK PRESSURE TEST RECORD SHEET 6
PT8.1 Polyethylene specific section 7
PT8.2 Non-Polyethylene specific section 7

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FOI 26-292 - Document 27

PT PIPE PRESSURE TESTING AND DISINFECTION

PT1 APPLICATION OF SECTION

This Section applies to the Site pressure acceptance testing for PVC, PE, GRP, DI and steel pipelines.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

PT2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS/NZS 2566.2 Buried Flexible Pipelines – Part 2: Installation

AS/NZS 2033 Installation of Polyethylene Pipe Systems

Water Corporation Standards, Specifications and Documents

WS-2 Welding Joining Specification Thermoplastics

WC Guideline Disinfection of Water Mains

WC Guideline Disposal of Highly Chlorinated / Alkaline Disinfection Water

PT3 LIST OF ACTIONS

Table PT3.1 summarises various actions required throughout section PT of the specification. The actions listed in table PT3.1 are not the only actions required and the table is not a substitute for familiarization with section PT in its entirety.

Record of actions noted in table PT3.1 need to be included in the MDR.

Table PT3.1: List of actions

Reference	Description	Timeframe
PT4.1 General	Notification of all pressure tests.	At least 5 working days in advance of pressure test.
PT4.1 General	Approval of leak rectification methodology.	Before bringing pipework into service.
PT4.2 Preparation for Pressure Test	Acceptance of location of water supply for testing purpose.	Before filling potable water pipeline for testing.
~~PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains~~	~~Notice to organise bacteriological sampling.~~	~~At least 5 working days before bacteriological sampling is required.~~
PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for ~~Potable Water Mains~~	Submission of disinfection and pressure test plan.	At least 10 working days before commencement of any testing or disinfection.

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FOI 26-292 - Document 27

NA

~~PT4.3.1 *Principal's* Contact Person~~	~~Submission of required documentation to Principal's Contact Person and Superintendent.~~	~~Before bringing pipework into service.~~
PT6.2 Pressure Pipe Testing	Approval to use basic pressure test (visual) for PE less than 50m and less than DN315.	Before pressure test.

PT4 GENERAL

PT4.1 General

At completion of construction and prior to connection to any existing pipework, the pipeline shall be subjected to a witnessed pressure test. The test pressure shall be nominated in the preliminaries section, this section and/or the drawings.

The Contractor shall provide any temporary isolation devices required to isolate the section of the pipeline for the purposes of the pressure test.

The pipeline to be tested shall be physically isolated from any 'live' system by an air gap.

The Contractor shall notify the Superintendent at least five (5) working days in advance of all pressure tests. Wherever possible, prior notice of the cancellation of a test shall be given. If no notice of cancellation is given, it will be treated as a failed test.

Any visible or detected leak shall be rectified in accordance with the manufacturer's recommendation and to the approval of the Superintendent before pipework is brought into service. The use of sealants or similar products to correct leakage as a result of material or construction faults is not permitted.

Further tests if required, shall be carried out at the Contractor's cost until the results are accepted by the Superintendent.

The details of all official pressure tests shall be recorded on the appropriate Pressure Test Record Sheet.

The results shall be signed by the *Contractor* and the Record Sheet forwarded to the *Superintendent*.

PT4.2 Preparation for Pressure Test

Each section of pipeline to be tested must not exceed 5km and the difference in elevation between any two points on the test section shall be less than 30 metres. The pressure test gauges shall be located as close as practicable to the lowest point on the test section. An adjustment shall be made by subtracting 10 kPa from the test pressure or by adding 10 kPa to the test pressure gauge reading for every metre that the gauge is elevated above the lowest part of the pipeline.

Prior to filling, the pipeline shall be cleaned of all debris.

Pipelines shall not be tested until at least 48 hours after anchor blocks have been poured.

Where a valve is shut or a deadplate is installed to form one end of the test section, adequate anchorage shall be installed to prevent movement of the valve, deadplate or that section of the pipeline.

The Contractor shall verify that any valves proposed to be used are suitable for the purposes of the pressure test prior to commencement of the test. Any reliance by the Contractor on the performance of existing infrastructure such as valves and flanges and other appurtenances is solely the Contractor's risk.

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FOI 26-292 - Document 27

Pipeline trenches shall be appropriately backfilled prior to testing.

Pipelines used for potable water shall, be filled using potable water from a location accepted by the Superintendent. If water from existing water supply mains is to be used, the tapping shall be made by the Principal or nominated agents and a reduced pressure zone device (RPZD) shall be supplied and installed by the Contractor.

PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains

The mains shall be filled with disinfecting water in accordance with Water Corporation Guideline "Disinfection of Water Mains".

The pressure test may be undertaken at this stage.

The pipeline shall remain full with the disinfection water for between 24 and 36 hours.

To prepare for bacteriological testing the mains shall be fully and completely drained or flushed with potable water, and water disposed of in accordance with the Water Corporation Guideline "Disposal of Highly Chlorinated / Alkaline Disinfection Water".

The pipeline shall be refilled with potable water.

NA

The *Contractor* shall arrange and facilitate access for bacteriological testing in accordance with the relevant Principal's published guidelines, supplied by the *Superintendent* upon request. The *Contractor* shall supply a suitable number of temporary sample take offs, location and number of as agreed by the *Principal*. The *Contractor* shall provide temporary sample take-offs with the final connection being a DN50 BSP 50mm female thread, suitable for the *Principal's* sampler to attach a sample spout. The take-offs shall be located to enable the *Principal's* sampler safe access (above ground, or no deeper than a knee high pit), and shall not be located in a confined space. Following successful sampling, the *Contractor* shall make good temporary take-offs in accordance with the design of the asset. The *Contractor* shall give the *Superintendent* a minimum of 8 working days' notice of bacteriological testing to enable the *Principal* to schedule a sampler.

The *Contractor* shall prepare a disinfection and pressure test plan. The plan shall include as a minimum; pressure test procedures, disinfection procedures, test water disposal procedures and relevant safety procedures. The plan shall be submitted to the *Superintendent* 10 working days prior to the commencement of any testing or disinfection.

Subsequent to acceptance of the test results by the *Principal*, the *Contractor* shall drain the pipeline as necessary to make the required connections to existing mains in accordance with the Principal's published procedures supplied by the *Superintendent* upon request.

The *Principal* will undertake bacteriological sampling and testing. The *Contractor* shall allow a minimum of 2 working days for the return bacteriological results.

Any costs incurred as a result of failure to comply with these requirements or failing a test shall be shall be borne by the Contractor.

PT4.3.1 *Principal's* Contact Person

The details of the *Principal's* contact person for all plans and forms required by the Water Corporation Guideline "Disposal of Highly Chlorinated / Alkaline Disinfection Water" will be advised by the *Superintendent*.

The Contractor must submit documentation to the *Principal's* Contact Person and Superintendent that demonstrates that:

a) the Disposal Plan has been developed in accordance with the Water Corporation Guideline "Disposal of Highly Chlorinated / Alkaline Disinfection Water",

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FOI 26-292 - Document 27

NA

b) the Disinfection Water Disposal Plan is completed correctly,
c) all required approvals during and following disposal have been obtained,
d) sufficient communication with DoE and other authorities during disposal has occurred,
e) monitoring results prior and during disposal of disinfection water are correctly registered, and
f) the Register of Disposed Disinfection Water is complete.

PT4.4 Test Equipment

The hydraulic pressure in the test section shall be raised and maintained for the duration of the test by means of a suitable pump.

Where a motorized positive displacement pump is used for the test, it shall be fitted with an effective form of pulsation damping. Also, to minimize the risk of potentially damaging over-pressurization occurring, a pressure relief valve shall be fitted. This relief valve shall be set correctly and have sufficient capacity to limit any possible pressure rise to a maximum of 100 kPa above the test pressure. Calibrated pressure gauges shall be connected to the pipeline (as close as practicable to the lowest point) and shall be capable of being read at 50 kPa intervals, on a minimum 100 mm diameter gauge.

The number of pressure gauges used shall comply with the requirement of AS2566.

PT4.5 Pipeline Filling

The test section shall be filled with water, taking care to purge all free air from the section. The pipe shall be filled at a rate to limit air entrainment and pressure surges at high points when air valves close during the filling process. The recommended rate of filling shall be based on a flow velocity of 0.05 m/s. After filling the Contractor shall allow sufficient time for the test water to stabilise and for dissolved air to exit the system. For cement mortar lined pipes filling of the main shall be completed at least 48 hours prior to the commencement of the witnessed pressure test to allow for water take-up in the mortar.

PT4.6 Non-Pressure Pipe Testing

Non-pressure pipe testing shall be carried out and test results recorded on the appropriate quality assurance certificates.

All non-pressure pipe up to and including 300 mm diameter shall be subjected to an air pressure of 50 kPa. The air supply shall then be shut off and the pressure of the air in the test section of pipe shall not fall below 35 kPa after one minute following shut off of air supply for each section of pipe. A section of pipe is defined as the pipe between access chambers or maintenance shafts (or a combination of each) or an Inspection Opening (IO) or Inspection Shaft (IS) from an access chamber or maintenance shaft or in the case of drains, between open-air inlets and outlets. The period of testing will be extended by one minute for each additional section of pipe. Pipes and culverts above 300 mm diameter shall be visually inspected for leaks and defects.

If testing of a pipe (including access chambers, maintenance shafts and property connections) results in a failure, the section of pipe shall be rectified and retested and inspected until the results are successful.

PT4.7 Measurement and Payment

All work addressed in this section is deemed to be included in the lump sum as applicable.

PT5 PIPELINES OTHER THAN POLYETHYLENE

PT5.1 Scope

This Section applies to the Site pressure acceptance testing for pipes other than polyethylene.

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FOI 26-292 - Document 27

PT5.2 Pressure Pipe Testing

Solvent-jointed PVC pressure pipelines shall be pressure-tested at least 24 hours after the last joint has been made.

The Constant Pressure Test (water loss) method in Appendix M M4 of AS/NZS 2566.2 shall be used for the pressure test.

The duration of the test for all pipelines shall be a minimum 2.0 hours or longer to allow all flanged joints to be inspected.

Before the commencement of the pressure test, the pipeline shall be held under pressure for at least one hour and make-up water added as required to maintain pressure.

For a pipeline to satisfactorily pass a pressure test, there shall be no sign of leakage and must not require any make-up water to maintain the test pressure. The requirement for no make-up water takes precedence the make-up water allowance of AS2566.

All access chambers shall be exposed during testing.

PT6 POLYETHYLENE PIPELINES

PT6.1 Scope

This Section applies to the Site pressure acceptance testing for polyethylene (PE) pipes.

PT6.2 Pressure Pipe Testing

Each PE pipeline shall be hydrostatically tested to verify its structural integrity and leak-tightness.

Irrespective of diameter, testing and test acceptance criteria shall be in accordance with the Constant Pressure (Water Loss) Method for Visco-elastic Pipes in Appendix M M5 – of AS/NZS 2566.2, based on the general pressure test (technical) method for visco-elastic pressure pipelines.

Where the pipe section length is less than 50m and less than DN315 and all the joints are accessible for inspection, the basic pressure test (visual) in accordance with AS/NZS 2033 Sub-clause 7.2.3 may be used, subject to the approval of the *Superintendent*.

PE pipe that is installed using horizontally directionally drilled methods must pass a pressure test both before and also after installation.

PT7 TEST RECORDS

Unless otherwise advised by the Superintendent or Commissioning Manager, Test records must be kept using the Water Corporation Pressure Test Record sheets and ITPs.

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FOI 26-292 - Document 27

PT8 PIPEWORK PRESSURE TEST RECORD SHEET

The following test record sheet shall be completed and included in the MDR unless otherwise advised by the Superintendent or Commissioning manager.

Section 1 and 2 shall be completed for all pipelines. In addition, For polyethylene section 3 needs to be completed, for non-polyethylene section 4 needs to be completed.

1. REFERENCE INFORMATION	
INSPECTION DATA	**ASSET DATA**
PROJECT NAME:	CHAINAGE FROM:
LOCATION:	CHAINAGE TO:
INSPECTION DATE:	WC DRAWING / P&ID NO.:
INSPECTOR NAME:	PIPE SIZE:
PROJECT / CONTRACT NO:	PIPE MATERIAL:
ATTENDEES:	

2. Calculation Table (derived from AS2566)				
Parameter	**Symbol**	**Formula**	**Result**	**Unit**
Design pressure	P_{design}			kPa
Pipe pressure rating	P_{pipe}			kPa
Lowest component pressure rating	P_{comp}			kPa
Test pressure	P_{test}	As per design unless otherwise advised by the Superintendent		kPa
Pipe diameter	D			m
Length of pipe being tested	L			m
Volume of pipe being tested	V	$V=\pi \times D^2/4 \times L$		m^3
Maximum fill rate (Contractor to select lower fill rate as appropriate to limit air entrapment)	Q_{fmax}	$Q_{fmax} = 39.27D^2$		L/s
Design temperature	T_{design}			°C
Pre-Test stabilisation period M2. This allows temperature of pipe and water to stabilise and dissolved air to exit the system.	t_{M2}	Duration between 3 and 24 hours is to be specified by the testing engineer.		Minutes
Average test head over pipe length under test	**H**	***measured**		**m**

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PT8.1 Polyethylene specific section

For polyethylene pipework following table need to be completed. For a successful test of Polyethylene pipework V2 shall be less than $V2_{max}$.

3. Polyethylene results				
1st Volume Added	V1	Measured volume required to maintain the test pressure constant between hour 2 and hour 3.		L
2nd Volume Added	V2	Measured volume required to maintain the test pressure between hour 4 and hour 5.		L
Maximum allowable make-up water	$V2_{max}$	$V2_{max} = 0.55V_1 + 0.00014LDH$ *NOTE: this calculation must be performed on site once V1 is determined*		L

PT8.2 Non-Polyethylene specific section

For non-polyethylene pipework following table need to be completed. For a successful test of non-polyethylene pipework Pressure shall be maintained without requiring any makeup water.

4. Non-Polyethylene results					
Hour	**Pressure (kPa)**	**Make Up Water Used (L)**	**Water Temperature (°C)**	**Ambient Temperature (°C)**	**Comments**
0	P_{Test}=	Nil Allowed			
1		Nil Allowed			
2		Nil Allowed			
3		Nil Allowed			
4		Nil Allowed			
5		Nil Allowed			
6		Nil Allowed			
7		Nil Allowed			
8		Nil Allowed			
9		Nil Allowed			
10		Nil Allowed			
11		Nil Allowed			
12		Nil Allowed			

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FOI 26-292 - Document 27

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SECTION ‘PT’

PIPE PRESSURE TESTING AND DISINFECTION

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FOI 26-292 - Document 27

Revision Status

The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.1	10/02/16	All	Initial version	Mgr, WW Conveyance	Principal Engr Water Conv.
PT6.2	2.0	29/11/16	1	Reference to pressure rebound test method removed	Principal Eng. WW Conveyance	Principal Eng. Water Conv.
PT8	2.0	29/11/16	2	Test procedure to AS2566 removed and replaced with test procedure to AS2033 Cl7.2.4	Principal Eng. WW Conveyance	Principal Eng. Water Conv.
Title page and PT1	3.0	14/11/17	1	Removed reference to 3 party. PT1 – amended to cover 2 party.	Principal Eng. WW Conveyance	Principal Eng. Water Conv.
PT5.2	3.0	14/11/17	4	Requirement for all mscl access chambers to remain exposed during testing added.	Principal Eng. WW Conveyance	Principal Eng. Water Conv.
PT6.2	3.0	14/11/17	4	Visual test of short and small diameter section of pipe subject to superintendent's approval. 45 min pressurization time removed	Principal Eng. WW Conveyance	Principal Eng. Water Conv.
PT2	3.1	05/06/19	1	AS takes precedence unless otherwise noted.	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.
PT3			1-2	Added section PT3.		
PT4.1			2	Contractor to provide any temporary isolation required. Repairs to occur before bringing pipeline in service.		

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FOI 26-292 - Document 27

PT4.2	3.1	05/06/19	2-3	Section length limit 5km. Contractor to verify performance of isolating equipment.	Snr Principal Eng. WW Conveyance	Snr Principal Eng. Water Conv.
PT4.3			3	Pipeline to be emptied no later than 36hours after disinfection start. Contractor to provide bacto sampling points. Contractor to prepare disinfection and sampling plan.		
PT4.3.1			3-4	Reworded second paragraph to improve clarity.		
PT4.6			4	Relocated from PT5.		
PT5			5	Renamed. Now apply to all pipes other than PE. Reinforced no make-up water requirement.		
PT6			5	Changed standard reference to AS2566.		
PT7			5	Added section PT7.		
PT8			6-7	Added section PT8.		

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FOI 26-292 - Document 27

Contents

PT1 APPLICATION OF SECTION 1
PT2 STANDARDS, CODES AND REGULATIONS 1
PT3 LIST OF ACTIONS 1
PT4 GENERAL 2
PT4.1 General 2
PT4.2 Preparation for Pressure Test 2
PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains 3
PT4.4 Test Equipment 3
PT4.5 Pipeline Filling 3
PT4.6 Non-Pressure Pipe Testing 3
PT4.7 Measurement and Payment 3
PT5 PIPELINES OTHER THAN POLYETHYLENE 4
PT5.1 Scope 4
PT5.2 Pressure Pipe Testing 4
PT6 POLYETHYLENE PIPELINES 4
PT6.1 Scope 4
PT6.2 Pressure Pipe Testing 4
PT7 TEST RECORDS 4
PT8 PIPEWORK PRESSURE TEST RECORD SHEET 5
PT8.1 Polyethylene specific section 6
PT8.2 Non-Polyethylene specific section 6

PT

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FOI 26-292 - Document 27

PT PIPE PRESSURE TESTING AND DISINFECTION

PT1 APPLICATION OF SECTION

This Section applies to the Site pressure acceptance testing for PVC, PE, GRP, DI and steel pipelines.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal*.

PT2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS/NZS 2566.2 Buried Flexible Pipelines – Part 2: Installation

AS/NZS 2033 Installation of Polyethylene Pipe Systems

Water Corporation Standards, Specifications and Documents

WS-2 Welding Joining Specification Thermoplastics

WC Guideline Disinfection of Water Mains

WC Guideline Disposal of Highly Chlorinated / Alkaline Disinfection Water

PT3 LIST OF ACTIONS

Table PT3.1 summarises various actions required throughout section PT of the specification. The actions listed in table PT3.1 are not the only actions required and the table is not a substitute for familiarization with section PT in its entirety.

Record of actions noted in table PT3.1 need to be included in the MDR.

Table PT3.1: List of actions

Reference	Description	Timeframe
PT4.1 General	Notification of all pressure tests.	At least 5 working days in advance of pressure test.
PT4.1 General	Approval of leak rectification methodology.	Before bringing pipework into service.
PT4.2 Preparation for Pressure Test	Acceptance of location of water supply for testing purpose.	Before filling potable water pipeline for testing.
PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains	Notice to organise bacteriological sampling.	At least 5 working days before bacteriological sampling is required.
PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains	Submission of disinfection and pressure test plan.	At least 10 working days before commencement of any testing or disinfection.

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FOI 26-292 - Document 27

PT4.3.1 *Principal's* Contact Person	Submission of required documentation to Principal's Contact Person and Superintendent.	Before bringing pipework into service.
PT6.2 Pressure Pipe Testing	Approval to use basic pressure test (visual) for PE less than 50m and less than DN315.	Before pressure test.

PT4 GENERAL

PT4.1 General

At completion of construction and prior to connection to any existing pipework, the pipeline shall be subjected to a witnessed pressure test. The test pressure shall be nominated in the preliminaries section, this section and/or the drawings.

The *Contractor* shall provide any temporary isolation devices required to isolate the section of the pipeline for the purposes of the pressure test.

The pipeline to be tested shall be physically isolated from any 'live' system by an air gap.

The *Contractor* shall notify the *Superintendent* at least five (5) working days in advance of all pressure tests. Wherever possible, prior notice of the cancellation of a test shall be given. If no notice of cancellation is given, it will be treated as a failed test.

Any visible or detected leak shall be rectified in accordance with the manufacturer's recommendation and to the approval of the *Superintendent* before pipework is brought into service. The use of sealants or similar products to correct leakage as a result of material or construction faults is not permitted.

Further tests if required, shall be carried out at the *Contractor's* cost until the results are accepted by the *Superintendent*.

The details of all official pressure tests shall be recorded on the appropriate Pressure Test Record Sheet.

The results shall be signed by the *Contractor* and the Record Sheet forwarded to the *Superintendent*.

PT4.2 Preparation for Pressure Test

Each section of pipeline to be tested must not exceed 5km and the difference in elevation between any two points on the test section shall be less than 30 metres. The pressure test gauge shall be located as close as practicable to the lowest point on the test section. An adjustment shall be made by subtracting 10 kPa from the test pressure or by adding 10 kPa to the test pressure gauge reading for every metre that the gauge is elevated above the lowest part of the pipeline.

Prior to filling, the pipeline shall be cleaned of all debris.

Pipelines shall not be tested until at least 48 hours after anchor blocks have been poured.

Where a valve is shut or a deadplate is installed to form one end of the test section, adequate anchorage shall be installed to prevent movement of the valve, deadplate or that section of the pipeline.

The *Contractor* shall verify that any valves proposed to be used are suitable for the purposes of the pressure test prior to commencement of the test. Any reliance by the Contractor on the performance of existing infrastructure such as valves and flanges and other appurtenances is solely the *Contractor*'s risk.

Pipeline trenches shall be appropriately backfilled prior to testing.

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FOI 26-292 - Document 27

Pipelines used for potable water shall, be filled using potable water from a location accepted by the *Superintendent*. If water from existing water supply mains is to be used, the tapping shall be made by the *Principal* or nominated agents and a reduced pressure zone device (RPZD) shall be supplied and installed by the *Contractor*.

PT4.3 Procedure for Disinfection, Bacteriological Testing and Disposal of Disinfection Water for Potable Water Mains

Not Used

PT4.3.1 *Principal's* Contact Person

Not Used

PT4.4 Test Equipment

The hydraulic pressure in the test section shall be raised and maintained for the duration of the test by means of a suitable pump.

Where a motorized positive displacement pump is used for the test, it shall be fitted with an effective form of pulsation damping. Also, to minimize the risk of potentially damaging over-pressurization occurring, a pressure relief valve shall be fitted. This relief valve shall be set correctly and have sufficient capacity to limit any possible pressure rise to a maximum of 100 kPa above the test pressure. A calibrated pressure gauge shall be connected to the pipeline (as close as practicable to the lowest point) and shall be capable of being read at 50 kPa intervals, on a minimum 100 mm diameter gauge.

PT4.5 Pipeline Filling

The test section shall be filled with water, taking care to purge all free air from the section. The pipe shall be filled at a rate to limit air entrainment and pressure surges at high points when air valves close during the filling process. The recommended rate of filling shall be based on a flow velocity of 0.05 m/s. After filling the *Contractor* shall allow sufficient time for the test water to stabilise and for dissolved air to exit the system. For cement mortar lined pipes filling of the main shall be completed at least 48 hours prior to the commencement of the witnessed pressure test to allow for water take-up in the mortar.

PT4.6 Non-Pressure Pipe Testing

Non-pressure pipe testing shall be carried out and test results recorded on the appropriate quality assurance certificates.

All non-pressure pipe up to and including 300 mm diameter shall be subjected to an air pressure of 50 kPa. The air supply shall then be shut off and the pressure of the air in the test section of pipe shall not fall below 35 kPa after one minute following shut off of air supply for each section of pipe. A section of pipe is defined as the pipe between access chambers or maintenance shafts (or a combination of each) or an Inspection Opening (IO) or Inspection Shaft (IS) from an access chamber or maintenance shaft or in the case of drains, between open-air inlets and outlets. The period of testing will be extended by one minute for each additional section of pipe. Pipes and culverts above 300 mm diameter shall be visually inspected for leaks and defects.

If testing of a pipe (including access chambers, maintenance shafts and property connections) results in a failure, the section of pipe shall be rectified and retested and inspected until the results are successful.

PT4.7 Measurement and Payment

All work addressed in this section is deemed to be included in the lump sum as applicable.

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FOI 26-292 - Document 27

PT5 PIPELINES OTHER THAN POLYETHYLENE

PT5.1 Scope

This Section applies to the Site pressure acceptance testing for pipes other than polyethylene.

PT5.2 Pressure Pipe Testing

Solvent-jointed PVC pressure pipelines shall be pressure-tested at least 24 hours after the last joint has been made.

The Constant Pressure Test (water loss) method in Appendix M M4 of AS/NZS 2566.2 shall be used for the pressure test.

The duration of the test for all pipelines shall be a minimum 2.0 hours or longer to allow all flanged joints to be inspected.

Before the commencement of the pressure test, the pipeline shall be held under pressure for at least one hour and make-up water added as required to maintain pressure.

For a pipeline to satisfactorily pass a pressure test, there shall be no sign of leakage and must not require any make-up water to maintain the test pressure. The requirement for no make-up water takes precedence the male up water allowance of AS2566.

All access chambers (manholes) shall be exposed during testing.

PT6 POLYETHYLENE PIPELINES

PT6.1 Scope

This Section applies to the Site pressure acceptance testing for polyethylene (PE) pipes.

PT6.2 Pressure Pipe Testing

Each PE pipeline shall be hydrostatically tested to verify its structural integrity and leak-tightness.

Irrespective of diameter, testing and test acceptance criteria shall be in accordance with the Constant Pressure (Water Loss) Method for Visco-elastic Pipes in Appendix M M5 –of AS/NZS 2566.2, based on the general pressure test (technical) method for visco-elastic pressure pipelines.

Where the pipe section length is less than 50m and less than DN315and all the joints are accessible for inspection, the basic pressure test (visual) in accordance with AS/NZS 2033 Sub-clause 7.2.3 may be used, subject to the approval of the *Superintendent*.

PE pipe that is installed using horizontally directionally drilled methods must pass a pressure test both before and also after installation.

PT7 TEST RECORDS

Unless otherwise advised by the Superintendent or Commissioning Manager, Test records must be kept using the Water Corporation Pressure Test Record sheets and ITPs.

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PT8 PIPEWORK PRESSURE TEST RECORD SHEET

The following test record sheet shall be completed and included in the MDR unless otherwise advised by the Superintendent or Commissioning manager.

Section 1 and 2 shall be completed for all pipelines. In addition, For polyethylene section 3 needs to be completed, for non-polyethylene section 4 needs to be completed.

1. REFERENCE INFORMATION	
INSPECTION DATA	**ASSET DATA**
PROJECT NAME:	CHAINAGE FROM:
LOCATION:	CHAINAGE TO:
INSPECTION DATE:	WC DRAWING / P&ID NO.:
INSPECTOR NAME:	PIPE SIZE:
PROJECT / CONTRACT NO:	PIPE MATERIAL:
ATTENDEES:	

2. Calculation Table (derived from AS2566)

Parameter	Symbol	Formula	Result	Unit
Design pressure	P_{design}			kPa
Pipe pressure rating	P_{pipe}			kPa
Lowest component pressure rating	P_{comp}			kPa
Test pressure	P_{test}	As per design unless otherwise advised by the Superintendent		kPa
Pipe diameter	D			m
Length of pipe being tested	L			m
Volume of pipe being tested	V	$V=\pi \times D^2/4 \times L$		m^3
Maximum fill rate (Contractor to select lower fill rate as appropriate to limit air entrapment)	Q_{fmax}	$Q_{fmax} = 39.27D^2$		L/s
Design temperature	T_{design}			°C
Pre-Test stabilisation period M2. This allows temperature of pipe and water to stabilise and dissolved air to exit the system.	t_{M2}	Duration between 3 and 24 hours is to be specified by the testing engineer.		Minutes
Average test head over pipe length under test	H	*measured		m

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PT8.1 Polyethylene specific section

For polyethylene pipework following table need to be completed. For a successful test of Polyethylene pipework V2 shall be less than $V2_{max}$.

3. Polyethylene results				
1st Volume Added	V1	Measured volume required to maintain the test pressure constant between hour 2 and hour 3.		L
2nd Volume Added	V2	Measured volume required to maintain the test pressure between hour 4 and hour 5.		L
Maximum allowable make-up water	$V2_{max}$	$V2_{max} = 0.55V_1 + 0.00014LDH$ *NOTE: this calculation must be performed on site once V1 is determined*		L

PT8.2 Non-Polyethylene specific section

For non-polyethylene pipework following table need to be completed. For a successful test of non-polyethylene pipework Pressure shall be maintained without requiring any makeup water.

4. Non-Polyethylene results					
Hour	**Pressure (kPA)**	**Make Up Water Used (L)**	**Water Temperature (°C)**	**Ambient Temperature (°C)**	**Comments**
0	P_{Test}=	Nil Allowed			
1		Nil Allowed			
2		Nil Allowed			
3		Nil Allowed			
4		Nil Allowed			
5		Nil Allowed			
6		Nil Allowed			
7		Nil Allowed			
8		Nil Allowed			
9		Nil Allowed			
10		Nil Allowed			
11		Nil Allowed			
12		Nil Allowed			

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FOI 26-292 - Document 27

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SUB-SECTION 'PVC'

PVC PIPELINES

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FOI 26-292 - Document 27

Revision Status

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REVISION STATUS The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
New	1.1	23/03/16	All	Initial version	Principal Eng. Water Conv.	Principal Eng. Water Conv.
Title	2.0	05/06/19	-	Removed reference to 3 party.	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.
PVC1			1	Amended to cover 2 party.		
PVC2			1-2	Updated references to other standards..		
PVC3			2	Added section PVC3		
PVC4.2.1			2-3	Renamed section, and moved solvent cement information to PVC4.6.		
PVC4.2.2			3	Renamed section, and added reference to SPS106.		
PVC4.5			3	Timber not allowed for thrust restraint		
PVC4.6			3-4	New section on solvent cements.		
PVC4.7			4	Corrected wording of second sentence.		
PVC5.1			4	Relocated spigot material limitation from section PVC5.2.3. Added guidance for laying direction of drainage and sewer mains.		
PVC5.2			4-5	Referred to AS/NZS 2032, manufacturer, and this spec for all PVC installation work (instead of just for jointing).		

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FOI 26-292 - Document 27

PVC5.2.3	2.0	05/06/19	5-6	Relocated reference to AS/NZS2032 to PVC5.2. Jointing information now apply so all joint (instead of RRJ only) Relocated Solvent cement information to PVC4.6.	Snr. Principal Eng. Water Conv.	Snr. Principal Eng. Water Conv.

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FOI 26-292 - Document 27

Contents

PVC1 APPLICATION OF SECTION 1
PVC2 STANDARDS, CODES AND REGULATIONS 1
PVC3 LIST OF ACTIONS 2
PVC4 MATERIALS 2
PVC4.1 Pipes 2
PVC4.2 Pipe Fittings 2
PVC4.3 Pipe Colour 3
PVC4.4 Corrosion Protection 3
PVC4.5 Timber 3
PVC4.6 Solvent Cement 3
PVC4.7 Handling of Materials 4
PVC5 CONSTRUCTION 4
PVC5.1 General 4
PVC5.2 Laying and Jointing 4

R

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FOI 26-292 - Document 27

PVC P.V.C PIPELINES

PVC1 APPLICATION OF SECTION

The PVC Pipelines section contains items relevant to PVC pipelines and PVC pipe laying. It is to be read as a sub-section of the Pipes and Pipe Laying section of the specification which must be included in the Specification when the PVC Pipelines section is used.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal.*

PVC2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS/NZS 1254	PVC-U pipes and fittings for stormwater and surface water applications
AS/NZS 1260	PVC-U pipes and fittings for drain, waste and vent application
AS/NZS 1477	Unplasticized PVC (UPVC) pipes and fittings for pressure applications
AS 1604.1	Specification for preservative treatment - Sawn and round timber
AS 1646	Elastomeric seals for waterworks purposes
AS/NZS 2032	Code of Practice for installation of UPVC pipe systems
AS 2082	Timber - Hardwood - Visually stress-graded for structural purposes
AS/NZS 2280	Ductile iron pressure pipes and fittings
AS/NZS 3879	Solvent cements and priming fluids for PVC and ABS pipes and fittings
AS 3894.1	Site testing of protective coatings - Non-conductive coatings - Continuity testing - High voltage ('brush') method
AS/NZS 4020	Testing of products for use in contact with drinking water
AS/NZS 4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4441	Oriented PVC (PVC-O) pipes for pressure applications
AS/NZS 4765	Modified PVC (PVC-M) pipes for pressure applications

Water Corporation Standards, Specifications and Documents

DS31-01	Pipework - Mechanical
SPS 106	Ductile Iron Pipe Fittings for Pressure Applications
SPS 115	PVC-U Pipe for Pressure Applications
SPS 116	PVC-M Pipe for Pressure Applications
SPS 117	PVC-O Pipe for Pressure Applications
G2	Thermal Bonded Polymeric coating on valves and fittings for water industry purposes.

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FOI 26-292 - Document 27

PVC3 LIST OF ACTIONS

Table PVC3.1 summarises various actions required throughout section PVC of the specification. The actions listed in table PVC3.1 are not the only actions required and the table is not a substitute for familiarization with section PVC in its entirety.

Record of actions noted in table PVC3.1 need to be included in the MDR.

Reference	Description	Timeframe
PVC4.1 Pipes	Approval to use pipes older than 12 months of age of exposed to sunlight for longer than 6 months.	Before using such pipe in *the works*.
PVC4.2.2 Pressure	Provision of on-site sampling and testing of fittings coating system	For the duration of *the works*.

PVC4 MATERIALS

PVC4.1 Pipes

PVC-U pressure pipe shall comply with AS/NZS 1477 Series 2 and SPS 115.

PVC-M pressure pipe shall comply with AS/NZS 4765 Series 2 and SPS 116.

PVC-O pressure pipe shall comply with AS/NZS 4441 Series 2 and SPS 117.

PVC pipes for use as gravity sewers shall comply with AS/NZS 1260.

Solvent cement for PVC gravity sewerage pipe joint work up to 300 mm in diameter shall be to AS 3879. All other pipes shall be rubber ring jointed.

The class of the pipe shall be as specified on the Drawings. Colour is specified as in PVC4.3

Rubber joint rings shall comply with the requirements of AS1646. The rubber joint rings shall be designed and manufactured specifically for the joint system of the brand of pipe being used. They shall be supplied by the pipe manufacturer and shall carry the pipe manufacturer's identifying mark.

A well-defined entry witness mark or marks shall be permanently marked around the full diameter of the spigot end of the pipe indicating the manufacturer's maximum and minimum spigot entry depth for jointing with matching PVC pipe socket.

Pipes exceeding twelve (12) months of age from the date of manufacture and more than 6 months exposed to direct sunlight shall not be used for the construction of the pipeline without prior written approval from the *Superintendent*. Pipes showing irregularities or abnormalities shall not be used under any circumstances.

PVC4.2 Pipe Fittings

PVC4.2.1 Non-Pressure Fittings

PVC-U non pressure pipes and fittings shall comply with AS/NZS 1260 for drain, waste, and vent applications and AS/NZS 1254 for stormwater and surface water applications.

Pipes and fittings shall be third-party certified by a JAS-ANZ accredited certifier under the StandardsMark, or WaterMark schemes or acceptable equivalent.

PVC fittings of the injection moulded type shall be used in preference to the fabricated type.

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FOI 26-292 - Document 27

PVC4.2.2 Pressure Fittings

DI pipe fittings shall be in accordance with SPS106, and AS/NZS 2280 including compliance with the requirements of AS/NZS 4158 for thermal-bonded polymeric coating externally and lining internally. Fittings shall comply with AS/NZS 4020 for use in contact with drinking and recycled water and to SPS 106.

The *Contractor* shall provide documentary evidence regarding the coating system thickness and continuity and verification of the coating system applicator license.

The *Contractor* shall provide for the on-*site* sampling of each batch of coated pipe fittings and for *site* testing of the coating system continuity and thickness in accordance with AS 3894.1. The acceptance limits for continuity testing shall be as per AS 4158.

The thermal bonded polymeric coating on valves and fittings shall be in accordance with the Water Corporation coating specification G2.

PVC4.3 Pipe Colour

Pipe colour for water, wastewater and re-use water shall be as follows:

Pipe type	Pipe material	Australian standard reference clause	Water	Sewer	Recycled water
Pressure	PVC-O	CL 9.3 AS/NZS 4441	Series 2 light blue	Cream	Purple
Pressure	PVC-U	CL 2.4 AS/NZS 1477	Series 2 light blue	Cream	Purple
Pressure	PVC-M	CL 2.4 AS/NZS 4765	Series 2 light blue	Cream	Purple
Gravity	PVC-U	CL 2.3 AS/NZS 1260	NA	Grey	NA

PVC4.4 Corrosion Protection

All exposed nuts and bolts on all fittings, valves, mechanical joints, tapping bands, etc and buried metallic flanged jointwork shall be corrosion protected according to Water Corporation Corrosion Protection specification.

All coating and wrapping shall be in accordance with section 'CPP' of this specification.

PVC4.5 Timber

Where specified, all timber used for valve boxes shall be seasoned jarrah or approved similar, stress grade F8 or better to AS/NZS 2082. Timber shall be treated to hazard class H5 as specified in AS 1604. Timber shall not be used for thrust blocks.

PVC4.6 Solvent Cement

Solvent cement welding of PVC pipework shall not be used for drinking water applications.

Solvent cements and priming fluids shall be as recommended by the PVC pipe supplier and for PVC-U and PVC-M comply with AS/NZS3879, for PVC-C comply with ASTM F493.

Solvent cement and pipe cleaning fluid shall be dyed with contrasting colours.

.

For Wastewater conveyance applications, Solvent cement for PVC fittings with tapered or interference socket design shall be type N. For sockets with parallel or low interference socket design, type G solvent cement shall be used.

For chemical dosing and sampling applications, refer to Water Corporation's DS31-01.

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FOI 26-292 - Document 27

PVC4.7 Handling of Materials

During construction, storage areas shall be selected which are free from surface irregularities such as stones, branches or other sharp projections. Pipes, fittings, sluice valves, mechanical joints etc shall be loaded in accordance with the manufacturer's specification and so as to avoid shock or damage. If mechanical handling equipment such as fork lifts or cranes are to be used on bundles, adequate spreader and lifting bars should be used. Wire slings must be kept clear of the pipes.

Socketed pipes should be stacked in layers with sockets placed at alternative ends of the rack and protruding, to avoid uneven stacks and distortion. The sockets should not be allowed to carry loads. Stack heights should be limited to prevent excessive ovalisation and to manufacturer's specification.

Where gouging or heavy scratching has occurred in the pipe wall to a depth of more than is allowed by the pipe manufacturer the pipes must be rejected.

Materials shall be carefully lowered into the trench in such a manner as to prevent damage to the materials, especially the protective coatings and lining. Under no circumstances shall such materials be dropped, dumped or scraped along surfaces.

Pipe handling on skid-ways shall not be skidded or rolled against pipe already on the ground.

PVC5 CONSTRUCTION

PVC5.1 General

Sewer pipes shall generally be laid in an upstream direction and sequence. Sewer pipe laying shall include running trap installation where shown on the Drawings.

Pipes shall be kept clean at all times.

The use of sealants or similar products to remedy leakage in constructed pipes is not acceptable.

The PVC bell shall not receive any spigot other than that of a pipe of similar material and manufacture. Spigotted iron fittings shall only be jointed to a PVC spigot end using a mechanical joint.

Drainage and sewer mains should be laid with their sockets at the upstream end and their barrels firmly and evenly embedded on the bedding material. Chases are to be formed in the bedding to accommodate the pipe sockets and/or couplings to allow even bearing along the full length of the pipe barrel.

PVC5.2 Laying and Jointing

Installation of PVC pipe systems shall comply with the requirements of AS/NZS 2032, the Manufacturer, and this technical specification.

PVC5.2.1 Inspection

All pipes shall be carefully examined for cracks and other defects immediately before being installed. Spigot ends shall be examined with particular care. Defective pipe shall not be used.

PVC5.2.2 Cleaning

Care shall be taken to remove all sand and other material from the inside of the pipes before they are lowered into the trench.

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FOI 26-292 - Document 27

The inside of the socket of the laid pipe and the inside and outside of the spigot of the pipe to be laid shall be carefully wiped clean to ensure that it is clean and dry before being placed on the end of the spigot.

PVC5.2.3 Jointing

Joints between pipes shall be strictly in accordance with the manufacturer's specification, ensuring that:

a) the spigot and especially the chamfer of the mating pipe is lubricated using the pipe manufacturer's jointing lubricant only,
b) the pipes are in a straight line prior to making the joint,
c) during the jointing process the socket of the joint is adequately restrained to prevent backward movement,
d) the spigot of the joint is pushed home until the first witness mark (i.e. the mark closest to the spigot) remains just visible,
e) the pipes are not damaged during the process, and
f) the pipes shall not be bent and joints deflected more than the manufacturers recommended maximum values.

END OF SECTION

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FOI 26-292 - Document 27

WATER CORPORATION
SPECIFICATION SECTION 'QA'

QUALITY ASSURANCE

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FOI 26-292 - Document 27

Revision Status

Aquadoc # 12529201

The revision status of this specification is shown by section below. It is important to note that the latest revisions including additions, deletions and changes to this version of the specification are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

Revision Status						
Sect	**Ver / Rev**	**Date**	**Pages Revised**	**Revision Description (section, clause, sub-clause)**	**Technical Custodian**	**Specification Manager**
3 to 11	1.2	27/10/16	All	QA3, 5 & 6 – Revised Contents, QA5, 9 & 11 – Revised Contents and title, QA7 - Revised title, QA8 & 10 – Deleted section from rev1.1,	Sup. Project Engineer (PMB)	Sup Eng Const Support (PMB)
1, 6	2.0		1, 3	Title Page - Removed reference to 3 party. QA1 – amended to cover 2 party. QA6 – amended CAMEL to PQR	T L – Quality Assurance (PMBU)	Prin - Const & Tech Support (PMBU)

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FOI 26-292 - Document 27

Contents

QA1 APPLICATION OF SECTION 1
QA2 STANDARDS, CODES AND REGULATIONS 1
QA3 GENERAL 1
QA3.1 Supply Verification (SV) 1
QA3.2 Construction Verification (CV) 2
QA3.3 Pre-Commissioning 2
QA4 *PROJECT* QUALITY PLAN (PQP) 2
QA5 INSPECTION AND TEST PLANS (ITP) 3
QA6 IDENTIFICATION AND TRACEABILITY 3
QA7 INSPECTION 4
QA8 COMPLIANCE TESTING 4
QA9 NON CONFORMANCE REPORTS (CONTINUAL IMPROVEMENT NOTICE) 4
QA10 QUALITY AUDITING 4
QA11 QUALITY RECORDS 4

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FOI 26-292 - Document 27

QA QUALITY ASSURANCE

QA1 APPLICATION OF SECTION

This section specifies the requirements for Quality Assurance. It is to be read in conjunction with the quality requirements with the Conditions of *Contract*. Items in relation to QA specific to this project will be identified in the relevant section of the Project Specific Preliminaries module.

This Specification Section has been written for use with 3 party contractual terms and conditions. When used with 2 party contractual terms and conditions, the responsibilities and actions of the *Superintendent* as identified within the Specification shall be assigned to the *Principal.*

QA2 STANDARDS, CODES AND REGULATIONS

Materials and workmanship shall comply with the Specification and the relevant current Australian Standards, Government Codes and Regulations including but not limited to those listed below.

Australian Standards

AS/NZS ISO 9000	Quality management systems – Fundamentals and vocabulary
AS/NZS ISO 9001	Quality management systems – Requirements
AS/NZS ISO 9004	Managing for the sustained success of an organization – A quality management approach

Standards

ISO/ICE 17025	General Requirements for the competence of testing and calibration laboratories.

QA3 GENERAL

The *Contractor* is required to control the quality of the *work* and fully implement a quality management system under this *Contract* in accordance with AS/NZS ISO 9001 or an approved equivalent Quality Assurance (QA) system.

The *Contractor* shall manage the revision and release of all *Contractor* supplied documents, including drawings (if applicable) and be able to demonstrate to the *Superintendent* that the documents used for the *WUC* are the approved revision.

The *Contractor* shall demonstrate the achievement of the specified standards through *testing*, measurement and the provision of documentation for the *WUC*, both on-*site* and off-*site* including the activities of all subcontractors and suppliers.

The *Contractor* shall prepare its own Quality Management System in the form of Procedures, Inspection and *Test* Plans (ITPs), Inspection and Test Records (ITRs) and Check Sheets for *the Works*. They shall be relevant to the *testing* and audit *testing* procedures and frequency of *testing* requirements of the specification and be not less stringent than those set out in this Specification.

QA3.1 Supply Verification (SV)

The quality of each procured, supplied and installed item, of civil, mechanical and electrical equipment, process control (including, where specified, SCADA system) hardware and software, shall be individually certified in accordance with the Standards, Codes, and specified requirements including:

a) all relevant equipment and major peripherals shall have the equipment details recorded on the corresponding ITP/ITR along with the respective and applicable test sheets or certificates;

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FOI 26-292 - Document 27

b) items such as spares, first fill consumables, manuals shall be tracked;

c) packaged equipment (including control systems) shall have Factory Acceptance Test (FAT). FAT plans, check sheets and records shall be provided for review at least fourteen (14) days before the FAT. Note that *Contractors* will also provide Supplier Acceptance Test (SAT) procedures and check sheet for these packages. The *Superintendent* shall be invited to witness each FAT; and

d) Instrumentation shall be reviewed for verification and tested for accuracy before installation. This should be either supplier pre-calibration or on site calibration.

QA3.2 Construction Verification (CV)

The quality of each constructed component of the *Works* shall be individually *tested* and certified as complying with specified requirements including:

a) ITPs – The inspection and testing based on agreed ITPs, showing associated ITRs or test sheets;

b) the works to be inspected or witnessed in accordance with *Superintendent's* inspection program and utilise the *Contractor's* ITP and supervisors; and

c) The civil, mechanical, electrical and instrumentation construction to have the ITRs reviewed and audited by the Superintendent during construction completion. All audits to be carried out with equipment in a non-energised state.

QA3.3 Pre-Commissioning

The functional quality of the *Works*, including individual and integrated components, assemblies and controls systems, shall be pre-commissioned (e.g. by dry-testing) and formally certified as complying with specified performance requirements prior to the commencement of any commissioning related *work*. Pre-commissioning *work* shall include verification by testing of the following:

a) liquid retaining facilities and pipework constructed in accordance with the specified material, structural and hydraulic parameters;

b) equipment including security and safety systems operationally functional within the specified production, performance and efficiency parameters; and

c) electrical and instrumentation devices energised and operationally functional and checked by bump / rotation tested, opened, closed, loop tested or SAT tested.

QA4 *PROJECT* QUALITY PLAN (PQP)

The Contractor's proposed Project Quality Plan (PQP) shall be submitted to the *Superintendent* within fourteen (14) days of *contract* award. The *Superintendent* may, at its discretion, require modifications before the PQP is accepted for use. The purpose of the PQP is to take a risk based approach to quality items required under the *Contract*.

The *Contractor* shall produce a PQP, for the purposes of *WUC*, including:

a) all the elements of the nominated management system, as applicable to *WUC*, including a Quality Register of all ITPs and ITRs;

b) *Contractor* organisation chart or list of nominated personnel showing their positions, management structures and the responsibilities of each position in detail;

c) Details of specific *work* items and operating procedures together with the staff positions responsible for identifying implementing, verifying, registering and distributing the associated quality records;

d) ITPs and ITRs of each *work* items submitted at least seven (7) days prior to commencement of the activity;

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FOI 26-292 - Document 27

e) *Test* facility NATA accreditation for all testing *work* proposed (and *test* apparatus and instrument calibration certificates if not included in the NATA accreditation); and

f) Details of any other quality records to be generated by *WUC* and pro-forma templates for these records.

QA5 INSPECTION AND TEST PLANS (ITP)

ITPs shall be implemented to record the following information for each significant activity and *work* item as defined:

a) description of activity;

b) specified requirements, Specification and *test* method references;

c) staff position responsible for activity;

d) hold points and witness points;

e) activity checklists;

f) *Test* type;

g) standards and codes compliance and other performance and acceptance criteria and tolerances;

h) identification of associated quality system procedures and records;

i) *Test* frequency; and

j) *Work* item identification.

ITPs shall be submitted to the *Superintendent* who may direct the addition of hold points and witness points to those already specified. Provision shall be made for sign-off at each hold point and witness point as appropriate. For each witness point and hold point, the *Contractor* shall notify the *Superintendent* at least one (1) day prior to the *work* being undertaken.

The *Contractor* shall be responsible for seeking and confirming acceptance from the *Superintendent* on using any ITP or ITR. The Water Corporation has a selection of sample and template ITPs and ITRs and can be made available to the *Contractor* upon request.

QA6 IDENTIFICATION AND TRACEABILITY

The *Contractor* shall maintain a Quality Register of all *work* items with numbers assigned. The Quality Register may be based on the *Principal*'s Project Quality Register (PQR) index or as proposed by the *Contractor* in the PQP. Each *work* item number shall, as a minimum, contain the following information:

a) a unique number or reference;

b) a drawing number, specification reference or chainage for the *work* item;

c) a brief description of the *work* item, including tag, equipment, size, rating or make and model if it is for an electrical, mechanical or SCADA item;

d) a column identifying *Principal* Supplied items;

e) a column identifying the *Contractor*'s nominated representative and the *Superintendent's* nominated representative for inspection of the *Works*. The representatives may be Commission Manager, Quality Assurance Assessor (QAA) and mechanical, electrical and SCADA representatives; and

f) a column identifying the status of Supply Verification (SV), Construction Verification (CV), Pre-Commissioning and Commissioning.

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FOI 26-292 - Document 27

The *Contractor* shall:

a) maintain traceability of each record relating to a *work* item in the Quality Register;

b) maintain and display the Quality Register on site and allow *Principal*'s SV documents to be co-located on site;

c) provide all quality records to the *Principal* progressively. The method and frequency of providing the records shall be proposed in the PQP and accepted by the *Superintendent*; and

d) maintain the Quality Register that all records are identified by a title combined with the unique item and the type of record (SV, CV, Pre-Commission, Commissioning). For example, the file name can be 10-1_SV_Submerisble_Pump_1.

QA7 INSPECTION

The *Superintendent* shall be provided access to any facility where *work* associated with the *Contract* is being performed, including the facilities of subcontractors or suppliers and any laboratory used for testing.

QA8 COMPLIANCE TESTING

Compliance testing shall be based on *work* items as defined and carried out by NATA accredited *test* facilities (or, if appropriate, by equivalent overseas *test* facilities duly accredited in accordance with ISO/IEC 17025). The frequency of compliance testing shall be as specified in the *Contract*.

Sampling methods shall be unbiased and either random or systematic in concept or as specified.

QA9 NON CONFORMANCE REPORTS (CONTINUAL IMPROVEMENT NOTICE)

The method of isolating or identifying non-conforming *work* or applying and releasing hold points shall be clearly stated in the PQP. The requirements of reviewing effectiveness of corrective actions shall be stated in the PQP.

Non-conformance reports shall be submitted within five (5) days of nonconforming *work* being identified. Non-conformance reports shall include:

a) nature and extent of non-conformance;

a) *Work* item number;

b) any relevant information, data, *test* reports and/or measurements (as applicable);

c) corrective actions proposed to address all non-conformances and to prevent recurrence; and

d) the timeframe within which the non-conformance will be rectified.

QA10 QUALITY AUDITING

The *Contractor* and the *Superintendent* shall undertake audits of the *WUC* using the Quality Register and associated ITPs/ITRs to verify the *works* being constructed are in accordance with the *Contract*. The *Contractor* shall support and provide assistance to the *Superintendent* for all audits.

QA11 QUALITY RECORDS

The quality records produced or any other documents required by the *Contract* for *WUC* shall be submitted to the *Superintendent* prior to the *date for practical completion*, including:

a) all non-conformance reports;

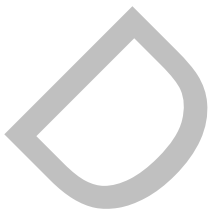
b) the duly completed ITPs and ITRs;

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FOI 26-292 - Document 27

c) the *Contractor*/Original Equipment Manufacturer (OEM) test records;
d) red line markup drawings with all changes to the *WUC*;
e) installation, operation and maintenance manuals for the *WUC*; and
f) other records as defined in the *Contract*.

END OF DOCUMENT



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WATER CORPORATION
ABN 28 003 434 917

S151 Prevention of Falls (Design)

Doc ID	Custodian	Approved
9220625	Senior Principal Engineer – Dams & Dam Safety	Head of Engineering
Version Date 15 November 2018	**Accountability Framework** Level 1 - Acquire Infrastructure Assets Level 2 - Design Assets	**Stakeholders** Water Corporation, alliance and contractor employees involved in design, construction, operation, maintenance and decommissioning of infrastructure assets.
Next Review Date 15 November 2019		

CONTENTS

1 General Information 2
1.1 Purpose 2
1.2 Scope 2
2 Prevention of Falls 2
2.1 Policy and Principles 2
2.2 Hierarchy of controls for fall protection 2
2.2.1 Asset-based controls 3
2.2.2 Fall injury prevention systems 3
2.2.3 Typical fall injury prevention controls 3
3 Asset Features 3
3.1 Site access by other parties 3
3.2 Access to and Egress from Work Areas 4
3.2.1 Selection of an appropriate access or egress method 4
3.3 Stairways 4
3.4 Fixed Ladders 4
3.5 Ladder Climbing System 5
3.6 Walkways and Platforms 6
3.7 Grid Mesh Flooring 6
3.8 Edge Protection 6
3.8.1 Guardrails 7
3.8.2 Portable barriers 8
3.9 Protection for Holes and Openings 8
3.9.1 Protective covers 9
3.9.2 Safety grates 9
3.9.3 Edge protection 9
3.10 Anchors 10
3.11 Davit Systems 11
3.12 Signage 11
4 Emergency Rescue 11
5 Definitions 11
6 References 12
7 Compliance Mapping 13

DRAFT

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1 General Information

1.1 Purpose

This standard defines minimum design requirements for the prevention of falls from height to ensure that the risk of injury is eliminated or minimised to as low as reasonably practicable (ALARP).

Working at height refers to any situation where a person working at any level has the potential to fall from, through or into any place or thing. This may occur above, at, or below ground level.

1.2 Scope

This standard is the primary corporate reference on design elements to prevent falls from height when designing assets. More detailed information about specific design will be found in the various subsidiary documents referenced within.

Excludes:

- Management of work activities where falls is a risk, see HSEAA-P-143 Falls

2 Prevention of Falls

2.1 Policy and Principles

Fall from height risks must be eliminated or reduced to as low as reasonably practicable (ALARP).

2.2 Hierarchy of controls for fall protection

The hierarchy of controls is an essential consideration when designing assets to reduce fall risks.

The hierarchy of control is:

- **elimination** – remove the need for the worker to be exposed to the fall risk, such as by relocating equipment to ground level
- **substitution** – substitute with a safer option such as by replacing a vertical ladder with a stairway
- **isolation** – isolate the worker from the fall risk such as by installing a guardrail or grate
- **engineering control** – engineering a solution such as a ladder climbing system or davit entry to a wet well
- **administrative control** –warning signs
- **personal protective equipment** – gloves, hard hat, harness

Ideally the fall risk can be eliminated by eliminating the need for a worker to be in the fall risk situation at all. However, if the fall risk cannot be eliminated, then a lower level control, or combination of controls, must be applied. The highest practicable level of control must be used.

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FOI 26-292 - Document 27

2.2.1 Asset-based controls

Asset-based controls are the physical asset features which reduce workers' exposure to fall risks.

Common asset-based controls are stable working platforms and walkways, rated edge protection, and davits.

Section 3 Asset Features describes the asset-based controls to be applied.

2.2.2 Fall injury prevention systems

A fall injury prevention system (FIPS) is a system or arrangement designed to prevent a person falling from one level to another. FIPS includes fall-restraint systems, fall-arrest systems and scaffolding systems.

2.2.3 Typical fall injury prevention controls

Typical fall prevention controls used on Water Corporation assets are shown in Figure 2-1 below. The controls shown include asset-based controls (e.g. guard railing), FIPS (e.g. ladder climbing system), and administrative controls (e.g. exclusion zone).

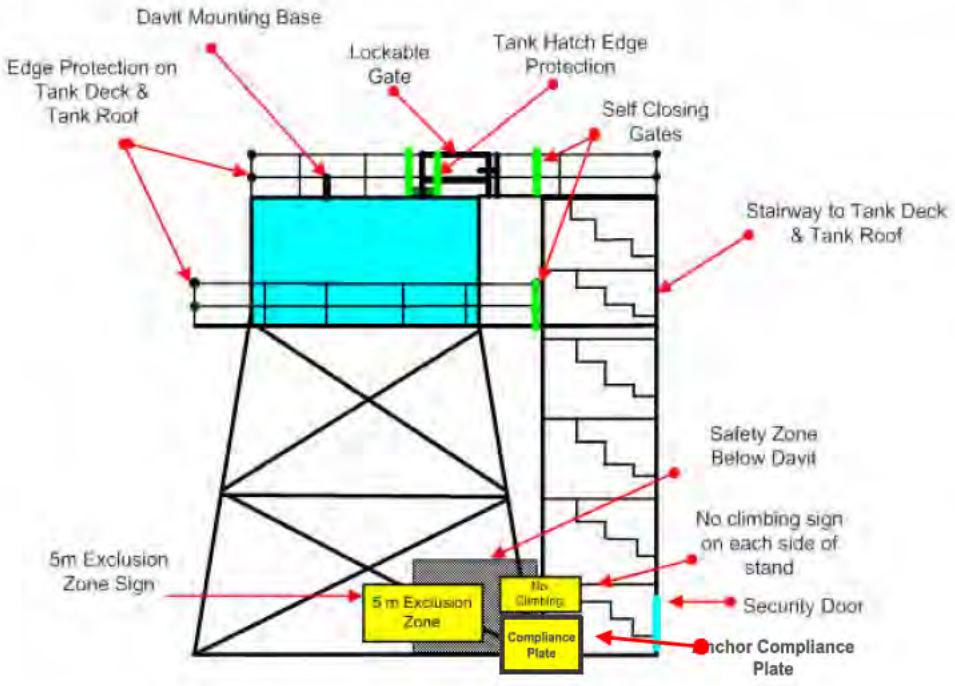


Figure 2-1 Typical fall prevention elements on an elevated tank

3 Asset Features

3.1 Site access by other parties

Consider asset features associated with other parties who may access a Water Corporation site such as related to:

- areas accessible to the public e.g. observation platforms
- access and egress for emergency services
- sites at risk of attracting trespassers e.g. high structures

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FOI 26-292 - Document 27

3.2 Access to and Egress from Work Areas

Arrangements shall be provided for safe access to, egress from, and movement around the work area. This requires consideration of aspects such as:

- walkways
- stairways
- ladders
- fixed and temporary work platforms
- fall injury prevention systems
- requirements for the movement, storage and use of equipment and tools
- the safety of work surfaces
- signage
- lighting

3.2.1 Selection of an appropriate access or egress method

The required means of access and egress to a worksite are:

- level walkway
- sloping walkway
- stairway
- fixed inclined ladder
- fixed vertical ladder
- portable ladder

The appropriate access or egress method for a specific asset will depend on the circumstances. However the highest practicable level of protection must be used.

Where an asset-based access or egress method is not practicable, a non-asset based access method may be required, such as a Bosun's chair.

3.3 Stairways

A stairway is the preferred means of access to a work area where a large vertical distance is involved, and a level or sloping walkway is not practicable.

Requirements:

1. Where permanent access is required to another level 3m or greater, an access stairway shall be provided, where practicable.
2. Where access is required to another level less than 3m, a stairway shall be provided where indicated by a risk assessment.
3. Where a stairway is not practicable, the next highest control measure shall be provided. See 3.4 Fixed Ladders.
4. Access ladders on existing assets shall be upgraded to a stairway, where indicated by a risk assessment.
5. Stairways shall comply with AS1657 Fixed Platforms, Walkways and Ladders.

3.4 Fixed Ladders

Fixed ladders are used for access and egress where a stairway is not practicable.

Requirements:

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FOI 26-292 - Document 27

1. Fixed access ladders shall be provided for access to a work site or platform where a higher form of access (e.g. stairway) is not practicable.
2. Where a fixed ladder is not practicable, an alternative safe access method shall be chosen such as portable davit. See section 3.11
3. The preferred type of ladder, in priority order is: step ladder, inclined rung ladder then vertical rung ladder.
4. Generally, fixed ladders shall not be provided for access into wet-wells, valve pits, access chambers and other below-ground structures. The provision of a fixed ladder shall be based on a risk assessment. Also see (5).
5. Wastewater pump stations without a non-fail isolation valve or penstock shall have an access ladder installed.
6. Fixed ladders shall comply with AS1657 Fixed Platforms, Walkways and Ladders.

3.5 Ladder Climbing System

A ladder climbing system (LCS) is a fall-arrest system which provides continuous fall protection for workers using fixed ladders. While using the ladder, the worker wears a harness anchored to a steel rail or cable by a rope grab. In the event of a fall, the locking mechanism in the grab will engage, gripping the rail or cable and arresting the fall. Free fall is limited to a maximum of 600mm.

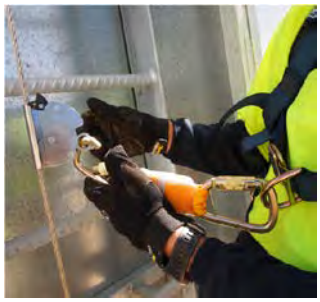


Figure 3-1 A cable grab on a ladder climbing system

Requirements:

1. A ladder climbing system shall be fitted to:
   - fixed ladders over 3m, where practicable.
   - fixed ladders less than 3m high, where a potential fall is 3m or greater (such as where the base of the ladder is located near an edge from which someone could fall to a lower level).
   - other ladders, where indicated by a risk assessment.
2. A ladder cage should not be installed where a ladder climbing system is provided. (Cages do not provide sufficient protection from falls and can make rescue difficult.)
3. A ladder climbing system shall not be fitted to internal ladders inside water tanks, wet-wells, surge vessels or similar structures.
4. Ladder climbing systems shall comply with *AS/NZS 1891.3 Industrial Fall-Arrest Systems and Devices: Fall-Arrest Devices and AS/NZS 1891.4 Industrial Fall-Arrest Systems and Devices: Selection, Use and Maintenance*.

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5. Ladder climbing systems shall be installed in accordance with 6037565 Ladder Climbing System - Installation Testing and Maintenance Procedure

6. Ladder climbing systems shall have an anchor point compliance plate fitted. Refer to 4437923 Prevention of Falls Equipment - Inspection, Testing and Maintenance.

7. Ladder climbing systems shall be maintained in accordance with 4437923 Prevention of Falls Equipment - Inspection, Testing and Maintenance.

3.6 Walkways and Platforms

Walkways and platforms are used for access and egress to site, and to provide a stable work platform for workers, material and equipment. Walkways and platforms must be stable and strong enough for their intended uses and provide protection from slips and falls.

Requirements

1. The design of walkways and platforms shall consider the range of uses and activities likely to be conducted from the walkway or platform over the life of the asset.

2. Walkways and working platforms shall comply with AS 1657 Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction.

3.7 Grid Mesh Flooring

Grid mesh is used for flooring on walkways, access ways and working platforms. To avoid severe fall hazards, grid mesh flooring must be correctly designed, installed, used and maintained.

Requirements:

1. Grid mesh flooring shall be designed and constructed in accordance with 3889754 DS100 Suspended Flooring (Grid Mesh and Chequer Plate)

2. Each panel shall be securely fixed to the supporting structure before the next panel is placed in position.

3. Where practicable, panels should be fitted to a structure prior to the structure being lifted into its permanent position.

4. Grid mesh, installed as part of a new asset or major asset upgrade, shall be inspected during the final OSH inspection for the project, prior to handover to Water Corporation. Refer to 589724 OSH Handover Report Guideline.

5. Where grid mesh panels are removed, the opening shall be immediately protected by a suitable cover.

6. If grid mesh panels are removed, a protective barrier and/or exclusion zones shall be provided if there is a risk of a fall, or where otherwise indicated by a risk assessment.

3.8 Edge Protection

Edge protection guardrailing is a barrier which prevents a worker accessing an open edge or opening where there is a risk of a fall. Guardrails usually consist of handrails, midrails and toeboards.

Generally a fall risk exists if a worker can approach within 2m of an open edge or other fall hazard, such as a fragile roof. However this minimum approach distance must be increased where there are additional risk factors such as a windy location, or a sloping, slippery or uneven surface.

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Edge protection may be permanent, such as a permanent guardrail around a working platform on a tank, or temporary, such as scaffolding or the Kennedy portable barrier system.

Edge protection has specific design requirements as detailed below:

3.8.1 Guardrails

1. A guardrail (or alternatively a fall injury prevention system - see 3 below) shall be provided:

    - where there is risk of falling 3m or more
    - where otherwise indicated by a risk assessment.

2. A guardrail shall be provided where there is a risk of falling 2m or more from the edge of a decking, fixed stair, landing, scaffold, suspended slab, formwork or falsework.

3. Where guardrailing in (1) is not practicable, a fall injury prevention system shall be provided. Examples of where a guardrail may not be practicable are:

    - where access is infrequent
    - where work is of low-intensity, low-complexity or short duration
    - where the risk exposure of providing guardrailing exceeds the benefit.

4. Where a fall hazard exists at the entry points to an asset (e.g. roofs or wet well), guardrailing shall be provided for a minimum distance of 2m on each side of the entry point.

5. Guardrailing around hatches and similar openings shall fully surround the opening. (Except for the access point with self-closing gate.)

6. Guardrailing shall be applied to regular work platforms and walkways where there is a fall risk within 2 m of the platform or walkway. e.g. a work platform on top of a tank located within 2 m of an open edge or fragile roof.

7. Guardrailing to areas *beyond* a regular work platform or walkway, where only infrequent access is required, shall be provided where indicated by a risk assessment.

    e.g. On a tank roof, guardrailing would typically only be provided at locations where there is a significant fall risk - i.e. at the roof access point, or around a work area within 2m of an open edge or other fall hazard.

    Edge protection would generally *not* be provided to protect a wider zone, such as the complete roof circumference, where only infrequent access to the area is required.

    Should it be necessary for a worker to access an unprotected area, such as approach within 2m of an open edge, alternative controls must then be applied. Alternative controls include an elevating work platform, fall-restraint tethering and /or control zones.

8. A self-closing gate shall be installed at the entry point to a work area where there is a fall risk. The gate shall be installed:

    - opening inwards at the point of entry to a roof or platform
    - opening outwards at the point of entry to a barrier around a wet-well, hatch, pit or similar opening

9. Guardrailing on surfaces with less than 15° pitch shall be constructed to withstand 55kg (0.55kN) applied at any point on the guardrailing. (For roofs with greater than 15° pitch refer to *AS1657 Fixed Platforms, Walkways and Ladders*.)

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FOI 26-292 - Document 27

10. Guardrail design shall consider the expected range of work activities conducted over the life of the asset, and the integrated operation of the infrastructure and equipment, such as:

    - ladder access to the work platform
    - the location and uses of davits
    - access for workers and equipment to openings and hatches
    - transport and use of tools and equipment
    - rescue and emergency access capability.

11. Where guardrails are required on steel structures or tilt up structures, where practicable, they shall be installed at ground level prior to lifting the structures into place.

12. Guardrails shall comply with AS 1657 Fixed Platforms, Walkways and Ladders, and AS 4576 Guidelines for Scaffolding, as appropriate.

3.8.2 Portable barriers

Portable barriers provide a temporary guardrail system where installation of a permanent guardrail is not practicable.



Figure 3-2 The Kennedy portable barrier system

3.9 Protection for Holes and Openings

Holes and openings through which a person could fall or receive a serious injury must be protected.

Different types of holes and openings require worker access for different reasons. Examples are valve pits, access chambers, wet-well access openings, tank hatches, and openings caused by the removal of grid-mesh flooring.

The appropriate control to be applied depends on the nature of the asset, the fall risks, and the types of work conducted. Effective controls may include a mix of covers, grates, edge protection or FIPS.

It is preferred that openings are protected by a physical fall barrier, rather than by FIPS as it is a higher level of control.

Examples of how openings can be protected:

- a grate covering a valve pit, drain, or duct
- a cover with a removable grate beneath – where frequent surface work can be conducted while leaving the grate in situ by opening the cover only (i.e. entry to the cavity is not required)
- a cover only - where frequent internal access to the cavity is required rather than surface only access – i.e. a grate is not required as the workers will always be anchored to FIPS for entry into the cavity

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FOI 26-292 - Document 27

- no cover or grate - where permanent edge protection is used, such as around a valve pit, or in low fall risk situations

Requirements:

1. Holes and openings into which someone could fall, must be protected

3.9.1 Protective covers

1. Protective covers (i.e. covers intended for fall prevention) shall be made of a material of adequate strength to prevent entry of objects or persons, and be fixed securely.
2. Protective covers shall comply with load and deflection criteria in AS1170 (set) Structural Design actions - permanent, imposed and other actions.

3.9.2 Safety grates

1. A safety grate shall be considered for the following situations:
   - to protect an opening, such as a drain, wet-well opening, open tank hatch, or opening caused by the removal of grid mesh flooring
   - in circumstances where work could be conducted through an opening in the safety grate without needing to remove the grate. (i.e. Placing a safety grate in position allows the worker sufficient and safe access to the work, avoiding the need for additional fall prevention methods.)
2. A safety grate is not required beneath a protective cover where the main reason for opening the cover is for a worker to physically enter the opening. (However, the worker must be attached to a fall injury prevention system.)
3. Unless a safety grate is designed to be walked on, it shall have a *No Step* sign attached..
4. Safety grates shall comply with load and deflection criteria in AS1170 Structural Design actions - permanent, imposed and other actions.

3.9.3 Edge protection

1. Generally, openings larger than 2m x 2m or 2m diameter shall have edge protection installed, or workers must use FIPS. See Section 3.8.1 - Guardrails.

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3.10 Anchors

Anchors are secure points of attachment for fall injury prevention equipment: static lines, restraint systems, ladder climbing systems, and davit arms. The following types of anchors are used:

- permanent fixed anchor
- temporary anchor such as a temporary roof anchor or sling
- davit base
- ladder climbing system

Anchors have specific design and usage requirements.

The anchor compliance plate indicates the inspection and test status of the anchor.



Figure 3-3 Anchor Point Inspection and Testing Compliance Plate

Requirements

1. Anchors shall be designed, manufactured, constructed, selected and installed in accordance with *AS/NZS 1891.4 Industrial Fall-Arrest Systems and Devices: Selection, Use and Maintenance.*
2. For frequent work, permanent anchors shall be established where possible. For infrequent work, temporary anchors may be established, such as slings around structural sections and temporary roof anchors.
3. Single point anchors (for single person attachment) shall have an ultimate strength of at least 15kN (1500kg).
4. Double anchors (for two person attachment) shall have an ultimate strength of at least 21kN (2100kg).
5. For anchors for static lines refer to manufacturers' requirements.
6. Where practicable, anchors shall be designed such that they do not require regular proof-load testing e.g. flush mount davit bases.
7. Permanently fixed anchors shall have an Anchor Point Inspection and Testing Compliance Plate (see Figure 3.3 above) displaying inspection and test status.
8. Permanently fixed anchors shall be inspected, tested and maintained by competent personnel in accordance with 4437923 Prevention of Falls Equipment - Inspection, Testing and Maintenance.

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3.11 Davit Systems

Davits are commonly used for raising and lowering equipment, moving workers to a different work level, such as in confined space entry, and for performing rescues. Various davit types are used in Water Corporation. Davit systems include the davit base, davit arm, digital winch for raising and lowering, and a recovery winch with inertia reel (type 3 winch).

Davit systems have defined design and maintenance requirements.

Requirements:

1. The permanent davit base and supporting structures shall be capable of sustaining a fall-arrest ultimate load of 15kN (1500kg) applied at the suspension point of the davit.
2. Davit bases shall be located with regard for all intended uses, including consideration of the relationship to adjacent equipment and infrastructure such as valves, hatches and guardrails, and accessibility for proof-load testing.
3. Davit bases shall have an associated Anchor Point Inspection and Testing Compliance Plate fitted. Refer to 4437923 Prevention of Falls Equipment - Inspection, Testing and Maintenance.
4. Where practicable, davit bases shall be designed such that they do not require regular proof-load testing e.g. flush mount davit bases.

3.12 Signage

Signage is an administrative control which may be required in some circumstances. Applicable signage types are:

- Keep Off Brittle and Fragile Roof
- No Step
- Control Zone
- Emergency Exit
- Safety Harness Must be Worn

For further details of signage refer to 384149 S197 Public Safety and Site Security Signage.

4 Emergency Rescue

When designing an asset, consideration must be given to access to people in a rescue situation.

5 Definitions

Term	Definition
ALARP	As low as reasonably practicable.
Code of Practice	Refers to the *WA Code of Practice for the Prevention of Falls at Workplaces 2004.*
fall-arrest system	A system designed to minimise the risk of injury associated with a free fall. A fall-arrest system must be designed so that a user cannot sustain a force greater than 6kN in the event of a fall.
fall prevention cover or grate	A cover or grate designed to prevent a person falling into or through an opening.
fall-restraint system	A system designed to prevent a user from getting into a position where a fall is possible.

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Term	Definition
FIPS, fall injury prevention system	A system designed to do the following: (a) arrest a person's fall from one level to another, or (b) minimise the risk of injury or harm should a person fall from one level to another. Examples of FIPS are ladder climbing system and scaffolding.
grid mesh	A metal or fibre-reinforced plastic panel used in the construction of walkways or platforms.
Kennedy barrier	A portable barrier / guardrail system providing edge protection around entry points such as wastewater wet-wells.
LCS, ladder climbing system	A fall-arrest system which provides continuous fall protection for persons using ladders. It consists of a rail sleeve or cable to which an operator wearing a fall-arrest harness can connect with a short lanyard and cable grab while ascending or descending the ladder.
practicable	Means capable of being done and reasonable to do considering all factors.
rated anchor / anchor point	An anchor point for a davit base or FIPS equipment intended for fall-restraint or fall-arrest and complying with *AS/NZS1891.4*.
must	Means mandatory.
Should	Means *recommended* and should be done unless there is an alternative equally safe or safer method.
worker	May be Water Corporation employee or contractor.
working at height	Refers to any situation where a person working at any level has the potential to fall from, through or into any place or thing, including falling down sloping surfaces. The situation may be above, at, or below ground level e.g. working on an elevated tank, working in or around a wastewater wet-well or working near an excavation.

6 References

Maintenance

- 4437923 Prevention of Falls Equipment - Inspection, Testing and Maintenance
- 6037565 Ladder Climbing System Installation - Testing and Maintenance Procedure

Occupational Safety and Health

- HSEAA-P-143 Falls procedure
- 6902367 B-Safe Rope Grab Instruction Manual
- 2776585 WC-OSH 036 Reinstated Grid Mesh Panel Assessments Procedure
- 7406902 Access into Wet Wells or Access Chambers - Guidelines
- 367451 S152 Public Safety at Construction Sites
- 384149 S197 Public Safety and Site Security Signage.
- 4614553 Rescue Planning Guideline
- 7584548 Rescue Plan Tracker
- 6410437 Radio Frequency Radiation Safety Procedure

Design Standards

- 168446 DS51 Design and Construction of Wastewater Pumping Stations and Pressure Mains 4.5 to 90 Litres per Second Capacity
- 1596772 DS61 Water Supply Distribution – Tanks

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DS62 – Standard Security Treatments (Restricted access – contact the Security Program Manager)

- 1052757 DS62 Guidance Notes for Security Treatments
- 3889754 DS100 Suspended Flooring (Grid Mesh and Chequer Plate)

Standard Drawings

- Security and General Fencing - Planset GX54
- Prevention of Falls Equipment - Planset IP76

Legislation and related documents

- Occupiers' Liability Act 1985
- Prevention of Falls at Workplaces - Code of Practice (2004)
- Code of Practice: Excavation (2005)

Referenced Australian Standards

AS 1170 (set)	Structural Design actions - permanent, imposed and other actions
AS 1657	Fixed Platforms, Walkways and Ladders
AS/NZS 1891.3	Industrial Fall-Arrest Systems and Devices: Fall-Arrest Devices
AS/NZS 1891.4	Industrial Fall-Arrest Systems and Devices: Selection, Use and Maintenance
AS 1892.5	Portable ladders Part 5: Selection, safe use and care.
AS/NZS 4576	Guidelines for Scaffolding

Document Revision History	
10 August 2007	First issue
8 April 2008	Section 13 revised
10 March 2009	Major revision
7 July 2010	Major revision including clarification for ease of understanding
16 July 2013	Major revision after a wide stakeholder review. (Refer to 9228871 for a list of revisions).
15 November 2018	Document updated to reflect only design requirements relating to prevention of falls. Content relating to falls risk when working is now addressed by HSEAA-P143 Falls. Refer to NOC 20377247.
16 December 2018	Accountability changed to Level 2 Design Assets and a new Custodian Michael Smith.

7 Compliance Mapping

Applicable Legislation, Standards and Codes of Practice

Key regulatory documents relevant to fall prevention are:

- *Occupational Safety and Health Act 1984*
- *Occupational Safety and Health Regulations 1996*
- *Code of Practice on the Prevention of Falls at Workplaces 2004*
- Various Australian standards.

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FOI 26-292 - Document 27

WATER CORPORATION

Assets Delivery Group
Infrastructure Design Branch

Strategic Product Specification

SPS 106

Ductile Iron Pipe Fittings for Pressure Applications

VERSION 2
REVISION 3

MAY 2017

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FOI 26-292 - Document 27

FOREWORD

Each Strategic Product Specification has been prepared to inform Water Corporation staff, consultants, contractors and land developers of the requirements for selecting and acquiring a manufactured product to be used in strategic Corporation infrastructure. The definition of 'Product' includes items that comprise assembled components, equipment or plant for mechanical, electrical and civil infrastructure applications.

The objective of a Strategic Product Specification is to specify fit-for-purpose Product which will contribute to the provision of effective water services at least whole-of-life cost and with least risk to service standards and safety. A Strategic Product Specification also provides uniform standards for compatibility of new water infrastructure with existing water assets.

Many Strategic Product Specifications have drawn on the design, asset management and operational experience of Product performance in live service gained by the Corporation over time. Some Strategic Product Specifications have drawn on the experience of the water industry nationally by referencing Australian or WSAA standards.

Strategic Product Specifications are intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure design and construction work;
- Private developer funded subdivision infrastructure for takeover by the Corporation;
- Operationally funded infrastructure design and construction work;
- Corporation period contracts for Product purchases;
- Product purchases for stock or for miscellaneous minor work.

A published Strategic Product Specification will, in some cases, comprise technical content that is typical of a range of products of the same type (type specification) but may exclude specific requirements that should apply to a particular project or application. In such cases, the project designer is required to document the supplementary project specific requirements in the appropriate Clause of the 'Project Specific Requirements' Appendix of the Specification.

The text of a published Specification should not be directly modified. In the event that a text variation is considered necessary to accommodate the needs of a particular project or application, the text modification should be documented in the appropriate Clause of a 'Project Specific Requirements' Appendix.

Enquiries relating to the technical content of this Specification should be directed to the Principal Engineer, Wastewater Conveyance Section, Infrastructure Design Branch to whom all enquiries relating to the technical content of the Specification should be directed. Future Specification changes, if any, will be issued to registered Specification users as and when published.

Manager, Infrastructure Design Branch

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REVISION STATUS

The revision status of this specification is shown section by section below. It is important to note that revisions including additions, deletions and changes to this version of the standard are also identified by use of a vertical line in the left hand margin, adjacent to the revised section.

REVISION STATUS						
SECT.	VER./ REV.	DATE	PAGES REVISED	REVISION DESCRIPTION (Section, Clause, Sub-Clause)	RVWD.	APRV.
0	2/0	02.03.07	All	New Version	KR	LL
0	2/1	25.06.14	All	Substituted Generic Foreword	KR	DV
1	2/0	02.03.07	All	New Version	KR	LL
1	2/1	25.06.14	All	1.1 to 1.4 updated as template	KR	DV
1	2/3	03.05.17	6-7, 9	1.3, 1.4.2 – 1.4.5, 1.4.21 updated	KR	KP
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5	2/1	25.06.14	All	Formatting and minor edits	KR	DV
5	2/2	26.10.16	14 to 32	Review/update of all MMR	IP/KR	KP
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FOI 26-292 - Document 27

Strategic Product Specification

SPS 106

Ductile Iron Pipe Fittings for Pressure Applications

CONTENTS

Section *Page*

1 Scope and General 6
1.1 Scope 6
1.2 Service Conditions 6
1.3 Reference Documents 6
1.4 Definitions and Notation 7
1.4.1 Australian Standards® 7
1.4.2 Certificate 7
1.4.3 Certification (or Conformity Assessment) Body 7
1.4.4 Certification Mark 7
1.4.5 Certification Scheme 7
1.4.6 Compliant Product 7
1.4.7 Corporation 7
1.4.8 Manufacturer 7
1.4.9 Notation 7
1.4.10 Officer 7
1.4.11 Product 8
1.4.12 Product Appraisal 8
1.4.13 Product Assessor 8
1.4.14 Product Certification 8
1.4.15 Product Verification Report 8
1.4.16 Product Warranty 8
1.4.17 Purchasing Schedule 8
1.4.18 Quality System 8
1.4.19 Standards Australia 8
1.4.20 Strategic Product 9
1.4.21 Strategic Product Appraisal Process 9
1.4.22 Supplier 9
1.4.23 Testing 9

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FOI 26-292 - Document 27

2 Materials, Design and Performance 10
2.1 General 10
2.2 Flanged Fittings 10
2.3 Fitting Joint Seals 10
2.4 Dimensions 10
2.5 Pressure Classification 10
3 Transportation, Handling and Storage 11
3.1 General 11
3.2 Preservation of Product in Storage 11
4 Quality Assurance 12
4.1 Certification 12
4.1.1 Certification of Product 12
4.1.2 Quality System 12
4.1.3 Product Re-verification 12
4.2 Compliance and Acceptance 12
4.2.1 Means of Demonstrating Compliance 12
4.2.2 Acceptance Criteria 13
4.3 Non-compliant Product 13
4.3.1 General 13
4.3.2 Manufacturing Repairs (In-process) 13
4.3.3 Product Warranty 13
4.3.4 Product Repair 13
5 Appendix A 14
5.1 Material Master Records 14

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FOI 26-292 - Document 27

1 Scope and General

1.1 Scope

This specification shall apply to the manufacture, supply, transportation, handling, delivery and storage of ductile iron pipe fittings for water and wastewater pressure applications, hereinafter referred to as Product. The Specification also details acceptance criteria for ductile iron pressure pipe intended for infrastructure project use and the means of demonstrating compliance with the Specification.

1.2 Service Conditions

For compliance with this specification, DI pipe fittings shall be designed for a service life expectancy in excess of 100 calendar years when used for waterworks purposes in buried pressurised applications in Western Australia.

1.3 Reference Documents

The following documents are referenced in this Specification:

AS	
1646	Elastomeric seals for waterworks purposes *(Performance requirements in AS 681)*
681.1	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Vulcanized rubber
681.2	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Thermoplastic elastomers
681.3	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Cellular materials of vulcanized rubber
681.4	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Cast polyurethane sealing elements
2550.1	Cranes, hoists and winches – Safe use – General requirements
2550.5	Cranes, hoists and winches – Safe use – Mobile
4087	Metallic flanges for waterworks purposes
AS/NZS	
2280	Ductile iron pipes and fittings
2566.1	Buried flexible pipelines - Structural design
2566.1 Supp 1	Buried flexible pipelines - Part 1: Structural design - Commentary
2032	Installation of PVC pipe systems
4020	Products for use in contact with drinking water
4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS ISO	
9001	Quality management systems – requirements
AS/NZS ISO/IEC	
17065	Conformity assessment – Requirements for bodies certifying products, processes and services
17067	Conformity assessment – Fundamentals of product certification and guidelines for product certification schemes
ISO/IEC	
17000	Conformity assessment – Vocabulary and general principles
17025	General requirements for the competence of testing and calibration laboratories
17026 (TR)	Conformity assessment – Example of a certification scheme for tangible products
17030	Conformity assessment – General requirements for third party marks of conformity
Guide 28	Conformity assessment — Guidance on a third-party certification system for products
PIPA	(Plastics Industry Pipe Association of Australia)
POP101	PVC Pressure Pipes Design for Dynamic Stresses
TN003	Temperature Derating of PVC Pipes for Pressure Applications

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FOI 26-292 - Document 27

1.4 Definitions and Notation

The following definitions are intended to clarify the terminology used in this Specification.

1.4.1 Australian Standards®

Standards that are developed, published and maintained by Standards Australia.

1.4.2 Certificate

A formal certificate issued by a Conformity Assessment (or Certification) Body as an outcome of a compliance audit in accordance with a third party product Certification System.

1.4.3 Certification Body

An independent impartial (or third party) organisation that fulfills the requirements of AS/ANZ ISO/IEC 17065 for bodies certifying products and more commonly known over recent years as a Conformity Assessment Body.

1.4.4 Certification Mark

A proprietary mark of product conformity issued in accordance with ISO/IEC 17030.

1.4.5 Certification System

An impartial third party product certification scheme or combination of schemes, as exemplified in ISO/IEC TR 17026, that are in accordance with the fundamentals of AS/NZS ISO/IEC 17067 and with the guiding principles of ISO/IEC Guide HB 18.28.

NOTE: The effect of this is to require maintenance by the manufacturer of effective production control planning in addition to full type testing from independently sampled production and subsequent verification of conformity with specified standards.

1.4.6 Compliant Product

Product that has been assessed, by means of Product Appraisal, as conforming with standards and specifications that are specified by the Corporation.

1.4.7 Corporation

The Water Corporation of Western Australia.

1.4.8 Manufacturer

An entity or combination of entities that are responsible for selection, processing and control of Product constituent materials or compounds and for the processing equipment that collectively result in the manufactured product.

1.4.9 Notation

Statements governed by use of the word 'shall' are mandatory or 'normative' requirements of the Specification. Statements expressed by use of the words 'should' or 'may' are 'informative' but not mandatory and are provided for information and guidance. Notes in Specification text are informative. Notes that form part of Specification Tables are normative. An Appendix to the Specification that is designated 'normative' contains mandatory requirements. An Appendix that is designated 'informative' is provided for information and guidance only. The term 'specified' includes requirements of the Specification and requirements stated or referenced in other project documentation.

1.4.10 Officer

A duly authorised representative or appointed agent of the Corporation.

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FOI 26-292 - Document 27

1.4.11 Product

A single unit or multiple units of manufactured end product or an assembly of manufactured component products, materials or equipment. This Specification and accompanying Purchasing Schedule define the nature and details of Product to be supplied.

NOTES
1: An end product is most commonly an output of manufacturing processes that result in finished end products having the same features and characteristics and can be the result of a single or multiple production batches.
2: Manufactured equipment and assemblies of Product components or materials are commonly procured for mechanical, electrical and civil infrastructure applications.

1.4.12 Product Appraisal

A formal process whereby Product, including product design, is subjected to systematic engineering assessment to determine Product fitness for prescribed end uses and to evaluate conformity of its production systems with specified standards and requirements. Product Appraisal includes verification of the extent of compliance in accordance with the requirements of a relevant 'Technical Compliance Schedule'.

1.4.13 Product Assessor

An organization, Officer or other person who, having demonstrated specialist product knowledge and competence acceptable to the Corporation, is appointed to evaluate Product, appraises the Product and issues one or more Product Verification Reports.

1.4.14 Product Certification

A formal process whereby the production and management systems for the manufacture of Product, are assessed by a Certification Body to evaluate compliance of these systems with specified product standards and tests in accordance with Certification Scheme rules.

1.4.15 Product Verification Report

A formal report wherein a Product Assessor evaluates the extent of Product compliance with the specified product standards and specifications.

NOTE: Verification may be on a project-by-project basis or at agreed intervals, as appropriate to the scope of a Purchasing Schedule and Product end use, subject to determination by the Corporation.

1.4.16 Product Warranty

A formal express undertaking by a Supplier that indemnifies the Corporation against the consequences of supplied Product failure to comply with specified fitness for application and in-service life expectancy performance requirements.

1.4.17 Purchasing Schedule

A Corporation purchase order, tender, schedule of prices, bill of quantities, or specification that details the nature, quantity and other characteristics of Product to be supplied, purchased or installed.

1.4.18 Quality System

A management system that establishes, documents, implements and maintains organizational structures, resources, responsibilities, processes and procedures for the manufacture of Product and provision of Product related services in accordance with the requirements of AS/NZS ISO 9001.

1.4.19 Standards Australia

The peak non-government standards development body in Australia which develops Australian Standards®.

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1.4.20 Strategic Product

An essential infrastructure component whose performance is critical to the elimination of risk to the safe and effective provision of water services, which are functions of the Corporation under the Water Corporation Act as licensed under the Water Services Coordination Act.

NOTE: Strategic product is a component of permanent Corporation infrastructure. Ancillary operational and safety equipment that does not form part of permanent infrastructure but offers exceptional enhancements in operational performance or personnel safety may also be deemed strategic.

1.4.21 Strategic Product Appraisal Process

The process described in Section 3 of the Strategic Products Register whereby manufactured products and equipment are evaluated and authorised for use in Corporation infrastructure, subject to compliance with the specified product performance requirements.

1.4.22 Supplier

An entity or combination of entities that is responsible for the supply of Product.

NOTE: A Supplier may be a Manufacturer, owner, producer, distributor, vendor, agent, tenderer or contractor for supply of Product or Product related service.

1.4.23 Testing

The determination of Product characteristics by inspection and by the application of specified test procedures.

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2 Materials, Design and Performance

2.1 General

DI pipe fittings shall be in accordance with AS/NZS 2280 including compliance with the requirements of AS/NZS 4158 for thermal-bonded polymeric coating externally and lining internally. Fittings shall comply with AS/NZS 4020 for use in contact with drinking and recycled water, for an exposure of 15000 mm^2 of internal fitting surface area to a litre of water.

NOTES

1: The design and installation of buried flexible pipelines including ductile iron pipe fittings should be in accordance with AS/NZS 2566.1 and AS/NZS 2566.2 respectively.

2: Requirements for socketed DI pipe fittings that can axially restrain unbalanced pipeline forces in buried or above ground applications (e.g. Tyton-Lok system) are not given in this specification. Appropriate requirements including installation and operational constraints should be specified in project documentation by the pipeline system designer.

3: Pipe fitting end configuration should be selected so as to avoid the insertion of any DI (or other metallic) pipe spigot into a plastics pipe socket.

2.2 Flanged Fittings

Flanged DI pipe fittings shall have integrally cast flanges in accordance with AS 4087 Figures B5 (PN 16) or B6 (PN 35) as appropriate to the pipeline system design pressure specified for the particular project application by the system designer.

NOTES

1: Flanged pipeline component pressure rating should exceed the specified maximum allowable operating pressure (MAOP) of the pipeline system.

2: Pipeline system flange configuration and gaskets should be in accordance with Corporation design standard DS 38-02 as appropriate to the particular project application.

3: Pipe fittings having screw-on flanges should not be used except as may be acceptable to the Corporation for specific project applications on the basis of justified design and installation methodology proposals.

2.3 Fitting Joint Seals

The elastomeric joint seals of socketed pipe fittings shall be EPDM or SBR, shall comply with AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4) and AS/NZS 4020 and shall be supplied by the manufacturer of the pipe fittings.

Note: Joint lubricants for use with pipe fittings should be limited to water-based emulsions with a bactericide of approved composition complying with AS/NZS 4020. Joint lubricants should be supplied by the pipe fittings manufacturer.

2.4 Dimensions

Minimum depths of entry for socketed ductile iron pipe fittings shall be in accordance with Table 3.1 of AS/NZS 2280 as appropriate to plastics pipe jointing applications. The effective lengths of special socketed fittings (which differ from those dimensioned in Appendix H of AS/NZS 2280) shall be verified during production by direct measurement in accordance with Appendix E of AS/NZS 2280 and shall be notified to the Corporation for specific referencing in its Strategic Products Register.

2.5 Pressure Classification

The pressure classification of ductile iron pipe fittings to be supplied shall be as defined in the Purchasing Schedule. Designated pressure classifications shall be clearly marked on ductile iron fittings.

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3 Transportation, Handling and Storage

3.1 General

Transportation, handling and storage facilities shall be designed to prevent Product damage or defects and maintain Product free of deleterious matter. Product shall not be dropped off elevated vehicle platforms or sites. Mechanical handling equipment shall be in accordance with AS 2550.1, AS 2550.3, AS 2550.5 and AS 2550.11 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia. Product restraint during transportation shall be in accordance with Load Restraint Guide – Guidelines for Safe Carriage of Loads of Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia.

Note: Where wire ropes or chains are used for loading and unloading, they should not come into direct contact with Product. Lifting elements in direct contact with Product should be of a non-abrasive design e.g. elastomeric or fabric webbing straps. During transportation, Product restraints should be checked for tension at regular intervals of travel and should not be released until the transporting vehicle is resting in a secure stable disposition on level ground.

3.2 Preservation of Product in Storage

Pipe fittings shall be packaged so as to prevent point loading, chafing, scoring, impact or other incidental pipe damage during transportation, handling and storage operations. Packaged pipe fittings shall include sufficient joint lubricant for supplied pipe fittings. Product shall be stored in original Product packaging in accordance with the published requirements of the manufacturer, prior to installation. Component materials shall be protected from extended exposure to direct sunlight and high temperatures. Storage of elastomeric pipe joint seals shall comply with the requirements of AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4). Designated Product storage areas shall be of sufficient size to accommodate Product deliveries and shall be flat, reasonably level and free of combustible vegetation, sharp stones or projections that could cause Product damage or defects.

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4 Quality Assurance

4.1 Certification

4.1.1 Certification of Product

Compliance with this Specification shall be certified by means of an ISO Type 5 Product Certification Scheme i.e. a scheme that meets the criteria described in HB 18.28 (ISO/IEC Guide 28), conducted by a JAS-ANZ accredited Certification Body. Each Certificate shall expressly attest conformity of all product items with the nominated Standards. Wherever specified, Certificates shall be submitted to the Officer nominated for this purpose. Product shall be marked in accordance with the requirements of the Certification Body.

Note: Conformity of Product - including related accessories and services - with nominated Standards and specified requirements may be verified by means of a Product Verification Report provided by a Product Assessor. The Product Verification Report should identify all relevant Certificates of product conformity, duly issued in accordance with Certification Scheme rules.

4.1.2 Quality System

The processes for manufacture, supply, transportation, handling, delivery and storage of product to be supplied in accordance with this Specification shall form part of a documented Quality System. The System shall be certified by a Certification Body as complying with the requirements of AS/NZS ISO 9001 and shall provide for identification and traceability, control of production and delivery to the specified destination, customer verification and control of documents and records.

4.1.3 Product Re-verification

Product conformity with the Specification shall be subject to re-verification by a Product Assessor when, during the agreed product supply period, there occurs any:

- Substantive change in product design or material formulation or performance
- Product failure to perform in operational service to the nominated performance specifications.

Re-verification shall require the issue of a new or supplementary Product Verification Report. Product components and test outcomes that are not significantly affected by the product change of failure may be excluded from the scope of re-verification, provided that these outcomes have already been reported in a current valid Product Verification Report that is acceptable to the Corporation.

Wherever the requirements of the Specification apply to a product supply period in excess of three years, continuing acceptance of product shall be subject to re-verification. The purpose of re-verification shall be to confirm the continuing conformity of product quality and production processes with the requirements of the Specification.

4.2 Compliance and Acceptance

4.2.1 Means of Demonstrating Compliance

Compliance with this Specification shall be demonstrated by means of Product Appraisal and issue by a Product Assessor of a Product Verification Report that confirms compliance. Otherwise, Product shall be deemed non-compliant and ineligible for registration as Product authorised for use in Corporation infrastructure.

NOTES

1: Where a project includes design work including Product design, Product Appraisal may form part of the project design review process and the Product Assessor may be a member of the project design review team.

2: A Product Verification Report should verify the extent of compliance with the Specification including all relevant 'Technical Compliance Schedule' Appendices and the currency of a Certificate where relevant to the Product.

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4.2.2 Acceptance Criteria

For acceptance, Product shall be supplied as specified in the Purchasing Schedule.

Prior to the implementation of any arrangement to supply Product, the Supplier shall, in accordance with specified requirements:

- Nominate applicable Product Warranty terms; and
- Provide documentary verification in the form of a current valid Certificate or Product Verification Report as appropriate to the Product; and
- Detail each element of Product that does not comply with the specified requirements together with the extent of non-compliance.

NOTE: Where the Specification includes Technical Compliance Schedules, the nature and extent of all non-compliances should be provided in accordance with the appropriate Schedules.

4.3 Non-compliant Product

4.3.1 General

Product whose design, workmanship or performance fails to conform to the specified requirements shall be clearly tagged and quarantined by the Supplier as non-compliant and shall be subject to rejection for return to and replacement by the Supplier.

4.3.2 Manufacturing Repairs (In-process)

Welding, the use of fillers and other repairs shall generally not be permissible on Product which is in the course of production. Repairs to custom-built Products may be considered only if determined by the Corporation to be minor casting repair work in non-strategic location. Accordingly, details of any defect which the Manufacturer considers can be repaired; together with details of proposed repair procedures shall be submitted in writing for determination by the Corporation.

The Manufacturer shall make provision in its production Quality System and in the appropriate ITP's for sufficient hold points whenever casting defects are encountered. Production work on non-compliant components shall cease and repair work shall not commence until the following details have been confirmed by the Corporation in writing:

(a) that repair of the non-compliant components in lieu of their replacement is acceptable; and
(b) that proposed repair procedures are acceptable; and
(c) that any proposal to vary the terms of the original Product Warranty is acceptable.

4.3.3 Product Warranty

The Supplier shall replace non-compliant Product with Product that conforms to the acceptance criteria or shall repair or rectify all faults, damage or losses caused by defective Product. Except as may otherwise be specified, the Product Warranty shall indemnify and keep indemnified the Corporation against all losses suffered by the Corporation as a result of non-compliant Product for a period no less than 24 months after Product delivery or 12 months after Product installation, whichever period elapses first.

4.3.4 Product Repair

All reasonable proposals for repair or remedy of defects will be considered, provided that each such proposal is accompanied by a methodology statement that accords with the performance objectives of this Specification, as determined by the Corporation. For acceptance, a proposal for repair or remedy of Product defects shall not void or otherwise diminish the provisions of the Product Warranty.

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5 Appendix A

5.1 Material Master Records

The following Material Master Records comprise Corporation catalogue numbers that are unique to the particular products tabulated herein for the purposes of Corporation activities or work.

MMR	Purchase Order Description (Adaptor/Connector)
9749	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN80; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit AC Pipe.
13611	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN100 x 152mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC, AC & GWI Pipe.
6793	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN100 x 203mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.
21321	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN35; Flanged to As 4087 Figure B6 to Spigot; DN100 x 203mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI & AC Pipe.
13612	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN150 x 152mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC, AC & GWI Pipe.
6794	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN150 x 203mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.
6795	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN200 x 229mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.
13613	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN200 x 152mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC, AC & GWI Pipe.
21612	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN225 x 155mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21697	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN225 x 230mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.

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MMR	Purchase Order Description (Adaptor/Connector)
18816	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN250 x 170mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC, AC & GWI Pipe.
19474	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN250 x 230mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.
21629	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN300 x 255mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.
21320	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN300 x 300mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21303	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN35; Flanged to AS 4087 Figure B6 to Socket; C/W Fitted Elastomeric Seal Joint; DN300 x 300mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21688	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN375 x 190mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21690	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN375 x 280mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.
21512	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN450 x 200mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21613	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN500 x 215mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21731	Adaptor, Straight, Flange To Pipe; Ductile Cast Iron; Connector; PN16; Flanged to AS 4087 Figure B5 to Spigot; DN500 x 305mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, AC & GWI Pipe.

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MMR	Purchase Order Description (Bend – 6 Degree)
21054	Elbow, Pipe; Ductile Cast Iron; 6 Degree Bend; DN100; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21055	Elbow, Pipe; Ductile Cast Iron; 6 Degree Bend; DN150; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21066	Elbow, Pipe; Ductile Cast Iron; 6 Degree Bend; DN200; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21314	Elbow, Pipe; Ductile Cast Iron; 6 Degree Bend; DN300; PN20; Socket to Socket; C/W Fitted Elastomeric Seal Joints; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

MMR	Purchase Order Description (Bend – 11-1/4 Degree)
1951	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal & External) To AS/NZS 4158.
13552	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1956	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13553	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1961	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13554	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18809	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
18364	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21310	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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MMR	Purchase Order Description (Bend – 11-1/4 Degree)
21319	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN35; Flanged to AS 4087 Figure B6; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21305	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21324	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21342	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN35; Flanged to AS 4087 Figure B6; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21326	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21730	Elbow, Flange to Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.
21350	Elbow, Flange; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21607	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21340	Elbow, Pipe; Ductile Cast Iron; 11-1/4 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.

MMR	Purchase Order Description (Bend – 22-1/2 Degree)
1953	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13555	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1958	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13556	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Bend – 22-1/2 Degree)
1963	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13557	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18810	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
18365	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21309	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21652	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit Series 1 DI Fittings & White PVC Pipe.
21318	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN35; Flanged to AS 4087 Figure B6; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21313	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21643	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158;
21343	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN35; Flanged to AS 4087 Figure B6; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21687	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21344	Elbow, Flange; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN450; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158.
21608	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21341	Elbow, Pipe; Ductile Cast Iron; 22-1/2 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Bend – 45 Degree)
1954	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13558	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1959	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13559	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1964	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13560	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18811	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
18366	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21316	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21317	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN35; Flanged to AS 4087 Figure B6; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21641	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21325	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21644	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC & AC Pipe.
21732	Elbow, Flange to Pipe; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.
21346	Elbow, Flange; Ductile Cast Iron; 45 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Bend – 45 Degree)
21609	Elbow, Pipe; Ductile Cast Iron; 45 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

MMR	Purchase Order Description (Bend – 90 Degree)
14985	Elbow, Flange to Pipe; Ductile Cast Iron; 90 Degree Washout Bend; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1955	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
1967	Elbow, Flange; Ductile Cast Iron; 90 Degree; PN16; Flanged to AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Asymmetric - 457mm Long Leg x 108mm Short Leg. Note: Non-Standard Fitting.
13561	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21739	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN35; Flanged to AS 4087 Figure B6; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
1960	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
1969	Elbow, Flange; Ductile Cast Iron; 90 Degree; PN16; Flanged to AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Asymmetric - 400mm Long Leg x 190.5mm Short Leg. Note: Non-Standard Fitting.
13562	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
1965	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13563	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21642	Elbow, Flange to Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.

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MMR	Purchase Order Description (Bend – 90 Degree)
18812	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
18367	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21640	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21307	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21919	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21352	Elbow, Flange to Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.
21639	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21351	Elbow, Flange to Pipe; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.
21349	Elbow, Flange; Ductile Cast Iron; 90 Degree Bend; PN16; Flanged to AS 4087 Figure B5; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21610	Elbow, Pipe; Ductile Cast Iron; 90 Degree Bend; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

MMR	Purchase Order Description (Cap)
13614	Cap, Pipe; Ductile Cast Iron; Socketed; PN16; C/W Fitted Elastomeric Seal Joint; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
13615	Cap, Pipe; Ductile Cast Iron; Socketed; PN16; C/W Fitted Elastomeric Seal Joint; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Cap)
13616	Cap, Pipe; Ductile Cast Iron; Socketed; PN16; C/W Fitted Elastomeric Seal Joint; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18359	Cap, Pipe; Ductile Cast Iron; Socketed; PN16; C/W Fitted Elastomeric Seal Joint; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21315	Cap, Pipe; Ductile Cast Iron; Socketed; PN16; C/W Fitted Elastomeric Seal Joint; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21713	Cap, Pipe; Ductile Cast Iron; Socketed; PN35; C/W Fitted Elastomeric Seal Joint; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

MMR	Purchase Order Description (Coupling)
13541	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN16; C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
13542	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN16; C/W Fitted Elastomeric Sealing Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
13543	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN16; C/W Fitted Elastomeric Seal Joints; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18363	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN16; C/W Fitted Elastomeric Seal Joints; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21304	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN35; C/W Fitted Elastomeric Seal Joints; DN300; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; To Suit CI, DI, Blue PVC and AC Pipe.
21689	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN35; C/W Fitted Elastomeric Seal Joints; DN375; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; To Suit CI, DI, Blue PVC and AC Pipe.
21611	Coupling, Pipe; Ductile Cast Iron; Socket to Socket; PN35; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Flange - Blank)
2051	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158.
2052	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158.
2053	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21866	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2054	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21867	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21618	Flange, Pipe, Blind; Ductile Cast Iron; Blank Type Raised Face; PN16; To AS 4087 Figure B5; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2050	Flange, Pipe; Ductile Cast Iron; Screw-on Type Raised Face; PN16; Drilled to AS 4087 Figure B5; Bore Threaded to AS ISO 7.1 Series RP2; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

MMR	Purchase Order Description (Hydrant Riser)
2102	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 100mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Note: Holes Slotted One End to Edge of Flange-Refer AS 2280 Figure J7.
2103	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 150mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21737	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN35; Flanged to AS 4087 Figure B6; DN100 x 150mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2105	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 225mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2106	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 300mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
20594	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 450mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21061	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 500mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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MMR	Purchase Order Description (Hydrant Riser)
20595	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 600mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21060	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 1000mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21323	Coupling, Pipe; Ductile Cast Iron; Hydrant Riser; PN16; Flanged to AS 4087 Figure B5; DN100 x 1300mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

MMR	Purchase Order Description (Puddle Flange)
21855	Pipe Assembly; Ductile Cast Iron; Flange Connector with Puddle Flange; PN16; Flanged to AS 4087 Figure B5; DN375 x 915mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21736	Pipe Assembly; Ductile Cast Iron; Socket Connector with Puddle Flange; PN16; Flanged to AS 4087 Figure B5 to Socket; C/W Fitted Elastomeric Seal Joint; DN450 x 900mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit DI, Blue PVC & AC Pipe.
21734	Pipe Assembly; Ductile Cast Iron; Flange Connector with Puddle Flange; PN16; Flanged to AS 4087 Figure B5; DN450 x 1200mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21735	Pipe Assembly; Ductile Cast Iron; Flange Connector with Puddle Flange; PN16; Flanged to AS 4087 Figure B5; DN500 x 1000mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

MMR	Purchase Order Description (Reducer)
9400	Reducer, Pipe; Ductile Cast Iron; PN16; Spigot to Spigot; DN80 x DN58; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit AC Pipe.
9401	Reducer, Pipe; Ductile Cast Iron; PN16; Spigot to Spigot; DN100 x DN58; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit AC Pipe.
2098	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN100 x DN80; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
9745	Reducer, Pipe; Ductile Cast Iron; PN16; Spigot to Spigot; DN100 x DN80; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit AC Pipe.
21322	Reducer, Pipe; Ductile Cast Iron; PN16; Eccentric; Flanged to AS 4087 Figure B5; DN150 x DN100; 235mm Length; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2099	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13997	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

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MMR	Purchase Order Description (Reducer)
9402	Reducer, Pipe; Ductile Cast Iron; PN16; Spigot to Flange (AS 4087 Figure B5); DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit AC Pipe.
21700	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN150 x DN80; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2100	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN200 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2101	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13996	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
9403	Reducer, Pipe; Ductile Cast Iron; PN16; Spigot to Flange (AS 4087 Figure B5); DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit AC Pipe.
21699	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN250 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
19974	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN250 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
18357	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joint; DN250 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21947	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN250 x DN200; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; To Suit CI, DI, Blue PVC and AC Pipe.
21701	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN250 x DN225; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21924	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300 x DN200; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158.
21844	Reducer, Pipe; Ductile Cast Iron; PN16; Eccentric; Flanged to AS 4087 Figure B5; DN300 x DN200; 387mm Length; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21920	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joint; DN300 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21698	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300 x DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Reducer)
21925	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN300 x DN250; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; To Suit CI, DI, Blue PVC and AC Pipe.
21691	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN375 x DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21692	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN375 x DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21747	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joint; DN375 x DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21615	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN450 x DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21707	Reducer, Pipe; Ductile Cast Iron; PN16; Eccentric; Flanged to AS 4087 Figure B5; DN450 x DN375; 356mm Length; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21714	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN450 x DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21353	Reducer, Pipe; Ductile Cast Iron; PN16; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450 x DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.
21616	Reducer, Pipe; Ductile Cast Iron; PN35; Socket to Socket; C/W Fitted Elastomeric Seal Joints; DN450 x DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & Blue PVC Pipe.
21868	Reducer, Pipe; Ductile Cast Iron; PN16; Eccentric; Flanged to AS 4087 Figure B5; DN500 x DN300; 667mm Length; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21617	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN500 x DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21869	Reducer, Pipe; Ductile Cast Iron; PN16; Eccentric; Flanged to AS 4087 Figure B5; DN500 x DN450; 305mm Length; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21614	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN500 x DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21733	Reducer, Pipe; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN525 (21IN) x DN500 x 248mm Long; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Tee)
21738	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN80; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2133	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13548	Tee, Flange to Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
13544	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
5603	Tee, Pipe; Ductile Cast Iron; PN16; Spigoted; DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
2134	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN150 x DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13549	Tee, Flange to Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joints; DN150 x DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
13545	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN150 x DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
5604	Tee, Pipe; Ductile Cast Iron; PN16; Spigoted; DN150 x DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
21744	Tee, Flange; Ductile Cast Iron; PN35; Flanged to AS 4087 Figure B6; DN150 x DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
2135	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21740	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
13546	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18978	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
5605	Tee, Pipe; Ductile Cast Iron; PN16; Spigoted; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Tee)
2136	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN200 x DN200 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13550	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joints; DN200 x DN200 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
9824	Tee, Pipe; Ductile Cast Iron; PN16; Spigoted; DN200 x DN200 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, & AC Pipe.
2137	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN200 x DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13551	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange (AS 4087 Figure B5); C/W Fitted Elastomeric Seal Joints; DN200 x DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21949	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN250 x DN250 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC and AC Pipe.
9825	Tee, Pipe; Ductile Cast Iron; PN16; Spigoted; DN200 x DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, & AC Pipe.
2138	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
13547	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
5606	Tee, Pipe; Ductile Cast Iron; PN16; Spigoted; DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
21946	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange AS 4087 Figure B5; DN200 x DN200 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI and AC Pipe.
18813	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN250 x DN250 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
18360	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN250 x DN250 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
18814	Tee, Flange; Ductile Cast Iron;; PN16; Flanged to AS 4087 Figure B5; DN250 x DN250 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Tee)
18361	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN250 x DN250 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
20187	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange AS 4087 Figure B5; DN250 x DN250 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
18815	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN250 x DN250 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21948	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN250 x DN250 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC and AC Pipe.
18362	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange (AS4087 Figure B5); C/W Fitted Elastomeric Seal Joints; DN250 x DN250 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
20186	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN250 x DN250 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
20185	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN250 x DN250 x DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
19973	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21511	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21794	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21306	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21645	Tee, Pipe; Ductile Cast Iron; PN16; Socketed; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
21301	Tee, Flange; Ductile Cast Iron; PN35; Flanged to AS 4087 Figure B6; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Tee)
21308	Tee, Flange To Pipe; Ductile Cast Iron; PN35; Socket to Socket to Flange AS 4087 Figure B6; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21646	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300 x DN300 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21312	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21745	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange AS 4087 Figure B5; DN300 x DN300 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
21647	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21648	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange AS 4087 Figure B5; DN300 x DN300 x DN300; Thermal Bonded Polymeric Coating (Internal & External) to S/NZS 4158; To Suit CI, DI & AC Pipe.
21793	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21606	Tee, Flange to Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN375 x DN375 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21746	Tee, Pipe; Ductile Cast Iron; PN35; Socketed; C/W Fitted Elastomeric Seal Joints; DN375 x DN375 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
21694	Tee, Flange to Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN375 x DN375 x DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21693	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN375 x DN375 x DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21695	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Tee)
21696	Tee, Pipe; Ductile Cast Iron; PN35; Socketed; C/W Fitted Elastomeric Seal Joints; DN375; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
21601	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN450 x DN450 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21605	Tee, Flange to Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN450 x DN450 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21604	Tee, Flange to Pipe; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN450 x DN450 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21602	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21603	Tee, Pipe; Ductile Cast Iron; PN35; Socketed; C/W Fitted Elastomeric Seal Joints; DN450; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC, & AC Pipe.
5599	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Air Valve & Hydrant Tee; To Suit CI, DI, & AC Pipe.
5600	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN150 x DN150 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Air Valve & Hydrant Tee; To Suit CI, DI & AC Pipe.
5601	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN200 x DN200 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Air Valve & Hydrant Tee; To Suit CI, DI & AC Pipe.
5602	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN200 x DN200 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Air Valve & Hydrant Tee; To Suit CI, DI, Blue PVC, & AC Pipe.
20188	Tee, Flange To Pipe; Ductile Cast Iron; PN16; Spigot to Spigot to Flange (AS 4087 Figure B5); DN250 x DN250 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Air Valve & Hydrant Tee; To Suit CI, DI & AC Pipe.
21651	Tee, Flange To Pipe; Scour Tee; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN250 x DN250 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21302	Tee, Flange; Scour Tee; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.

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FOI 26-292 - Document 27

MMR	Purchase Order Description (Tee)
21649	Tee, Flange To Pipe; Scour Tee; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21311	Tee, Flange To Pipe; Scour Tee; Ductile Cast Iron; PN35; Socket to Socket to Flange AS 4087 Figure B6; C/W Fitted Elastomeric Seal Joints; DN300 x DN300 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21918	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN300 x DN300 x DN200; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21327	Tee, Flange; Scour Tee; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN375 x DN375 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI & AC Pipe.
21916	Tee, Flange To Pipe; Scour Tee; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN375 x DN375 x DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.
21917	Tee, Flange; Ductile Cast Iron; PN16; Flanged to AS 4087 Figure B5; DN375 x DN375 x DN250; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21729	Tee, Flange To Pipe; Scour Tee; Ductile Cast Iron; PN16; Socket to Socket to Flange AS 4087 Figure B5; C/W Fitted Elastomeric Seal Joints; DN450 x DN450 x DN100; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; To Suit CI, DI, Blue PVC & AC Pipe.

MMR	Purchase Order Description (Wye)
21750	Wye, Pipe; Flange Wye; Ductile Cast Iron; PN16; Flanged AS 4087 Figure B5; DN150; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158.
21748	Wye, Pipe; Spigot-Flange Wye; Ductile Cast Iron; PN16; Spigot to Spigot; Flanged to AS 4087 Figure B5; DN200; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; To Suit CI, DI and AC Pipe.
21749	Wye, Pipe; Spigot-Flange Wye; Ductile Cast Iron; PN16; Spigot to Spigot; Flanged to AS 4087 Figure B5; DN250; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; To Suit CI, DI and AC Pipe.

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WATER CORPORATION

Assets Delivery Group
Engineering

Strategic Product Specification

SPS 116
Modified Polyvinylchloride (PVC-M) Pipe for Pressure Applications

DRAFT

VERSION 1
REVISION 2

JUNE 2019

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FOI 26-292 - Document 27

FOREWORD

Each Strategic Product Specification has been prepared to inform Water Corporation staff, consultants, contractors and land developers of the requirements for selecting and acquiring a manufactured product to be used in strategic Corporation infrastructure. The definition of 'Product' includes items that comprise assembled components, equipment or plant for mechanical, electrical and civil infrastructure applications.

The objective of a Strategic Product Specification is to specify fit-for-purpose Product which will contribute to the provision of effective water services at least whole-of-life cost and with least risk to service standards and safety. A Strategic Product Specification also provides uniform standards for compatibility of new water infrastructure with existing water assets.

Many Strategic Product Specifications have drawn on the design, asset management and operational experience of Product performance in live service gained by the Corporation over time. Some Strategic Product Specifications have drawn on the experience of the water industry nationally by referencing Australian or WSAA standards.

Strategic Product Specifications are intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure design and construction work;
- Private developer funded subdivision infrastructure for takeover by the Corporation;
- Operationally funded infrastructure design and construction work;
- Corporation period contracts for Product purchases;
- Product purchases for stock or for miscellaneous minor work.

A published Strategic Product Specification will, in some cases, comprise technical content that is typical of a range of products of the same type (type specification) but may exclude specific requirements that should apply to a particular project or application. In such cases, the project designer is required to document the supplementary project specific requirements in the 'Project Specific Requirements' Appendix of the Specification.

The text of a published Specification should not be directly modified. In the event that a text variation is considered necessary to accommodate the needs of a particular project or application, the text modification should be documented in the appropriate Clause of a 'Project Specific Requirements' Appendix.

Enquiries relating to the technical content of this Specification should be directed to the Senior Principal Engineer, Wastewater Conveyance, Engineering.

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Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

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The revision status of this specification is shown section by section below:

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FOI 26-292 - Document 27

Strategic Product Specification
SPS116
Modified Polyvinylchloride (PVC-M) Pipe for Pressure Applications

CONTENTS

Section Page

1 Scope and General 6
1.1 Scope 6
1.2 Referenced Documents 6
1.3 Definitions and Notation 7
1.3.1 Australian Standards® 7
1.3.2 Certificate 7
1.3.3 Certification Mark 7
1.3.4 Certification System 7
1.3.5 Conforming Product 7
1.3.6 Conformity Assessment Body (CAB) 8
1.3.7 Corporation 8
1.3.8 Manufacturer 8
1.3.9 Notation 8
1.3.10 Officer 8
1.3.11 Product 8
1.3.12 Product Appraisal 8
1.3.13 Product Assessor 8
1.3.14 Product Certification 8
1.3.15 Product Verification Report 9
1.3.16 Product Warranty 9
1.3.17 Purchasing Schedule 9
1.3.18 Quality System 9
1.3.19 Standards Australia 9
1.3.20 Strategic Product 9
1.3.21 Strategic Product Appraisal Process 9
1.3.22 Supplier 9
1.3.23 Testing 9

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FOI 26-292 - Document 27

2 Materials, Design and Performance 10
2.1 General 10
2.2 Temperature and Fatigue Considerations 10
2.3 Colour 10
2.4 Effect on Water 11
3 Transportation, Handling and Storage 12
3.1 General 12
3.2 Packaging 12
3.3 Lifting 12
3.4 Transportation and Unloading 12
3.5 Pipe Storage 13
3.6 Pipe Stacking 13
3.7 Pipe Stringing 13
Figure 3.1 - Handling and stacking at pipe storage sites 15
Figure 3.2 - Handling and stacking on pipe installation sites 16
4 Conformity with Requirements 17
4.1 General 17
4.2 Certification of Product 17
4.3 Product Re-verification 17
4.4 Acceptance Criteria 18
4.5 Non-conforming Product 18
4.5.1 General 18
4.5.2 Manufacturing Repairs (In-process) 18
4.5.3 Product Warranty 18
4.5.4 Product Repair 18
4.5.5 Access to the Place of Manufacture 19
5 Appendix A: Material Master Records (Informative) 20

DRAFT

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FOI 26-292 - Document 27

1 Scope and General

1.1 Scope

This Specification shall apply to the manufacture, supply, transportation, handling and delivery of modified polyvinyl chloride (PVC-M) pressure pipe, for pressure water, wastewater and drainage applications. The Specification also details the acceptance criteria for PVC-M pipes intended for infrastructure projects use and the means of demonstrating conformity with the Specification.

1.2 Referenced Documents

The following documents are referenced in this Specification or are provided for the purposes of design and installation context relevant to the Product:

Water Corporation

DS 50	Design and construction requirements for gravity sewers DN 150 to DN 600
DS 51	The Design and Construction of Wastewater Pumping Stations and Pressure Mains 4.5 to 180 Litres Per Second Capacity
DS 60	Water Supply Distribution Standard - Pipelines Other than Reticulation
DS 63	Water Reticulation Standard -Design and Construction Requirements for Water Reticulation Systems up to DN250
DS 66	Urban Main Drainage Standard
	Strategic Products Register

AS

1646	Elastomeric seals for waterworks purposes *(Performance requirements in AS 681)*
681.1	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Vulcanized rubber
681.2	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Thermoplastic elastomers
681.3	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Cellular materials of vulcanized rubber
681.4	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Cast polyurethane sealing elements
1462.24	Methods of test for plastics pipes and fittings Method 24:Determination of resistance to crack propagation—Test methods for slow crack growth in notched pipes(notch test) (This MOT was reproduced from and is equivalent to ISO 13479)
2345	Dezincification resistance of copper alloys
3688	Water supply and gas systems - Metallic fittings and end connectors
2550.1	Cranes - Safe use - General requirements
2550.5	Cranes - Safe use - Mobile and vehicle-loading cranes

AS/NZS

2566.1	Buried flexible pipelines - Structural design
	2566.1 Supplement 1: Buried flexible pipelines - Part 1: Structural design - Commentary
2566.2	Buried flexible pipelines - Part 2: Installation
2032	Installation of PVC pipe systems
3500	National Plumbing and Drainage Code
4020	Products for use in contact with drinking water
4765	Modified PVC (PVC-M) pipes for pressure applications

AS/NZS ISO

7.1	**AS/ISO 7.1**: Pipe threads where pressure-tight joints are made on the threads - Dimensions, tolerances and designation
9001	Quality management systems - requirements
17000	ISO/IEC 17000: Conformity assessment – Vocabulary and general principles

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FOI 26-292 - Document 27

17025	ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories
17026	ISO/IEC 17026 (TR): Conformity assessment – Example of a certification scheme for tangible products
Guide 28	ISO/IEC Guide 28: Conformity assessment -- Guidance on a third-party certification system for products
17030	Conformity assessment -- General requirements for third-party marks of conformity
17065	Conformity assessment -- Requirements for bodies certifying products, processes and services
17067	AS/NZS ISO/IEC 17067: Conformity assessment – Fundamentals of product certification and guidelines for product certification schemes
ISO	
228.1	Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation
9080	Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
POP	**PIPA** (Plastics Industry Pipe Association of Australia) **Guidelines**
101	PVC Pressure Pipes Design for Dynamic Stresses
103	Depth Of Engagement For PVC Pipes
104	PVC pipe equivalence
106	Verification Guidelines For Best Environmental Practice PVC Pipe And Fittings
201	Resistance Of Plastics Pipes And Fittings To Water And Wastewater Chemicals
202	PVC And PE Pressure Pipe Installation On Curved Alignments
204	Expected Service Life Of Elastomeric Pipe Seals
205	Water Jet Cleaning Of Plastics Pipes
207	Installation Of Potable Watermains In Contaminated Ground

1.3 Definitions and Notation

The following definitions are intended to clarify the terminology used in this Specification.

1.3.1 Australian Standards®

Standards that are developed, published and maintained by Standards Australia

1.3.2 Certificate

A formal certificate issued by a Conformity Assessment Body as an outcome of a conformance audit in accordance with a Certification System.

1.3.3 Certification Mark

A proprietary mark of product conformity issued in accordance with ISO/IEC 17030.

1.3.4 Certification System

An impartial third party product certification scheme or combination of schemes, as exemplified in ISO/IEC TR 17026, that are in accordance with the fundamentals of AS/NZS ISO/IEC 17067 and with the guiding principles of ISO/IEC Guide 28.

NOTE: The effect of this is to require maintenance by the manufacturer of effective production control planning in addition to full type testing from independently sampled production and subsequent verification of conformity with specified standards.

1.3.5 Conforming Product

Product that demonstrably conforms with standards and specifications nominated by the Corporation, where assessed by means of Product Appraisal.

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1.3.6 Conformity Assessment Body (CAB)

A third party organisation that has been duly accredited as meeting the requirements of AS/ANZ ISO/IEC 17065 by a signatory member of the International Accreditation Forum (IAF) Multilateral Arrangement (MLA), previously known as a **Certification Body**.

1.3.7 Corporation

The Water Corporation of Western Australia.

1.3.8 Manufacturer

An entity or combination of entities that are responsible for selection, processing and control of Product constituent materials or compounds and for the processing equipment that collectively result in the manufactured product.

1.3.9 Notation

Statements governed by use of the word 'shall' are mandatory or 'normative' requirements of the Specification. Statements expressed by use of the words 'should' or 'may' are 'informative' but not mandatory and are provided for information and guidance. Notes in Specification text are informative. Notes that form part of Specification Tables are normative. An Appendix to the Specification that is designated 'normative' contains mandatory requirements. An Appendix that is designated 'informative' is provided for information and guidance only. The term 'specified' includes requirements of the Specification and requirements stated or referenced in other project documentation.

1.3.10 Officer

A duly authorized representative or appointed agent of the Corporation.

1.3.11 Product

A single unit or multiple units of manufactured end product or an assembly of manufactured component products, materials or equipment. This Specification and accompanying Purchasing Schedule define the nature and details of Product to be supplied.

NOTES
1: An end product is most commonly an output of manufacturing processes that result in finished end products having the same features and characteristics and can be the result of a single or multiple production batches.
2: Manufactured equipment and assemblies of Product components or materials are commonly procured for mechanical, electrical and civil infrastructure applications.

1.3.12 Product Appraisal

A formal process whereby Product is subjected to systematic engineering assessment to determine Product fitness for prescribed end uses and to evaluate its conformity with specified standards and requirements. Product Appraisal includes verification of the extent of conformity in accordance with the requirements of a relevant 'Technical Compliance Schedule'.

1.3.13 Product Assessor

An organization, Officer or other person who, having demonstrated specialist product knowledge and competence acceptable to the Corporation, is appointed to evaluate Product, appraises the Product and issues one or more Product Verification Reports.

1.3.14 Product Certification

A formal process whereby the production and management systems for the manufacture of Product, are assessed by a Conformity Assessment Body to evaluate conformity of these systems with specified product standards and tests, in accordance with Certification System rules.

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1.3.15 Product Verification Report

A formal report wherein a Product Assessor evaluates the extent of Product conformity with the specified product standards and specifications.

NOTE: Verification may be on a project-by-project basis or at agreed intervals, as appropriate to the scope of a Purchasing Schedule and Product end use, subject to determination by the Corporation.

1.3.16 Product Warranty

A formal express undertaking by a Supplier that indemnifies the Corporation against the consequences of supplied Product failure to conform with specified fitness for application and in-service life expectancy performance requirements.

1.3.17 Purchasing Schedule

A Corporation purchase order, tender, schedule of prices, bill of quantities, or specification that details the nature, quantity and other characteristics of Product to be supplied, purchased or installed.

1.3.18 Quality System

A management system that establishes, documents, implements and maintains organizational structures, resources, responsibilities, processes and procedures for the manufacture of Product and provision of Product related services in accordance with the requirements of AS/NZS ISO 9001.

1.3.19 Standards Australia

The peak non-government standards development body in Australia which develops Australian Standards®.

1.3.20 Strategic Product

An essential infrastructure component whose performance is critical to the elimination of risk to the safe and effective provision of water services, which are functions of the Corporation under the Water Corporation Act as licensed under the Water Services Coordination Act.

NOTE: Strategic product is a component of permanent Corporation infrastructure. Ancillary operational and safety equipment that does not form part of permanent infrastructure but offers exceptional enhancements in operational performance or personnel safety may also be deemed strategic.

1.3.21 Strategic Product Appraisal Process

The process described in Section 3 of the Strategic Products Register whereby manufactured products and equipment are evaluated and authorized for use in Corporation infrastructure, subject to demonstrated conformity with the nominated product performance requirements.

1.3.22 Supplier

An entity or combination of entities that is responsible for the supply of Product.

NOTE: A Supplier may be a Manufacturer, owner, producer, distributor, vendor, agent, tenderer or contractor for supply of Product or Product related service.

1.3.23 Testing

The determination of Product characteristics by inspection and by the application of specified test procedures in order to determine Product conformity with nominated performance requirements.

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2 Materials, Design and Performance

2.1 General

Pipes shall be manufactured in accordance with the requirements of AS/NZS 4765 Series 2 and shall be supplied in standard 6 metre lengths with integral joint sockets, except as may otherwise be specified. Elastomeric pipe joint seals shall be AS/NZS 4020 conforming EPDM or NBR in accordance with AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4) for the nominated elastomer IRHD hardness. Seals for integral pipe joint sockets shall be supplied by the original pipe manufacturer to assure installed pipe and jointing system compatibility and performance in service. Solvent weld jointing of AS/NZS 4765 Series 2 PVC-M pressure pipe shall not be permissible.

PVC pressure pipe and fitting characteristics shall be selected in accordance with the requirements of the applicable Corporation Design Standard (DS 51, DS 60, DS 63 or DS 66) as appropriate to each project application. For applications where pipes and fittings may be exposed to elevated temperatures and pressure transients, the pressure rating of pipeline components shall be selected to sustain safe service pressure and cyclic fatigue resistance performance over the nominated pipeline design life. Guidance on the selection of design factors for re-rating nominal pipe pressure ratings for exposure to elevated temperatures and cyclic pressure transients is available in the Corporation's Pipeline Selection Guidelines.

NOTES
1. Elastomeric seal jointed PVC-M pressure pipe should not form part of a vacuum reticulation system, given that AS/NZS 4765 requires joint leak tightness testing to a negative internal operating pressure value no lower than -80 KPa.
2. Wherever a PVC pipeline may be at risk of exposure to UV rays from natural and man-made radiation and heat sources, its exterior surface should be physically shielded or coated with an approved pastel shade paint in accordance with DS 95 to mitigate structural degradation risks.
3. NBR is a preferred elastomeric pipe joint sealing material for wastewater applications because of its superior long term resistance to hydrocarbons in wastewater.

2.2 Temperature and Fatigue Considerations

Prior to selecting PVC-M pressure pipe pressure (PN) ratings for particular pipeline projects and environments, consideration shall be given to its reduced maximum allowable pressure (MAOP) capacity for a given nominal pressure (PN) rating, where its wall temperature is likely to exceed 20°C and where pumping pressure cycling frequency may reduce its long term structural strength, arising from the inherent fatigue response characteristics of the PVC pipeline over its nominated service life.

The selected re-rating factors shall be in accordance with the requirements of the appropriate application Design Standard – DS 51 for wastewater, DS 60 for water distribution, DS 63 for water reticulation and DS 66 for urban drainage.

NOTES:
1. High level guidance is provided in the Pipeline Selection Guidelines on the definitions and inter-relationships of PVC pipe stiffness rating (SN), nominal pressure rating (PN), maximum allowable operating pressure (MAOP), allowable site test pressure (ASTP) and appropriate pressure de-rating factors for elevated (> 20°C) PVC pipe temperatures and for cyclic pressure transients.
2. The PVC-M pipeline system design pressure and the corresponding field test pressure should be as calculated by the pipeline designer and as nominated on project design drawings for the pipeline wall temperatures at the project site.
3. Field test operatives should ensure that the designer nominated design pressure and field test pressure are duly adjusted/re-rated (or not) for pipe wall temperatures at the location and time of testing and are applied to the lowest elevation of pipeline sections to be tested, in accordance with the appropriate Design Standard.

2.3 Colour

PVC-M pipe for buried pressure applications shall be coloured in accordance with the colour requirements of AS/NZS 4765

NOTE: Wastewater pressure pipe applications include use in vacuum reticulation and main drainage systems.

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2.4 Effect on Water

Pipe, elastomeric seals, lubricants, priming fluids and solvent cements for all applications shall conform with AS/NZS 4020 for a scaling factor of 1.

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3 Transportation, Handling and Storage

3.1 General

Product shall be transported, handled and stored in accordance with AS/NZS 2032 so as to prevent damage by impact, rough handling, crushing, piercing by sharp objects, contact with aggressive chemicals or by extended exposure to high temperature sources. Product items shall not be lifted by hooking at ends or by dropping off elevated vehicle platforms or sites. Pipes shall be loaded and unloaded by means of reinforced wide-band elastomeric or fabric webbing straps or slings of an acceptable design. Where wire ropes or chains are used, these shall not come into direct contact with product.

NOTES
1: PVC pipe, being made from a thermoplastic material, is sensitive to deformation under increasing load, elevated temperature, point loadings and cuts and scratches which can lead to sudden pipe failure in service. Prolonged exposure of PVC pipe to sunlight and high temperatures can lead to embrittlement of the pipe material.
2: Appropriate consideration should be given to personnel safety when working with loose or stacked PVC pipes because their smooth surface finish renders them slippery, particularly in wet conditions.

3.2 Packaging

Pipes shall be packaged in supporting crates or in strapped bundles that have been designed to prevent point loading, chafing, scoring, impact or other pipe damage during transportation, handling and storage operations. Pipes shall be seated on scallop-profiled timber bearers and separating packers. Pipes shall be bundled so that socketed pipe ends alternately adjoin but extend beyond spigoted pipe ends (See Figure 2.1). Each pipe bundle or crate shall be constructed so that pipe loads are directly supported by the bundle or crate structure and not by other pipes.

Packaged pipe bundles shall be restrained by timber framework or by padded strapping all round. Support framework, bearers, packers and strapping shall be at support centres no farther apart than 2.5 metres. A packaged pipe bundle shall not exceed one metre in height when on level ground. Pipes shall not be nested unless both inner and outer pipes have been adequately secured from movement and deformation relative to each other and relative to the supporting system. Where pipe bundles are packaged in timber crates, the distance between timber framework support centres shall be constant throughout if vertical stacking of the crates is required.

3.3 Lifting

Pipes shall be supported at nominal quarter points from pipe ends during lifting operations. Mechanical equipment and slings used for handling of pipes and fittings shall be in accordance with AS 2550.1 and AS 2550.5 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia.

3.4 Transportation and Unloading

All loading, unloading and transport operations shall be in accordance with the requirements of AS/NZS 2032. Unsupported pipe overhangs shall be limited to one metre. Individual or loose pipes shall be lowered, lifted and carried in a controlled fashion and shall not be thrown or dropped from loading platforms or transporting vehicles or dragged along the ground at storage or installation sites (See Figure 3.2). Climbing or standing on pipes shall not be permissible.

Pipes and supporting system load restraints shall be secured to the transporter to prevent displacement relative to the transporter during transportation. This may be by means of straps, bolsters or other appropriate restraints in accordance with Load Restraint Guide—Guidelines for Safe Carriage of Loads on Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia. Load restraint mechanisms shall be checked for tension at

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regular intervals not exceeding 300 kilometres of travel and shall not be released until the transporting vehicle is resting in a secure stable disposition on level ground.

Each bundle or crate shall be separately secured. The timber bearers or spacers of one bundle or crate shall not be nailed to those of another. The timber bearers of stacked pipe bundles or crates shall be positioned vertically above each other and shall not be used for lifting. Lifting slings shall be placed around the pipe bundles beyond the positions of supporting timbers bearers or spacers.

Transport by rail, sea or air, shall be in accordance with the relevant regulations for the particular mode of transport. Cushioned pipe end protection of an acceptable design shall be provided to prevent damage from shunting shocks during transportation.

NOTE: Pipe deliveries in packaged or bundled form should be retained in this form until required for installation activities. Pipe deliveries in small quantities should be secured by means of side chocking, end support and temporary strapping or packing to prevent any sideways or longitudinal movement during transportation. Pipes should be off-loaded from high-sided vehicles by rolling them down two timber runners under rope control. Off-loading below head height should be achieved by gently sliding each pipe from the opened tail of the transporting vehicle to a practicable manual carrying position on site (See Figure 3.2).

3.5 Pipe Storage

Designated storage areas at pipe depots and at pipe installation sites shall be of sufficient size to accommodate pipe deliveries. Storage areas and procedures shall conform with the requirements of AS/NZS 2032. Illustrations of right and wrong handling and stacking practices for pipes in storage depots and on installation sites are given in Figures 3.1 and 3.2. Storage of elastomeric pipe joint seals shall conform with the requirements of AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4).

NOTES
1: Pipe fittings and jointing materials should be stored separately and under cover. Discrete or loose pipe components should be stored in original product packaging, prior to pipe installation.
2: Pipes or pipe bundles should be supported on a grid structure of timber or sandbags that avoids direct pipe contact with the ground or soil materials with adequate space provided around pipe storage stacks for the movement of machinery and lifting equipment, without risk of pipe damage.

3.6 Pipe Stacking

Pipe stacking heights shall be kept to a minimum to enable safe lifting manoeuvres. Stacked pipe bundles or crates shall be no more than three units high subject to a maximum overall stack height of two metres. Timber framed pipe bundles or crates shall be stacked timber to timber. Provision shall be made for side support to prevent stack collapse when the banding or framing is removed.

Where loose or individual pipe stacks have vertical side supports stack height shall be restricted to a maximum of 1.5 metres to minimise pipe ovalization or deformation while stored. Loose pipe stacks on installation sites shall be no higher than one metre (See Figures 3.1 and 3.2). The number of supports between stacked layers of nested pipes (i.e. pipes stored inside pipes of a larger diameter) shall be increased so that point loads on individual pipes are no greater than for un-nested pipes.

Stacked pipe barrels shall be continuously and uniformly supported with socketed pipe ends alternately adjoining but extending beyond spigoted pipe ends. Where pipes of different stiffness or pressure classes are stored in the same stack, the highest rated class shall be at the bottom of the stack. Where pipe deformation does occur, particularly in the lower layers of pipe storage stacks, the deformed pipes shall be removed at a sufficient time before installation to allow re-rounding to occur.

NOTE: The width of bottom stack layers should not exceed 3 metres. Timber stack supports should be sufficiently thick to prevent pipe sockets bearing directly on the ground. Vertical supports and chock blocks should be provided to prevent accidental slippage, rolling or collapse of pipe stacks.

3.7 Pipe Stringing

Pipe ‘stringing’ at installation sites shall be restricted to a sufficiently short length to reduce the risk of damage or contamination. Pipes shall be strung at a safe distance from spoil heaps, heavy operating machinery and vehicle tracking areas.

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NOTE: Pipe 'stringing' should be restricted to one or two working days. In urban areas, individual pipes should be chocked to prevent accidental movement with appropriate warning signs and lighting provided.

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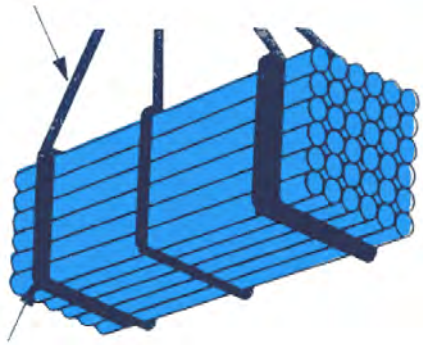
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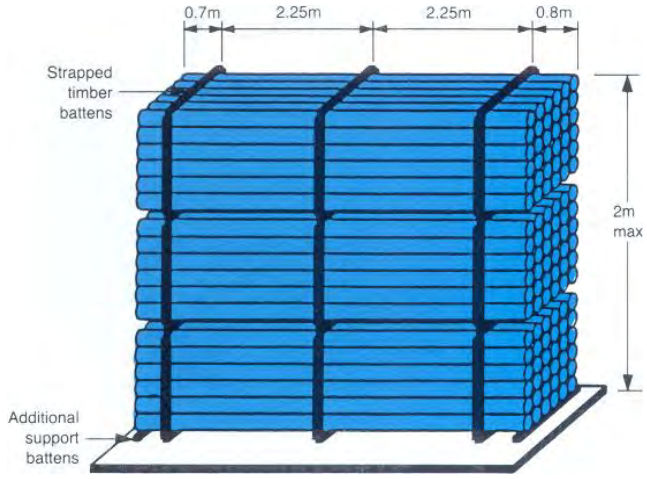
FOI 26-292 - Document 27

Lifting bundle-packs

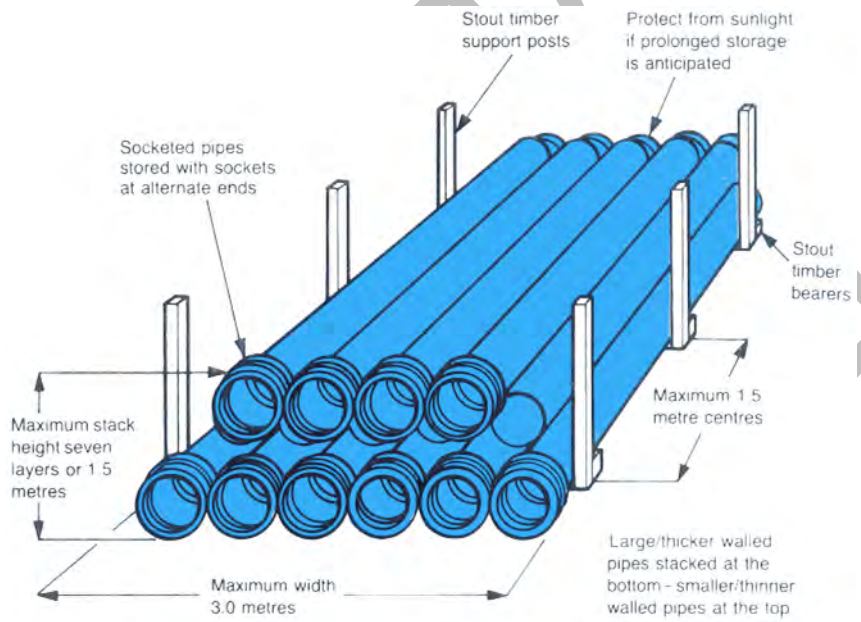
Non-metallic
wide-band webbing



Webbing positioned beyond locations of
timber supports, packers or framework battens



(a) Typical lifting and stacking arrangements for pipe bundles and crates



(b) Typical stacking arrangements for loose pipes

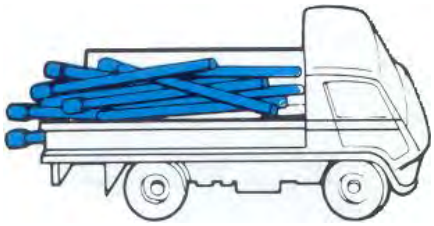
Figure 3.1 - Handling and stacking at pipe storage sites

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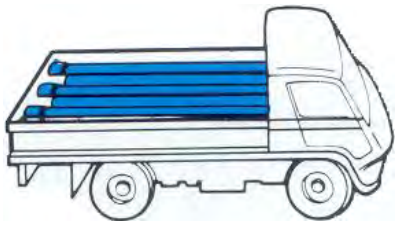
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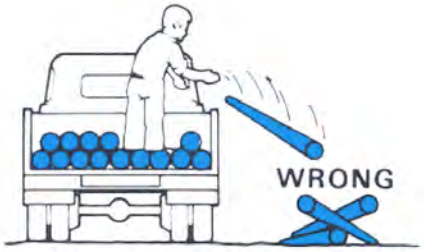
FOI 26-292 - Document 27



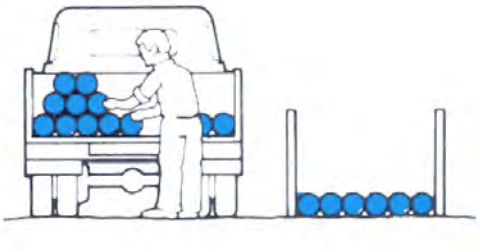
WRONG way to load pipes



RIGHT way to load pipes

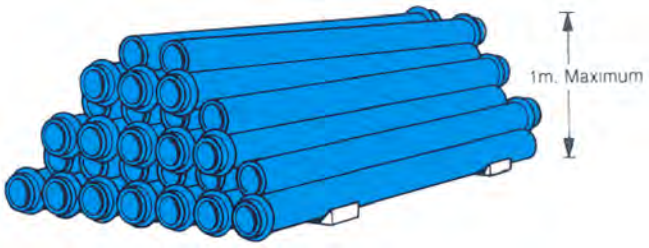


WRONG way to off-load pipes

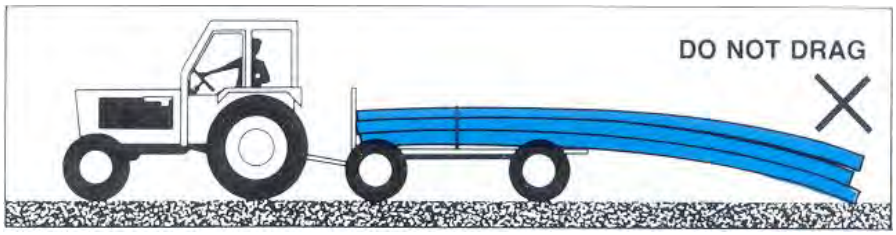


RIGHT way to off-load pipes

(a) Common (wrong and right) loading and off-loading arrangements for small pipe quantities



(b) Typical stacking arrangement for individual or loose pipes



(c) Common (wrong) on-site transportation arrangement for loose pipes

Figure 3.2 - Handling and stacking on pipe installation sites

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4 Conformity with Requirements

4.1 General

Product conformity with the specified requirements shall be verified by means of an acceptable inspection and test plan (ITP). The ITP shall provide for product component structural and durability design, materials control and performance conformity testing throughout production. The inspection and test plan shall be embodied in a duly accredited ISO 9001 production quality management system.

Product shall be deemed to conform with requirements where test outcomes have been formally verified by a Product Assessor or certified by a Conformity Assessment Body (CAB) in accordance with the requirements of a product standard acceptable to the Corporation. Otherwise, it shall be classified as non-conforming Product.

NOTE: For acceptance, performance testing and calibration laboratories should be accredited as meeting the requirements of AS/NZS ISO/IEC 17025 by a signatory member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). The scope of laboratory/facility accreditation should include the competencies and capabilities required to execute the particular product testing and calibration work to be undertaken.

4.2 Certification of Product

Products, in respect of which conformity with a particular nominated product Standard(s) is claimed, shall, for acceptance, be assessed in accordance with an acceptable product certification system and shall be subject to the issue of a certificate of conformity with the nominated Standard(s) by a duly accredited CAB.

The certification system or scheme with which product conformity is claimed shall:

- be based on ISO/IEC TR 17026, Conformity assessment -- Example of a certification scheme for tangible products and shall be in accordance with the fundamentals of AS/NZS ISO/IEC 17067 and with the guiding principles of ISO/IEC Guide 28;
- include product type testing from independently sampled production;
- require the manufacturer's production processes and associated controls to be part of a quality management system that has been certified as meeting the requirements of AS/NZS ISO 9001, Quality management systems - Requirements; and shall
- include subsequent verification that the manufacturer continues to maintain effective production control and product conformity with the nominated product Standard(s), at intervals not exceeding 12 months.

NOTE: Evidence of Product conformity with the specified requirements may be by means of a Product Verification Report provided by a Product Assessor including reference to a current relevant water industry appraisal report or certificate issued by WSAA.

4.3 Product Re-verification

Product conformity with the Specification shall be subject to re-verification by a Product Assessor when, during the agreed product supply period, there occurs any:

- substantive change in product design or material formulation or performance;
- Product failure to perform in operational service to the nominated performance specifications.

Re-verification shall require the issue of a new or supplementary Product Verification Report. Product components and test outcomes that are not significantly affected by the product change or failure may be excluded from the scope of re-verification, provided that these outcomes have already been reported in a current valid Product Verification Report that is acceptable to the Corporation.

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4.4 Acceptance Criteria

For acceptance, Product shall be supplied as specified in the Purchasing Schedule and shall be clearly and indelibly provided with product markings in accordance with AS/NZS 4765.

Prior to the implementation of any arrangement to supply product, the Supplier shall, in accordance with specified - including acceptance - requirements:

- nominate applicable Product Warranty terms; and
- provide documentary verification of conformity with performance requirements in the form of a current valid Certificate, certified evidence of conformity with an inspection and test plan (ITP) or a Product Verification Report that is appropriate to the Product, subject to the acceptability of certification credentials; and
- detail each element of Product that does not conform with the specified requirements together with the extent of non-conformity.

NOTE: Where the Specification includes Technical Compliance Schedules, the nature and extent of all non-conformities should be recorded in the appropriate Schedules to be submitted for acceptance.

4.5 Non-conforming Product

4.5.1 General

Product whose design, workmanship or performance fails to conform to the specified requirements shall be clearly tagged and quarantined by the Supplier as non-conforming and shall be subject to rejection for return to and replacement by the Supplier.

4.5.2 Manufacturing Repairs (In-process)

The Manufacturer shall make provision in its production Quality System and in its ITP for sufficient hold points whenever Product non-conformities are encountered. Production work on non-conforming components shall cease and repair work shall not re-commence until the following have been confirmed by the Corporation in writing:

- acceptability of non-conforming component repair in lieu of component replacement; and
- acceptability of particular proposed repair procedures; and
- acceptability of any proposal to vary the terms of the original Product Warranty as a consequence of an in-process repair.

4.5.3 Product Warranty

The Supplier shall replace non-conforming Product with Product that conforms with the acceptance criteria or shall repair or rectify all faults, damage or losses caused by non-conforming Product. Except as may otherwise be specified, the Product Warranty shall indemnify and keep indemnified the Corporation against all losses suffered by the Corporation as a result of non-conforming Product for a period no less than 24 months after product delivery or 12 months after |Product installation, whichever period elapses first.

4.5.4 Product Repair

All reasonable proposals for repair or remedy of defects will be considered, provided that each such proposal is accompanied by a methodology statement that accords with the performance objectives of this Specification, as determined by the Corporation. For acceptance, a proposal for repair or remedy of Product non-conformities shall not void or otherwise diminish the provisions of the Product Warranty.

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4.5.5 Access to the Place of Manufacture

The Corporation shall be afforded access, at all reasonable times, to all places of manufacture of Product and shall be authorized to arrange or undertake such testing there as the Corporation deems appropriate to the agreed design proving or testing regime.

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5 Appendix A: Material Master Records (Informative)

The following Material Master Records (MMR) comprise Corporation catalogue numbers that are unique to the particular products described for the purposes of Corporation activities or work.

MMR	DESCRIPTION (Blue Series 2 PN12)	BUOM
13515	Pipe, Plastic; MPVC; Series 2; Blue; DN100; PN12; Elastomeric Seal Joint; 6m Length.	LG
13516	Pipe, Plastic; MPVC; Series 2; Blue; DN150; PN12; Elastomeric Seal Joint; 6m Length.	LG
14942	Pipe, Plastic; MPVC; Series 2; Blue; DN200; PN12; Elastomeric Seal Joint; 6m Length.	LG
18307	Pipe, Plastic; MPVC; Series 2; Blue; DN250; PN12; Elastomeric Seal Joint; 6m Length.	LG
18643	Pipe, Plastic; MPVC; Series 2; Blue; DN300; PN12; Elastomeric Seal Joint; 6m Length.	LG
18699	Pipe, Plastic; MPVC; Series 2; Blue; DN375; PN12; Elastomeric Seal Joint; 6m Length.	LG
19978	Pipe, Plastic; MPVC; Series 2; Blue; DN200; PN12; Elastomeric Seal Joint; C/W Collar; 3m Length. Note: This Pipe can be Supplied with or without Collar, for Pipe Repairs only.	LG
19979	Pipe, Plastic; MPVC; Series 2; Blue; DN250; PN12; Elastomeric Seal Joint; C/W Collar; 3m Length. Note: This Pipe can be Supplied with or without Collar, for Pipe Repairs only.	LG

MMR	DESCRIPTION (Blue Series 2 PN16)	BUOM
19831	Pipe, Plastic; MPVC; Series 2; Blue; DN100; PN16; Elastomeric Seal Joint; 6m Length.	LG
19832	Pipe, Plastic; MPVC; Series 2; Blue; DN150; PN16; Elastomeric Seal Joint; 6m Length.	LG
19833	Pipe, Plastic; MPVC; Series 2; Blue; DN200; PN16; Elastomeric Seal Joint; 6m Length.	LG
19834	Pipe, Plastic; MPVC; Series 2; Blue; DN250; PN16; Elastomeric Seal Joint; 6m Length.	LG
21595	Pipe, Plastic; MPVC; Series 2; Blue; DN300; PN16; Elastomeric Seal Joint; 6m Length.	
22036	Pipe, Plastic; MPVC; Series 2; Blue; DN375; PN16; Elastomeric Seal Joint; 6m Length.	

MMR	DESCRIPTION (Blue Series 2 PN20)	BUOM
13513	Pipe, Plastic; MPVC; Series 2; Blue; DN100; PN20; Elastomeric Seal Joint; 6m Length. Note: To be Purchased in Small Quantities for Repair/Replacement Work or Conditional New Work Only.	LG
13514	Pipe, Plastic; MPVC; Series 2; Blue; DN150; PN20; Elastomeric Seal Joint; 6m Length. Note: To be Purchased in Small Quantities for Repair/Replacement Work or Conditional New Work Only.	LG
16733	Pipe, Plastic; MPVC; Series 2; Blue; DN200; PN20; Elastomeric Seal Joint; 6m Length. Note: To be Purchased in Small Quantities for Repair/Replacement Work or Conditional New Work Only.	LG

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MMR	DESCRIPTION (Cream Sewer Series 2 PN12)	BUOM
20006	Pipe, Plastic; MPVC; Cream; Series 2; Sewer; DN100; Pressure Class PN12; Elastomeric Seal Joint; 6m Length.	LG
18480	Pipe, Plastic; MPVC; Cream; Series 2; Sewer; DN200; Pressure Class PN12; Elastomeric Seal Joint; 6m Length.	LG
20007	Pipe, Plastic; MPVC; Cream; Series 2; Sewer; DN250; Pressure Class PN12; Elastomeric Seal Joint; 6m Length.	LG
20008	Pipe, Plastic; MPVC; Cream; Series 2; Sewer; DN300; Pressure Class PN12; Elastomeric Seal Joint; 6m Length.	LG
18713	Pipe, Plastic; MPVC; Cream; Series 2; Sewer; DN375; Pressure Class PN12; Elastomeric Seal Joint; 6m Length.	LG

MMR	DESCRIPTION (Cream Sewer Series 2 PN16)	BUOM
21630	Pipe, Plastic; MPVC; Cream; Series 2; Sewer; DN100; Pressure Class PN16; Elastomeric Seal Joint; 6m Length.	LG

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END OF DOCUMENT

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Assets Planning and Delivery Group
Engineering

Strategic Product Specification

SPS 125
Polyethylene and Polypropylene Pipe and Pipe Fittings

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VERSION 1
REVISION 4

SEPTEMBER 2020

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FOI 26-292 - Document 27

FOREWORD

Each Strategic Product Specification has been prepared to inform Water Corporation staff, consultants, contractors and land developers of the requirements for selecting and acquiring a manufactured product to be used in strategic Corporation infrastructure. The definition of 'Product' includes items that comprise assembled components, equipment or plant for mechanical, electrical and civil infrastructure applications.

The objective of a Strategic Product Specification is to specify fit-for-purpose Product which will contribute to the provision of effective water services at least whole-of-life cost and with least risk to service standards and safety. A Strategic Product Specification also provides uniform standards for compatibility of new water infrastructure with existing water assets.

Many Strategic Product Specifications have drawn on the design, asset management and operational experience of Product performance in live service gained by the Corporation over time. Some Strategic Product Specifications have drawn on the experience of the water industry nationally by referencing Australian or WSAA standards.

Strategic Product Specifications are intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure design and construction work;
- Private developer funded subdivision infrastructure for takeover by the Corporation;
- Operationally funded infrastructure design and construction work;
- Corporation period contracts for Product purchases;
- Product purchases for stock or for miscellaneous minor work.

A published Strategic Product Specification will, in some cases, comprise technical content that is typical of a range of products of the same type (type specification) but may exclude specific requirements that should apply to a particular project or application. In such cases, the project designer is required to document the supplementary project specific requirements in the 'Project Specific Requirements' Appendix of the Specification.

The text of a published Specification should not be directly modified. In the event that a text variation is considered necessary to accommodate the needs of a particular project or application, the text modification should be documented in the appropriate Clause of a 'Project Specific Requirements' Appendix.

Enquiries relating to the technical content of this Specification should be directed to the Senior Principal Engineer, Wastewater Conveyance, Engineering

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Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

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REVISION STATUS

The revision status of this specification is shown section by section below:

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
1	1/0		All	New Specification	KR	MH
1	1/1	25.6.2014		1.2/1.3.21 minor editorials	KR	DV
1	1/2	11.6.2018		ISO & EN standards referenced. Compliance/certification changed to conformity assessment	KR	KP
1	1/4	31.08.2020	9	Updated definition of Product.	PV	JD
2	1/0		All	New Specification	KR	MH
2	1/1	25.6.2014		2.1/2.4.1/2.4.2 design/selection notes	KR	DV
2	1/2	11.6.2018		Fitting performance and ISO/EN conformity requirements detailed. New PE resin (e.g. PE-HSCR) options added.	KR	KP
2	1/3	19.09.2018		Added requirement for PE100-HSCR in drinking water applications	PV	JD
2.1	1/4	31.08.2020	11	Removed second paragraph, temperature derating factors are described in the Design Standards.	PV	JD
2.1.1	1/4	31.08.2020	11	Added definition for Disinfectant Resistant PE, updated definition for HSCR PE, and removed specification for alternative installation techniques.	PV	JD
2.1.2	1/4	31.08.2020	11-12	Referred to AS/NZS 4129 requirements for spigot fittings, updated definition of HSCR and RC PE, added definition for Disinfectant Resistant PE, replaced EN14525 reference with SPS125, and clarified DN63 limit on compression fittings.	PV	JD
2.5.2	1/4	31.08.2020	15	Removed duplicate WS-2 reference	PV	JD
3	1/0		All	New Specification	KR	MH
3	1/1	25.6.2014		3.2/3.4/3.5/3.8 editorials	KR	DV
3	1/2	11.6.2018		Technical clarifications, editorials and industry references added	KR	KP
3.5	1/4	31.08.2020	16	Corrected wording of second paragraph.	PV	JD
4	1/0		All	New Specification	KR	MH
4	1/1	25.6.2014		4.1.1 editorial; New 4.3.2 added	KR	DV
4	1/2	11.6.2018		Conformity requirements aligned	KR	KP

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REVISION STATUS						
SECT.	VER./ REV.	DATE	PAGES REVISED	REVISION DESCRIPTION (Section, Clause, Sub-Clause)	RVWD.	APRV.
				with new SA rules and WSAA Technical Note 08		
4	1/3	19.09.2018		Added requirement for resin manufacturer and designation in pipe marking string	PV	JD
4.6	1/4	31.08.2020		Testing need not be undertaken at place of manufacture and testing not limited to agreed test regime.	PV	JD
5	1/0		All	New Specification	KR	MH
5	1/2	30.6.2018	All	MMRs for PN 12.5 product options removed	KR/IP	KP
5	1/4	31.06.2020	21-22	Reference to DS63 update Bulleting 17-2 removed	PV	JD
6	1/4	31.06.2020	26-28	New Section defining Assessment Criteria for Resistance to Disinfectants.	PV	JD

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Strategic Product Specification
SPS 125
Polyethylene and Polypropylene Pipe and Pipe Fittings

CONTENTS

Section *Page*

1 Scope and General 7
1.1 Scope 7
1.2 Referenced Documents 7
1.3 Definitions and Notation 9
1.3.1 Australian Standards® 9
1.3.2 Certificate 9
1.3.3 Certification Mark 9
1.3.4 Certification System 9
1.3.5 Conforming Product 9
1.3.6 Conformity Assessment Body (CAB) 10
1.3.7 Corporation 10
1.3.8 Manufacturer 10
1.3.9 Notation 10
1.3.10 Officer 10
1.3.11 Product 10
1.3.12 Product Appraisal 10
1.3.13 Product Assessor 10
1.3.14 Product Certification 10
1.3.15 Product Verification Report 10
1.3.16 Product Warranty 11
1.3.17 Purchasing Schedule 11
1.3.18 Quality System 11
1.3.19 Standards Australia 11
1.3.20 Strategic Product 11
1.3.21 Strategic Product Appraisal Process 11
1.3.22 Supplier 11
1.3.23 Testing 11
2 Materials and Components 12
2.1 PE Pressure Pipe and Fittings 12
2.1.1 PE Pipe 12
2.1.2 PE Pipe Fittings 12
2.2 Non-pressure Pipe and Fittings 13
2.3 Colour 13
2.4 Effect on Water 14
2.5 Joint Configuration 14
2.5.1 Mechanical Jointing 14
2.5.2 Fusion Jointing 14

DRAFT

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FOI 26-292 - Document 27

3 Transportation, Handling and Storage 16
3.1 General 16
3.2 Protection from Elevated Temperatures and Sunlight 16
3.3 Preservation of Product in Storage 16
3.4 Pipe Storage 16
3.5 Pipe Stacking 16
3.6 Pipe Stringing 17
3.7 Lifting 17
3.8 Transportation and Unloading 17
4 Conformity with Requirements 18
4.1 General 18
4.2 Certification of Product 18
4.3 Product Re-verification 18
4.4 Acceptance Criteria 18
4.5 Non-conforming Product 19
4.5.1 General 19
4.5.2 Manufacturing Repairs (In-process) 19
4.5.3 Product Warranty 19
4.5.4 Product Repair 20
4.6 Access to the Place of Manufacture 20
5 Appendix A: Material Master Records (Informative) **21**
6 Appendix B: Assessment Criteria for Resistance to Disinfectants (Normative) 26

DRAFT

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FOI 26-292 - Document 27

1 Scope and General

1.1 Scope

This Specification sets out requirements for the supply, handling and delivery of polyethylene and polypropylene pipe and associated pipe fittings that respectively meet the requirements of AS/NZS 4130 "Polyethylene (PE) pipes for pressure water and wastewater applications" and AS/NZS 5065 "Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications". The Specification also details the acceptance criteria for polyethylene and polypropylene pipe and pipe fittings intended for infrastructure project use and the means of demonstrating conformance with the Specification.

NOTES:

1 Polypropylene pipes and fittings (to AS/NZS 5065) are intended exclusively for non-pressure wastewater conveyance and, subject to project-by-project agreement, drainage applications. They are neither intended nor suitable for drinking water applications.

2 Polyethylene pipe systems should be installed in accordance with AS/NZS 2033 Polyethylene (PE). Polypropylene (PP) pipelines for buried applications should be designed and installed in accordance with AS/NZS 2566.

1.2 Referenced Documents

The following documents are referenced in this Specification:

Water Corporation

DS 50	Design and construction requirements for gravity sewers DN 150 to DN 600
DS 51	The Design and Construction of Wastewater Pumping Stations and Pressure Mains 4.5 to 180 Litres Per Second Capacity
DS 60	Water Supply Distribution Standard - Pipelines Other than Reticulation
DS 63	Water Reticulation Standard -Design and Construction Requirements for Water Reticulation Systems up to DN250
DS 66	Urban Main Drainage Standard
	Strategic Products Register

AS

1646	Elastomeric seals for waterworks purposes *(Performance requirements in AS 681 Parts 1 to 4)*
681.1	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Vulcanized rubber
681.2	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Thermoplastic elastomers
681.3	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Cellular materials of vulcanized rubber
681.4	Elastomeric seals - Material requirements for pipe joint seals used in water and drainage applications - Cast polyurethane sealing elements
1462.24	Methods of test for plastics pipes and fittings Method 24:Determination of resistance to crack propagation—Test methods for slow crack growth in notched pipes(notch test) (This MOT was reproduced from and is equivalent to ISO 13479)
1745.2	Outdoor weathering of plastics in the Australian environment - Part 2: Guide for design purposes
2345	Dezincification resistance of copper alloys
3688	Water supply - Copper and copper alloy body compression and capillary fittings and threaded-end connectors

AS/NZS

1462.6	Methods of test for plastics pipes and fittings - Method 6: Thermoplastics pipes, fittings and assemblies for the transport of fluids under pressure - Resistance to internal pressure (This MOT was based on and is equivalent to ISO 1167.1, 1167.2, 1167.3 and 1167.4)
1462.25	Methods of test for plastics pipes and fittings - Determination of slow-crack-growth of PE (polyethylene) resins - Notched, constant ligament-stress (NCLS) method
1462.29	Methods of test for plastics pipes and fittings - Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation (ISO 9080:2003, MOD)
2033	Installation of polyethylene pipe systems

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2566.1	Buried flexible pipelines - Part 1: Structural design
2566.2	Buried flexible pipelines - Part 2: Installation
3500	National Plumbing and Drainage Code
4020	Products for use in contact with drinking water
4087	Metallic flanges for waterworks purposes
4129	Fittings for polyethylene (PE) pipes for pressure applications
4130	Polyethylene (PE) pipes for pressure applications
4131	Polyethylene (PE) compounds for pressure pipes and fittings
5065	Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications

POP **PIPA (Plastics Industry Pipe Association) Guidelines**

001	Electrofusion jointing of PE pipe and fittings for pressure applications
003	Butt fusion jointing of PE pipes and fittings - Recommended parameters
004	Polyethylene pipe compounds
004A	Supplementary List - Materials Specific to Electrofusion and Moulded Fittings
005	Packaging, handling and storage of polyethylene pipes and fittings
006	Derating requirements for fittings
007	Metal backing flanges for use with polyethylene (PE) pipe flange adaptors
008	Striping of polyolefin pipes
010A	Part 1: polyethylene pressure pipes design for dynamic stresses
010B	Part 2: fusion fittings for use with polyethylene pressure pipes design for dynamic stresses
013	Temperature re-rating of PE Pipes Systems
014	Assessment of Polyethylene Welds
016	High Stress Crack Resistant PE100 (PE 100-HSCR)
017	Material Requirements for White PE Jacket Compounds Suitable for Long Term UV Exposure
201	Resistance of plastics pipes and fittings to water and wastewater chemicals
204	Expected service life of elastomeric pipe seals
205	Water jet cleaning of plastics pipes

ISO

228.1	Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation
1133	Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics
1183.1	Plastics - Methods for determining the density of non-cellular plastics - Part 1: Immersion method, liquid pyknometer method and titration method
3126	Plastics piping systems - Plastics piping components - Measurement and determination of dimensions
4427-2	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 2: Pipes
4427-3	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 3: Fittings
4437-2	Plastics piping systems for the supply of gaseous fuels. Polyethylene (PE) - Part 2: Pipes
4437-3	Plastics piping systems for the supply of gaseous fuels. Polyethylene (PE) - Part 3: Fittings
6964	Polyolefin pipes and fittings - Determination of carbon black content by calcination and pyrolysis - Test method and basic specification
9080	Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
11357.6	Plastics - Differential scanning calorimetry (DSC) - Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)
11413	Plastics pipes and fittings—Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting
11414	Plastics pipes and fittings—Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion
12162	Thermoplastics materials for pipes and fittings for pressure applications - Classification and designation - Overall service (design) coefficient
12176-1	Plastics pipes and fittings—Equipment for fusion jointing polyethylene systems - Butt fusion
12176-2	Plastics pipes and fittings—Equipment for fusion jointing polyethylene systems - Electrofusion
13477	Thermoplastics pipes for the conveyance of fluids - Determination of resistance to rapid crack propagation (RCP) - Small-scale steady-state test (S4 test)
13478	Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST)
13479	Polyolefin pipes for the conveyance of fluids - Determination of resistance to crack propagation - Test method for slow crack growth on notched pipes

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FOI 26-292 - Document 27

16770	Plastics. Determination of environmental stress cracking (ESC) of polyethylene. Full-notch creep test (FNCT)
24033	Polyethylene of raised temperature resistance (PE-RT) pipes — Effect of time and temperature on the expected strength

BS EN

1555-1	Plastics piping systems for the supply of gaseous fuels. Polyethylene (PE) - Part 1: General
1555-2	Plastics piping systems for the supply of gaseous fuels. Polyethylene (PE) - Part 2: Pipes
1555-3	Plastics piping systems for the supply of gaseous fuels. Polyethylene (PE) - Part 3: Fittings
12201-1	Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) - Part 1: General
12201-2	Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) - Part 2: Pipes
12201-3	Plastics piping systems for water supply, and for drainage and sewerage under pressure - Polyethylene (PE) - Part 3: Fittings
14525	Ductile iron wide tolerance couplings and flange adaptors for use with pipes of different materials: ductile iron, grey iron, steel, PVC-U, PE, fibre-cement

DIN	**PAS (Publically available specification)**
1075	Pipes made from Polyethylene for alternative installation techniques - Dimensions, technical requirements and testing

AS/NZS ISO IEC

7.1	**AS/ISO** 7.1: Pipe threads where pressure-tight joints are made on the threads - Dimensions, tolerances and designation
9001	**AS/NZS ISO** 9001: Quality management systems – requirements
17000	**ISO/IEC 17000**: Conformity assessment – Vocabulary and general principles
17025	**ISO/IEC 17025**: General requirements for the competence of testing and calibration laboratories
17026	**ISO/IEC 17026 (TR)**: Conformity assessment – Example of a certification scheme for tangible products
17067	**AS/NZS ISO/IEC 17067**: Conformity assessment – Fundamentals of product certification and guidelines for product certification schemes

1.3 Definitions and Notation

The following definitions are intended to clarify the terminology used in this Specification.

1.3.1 Australian Standards®

Standards that are developed, published and maintained by Standards Australia

1.3.2 Certificate

A formal certificate issued by a Conformity Assessment Body as an outcome of a conformance audit in accordance with a Certification System.

1.3.3 Certification Mark

A proprietary mark of product conformity issued in accordance with ISO/IEC 17030.

1.3.4 Certification System

An impartial third party product certification scheme or combination of schemes, as exemplified in ISO/IEC TR 17026, that are in accordance with the fundamentals of AS/NZS ISO/IEC 17067 and with the guiding principles of ISO/IEC Guide 28.

NOTE: The effect of this is to require maintenance by the manufacturer of effective production control planning in addition to full type testing from independently sampled production and subsequent verification of conformity with specified standards.

1.3.5 Conforming Product

Product that demonstrably conforms with standards and specifications nominated by the Corporation, where assessed by means of Product Appraisal.

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FOI 26-292 - Document 27

1.3.6 Conformity Assessment Body (CAB)

A third party organisation that has been duly accredited as meeting the requirements of AS/ANZ ISO/IEC 17065 by a signatory member of the International Accreditation Forum (IAF) Multilateral Arrangement (MLA), previously known as a **Certification Body**.

1.3.7 Corporation

The Water Corporation of Western Australia.

1.3.8 Manufacturer

An entity or combination of entities that are responsible for selection, processing and control of Product constituent materials or compounds and for the processing equipment that collectively result in the manufactured product.

1.3.9 Notation

Statements governed by use of the word 'shall' are mandatory or 'normative' requirements of the Specification. Statements expressed by use of the words 'should' or 'may' are 'informative' but not mandatory and are provided for information and guidance. Notes in Specification text are informative. Notes that form part of Specification Tables are normative. An Appendix to the Specification that is designated 'normative' contains mandatory requirements. An Appendix that is designated 'informative' is provided for information and guidance only. The term 'specified' includes requirements of the Specification and requirements stated or referenced in other project documentation.

1.3.10 Officer

A duly authorized representative or appointed agent of the Corporation.

1.3.11 Product

A single unit or multiple units of manufactured end product or an assembly of manufactured component products, materials or equipment.

NOTE 1: An end product is most commonly an output of manufacturing processes that result in finished end products having the same features and characteristics and can be the result of a single or multiple production batches.

NOTE 2: Manufactured equipment and assemblies of Product components or materials are commonly procured for mechanical, electrical and civil infrastructure applications.

1.3.12 Product Appraisal

A formal process whereby Product is subjected to systematic engineering assessment to determine Product fitness for prescribed end uses and to evaluate its conformity with specified standards and requirements. Product Appraisal includes verification of the extent of conformance in accordance with the requirements of a relevant 'Technical Compliance Schedule'.

1.3.13 Product Assessor

An organisation, Officer or other person who, having demonstrated specialist product knowledge and competence acceptable to the Corporation, is appointed to evaluate Product, appraises the Product and issues one or more Product Verification Reports.

1.3.14 Product Certification

A formal process whereby the production and management systems for the manufacture of Product, are assessed by a Conformity Assessment Body to evaluate conformance of these systems with specified product standards and tests, in accordance with Certification System rules.

1.3.15 Product Verification Report

A formal report wherein a Product Assessor evaluates the extent of Product conformance with the specified product standards and specifications.

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NOTE: Verification may be on a project-by-project basis or at agreed intervals, as appropriate to the scope of a Purchasing Schedule and Product end use, subject to determination by the Corporation.

1.3.16 Product Warranty

A formal express undertaking by a Supplier that indemnifies the Corporation against the consequences of supplied Product failure to conform with specified fitness for application and in-service life expectancy performance requirements.

1.3.17 Purchasing Schedule

A Corporation purchase order, tender, schedule of prices, bill of quantities, or specification that details the nature, quantity and other characteristics of Product to be supplied, purchased or installed.

1.3.18 Quality System

A management system that establishes, documents, implements and maintains organisational structures, resources, responsibilities, processes and procedures for the manufacture of Product and provision of Product related services in accordance with the requirements of AS/NZS ISO 9001.

1.3.19 Standards Australia

The peak non-government standards development body in Australia which develops and publishes Australian Standards®.

1.3.20 Strategic Product

An essential infrastructure component whose performance is critical to the elimination of risk to the safe and effective provision of water services, which are functions of the Corporation under the Water Corporation Act as licensed under the Water Services Coordination Act.

NOTE Strategic product is a component of permanent Corporation infrastructure. Ancillary operational and safety equipment that does not form part of permanent infrastructure but offers exceptional enhancements in operational performance or personnel safety may also be deemed strategic.

1.3.21 Strategic Product Appraisal Process

The process described in Section 3 of the Strategic Products Register whereby manufactured products and equipment are evaluated and authorized for use in Corporation infrastructure, subject to demonstrated conformity with the nominated product performance requirements.

1.3.22 Supplier

An entity or combination of entities that is responsible for the supply of Product.

NOTE: A Supplier may be a Manufacturer, owner, producer, distributor, vendor, agent, tenderer or contractor for supply of Product or Product related service.

1.3.23 Testing

The determination of Product characteristics by inspection and by the application of specified test procedures in order to determine Product conformity with nominated performance requirements.

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FOI 26-292 - Document 27

2 Materials and Components

2.1 PE Pressure Pipe and Fittings

PE pressure pipe and fittings shall be selected and designed to safely sustain the foreseeable ultimate pipeline system design operating pressure specified by the pipeline designer. Pipe and pipe fitting characteristics and applications shall be in accordance with the requirements of the applicable Corporation Design Standard (DS 51, DS 60, DS 63 or DS 66) as appropriate to each project application. All pipe and fittings shall allow for thermal, cyclic fatigue and oxidative derating in accordance with the relevant Design Standard,and shall be a minimum of PN 16 at 20ºC.

NOTE: AS/NZS 4130/AS/NZS 4129 PE pipe and pipe fitting dimensional and mechanical performance requirements closely align with those of respective International and European product standards, as follows:

- ISO 4427.2/ISO 4427.3 for water supply applications;
- ISO 4437.2/ISO 4437.3 for gaseous fuel applications;
- EN 1555.2/EN 1555.3 for gaseous fuel applications; and
- EN 12201.2/EN 12201.3 for water supply, drainage and sewerage applications.

2.1.1 PE Pipe

PE pipe for general pressure applications shall be manufactured in accordance with the requirements of AS/NZS 4130 (Series 1) from a pre-compounded PE 100 base resin material that has been assessed for conformity with AS/NZS 4131 and duly listed as such in POP 004.

Disinfectant Resistant PE pipe shall be made entirely of a resin that has been assessed by the Water Corporation as Disinfectant Resistant in accordance with Appendix B and listed as such in the Strategic Product Register.

HSCR PE Pipe shall be made entirely of a resin that has been assessed as HSCR in accordance with POP 016 and duly listed as such in POP 004.

NOTES

1 PE pipes should be selected and designed in accordance with the Design Standards and with an acceptable service risk evaluation process. The **cumulative** application of "informative" design factors in Table C1 of AS/NZS 4130 Appendix C is not an acceptable basis for PE pipe selection or design for water industry applications.

2.1.2 PE Pipe Fittings

Pipe fittings including electrofusion and injection moulded fittings made from PE material shall, for pressure pipeline applications, conform with AS/NZS 4129 and the following:

1. Base PE 100 resin material for pipe fittings shall conform with AS/NZS 4131 and shall be subject to formal industry acceptance by its listing in POP 004/POP 004A as a conforming compound;
2. Welded PE component and segment fabrication welding work shall conform with the requirements of WS-2 including POP 003;
3. Fabricated and heat-formed (or post-formed) fittings shall, conform to the mechanical property requirements for spigot fittings in AS/NZS 4129 (Table 6.3).
4. PE 100-HSCR fittings shall be made entirely of resin that has been assessed as HSCR in accordance with POP 016 and duly listed as such in POP 004 or POP004A;
5. PE 100-RC fittings shall be made entirely of resin conforming with DIN PAS1075 requirements and shall be subject to Corporation acceptance;
6. Disinfectant Resistant PE fittings shall be made entirely of a resin that has been assessed by the Water Corporation as Disinfectant Resistant in accordance with Appendix B and listed as such in the Strategic Product Register;

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FOI 26-292 - Document 27

1 The sustainable working pressure ratings of PE fittings that are typically heat-formed should be demonstrated by type pressure testing or, where agreed, by means of an acceptable FEA design verification supported by type testing confirmation of fitting wall thickness throughout the fitting body. Body dimensions of subsequently (heat-formed) manufactured fittings should be routinely verified during production to demonstrate continuing conformity with fitting dimensions that have been type tested to the duly nominated pressure rating(s).

2 Fabricated and heat-formed PE pipe fittings should be selected on the basis of manufacturer declared pressure de-rating factors ($\leq$ 1) duly supported by independently witnessed valid test performance reports, irrespective of manufacturer declared **nominal** fitting dimension ratio (SDR) and **nominal** pressure rating (PN).

Mechanical grip (non-fusion) fitting jointing systems for PE pipe shall incorporate elastomeric seal and joint grip components that have been designed and tested for restraint of internally pressurised PE pipe ends from axial movement relative to the joint. The jointing systems shall maintain joint water-tightness seal, notwithstanding fluctuation of pipeline service pressures between zero and design maximum operating pressure (MAOP). Ductile iron (DI) couplings and flange adaptors for use with PE pipe shall be in accordance with SPS 106.

Mechanical jointing systems to be installed on PE pipelines, that are DN 125 or larger in diameter, shall, for acceptance, incorporate a 316L stainless steel ring stiffening insert that is designed to provide internal support for and tightly fit the nominated PE pipe internal bore.

Mechanical compression and thread jointed pipe fittings (usually in end-of-line property water service and cul-de-sac applications) and fusion jointed fittings in pressure applications shall conform with AS/NZS 4129. Mechanical compression and thread jointed pipe fittings shall not be larger than DN63.

NOTES

1 Mechanical couplings and flange adaptors of materials other than DI for use with PE pipe shall comply with a coupling product standard or specification that has been agreed with or endorsed by the Corporation.

2 New PE pipeline infrastructure (larger than DN 63) should generally be fusion jointed in accordance with project drawings and specifications, to the exclusion of non-fusion mechanical jointing systems. The use of mechanical jointing systems and products should be limited to in-service PE pipeline repair and replacement operations where fusion jointing methods are impracticable from a service continuity or community acceptance perspective.

2.2 Non-pressure Pipe and Fittings

PE and PP pipe and pipe fittings for non-pressure applications shall conform with AS/NZS 5065 and shall be supplied with integral joint sockets that demonstrably provide long term installed pipe and jointing system integrity, stability and service performance in the proposed service applications. Joint seals for AS/NZS 5065 PE pipelines in non-pressure applications shall be EPDM or NBR in accordance with AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4) for the nominated elastomer IRHD hardness and shall be supplied by the original pipe or pipe fittings manufacturer.

2.3 Colour

PE pipe for buried pipeline network applications shall be externally coloured as follows:

Application	Network Element	Colour
Drinking water	Pressure Main	Black striped blue
	Service Connection	Black striped blue
Wastewater	Pressure/Vacuum Main	Black striped cream
	Non-pressure	Grey
Stormwater	Pressure Main	Black
	Non-pressure	Black
Non-drinking Water	Pressure Main	Black striped purple
	Service Connection	Purple

Pipe Colour specifications shall be in accordance with the following

Colour Specification[3]		
Colour	**No lighter than**	**No darker than**

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FOI 26-292 - Document 27

Blue	RAL 200 90 10	RAL 200 80 25
Cream	RAL 080 90 20	RAL 075 80 20
Grey	AS 2700 Pearl Grey N11	AS 2700 Cloud Grey N22
Purple	RAL 310 70 15	RAL 330-40-40 or 310 50 30

NOTES

1: PE compounds for co-extruded pressure pipe stripes and jackets should be selected from those classified in POP 004 as being AS/NZS 4130 and AS/NZS 4131 conforming.

2: Colour striping coverage, as a proportion of external pipe surface, should be no less than that given in POP 008.

3: Information on the RAL colour range may be obtained by contacting RAL Deutsches Institut fur Gutesicherung und Kennzeichnung e.V., Siegburger Strassse 39 D-53757 Sankt Augustin or by visiting www.ral.de

2.4 Effect on Water

Pressure pipe and pipe fitting joint seals and associated components and lubricants shall conform with AS/NZS 4020 for use in contact with drinking and non-drinking water, using a scaling factor of 1 for pipe and a scaling factor in accordance with AS/NZS 4129 for pipe fittings, joint components and associated lubricants.

NOTE: PE pressure pipeline components procured for wastewater and drainage applications should also comply with this requirement in order to eliminate cross-contamination risk arising from their unintentional or intentional use in drinking water applications.

2.5 Joint Configuration

2.5.1 Mechanical Jointing

The use of mechanically bolted jointing systems with elastomeric seals to joint PE pressure pipelines exceeding DN 63 in diameter shall be limited to applications where pipeline fusion jointing is proven to be impracticable and shall be subject to acceptance by the Corporation, based on demonstrated project-by-project need.

The jointing and seal configuration systems of AS/NZS 5065 PE and PP pipes and fittings for non-pressure applications shall be designed to provide pipeline joint structural and dimensional integrity and stability during handling, assembly, installation, hydrostatic testing, burial and operation over a service life in excess of 50 years.

2.5.2 Fusion Jointing

Pipe fittings intended for electrofusion and butt fusion weld jointing shall be manufactured in accordance with the particular performance and dimensional requirements of AS/NZS 4129 Section 3 and AS/NZS 4130 Section 9 respectively. The spigots of pipe fittings intended for butt fusion weld jointing shall also be dimensioned to readily and safely accommodate the configuration, reach and articulation of transporting, handling, clamping and welding equipment to be used for installation.

Polyethylene pipe and fitting fabrication, welding and acceptance testing shall conform with the requirements of WS-2 “Welding & Joining Specification Thermoplastics” and shall be in accordance with POP 014 industry guidelines for the assessment of PE joint welds.

NOTES

1 Only PE pressure pipes and fittings designed for fusion jointing should be selected for use in a vacuum reticulation system. Elastomeric seal mechanically-jointed PE pipe and fittings are not designed for and should not be used in vacuum applications.

2 Non-pressure and pressure PE pipeline systems including fusion weld, mechanical compression, flanged and threaded jointing work should be in accordance with AS/NZS 2033.

3 The design of fusion jointed PE pipeline interconnection with pipelines having unrestrained or flexible joints shall assure positive restraint of the PE pipelines from axial movement relative to the axially unrestrained pipelines.

4 Fusion jointing should be undertaken only by welders who have been duly accredited by a Registered Training Organisation (RTO) as having met the competency standard (covered by training modules PMBWELD301B through to PMBWELD311B) that is appropriate to the scope of each particular PE asset delivery project.

5: For acceptability of welder competency, the accrediting RTO should have current and appropriate accreditation in accordance with Australian National Training Authority guidelines and should employ trainers that are qualified to deliver training in accordance with the appropriate training module requirements. The accreditation status and currency of an RTO and the content of the PMBWELD training modules may be referenced at training.gov.au.

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3 Transportation, Handling and Storage

3.1 General

PE pipe and fittings shall be transported, handled and stored in accordance with the relevant requirements of AS/NZS 2033 and with POP 005 guidelines.

Mechanical handling equipment shall be in accordance with AS 2550.1, AS 2550.3, AS 2550.5 and AS 2550.11 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia. Product restraint during transportation shall be in accordance with Load Restraint Guide—Guidelines for Safe Carriage of Loads on Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia.

NOTES

1: Notwithstanding the use of carbon black and ultraviolet light stabilisers in the manufacture of PE pipes and pipe fittings, neither should be subjected to prolonged exposure to ultra-violet light (e.g. direct strong sunlight) for a period exceeding 12 months. Pipe fittings should be retained in their delivery packaging until their installation is planned and imminent.

2: Appropriate consideration should be given to personnel safety when working with loose or stacked PE pipes and pipe fittings because their smooth surface finish can render them slippery, particularly in wet conditions.

3.2 Protection from Elevated Temperatures and Sunlight

Where the total period of exposed storage outdoors - determined from the date of Product manufacture - is likely to exceed the maximum period defined in AS/NZS 2033, pipes, pipe stacks and pipe fittings shall be protected by means of under-cover storage or by covering with an appropriate material - such as hessian - that will not entrap heat in the vicinity of stored pipes or pipe stacks (See Note). Black plastics or other non-permeable sheeting shall not be a permissible shade material.

NOTE: High temperature and uneven heating is likely to soften and deform PE pipe and pipe fittings. The consequent distortion – particularly in lower layers of stacked products - can render PE pipeline components unsuitable for fusion jointing without significant rework including re-rounding and joint re-alignment. Thermal ageing due to extended exposure to high temperatures on project storage sites and in open trenches impairs Product performance and service life permanently and may, in some instances, result in rejection for re-supply

3.3 Preservation of Product in Storage

Product shall be stored in original Product packaging in accordance with the published requirements of the manufacturer, prior to installation. Designated Product storage areas shall be of sufficient size to accommodate Product deliveries and shall be flat, reasonably level and free of combustible vegetation, deleterious material, sharp stones or projections that could cause Product damage or defects.

3.4 Pipe Storage

PE pipe and pipe fittings shall be stored in accordance with the storage requirements of AS/NZS 2033. Designated storage areas at pipe depots and at pipe installation sites shall be of sufficient size to accommodate pipe deliveries securely and fit for purpose.

NOTE 1: Pipe fittings and jointing materials should be stored separately and under cover. Individual discrete or loose pipe components should be stored in original product packaging, prior to their installation.

NOTE 2: Pipes and pipe fittings should be supported on a grid structure of timber or sandbags that avoids direct pipe contact with the ground or soil materials with adequate space provided around stored components for the movement of handling, lifting and construction equipment, without risk to product performance or personnel safety.

3.5 Pipe Stacking

Pipe stacking heights shall be in accordance with those recommended by the pipe manufacturer and shall be kept to a minimum to enable safe handling and lifting and prevent pipe deformation. Provision shall be made for side support to prevent stack collapse during removal.

Where pipes of different pressure rating are stored in a single pipe stack, pipes of lower pressure rating shall be positioned above those of higher pressure rating. Where pipe deformation does occur -

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FOI 26-292 - Document 27

particularly in lower pipe storage stack layers - deformed pipes and pipe fittings shall be liable for removal/re-rounding to regain respective conformity with AS/NZS 4130 and AS/NZS 4129 dimensional requirements or to replacement.

NOTE: Vertical supports and chock blocks should be designed and arranged to prevent accidental slippage, rolling or collapse of pipe stacks.

3.6 Pipe Stringing

Pipe 'stringing' at installation sites shall be restricted to sufficiently short lengths to minimise pipe damage or contamination risks. Pipes shall be strung at a safe distance from spoil heaps, heavy operating machinery and vehicle tracks.

3.7 Lifting

Mechanical equipment and slings used for handling of pipes and fittings shall be in accordance with AS 2550.1 and AS 2550.5 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia.

3.8 Transportation and Unloading

Loading, unloading and transport operations shall be carried out in accordance with AS/NZS 2033. Climbing or standing on pipes shall not be permissible.

Pipes and supporting system load restraints shall be secured to the transporter to prevent displacement relative to the transporter during transportation. This may be by means of straps, bolsters or other appropriate restraints in accordance with Load Restraint Guide—Guidelines for Safe Carriage of Loads on Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia. Load restraint mechanisms shall be checked for tension at regular intervals not exceeding 300 kilometres of travel and shall not be released until the transporting vehicle is resting in a secure stable disposition on level ground.

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FOI 26-292 - Document 27

4 Conformity with Requirements

4.1 General

Product conformity with the specified requirements shall be verified by means of an acceptable inspection and test plan (ITP). The ITP shall provide for product component structural and durability design, materials control and performance conformity testing throughout production. The inspection and test plan shall be embodied in a duly accredited ISO 9001 production quality management system.

Product shall be deemed to conform with requirements where test outcomes have been formally verified by a Product Assessor or certified by a Conformity Assessment Body (CAB) in accordance with the requirements of a product standard acceptable to the Corporation. Otherwise, it shall be classified as non-conforming Product.

NOTE:For acceptance, performance testing and calibration laboratories should be accredited as meeting the requirements of AS/NZS ISO/IEC 17025 by a signatory member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). The scope of laboratory/facility accreditation should include the competencies and capabilities required to execute the particular product testing and calibration work to be undertaken.

4.2 Certification of Product

Products, in respect of which conformity with a particular nominated product Standard(s) is claimed, shall, for acceptance, be assessed in accordance with an acceptable product certification system and shall be subject to the issue of a certificate of conformity with the nominated Standard(s) by a duly accredited CAB.

The certification system or scheme with which product conformity is claimed shall:

- be based on ISO/IEC TR 17026, Conformity assessment -- Example of a certification scheme for tangible products and shall be in accordance with the fundamentals of AS/NZS ISO/IEC 17067 and with the guiding principles of ISO/IEC Guide 28;
- include product type testing from independently sampled production;
- require the manufacturer's production processes and associated controls to be part of a quality management system that has been certified as meeting the requirements of AS/NZS ISO 9001, Quality management systems - Requirements; and shall
- include subsequent verification that the manufacturer continues to maintain effective production control and product conformity with the nominated product Standard(s), at intervals not exceeding 12 months.

NOTE: Evidence of Product conformity with the specified requirements may be by means of a Product Verification Report provided by a Product Assessor including reference to a current relevant water industry appraisal report or certificate issued by WSAA.

4.3 Product Re-verification

Product conformity with the Specification shall be subject to re-verification by a Product Assessor when, during the agreed Product supply period, there occurs any:

- substantive change in Product design, material formulation or performance
- Product failure to perform in operational service to the nominated performance specification.

Re-verification shall require the issue of a new or supplementary Product Verification Report. Product components and test outcomes that are not significantly affected by the Product change or failure may be excluded from the scope of re-verification, provided that these outcomes have already been reported in a current valid Product Verification Report that is acceptable to the Corporation.

4.4 Acceptance Criteria

For acceptance, Product shall be supplied as specified in the Purchasing Schedule and shall be clearly and indelibly provided with product markings as follows:

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FOI 26-292 - Document 27

- PE pipe markings in accordance with AS/NZS 4130 requirements and PE pipe fitting markings in accordance with AS/NZS 4129 requirements; and
- Additional markings to uniquely identify which PE base resin compound (i.e. PE 100, PE 100-HSRC, PE 100-RC or other recognised proprietary PE material) a pipe or fitting has been manufactured from; and
- Additional markings to identify resin manufacturer and resin manufacturer's resin designation

NOTES:
1 PE base compound identification marking acronyms or abbreviations should be in accordance with ISO 1043-1, ASTM D1600 or AS/NZS 4131 and should also clearly identify compound variants that differ from AS/NZS 4131 and POP 004 defined (third generation) PE 100 compounds.

2 Marking information may be provided on the body of a pipe fitting or by means of a label, pressure sensitive tape on its product packaging, subject to acceptance by the Corporation of marking durability (in long term buried service applications) and positioning.

Prior to the implementation of any arrangement to supply Product, the Supplier shall, in accordance with specified - including acceptance - requirements:

- nominate applicable Product Warranty terms including service longevity limitations; and
- provide documentary verification of conformity with performance requirements in the form of a current valid Certificate, certified evidence of conformance with an inspection and test plan (ITP) or a Product Verification Report that is appropriate to the Product, subject to the acceptability of certification credentials; and
- detail each element of Product that does not conform with any specified requirement together with the extent of non-conformance.

NOTE: Where the Specification includes Technical Compliance Schedules, the nature and extent of all non-conformances should be recorded in the appropriate Schedules to be submitted for acceptance.

4.5 Non-conforming Product

4.5.1 General

Product whose design, workmanship or performance fails to conform to the specified requirements shall be clearly tagged and quarantined by the Supplier as non-conforming and shall be subject to rejection for return to and replacement by the Supplier.

4.5.2 Manufacturing Repairs (In-process)

The Manufacturer shall make provision in its production Quality System and in the appropriate ITP's for sufficient hold points whenever significant defects occur. Production work on non-conforming components shall cease and repair work shall not commence until it has been confirmed by the Corporation in writing that:

(a) repair of the non-conforming components in lieu of their replacement is acceptable; and

(b) proposed repair procedures are acceptable; and

(c) any proposal to vary the terms of the original Product Warranty as a consequence of the in-process repair is acceptable.

4.5.3 Product Warranty

The Supplier shall replace non-conforming Product with Product that conforms with the acceptance criteria or shall repair or rectify all faults, damage or losses caused by non-conforming Product. Except as may otherwise be specified, the Product Warranty shall indemnify and keep indemnified the Corporation against all losses suffered by the Corporation as a result of non-conforming Product for a period no less than 24 months after Product delivery or 12 months after Product installation, whichever period elapses first.

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FOI 26-292 - Document 27

4.5.4 Product Repair

All reasonable proposals for repair or remedy of defects will be considered, provided that each such proposal is accompanied by a methodology statement that accords with the performance objectives of this Specification, as determined by the Corporation. For acceptance, a proposal for repair or remedy of Product non-conformances shall not void or otherwise diminish the provisions of the Product Warranty.

4.6 Access to the Place of Manufacture

The Corporation shall be afforded access, at all reasonable times, to all places of manufacture of Product and shall be authorized to arrange or undertake such testing as the Corporation deems appropriate.

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5 Appendix A: Material Master Records (Informative)

The following Material Master Records (MMR) comprise Corporation catalogue numbers that are unique to the particular products described for the purposes of Corporation activities or work.

MMR	PURCHASE ORDER LONG TEXT	BUOM
	Polyethylene Pipe (PN16)	
20997	Pipe, Plastic; DN25; PN16; Polyethylene; PE100; Black/4 Stripe Blue; SDR 11; 100m Coil.	M
20998	Pipe, Plastic; DN32; PN16; Polyethylene; PE100; Black/4 Stripe Blue; SDR 11; 50m Coil.	M
22185	Pipe, Plastic; DN63; PN16; Polyethylene; PE100; Black/4 Stripe Blue; SDR11; 100m Coil.	M
22278	Pipe, Plastic; DN63; PN16; Polyethylene; PE100; Black/4 Stripe Blue; SDR11; 6m Length. Note: To be Purchased in 30 x 6m Lengths only. Supplier (Iplex) will run Orders in Conjunction with DN63 Coils.	LG
19963	Pipe, Plastic; DN90; PN16; Polyethylene; PE100; Black/4 Stripe Blue; SDR 11; 100m Coil. Note: Water Corporation Policy - "Farmlands Use Only". Refer I.D.B.	CO
19964	Pipe, Plastic; DN110; PN16; Polyethylene; PE100; Black/6 Stripe Blue; SDR 11; 100m Coil. Note: Water Corporation Policy - "Farmlands Use Only". Refer I.D.B.	CO

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MMR	PURCHASE ORDER LONG TEXT	BUOM
	Polyethylene Pipe (PN16)	
20130	Pipe, Plastic; DN125; PN16; Polyethylene; PE100; Black/6 Stripe Blue; SDR 11; 12m Length.	LG
22186	Pipe, Plastic; DN125; PN16; Polyethylene; PE100; Black/6 Stripe Blue; SDR 11; 6m Length.	LG
20131	Pipe, Plastic; DN180; PN16; Polyethylene; PE100; Black/6 Stripe Blue; SDR 11; 12m Length.	LG
22107	Pipe, Plastic; DN180; PN16; Polyethylene; PE100; Black/6 Stripe Blue; SDR 11; 6m Length. Please Note: Supplier to cut 1 x 12M Length in half to supply 2 x 6M Lengths. Minimum Order Qty = 2 x 6M Lengths.	LG

MMR	PURCHASE ORDER LONG TEXT	BUOM
	Polyethylene Pipe (PN20)	
22182	Pipe, Plastic; DN25; PN20; Polyethylene; High Stress, Crack Resistance PE100; Black/4 Stripe Blue; SDR 9; 50m Coil.	M
22183	Pipe, Plastic; DN32; PN20; Polyethylene; High Stress, Crack Resistance PE100; Black/4 Stripe Blue; SDR 9; 50m Coil.	M
22184	Pipe, Plastic; DN63; PN20; Polyethylene; High Stress, Crack Resistance PE100; Black/4 Stripe Blue; SDR 9; 50m Coil.	M

Note: MMR numbers for High Stress Crack Resistant and Disinfection Resistant PN20 PE pipe to be created in the future.

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MMR	PURCHASE ORDER LONG TEXT	BUOM
	Polypropylene Compression Type Fittings for Polyethylene Pipe	
19094	Adaptor, Straight, Flange to Pipe; DN75 x 3IN; Polypropylene; Flanged to AS 4087 Figure B7 to Compression Type; C/W Metal Flange; To Suit Metric Polyethylene Pipe.	EA
18328	Adaptor, Straight, Flange to Pipe; DN100 x DN110; Polypropylene; Flanged to AS 2129 Table E to Compression Type; C/W Metal Flange; To Suit Metric Polyethylene Pipe.	EA
19024	Adaptor, Straight, Flange to Pipe; DN150 x DN160; Polypropylene; Flanged to AS 2129 Table E to Compression Type; C/W Metal Flange; To Suit Metric Polyethylene Pipe.	EA
19150	Adaptor, Straight, Pipe to Tube; DN20 x DN25; Polypropylene; Female to Female; Metric Polyethylene Compression Type to Copper Tube; Cold Water Applications Only.	EA
21164	Adaptor, Straight, Pipe to Tube; DN25 x DN32; Polypropylene; Female to Female; Metric Polyethylene Compression Type to Copper Tube; Cold Water Applications Only.	EA
18330	Adaptor, Straight, Pipe to Tube; DN25 x R1(25); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
13984	Adaptor, Straight, Pipe to Tube; DN25 x R3/4(20); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
18972	Adaptor, Straight, Pipe to Tube; DN25 x RP3/4(20); Polypropylene; Metric Polyethylene Compression Type to Female Thread.	EA
13986	Adaptor, Straight, Pipe to Tube; DN32 x R1(25); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
18415	Adaptor, Straight, Pipe to Tube; DN32 x R1-1/4(32); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
13985	Adaptor, Straight, Pipe to Tube; DN32 x R3/4(20); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
19078	Adaptor, Straight, Pipe to Tube; DN32 x RP1(25); Polypropylene; Metric Polyethylene Compression Type to Female Thread.	EA
13987	Adaptor, Straight, Pipe to Tube; DN50 x R1-1/2(40); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
13988	Adaptor, Straight, Pipe to Tube; DN63 x R1-1/2(40); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
13989	Adaptor, Straight, Pipe to Tube; DN63 x R2(50); Polypropylene; Metric Polyethylene Compression Type to Male Thread.	EA
19079	Adaptor, Straight, Pipe to Tube; DN63 x RP2(50); Polypropylene; Metric Polyethylene Compression Type to Female Thread.	EA
13981	Coupling, Pipe; DN25; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
18912	Coupling, Pipe; DN25 x DN25; Polypropylene; Push Fit Type; To Suit Metric Polyethylene Pipe.	EA
21196	Coupling, Pipe; PN16; DN25; Polypropylene; Compression Type Slip/Repair Coupling; To Suit Metric Polyethylene Pipe.	EA
13982	Coupling, Pipe; DN32; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
18913	Coupling, Pipe; DN32 x DN32; Polypropylene; Push Fit Type; To Suit Metric Polyethylene Pipe.	EA
21197	Coupling, Pipe; PN16; DN32; Polypropylene; Compression Type Slip/Repair Coupling; To Suit Metric Polyethylene Pipe.	EA
7830	Coupling, Pipe; DN50; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA

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MMR	PURCHASE ORDER LONG TEXT	BUOM
	Polypropylene Compression Type Fittings for Polyethylene Pipe	
19072	Coupling, Pipe; DN63 x DN40; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
18230	Coupling, Pipe; DN63; Polypropylene; Compression Type Repair Coupling; To Suit Metric Polyethylene Pipe.	EA
13983	Coupling, Pipe; DN63; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
22200	Coupling, Pipe; DN90; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
22201	Coupling, Pipe; PN16; DN90; Polypropylene; Compression Type Slip/Repair Coupling; To Suit Metric Polyethylene Pipe.	EA
18329	Coupling, Pipe; DN110; Polypropylene; Compression Type Repair Coupling; To Suit Metric Polyethylene Pipe.	EA
18326	Coupling, Pipe; DN110; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
19077	Elbow, Pipe; 90 Degree; DN25 x RP3/4(20); Polypropylene; Compression Type to Female Thread; To Suit Metric Polyethylene Pipe.	EA
18369	Elbow, Pipe; 90 Degree; DN25; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
19074	Elbow, Pipe; 90 Degree; DN32 x RP1/(25); Polypropylene; Compression Type to Female Thread; To Suit Metric Polyethylene Pipe.	EA
19073	Elbow, Pipe; 90 Degree; DN32 x RP3/4(20); Polypropylene; Compression Type to Female Thread; To Suit Metric Polyethylene Pipe.	EA
19076	Elbow, Pipe; 90 Degree; DN63 X R2(50); Polypropylene; Compression Type to Male Thread; To Suit Metric Polyethylene Pipe.	EA
16625	Elbow, Pipe; 90 Degree; DN63 x RP2(50); Polypropylene; Compression Type to Female Thread; To Suit Metric Polyethylene Pipe.	EA
20168	Elbow, Pipe; 90 Degree; DN32; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
13990	Elbow, Pipe; 90 Degree; DN63; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
18293	Plug, Pipe; DN25; Polypropylene; Compression Type End Plug; To Suit Metric Polyethylene Pipe.	EA
18294	Plug, Pipe; DN32; Polypropylene; Compression Type End Plug; To Suit Metric Polyethylene Pipe.	EA
18295	Plug, Pipe; DN63; Polypropylene; Compression Type End Plug; To Suit Metric Polyethylene Pipe.	EA
18331	Tee, Pipe; DN25 x DN25 x DN25; Polypropylene; Compression Type x Female Threaded Branch RP1(25); To Suit Metric Polyethylene Pipe.	EA
18327	Tee, Pipe; DN25 x DN25 x DN25; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
18414	Tee, Pipe; DN25 x DN25 x DN32; Polypropylene; Compression Type x Female Threaded Branch RP1-1/4(32); To Suit Metric Polyethylene Pipe.	EA
18670	Tee, Pipe; DN25 x DN25 x DN32; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
19071	Tee, Pipe; DN32 x DN32 x DN32; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA
18947	Tee, Pipe; DN63 x DN63 x DN63; Polypropylene; Compression Type; To Suit Metric Polyethylene Pipe.	EA

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MMR	PURCHASE ORDER LONG TEXT	BUOM
	Polyethylene Electrofusion Joined Pipe Fittings	
20135	Adaptor, Straight, Flange to Pipe; Stub Flange; DN125; PN16; SDR11; Electrofusion Joined; C/W Flange Backing Ring; Hot Dip Galvanised Steel; DN100; Flanged to AS 4087 Figure B7; Flange ID to Suit Stub OD.	KIT
20136	Adaptor, Straight, Flange to Pipe; Stub Flange; DN125; PN16; SDR11; Electrofusion Joined; C/W Flange Backing Ring; Stainless Steel; DN100; Flanged to AS 4087 Figure B7; Flange ID to Suit Stub OD.	KIT
20141	Adaptor, Straight, Flange to Pipe; Stub Flange; DN180; PN16; SDR11; Electrofusion Joined; C/W Flange Backing Ring; Hot Dip Galvanised Steel; DN150; Flanged to AS 4087 Figure B7; Flange ID to Suit Stub OD.	KIT
20142	Adaptor, Straight, Flange to Pipe; Stub Flange; DN180; PN16; SDR11; Electrofusion Joined; C/W Flange Backing Ring; Stainless Steel; DN150; Flanged to AS 4087 Figure B7; Flange ID to Suit Stub OD.	KIT
21031	Adaptor, Straight, Flange to Pipe; Stub Flange; DN250; PN16; SDR11; Electrofusion Joined; C/W Flange Backing Ring; Hot Dip Galvanised Steel; DN250; Flanged to AS 4087 Figure B7; Flange ID to Suit Stub OD.	KIT
21028	Adaptor, Straight, Flange to Pipe; Stub Flange; DN315; PN16; SDR11; Electrofusion Joined; C/W Flange Backing Ring; Hot Dip Galvanised Steel; DN300; Flanged to AS 4087 Figure B7; Flange ID to Suit Stub OD.	KIT
20132	Coupling, Pipe; DN110; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Without Central Stop (Slip-on); Electrofusion Joined.	EA
19836	Coupling, Pipe; DN125; PN16; SDR 11; Polyethylene PE100; Socket to Socket; C/W Central Stop; Electrofusion Joined.	EA
20139	Coupling, Pipe; DN160; PN16; SDR 11; Polyethylene PE100; Socket to Socket; C/W Central Stop; Electrofusion Joined.	EA
19837	Coupling, Pipe; DN180; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
21030	Coupling, Pipe; DN250; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
21029	Coupling, Pipe; DN315; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
19839	Elbow, Pipe; 45 Degree; DN125; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
19841	Elbow, Pipe; 45 Degree; DN180; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
19838	Elbow, Pipe; 90 Degree; DN125; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
19840	Elbow, Pipe; 90 Degree; DN180; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
20138	Reducer, Pipe; DN125 x DN110; PN16; SDR 11; Polyethylene PE100; Socket to Socket; Electrofusion Joined.	EA
20137	Reducer, Pipe; DN125 x DN110; PN16; SDR 11; Polyethylene PE100; Spigot to Spigot; Electrofusion Joined.	EA
20143	Reducer, Pipe; DN180 x DN160; PN16; SDR 11; Polyethylene PE100; Spigot to Spigot; Electrofusion Joined.	EA
20134	Tee, Pipe; DN125; PN16; SDR 11; Polyethylene PE100; Socket to Socket to Socket; Electrofusion Joined.	EA
20140	Tee, Pipe; DN180; PN16; SDR 11; Polyethylene PE100; Socket to Socket to Socket; Electrofusion Joined.	EA

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6 Appendix B: Assessment Criteria for Resistance to Disinfectants (Normative)

Philosophy

The assessment of a PE resin's Disinfection Resistance is based on the following principle:

> "*A* Disinfection Resistant *resin is a resin that does not have its minimum life expectancy reduced when used in a chlorinated water application"*

The minimum life expectancy of a Disinfection Resistant polyolefin (e.g. PE100) resin is to be in accordance with the rerating factors and minimum life established in PIPA POP 013 in both chlorinated and unchlorinated applications.

Methods for demonstration

To demonstrate Disinfectant Resistance, the resin needs to be evaluated in a method accepted by Water Corporation to demonstrate chlorine resistance. Currently, only one method is accepted, which is based on adopting elements from a number of internationally recognised standards, specifically ASTM 2263 and ISO 9080. Other methods for evaluation may be considered at the Water Corporation's discretion, although any proposal must be at least as robust as the one described herein.

Methods such as CC ratings (as per PPI TN43), or NOL ring testing are not deemed to be adequate and are not considered suitable methods for demonstrating Disinfection Resistance.

Acceptable method for evaluating Disinfection Resistance

An acceptable method for demonstrating is described as follows:

1. Conduct testing in accordance with ASTM F2263 under the following conditions:
   - ORP ≥ 825mV
   - 6.5 ≤ pH ≤ 8.0
   - free chlorine concentration = 4.3mg/L
   - Pipe DN = ≤20mm
2. Generate a 4 parameter model via multiple linear regression in accordance with ISO 9080 with a minimum R^2 value of 0.9.
3. Plot the failure curve for each temperature listed in Table 1.

Table 1: Baseline PE100 resin performance

Temp (°C)	Minimum Life (yr)	Design Factor	Equivalent Wall Stress (MPa)
20	100	1	8
30	100	1.1	7.3
40	50	1.2	6.7

A PE resin shall be considered Disinfection Resistant if for each temperature and stress combination in Table 1 the predicted time to failure exceeds the minimum life as per Table 1.

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Examples

The method described above has been applied to two hypothetical resins shown below. The results shown in Figure 1 are for a resin that is considered Disinfectant Resistant while the results shown in Figure 2 are of a resin not resistant to disinfectant.

Figure 1: Example of a hypothetical resin test results for a resin considered to be Disinfection Resistant

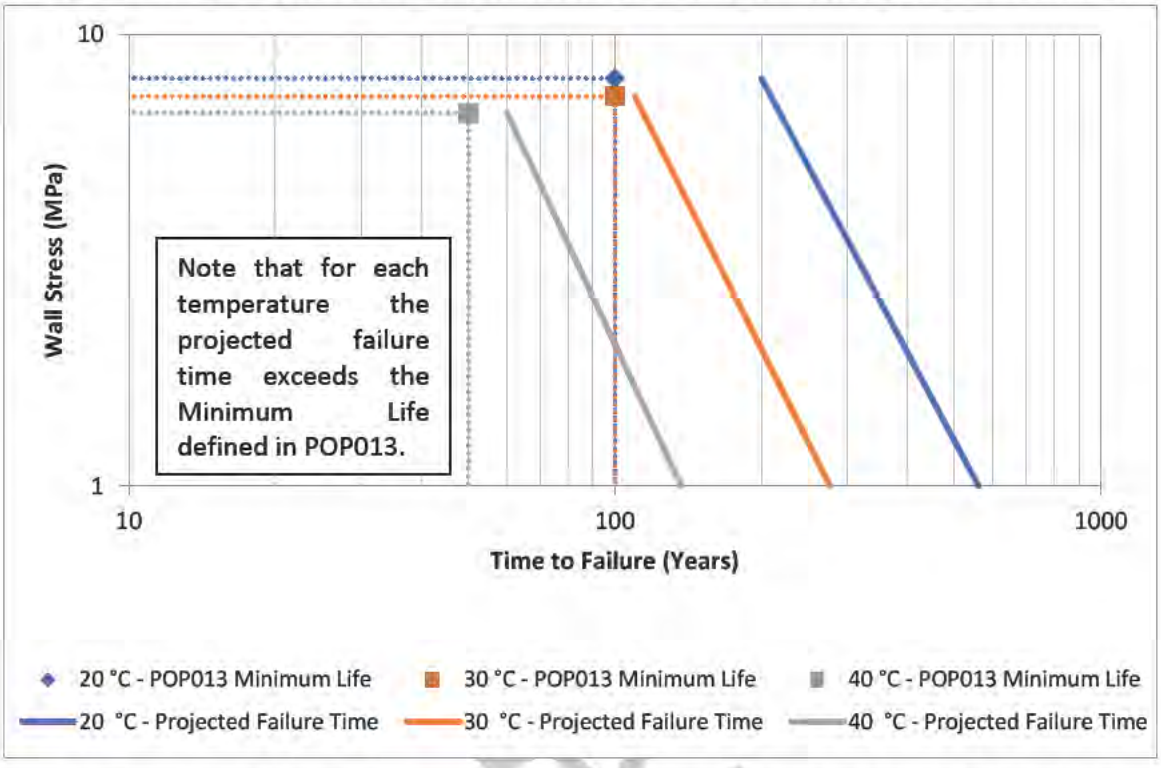
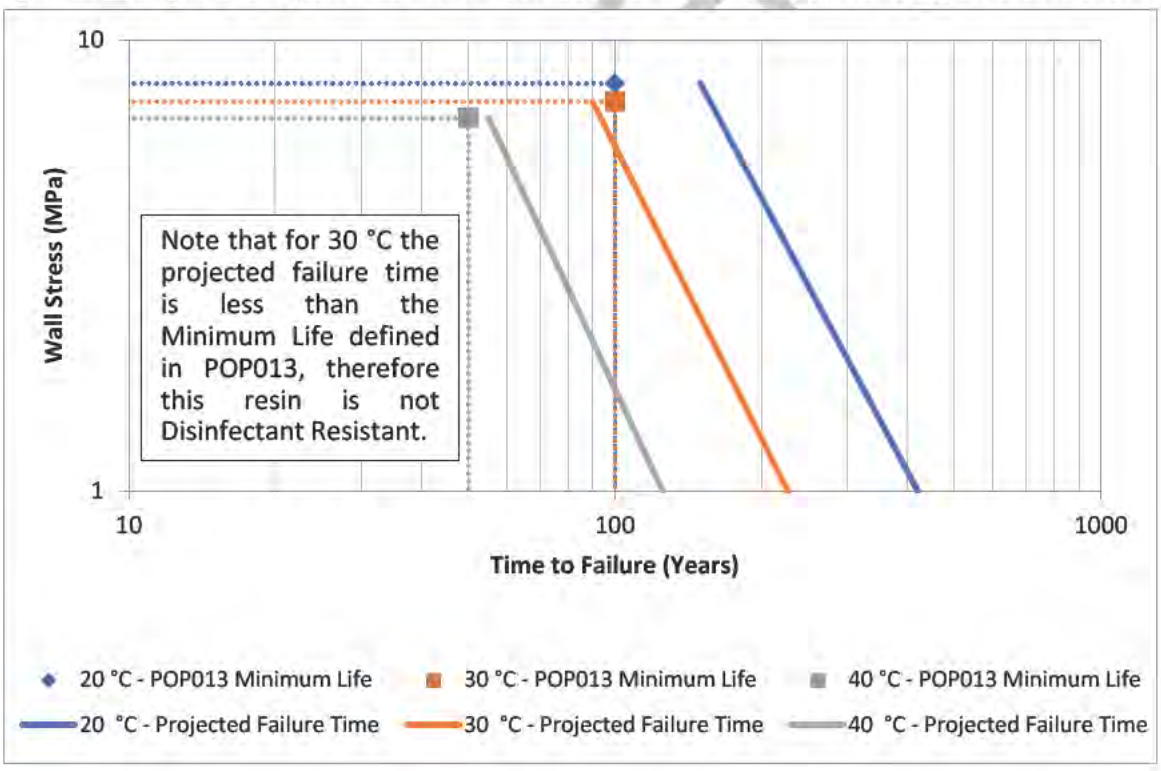


Figure 2: Example of a hypothetical resin test results for a resin considered to not be Disinfection Resistant



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END OF DOCUMENT

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Acquisition Group
Infrastructure Design Branch

Strategic Product Specification

SPS 272
Gate Valves for Waterworks Purposes – Resilient Seated

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VERSION 5
REVISION 3

JULY 2014

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FOI 26-292 - Document 27

FOREWORD

Each Strategic Product Specification has been prepared to inform Water Corporation staff, consultants, contractors and land developers of the requirements for selecting and acquiring a manufactured product to be used in strategic Corporation infrastructure. The definition of 'Product' includes items that comprise assembled components, equipment or plant for mechanical, electrical and civil infrastructure applications.

The objective of a Strategic Product Specification is to specify fit-for-purpose Product which will contribute to the provision of effective water services at least whole-of-life cost and with least risk to service standards and safety. A Strategic Product Specification also provides uniform standards for compatibility of new water infrastructure with existing water assets.

Many Strategic Product Specifications have drawn on the design, asset management and operational experience of Product performance in live service gained by the Corporation over time. Some Strategic Product Specifications have drawn on the experience of the water industry nationally by referencing Australian or WSAA standards.

Strategic Product Specifications are intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure design and construction work;
- Private developer funded subdivision infrastructure for takeover by the Corporation;
- Operationally funded infrastructure design and construction work;
- Corporation period contracts for Product purchases;
- Product purchases for stock or for miscellaneous minor work.

A published Strategic Product Specification will, in some cases, comprise technical content that is typical of a range of products of the same type (type specification) but may exclude specific requirements that should apply to a particular project or application. In such cases, the project designer is required to document the supplementary project specific requirements in the appropriate Clause of the 'Project Specific Requirements' Appendix..

The text of a published Specification should not be directly modified. In the event that a text variation is considered necessary to accommodate the needs of a particular project or application, the text modification should be documented in the appropriate Clause of a 'Project Specific Requirements' Appendix of the specification.

Enquiries relating to the technical content of this specification should be directed to the Principal Mechanical Engineer, Infrastructure Design Branch. Future specification changes, if any will be issued to registered specification users as when published.

Manager, Infrastructure Design Branch

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

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REVISION STATUS

The revision status of this specification is shown section by section below:

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
1	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
1	**5/3**	**21.05.14**	**10**	**Clause 1.4 amended to include PN21 & PN25 valves up to DN300**	**GP**	**SWE**
				Clause 1.5 added specifying allowable pressures for PN21 valves	**GP**	**SE**
2	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
3	**5/0**	**30.04.07**	**All**	**Reformatted into std template, Clause 3.1 amended, Table 3.1 added**	**EJP**	**AAK**
3	**5/1**	**01.05.07**	**13**	**Clause 3.2 amended**	**EJP**	**AAK**
3	**5/3**	**21.05.14**	**12, 13**	**Clause 3.2 amended. Clauses 3.3 & 3.4 added.**	**GP**	**SE**
4	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
4	**5/3**	**06.06.14**		**Clause 4.2 added**	**GP/VC**	**SE**
5	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
6	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
7	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
8	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
9	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
10	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
11	**5/0**	**30.04.07**	**All**	**Reformatted into std template, Table 11.1 amended**	**EJP**	**AAK**

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11	**5/3**	**21.05.14**	**22**	**Note 5 added to Table 11.1**	**GP**	**SE**
12	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
13	**5/0**	**30.04.07**	**All**	**Reformatted into std template**	**EJP**	**AAK**
13	**5/1**	**01.05.07**	**28,29**	**MMR amended to include DN600**	**EJP**	**AAK**
13	**5/2**	**12.05.08**	**All**	**MMR's amended**	**SE**	**AAK**
13	**5/3**	**21.05.14**	**29**	**MMRs for PN21 valves up to DN300 added**	**GP**	**SE**

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FOI 26-292 - Document 27

Strategic Product Specification
SPS 272
Gate Valves for Waterworks Purposes – Resilient Seated

CONTENTS

Section *Page*

1 Scope and General 8
1.1 Scope 8
1.2 Referenced Documents 8
1.3 Definitions and Notation 9
1.3.1 Certificate 9
1.3.2 Certification Body 9
1.3.3 Certification Mark 9
1.3.4 Certification Scheme 9
1.3.5 Compliant Product 9
1.3.6 Corporation 9
1.3.7 Manufacturer 9
1.3.8 Notation 10
1.3.9 Officer 10
1.3.10 Pressure Classification (PN) 10
1.3.11 Product 10
1.3.12 Product Appraisal 10
1.3.13 Product Assessor 10
1.3.14 Product Certification 10
1.3.15 Product Verification Report 10
1.3.16 Product Warranty 11
1.3.17 Purchasing Schedule 11
1.3.18 Quality System 11
1.3.19 Strategic Product 11
1.3.20 Supplier 11
1.3.21 Testing 11
1.3.22 WSAA 11
1.4 Designation of Size 11
1.5 Allowable Operating Pressures 12
2 Materials and Components 13
2.1 General 13
2.2 Non-metallic Materials 13
3 Design 14
3.1 Gate Valve 14
3.2 Gearbox 14
3.3 End Connections 15
3.4 Lockout Devices 15
4 Coatings 16
4.1 General 16

AF

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FOI 26-292 - Document 27

4.2 Gearbox 16
5 Testing 17
5.1 General 17
5.2 Notification of Testing 17
5.3 Access to the Place of Manufacture 17
5.4 Place of Manufacture other than WA 17
5.5 Performance Test Requirements 17
5.5.1 Production Tests 17
5.5.2 Coating Tests 17
5.5.3 Test Certificates 17
6 Marking and Packaging 18
6.1 Marking 18
6.2 Packaging 18
6.2.1 General 18
6.2.2 Identification Tag 18
6.2.3 Marking of Packaging 18
7 Manuals 19
7.1 Format and Language 19
7.2 Content 19
8 Spare Parts and Special Tools 20
8.1 Spare Parts 20
8.1.1 Interchangeability 20
8.1.2 Availability 20
8.2 Special Tools 20
9 Transportation, Handling and Storage 21
9.1 General 21
9.2 Preservation of Product in Storage 21
10 Quality Assurance 22
10.1 Certification 22
10.1.1 Certification of Product 22
10.1.2 Quality System 22
10.1.3 Product Re-verification 22
10.2 Compliance and Acceptance 22
10.2.1 Means of Demonstrating Compliance 22
10.2.2 Acceptance Criteria 23
10.3 Non-compliant Product 23
10.3.1 General 23
10.3.2 Manufacturing Repairs (In-process) 23
10.3.3 Product Warranty 23
10.3.4 Product Repair 24
11 Appendix A: Project Specific Requirements (Normative) 25
11.1 General 25
11.2 Technical Requirements 25

AF

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FOI 26-292 - Document 27

12 Appendix B: Technical Compliance Schedules (Normative) 26
12.1 Compliance Schedules 26
13 Appendix C: Material Master Records (Informative) 31

AF

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FOI 26-292 - Document 27

1 Scope and General

1.1 Scope

This Specification sets out requirements for the manufacture, supply, handling and delivery of non-rising stem, ductile iron, resilient seated gate valves for waterworks purposes and as further described in the following. Valves shall be in a new unused condition.

The Specification details the requirements in lieu of specific clauses, or as clarification for options that exist within, or as additional requirements to AS 2638.2. Accordingly, unless otherwise specified in this Specification, the valves shall be manufactured, tested and supplied in accordance with the requirements of AS 2638.2. The Specification also details the means by which compliance with the Specification shall be demonstrated and the criteria for acceptance of Product.

NOTE: For gate valves larger than the size range or pressure classification (PN) applicable to resilient seated gate valves refer to SPS 271.

1.2 Referenced Documents

The following documents are referenced in this Specification:

AS

1442	Carbon steels and carbon-manganese steels – Hot – rolled bars and semi-finished products
1830	Iron castings – Grey cast iron
2550.1	Cranes, hoists and winches – Safe use – General
2550.3	Cranes, hoists and winches – Safe use – Bridge, gantry, portal (including container cranes) jib and monorail cranes
2550.5	Cranes, hoists and winches – Safe use – Mobile
2550.11	Cranes, hoists and winches – Safe use – Vehicle loading cranes
2638.1	Gate valves for waterworks purposes – Metal seated
3894.1	Site testing of protective coatings – Method 1: Non-conductive coatings – Continuity testing – High voltage ('brush')

AS/NZS ISO

9001	Quality management systems – requirements

ISO/IEC

17025	General requirements for the competence of testing and calibration laboratories

Standards Australia Guides

HB 18	Guidelines for third-party certification and accreditation
HB 18.2	Guide 2-General terms and their definitions concerning standardization and related activities
HB 18.22	Guide 22-Information on manufacturer's declaration of conformity with standards and other technical specifications
HB 18.23	Guide 23-Methods of indicating conformity with standards for third-party certification systems
HB 18.28	Guide 28-General rules for model third-party certification system for products
MP52	Manual of authorization procedures for plumbing and drainage products

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ASTM

A 480M Standard specification for general requirements for flat-rolled stainless and heat-resisting steel plate, sheet and strip

SPS

271 Gate Valves – Metal Seated

Water Corporations Technical Specifications

A1 Surface Preparation for the Application of Protective Coatings on Steel and Cast Iron

D1 Zinc Rich Epoxy Primer, Epoxy Mastic Coat, Polyurethane Top Coat on steel or Cast Iron

1.3 Definitions and Notation

1.3.1 Certificate

A formal certificate defined in SAA HB 18.2 and operated in accordance with SAA HB 18.22 that, as an outcome of Product Certification, attests Product conformity with the nominated product and test standards and authorizes the use of a Certification Mark.

1.3.2 Certification Body

An independent (or third party) organisation duly accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) to operate Certification Schemes.

In the case of a non-strategic plumbing Product, a Certification Body means an organisation approved by Standards Australia to administer the National Certification of Plumbing and Drainage Products (NCPDP) Scheme in accordance with SAA MP 52.

1.3.3 Certification Mark

A trademark or other mark of product conformity with a specified standard defined in SAA HB 18.2 and applied in accordance with SAA HB 18.23 that is issued under the rules of a Certification Scheme.

1.3.4 Certification Scheme

A product certification program or system which is operated in accordance with JAS-ANZ Procedure 15 – General requirements for bodies operating product certification systems and in accordance with the general rules of SAA HB 18.28 and System No. 5 as defined in ISO/ITC publication - Certification - Principles and practice. In the case of a non-strategic plumbing Product, a Certification Scheme means the NCPDP Scheme.

NOTE: The effect of this is to require maintenance by the manufacturer of effective production control planning in addition to full type testing from independently sampled production and subsequent verification of conformity with specified standards.

1.3.5 Compliant Product

Product that has been assessed, by means of Product Appraisal, as conforming to standards and specifications that are nominated by the Corporation.

1.3.6 Corporation

The Water Corporation of Western Australia.

1.3.7 Manufacturer

An entity or combination of entities that are responsible for selection, processing and control of Product constituent materials or compounds and for the processing equipment that collectively result in the manufactured product.

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1.3.8 Notation

Statements expressed by use of the word 'shall' are mandatory or 'normative' requirements of the Specification. Statements expressed by use of the words 'should' or 'may' are 'informative' but not mandatory and are provided only for information and guidance. Notes in Specification text are informative. Notes that form part of Specification Tables are normative. An Appendix to the Specification that is designated 'normative' contains mandatory requirements. An Appendix that is designated 'informative' is provided for information and guidance only. The term 'specified' includes requirements of the Specification and requirements stated or referenced in other project documentation.

1.3.9 Officer

A duly authorised representative or appointed agent of the Corporation.

1.3.10 Pressure Classification (PN)

A classification of pressure by PN number, based on the allowable operating pressure (AOP) expressed in Megapascals (PN = 10 x AOP).

1.3.11 Product

A single unit or multiple units of manufactured end product or an assembly of manufactured component products, materials or equipment. This Specification and accompanying Purchasing Schedule define the nature and details of Product to be supplied. In this Specification the Product shall refer to resilient seated gate valves for waterworks purposes including the operator.

NOTE 1: An end product is most commonly an output of manufacturing processes that result in finished end products having the same features and characteristics and can be the result of a single or multiple production batches.

NOTE 2: Manufactured equipment and assemblies of Product components or materials are commonly procured for mechanical, electrical and civil infrastructure applications.

1.3.12 Product Appraisal

A formal process whereby Product, including product design, is subjected to systematic engineering assessment to determine Product fitness for prescribed end uses and to evaluate the extent of Product and production systems conformity with nominated standards and specifications. Product Appraisal includes verification of the extent of compliance in accordance with the requirements of a relevant 'Technical Compliance Schedule' Appendix.

1.3.13 Product Assessor

An organization, Officer or other person who, having demonstrated specialist product knowledge and competence acceptable to the Corporation, is nominated by the Corporation, subjects Product to Product Appraisal and issues one or more Product Verification Reports.

1.3.14 Product Certification

A formal process whereby the production and management systems for the manufacture of Product, are assessed by a Certification Body to evaluate compliance of these systems with prescribed product standards and tests, under Certification Scheme rules.

1.3.15 Product Verification Report

A formal report wherein a Product Assessor evaluates the extent of Product compliance with the nominated product standards and specifications.

NOTE: Verification may be on a project-by-project basis or at agreed intervals, as appropriate to the scope of a Purchasing Schedule and Product end use, subject to determination by the Corporation.

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1.3.16 Product Warranty

A formal express undertaking by a Supplier or Manufacturer that Product is:

- In conformity with the nominated product specification and referenced standards;
- Fit for the nominated Product end use or application;
- Designed for sustained operation at the nominated service performance levels for the specified design life;
- Adequately packaged for intended transportation, handling and storage conditions;
- Supported by English language installation, operating and servicing instructions;
- Adequately supported by Supplier capacity to provide technical Product support.

NOTE: Where required, a Product Warranty should indemnify the Corporation against claims made or losses suffered as a result of breach of the Warranty by means of Public and Products Liability Insurances as specified in the undertaking.

1.3.17 Purchasing Schedule

A Corporation purchase order, tender, schedule of prices, bill of quantities, or specification that details the nature, quantity and other characteristics of Product to be supplied, purchased or installed.

1.3.18 Quality System

A management system that establishes, documents, implements and maintains organizational structures, resources, responsibilities, processes and procedures for the manufacture of Product and provision of Product related services in accordance with the requirements of AS/NZS ISO 9001.

1.3.19 Strategic Product

An essential product whose performance is critical in eliminating risk to the safe and effective provision of water services, which are functions of the Corporation under the Water Corporation Act as licensed under the Water Services Coordination Act.

NOTE 1: Strategic product is most commonly an element of permanent Corporation infrastructure. Ancillary operational and safety equipment, not intended to form part of this infrastructure, may be considered strategic by virtue of enhanced operational performance or personnel safety.

NOTE 2: Plumbing products (end-of-line water service fittings DN 32 or smaller) used in strategic services may, by virtue of statutory and regulatory requirements, be considered strategic in Corporation applications.

1.3.20 Supplier

An entity or combination of entities that is responsible for the supply of Product.

NOTE: A Supplier may be a Product manufacturer, owner, producer, distributor or vendor or an agent, tenderer or contractor for supply of Product or Product related service.

1.3.21 Testing

The determination of Product characteristics by inspection, and by the application of specified test procedures.

1.3.22 WSAA

The Water Services Association of Australia of which the Water Corporation is a corporate member.

1.4 Designation of Size

Clause 1.5 of AS 2638.2 shall be amended to include valve sizes up to and including DN 900 (valves rated PN16) and DN80 - DN300 valves rated PN21 and PN25.

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1.5 Allowable Operating Pressures

Table 1.1 contained in AS2638.2 shall be amended to include the following;

Table 1.1 Allowable Pressures for PN21 Valves

PN	AOP kPa	MAOP kPa	ASTP kPa
21	**2100**	**2520**	**2625**

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2 Materials and Components

2.1 General

Materials shall comply with the basic materials referred to in the Table 2.1 contained in AS 2638.2 with additions as shown in Table 2.1 of this Specification below:

Table 2.1 – Materials for Metal Seated Gate Valves

Component	Material	Standard	Minimum Grade
Indicator gears	Stainless steel	ASTM A480M	304
Gearbox body	Grey cast iron	AS 1830	250
Shaft bushes	Gunmetal	AS 1565	C83600
Gears and shaft	Material design in accordance with AS 2938		

2.2 Non-metallic Materials

Non-metallic materials or components used in the Product shall be fit for the intended purpose and exhibit dimensional stability, durability and longevity in the relevant operating environment e.g. buried, immersed or exposed to sunlight.

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3 Design

3.1 Gate Valve

The valve design shall comply with the following:

(a) Valves shall be of the non-rising stem type.

(b) All valves shall be suitable for installation with the valve stem in the vertical or horizontal positions.

(c) The valve shall close when the valve key or operator handwheel is rotated anticlockwise when viewed from the operating position.

3.2 Gearbox

Where specified in the purchasing schedule, gearbox actuator design and construction shall comply with Section 6 of AS 2638.2 and the following:

(a) Gearbox design shall incorporate spur or bevel gear reduction.

(b) The gearbox input shaft shall be extended at one end only and shall be fitted with a handwheel.

(c) Direction of rotation shall be anticlockwise-to-close the valve when viewed from the operating position. Direction of rotation arrows shall be cast onto the handwheel.

(d) Handwheels shall incorporate a freely rotating handle.

(e) All gear boxes for buried service applications shall have an enclosure rating of IP68 in accordance with AS60529.

(f) Gearbox ratios shall comply with the table below.

(g) The gearbox shall incorporate a gear-driven clock type position indicator which shall provide accurate indication of the valve in the fully open and fully closed positions when viewed from above the input shaft. The indicator gears shall be machine-cut and mated.

(h) Where the valve has to close against flow it shall be fitted with a gearbox with a reduction ratio as shown in Table 3.1.

NOTE:
A gearbox should be fitted under the following circumstances:

1. The valve is to be operated against unbalanced head conditions.
2. For PN 16, DN 600 valves operating at > 60 m.
3. For PN 16, DN 700 valves and larger.
4. For PN 35, DN 400 valves and larger.

Table 3.1 – Gate Valve Gearbox Ratios

DN	Gearbox Ratio	
	PN 16	PN 25
80	Not required	Note 2
100		
150		
200		
225	2:1	
250	2:1	
300	2:1	
375	4:1	
400	4:1	
450	4:1	
500	6:1	
600	6:1	
700	12:1	
750	12:1	

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NOTES:

1. The sizing criteria for gearbox ratios are based on:

   (a) Torques to seal the valve at an allowable operating pressure of 1600 kPa.

   (b) Full unbalanced head conditions.

2. Refer to the valve manufacturer for PN 25 gearbox ratios.

3.3 End Connections

End connections of all PN16 rated valves shall comply with section 3.3 of AS2638. Flange dimensions and drilling of PN16 rated valves shall comply with AS4087 Figure B5.

Flange drilling of PN21 rated valves shall be in accordance with AS2129 Table F.

Flange drilling of PN25 rated valves shall comply with EN1092 PN25.

3.4 Lockout Devices

Valves shall be either fitted with lockout devices to enable their secure isolation, or be capable of accommodating them, as specified in the following:

a) Spindle cap operators shall accommodate the Corporation's valve locking device in accordance with Drawing No EG20-11-2.. The bottom plate of the locking device shall be capable of either being fitted under the spindle cap or alternatively locate into a groove in the body of the spindle cap. Other methods of accommodating the Corporation's valve locking device may be acceptable subject to approval by the Corporation.

b) Handwheels shall be fitted with provision for locking with a padlock.

c) Where the valve is electrically actuated, it shall incorporate padlockable lockout devices in accordance with DS 26-41.

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4 Coatings

4.1 General

Valves shall be coated in accordance with the requirements specified in Section 4 of AS 2638.2.

4.2 Gearbox

The casings of gearboxes for buried services shall be externally coated in accordance with Water Corporations Technical Specifications A1 Surface Preparation for the Application of Protective Coatings on Steel and Cast Iron and D1-Zinc Rich Epoxy Primer, Epoxy Mastic Coat, Polyurethane Top Coat on steel or Cast Iron

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5 Testing

5.1 General

Product shall be tested in accordance with the test requirements of this Specification. Testing shall be deemed acceptable when test outcomes have been formally verified by a Certification Body or witnessed by a testing Officer. Product for which a test requirement has not been met shall be classified as non-compliant Product.

NOTE 1: Testing should be carried out by an organisation accredited by NATA or in accordance with ISO/IEC 17025.

NOTE 2: A testing Officer should normally be an Officer who has specialist knowledge of or training in product or materials testing appropriate to the Product characteristics to be tested.

5.2 Notification of Testing

The Corporation shall be notified in writing of each formal test proposal at least seven (7) days prior to the preparation of Product for testing except where a specified test has been the subject of a current valid Certificate issued by a Certification Body. This notification is required to enable the Corporation to make all necessary arrangements including appointment of a testing Officer in a timely manner.

5.3 Access to the Place of Manufacture

The testing Officer shall be afforded access, at all reasonable times, to all places of manufacture of Product or product components and shall be authorised to arrange or undertake such testing there as the Corporation deems appropriate to the testing regime specified.

5.4 Place of Manufacture other than WA

Where any Product or product component is being manufactured other than in Western Australia the Corporation may appoint a local inspecting Officer to undertake inspections and witnessed testing as required. The testing Officer shall be provided with all due authority and permits required to carry out testing at the place of manufacture.

NOTE: The cost of witnessed testing arranged by the Corporation will normally be borne by the Corporation unless otherwise negotiated.

5.5 Performance Test Requirements

5.5.1 Production Tests

Each Product item shall be tested in accordance with the relevant production test requirements contained in Section 5 of AS 2638.2.

5.5.2 Coating Tests

The integrity of all coated surfaces, excepting external corners and embossed areas, shall be tested in accordance with the coating test requirements contained in Section 5 of AS 2638.2.

5.5.3 Test Certificates

For the purposes of acceptance, each test certificate shall, as a minimum, bear the relevant Product item serial number and shall certify that the Product item has complied with the specified test requirements.

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6 Marking and Packaging

6.1 Marking

The body of the valve shall be marked in accordance with the requirements of Section 7 of AS 2638.2.

6.2 Packaging

6.2.1 General

Valves shall be packed in accordance with the requirements of Section 7 of AS 2638.2 and the following. Product shall be packaged with appropriate protection, which shall prevent damage or defects as a result of handling, storage or transportation. Flexible packaging material shall have a minimum expected life in outside storage conditions of 12 months from the date of delivery.

6.2.2 Identification Tag

Wherever requested in the Purchasing Schedule each Product item shall be identified using a weatherproof marking pen on a corrosion resistant metal identification tag securely wired to the Product in a conspicuous position using a galvanized tie wire with the following information:

a) Material Master Record number (MMR)

b) Contract number

c) Purchase order number.

6.2.3 Marking of Packaging

Where requested in the Purchasing Schedule, the Product shall be identified by marking on the outside of any protective packaging with the same information as shown on the identification tag.

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7 Manuals

7.1 Format and Language

Where required, Product shall be supplied complete with appropriate installation, operation and maintenance, and safety instructions or manuals, in clear diagrammatic and text format, in English

7.2 Content

The manuals shall contain all the relevant information required to commission and maintain the Product in operational service, including the following:

a) Details of Product features

b) Operational adjustments

c) Installation and commissioning instructions

d) Preventative maintenance requirements and intervals

e) Testing procedures

f) Trouble shooting guidelines

g) Safety procedures

h) Complete list of parts and associated exploded views or sectional diagrams and reference part numbers

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8 Spare Parts and Special Tools

8.1 Spare Parts

8.1.1 Interchangeability

All spare parts shall be interchangeable for a manufacturer's Product of the same size and model.

8.1.2 Availability

Spare parts and servicing facilities for the product shall be readily available in Western Australia.

8.2 Special Tools

Any special tools required for service and maintenance of the Product shall be supplied.

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9 Transportation, Handling and Storage

9.1 General

Transportation, handling and storage facilities shall be designed to prevent Product damage or defects and to maintain Product free of deleterious matter. Product shall not be dropped off elevated vehicle platforms or sites. Mechanical handling equipment shall be in accordance with AS 2550.1, AS 2550.3, AS 2550.5 and AS 2550.11 and shall be appropriate to the loads to be lifted. Manual handling shall be in accordance with the National Standard for Manual Handling and the National Code of Practice for Manual Handling, published by National Occupational Health and Safety Commission, Australia. Product restraint during transportation shall be in accordance with Load Restraint Guide—Guidelines for Safe Carriage of Loads on Road Vehicles, published jointly by the Federal Office of Road Safety and the National Road Transport Commission, Australia.

NOTE: Where wire ropes or chains are used for loading and unloading, they should not come into direct contact with Product. Lifting elements in direct contact with Product should be of a non-abrasive design e.g. elastomeric or fabric webbing straps. During transportation, Product restraints should be checked for tension at regular intervals of travel and should not be released until the transporting vehicle is resting in a secure stable disposition on level ground.

9.2 Preservation of Product in Storage

Product shall be stored in original Product packaging in accordance with the published requirements of the manufacturer, prior to installation. Sensitive component materials shall be protected from extended exposure to direct sunlight and high temperatures e.g. elastomeric components shall be stored in accordance with the general principles of AS 1646.1 Clause 6. Designated Product storage areas shall be of sufficient size to accommodate Product deliveries and shall be flat, reasonably level and free of combustible vegetation, sharp stones or projections that could cause Product damage or defects.

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10 Quality Assurance

10.1 Certification

10.1.1 Certification of Product

Wherever this Specification requires compliance with nominated Product and test Standards, conformance shall be certified by means of a Certification Scheme, conducted by a Certification Body. Each Certificate shall expressly attest compliance of all Product items with the nominated Standards. Wherever specified, Certificates shall be submitted to the Officer nominated for this purpose. Product shall be marked in accordance with the requirements of the Certification Body.

NOTE: Compliance of Product including related accessories and services with nominated Standards and specified requirements may be verified by means of a Product Verification Report provided by a Product Assessor. The Product Verification Report should identify all relevant Certificates of Product compliance, duly issued in accordance with Certification Scheme rules.

10.1.2 Quality System

The processes for manufacture, testing, supply, transportation, handling, delivery and storage of Product to be supplied in accordance with this Specification shall form part of a documented Quality System. The System shall be certified by a Certification Body as complying with the requirements of AS/NZS ISO 9001 and shall provide for identification and traceability, control of production and delivery to the specified destination, customer verification and control of documents and records.

10.1.3 Product Re-verification

Product compliance with the Specification shall be subject to re-verification by a Product Assessor when, during the agreed Product supply period, there occurs any:

- Substantive change in Product design, material formulation or performance
- Product failure to perform in operational service to the nominated performance specification.

Re-verification shall require the issue of a new or supplementary Product Verification Report. Product components and test outcomes that are not significantly affected by the Product change or failure may be excluded from the scope of re-verification, provided that these outcomes have already been reported in a current valid Product Verification Report that is acceptable to the Corporation.

Wherever the requirements of the Specification apply to a Product supply period in excess of three years, continuing acceptance of Product shall be subject to re-verification. The purpose of re-verification shall be to confirm the continuing compliance of Product quality and production control processes with the requirements of the Specification

10.2 Compliance and Acceptance

10.2.1 Means of Demonstrating Compliance

Compliance with this Specification shall be demonstrated by means of Product Appraisal and issue by a Product Assessor of a Product Verification Report that confirms compliance. Otherwise, Product shall be deemed non-compliant and ineligible for registration as Product authorized for use in Corporation infrastructure.

NOTE 1: Where a project includes design work including Product design, Product Appraisal may form part of the project design review process and the Product Assessor may be a member of the project design review team.

NOTE 2: A Product Verification Report should verify the extent of compliance with the Specification including all relevant 'Technical Compliance Schedule' Appendices and the currency of a Certificate where relevant to the Product.

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10.2.2 Acceptance Criteria

For acceptance, Product shall be supplied as specified in the Purchasing Schedule.

Prior to the implementation of any arrangement to supply Product, the Supplier shall, in accordance with specified requirements:

- nominate applicable Product Warranty terms; and
- provide documentary verification in the form of a current valid Certificate or Product Verification Report as appropriate to the Product; and
- detail each element of Product that does not comply with the specified requirements together with the extent of non-compliance.

NOTE : Where the Specification includes Technical Compliance Schedules, the nature and extent of all non-compliances should be provided in accordance with the appropriate Schedules.

10.3 Non-compliant Product

10.3.1 General

Product whose design, workmanship or performance fails to conform to the specified requirements shall be clearly tagged and quarantined by the Supplier as non-compliant and shall be subject to rejection for return to and replacement by the Supplier.

Where the Specification includes a 'Technical Compliance Schedule', Product shall be deemed non-compliant except where a Supplier has demonstrated compliance in accordance with the requirements of the 'Technical Compliance Schedule' Appendices of the Specification.

10.3.2 Manufacturing Repairs (In-process)

Welding, the use of fillers and other repairs shall generally not be permissible on Product which is in the course of production. Repairs to custom-built Products such as axially-split pumps and large valves may be considered only if determined by the Corporation to be minor casting repair work in non-strategic locations. Accordingly, details of any defect which the Manufacturer considers can be repaired; together with details of proposed repair procedures shall be submitted in writing for determination by the Corporation.

The Manufacturer shall make provision in its production Quality System and in the appropriate inspection and testing plans (ITPs) for sufficient hold points whenever casting defects are encountered. Production work on non-compliant components shall cease and repair work shall not commence until the following details have been confirmed by the Corporation in writing:

(a) that repair of the non-compliant components in lieu of their replacement is acceptable; and

(b) that proposed repair procedures are acceptable; and

(c) that any proposal to vary the terms of the original Product Warranty as a consequence of the in-process repair is acceptable.

10.3.3 Product Warranty

The Supplier shall replace non-compliant Product with Product that conforms to the acceptance criteria or shall repair or rectify all faults, damage or losses caused by defective Product. Except as may otherwise be specified, the Product Warranty shall indemnify and keep indemnified the Corporation against all losses suffered by the Corporation as a result of non-compliant Product for a period no less than 24 months after Product delivery or 12 months after Product installation, whichever period elapses first.

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10.3.4 Product Repair

All reasonable proposals for repair or remedy of defects will be considered, provided that each such proposal is accompanied by a methodology statement that accords with the performance objectives of this Specification, as determined by the Corporation. For acceptance, a proposal for repair or remedy of Product defects shall not void or otherwise diminish the provisions of the Product Warranty.

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11 Appendix A: Project Specific Requirements (Normative)

11.1 General

Project specific information and requirements, not included elsewhere in this Strategic Product Specification shall apply as specified in the following.

11.2 Technical Requirements

Table 11.1 details project specific requirements for the valves to be procured.

TABLE 11.1: SCHEDULE OF PROJECT TECHNICAL REQUIREMENTS

MMR No	No Off	DN	PN	Special Requirements Refer Notes 1, 2, 3, 4,5

NOTES:

1. The materials of construction should comply with the Basic Materials contained in Table 2.1 of AS 3638.2 unless otherwise stated.
2. Specify the type of end connections e.g. double flanged or socketed.
3. Specify the operator type e.g. key or handwheel.
4. Specify if a gearbox is required
5. Flange drilling of PN21 valve shall be in accordance with AS2129 Table F. Flange drilling of PN25 rated valves shall be in accordance with EN1092 PN25.

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12 Appendix B: Technical Compliance Schedules (Normative)

12.1 Compliance Schedules

Suppliers shall demonstrate Product compliance with the Specification by completing Technical Compliance Schedule 1 as shown in **TABLE 12.1A** and **TABLE 12.1B** on an item by item basis. Table 12.1A refers to clauses contained in AS 2638.2 whereas Table 12.1B refers to additional clauses contained in this Specification.

For acceptance, the extent of scheduled technical item compliance shall be supported by verifiable documentary evidence. Each scheduled item nominates a Specification clause number with which the extent of Product compliance shall be demonstrated.

The Supplier shall denote compliance of an item by ticking the unshaded 'Yes' column appropriate to that item. Where Product does not comply with specified requirements, the Supplier shall tick the 'No' column and shall detail the reasons for non-conformance and any proposed alternatives in the 'Comments' column. The Supplier shall denote acceptance and understanding of a Specification clause by ticking the corresponding 'Noted' column wherever unshaded.

Failure to notify the Corporation of all non-compliant Product components, including the extent of non-compliance, may void an accepted offer to supply or may result in rectification of all non compliant Product elements, at the Supplier's cost.

TABLE 12.1A: AS 2638.2 TECHNICAL COMPLIANCE SCHEDULE 1A

Resilient Seated Gate Valves					
Section/Clause		**Noted**	**Compliance**		**Comments**
			Yes	**No**	
1. SCOPE AND GENERAL					
1.1	Scope				
1.2	Referenced Documents				
1.3	Definitions				
1.4	Designation of Size				
1.5	Allowable Pressures				
2. MATERIALS AND COMPONENTS					
2.1	Materials				
2.2	Dezincification-resistant Materials				
2.3	Contamination of Water				
2.4	O-rings (elastomeric toroidal sealing rings)				
3. DESIGN					
3.1	General				
3.2	Dimensions				
3.3	End Connections				
3.4	Gate				
3.5	Component Jointing				
3.6	Waterway				
3.7	Spindle				
3.7.1	Spindle diameter				
3.7.2	Spindle thread				
3.7.3	Spindle sealing				
3.7.4	Thrust collar				
3.7.5	Spindle seat retainer				
3.8	Operation				
3.8.1	General				
3.8.2	Spindle cap and key				
3.8.3	Extension spindle				
3.8.4	Handwheels				
3.8.5	Direction of closure				
3.9	Lifting Devices				
3.10	Support Feet				
3.11	Bypass Arrangements				

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4. COATINGS					
4.1	General				
4.2	Design				
5. TESTING					
5.1	Type Tests				
5.1.1	General				
5.1.2	Strength test (thrust collar, spindle, nut and cap) (Test A)				
5.1.3	Body pressure test (Test B)				
5.1.4	Gate strength test (Test C)				
5.1.5	Torque test (Test D)				
5.1.6	Valve seat test (Test E)				
5.1.7	Sensitivity test (Test F)				
5.1.8	Functional test (Test G)				
5.1.9	Spindle seal replacement or repair test (Test H)				
5.1.10	Final inspection				
5.1.11	Cyclic flow test (Test I)				
5.1.12	Endurance cyclic flow test (Test J)				
5.1.13	Gate rubber adhesion test (Test K)				
5.1.14	Strength test (valve key) (Test L)				
5.1.15	Strength test (spindle extension) (Test M)				
5.2	Production Tests				
5.2.1	General				
5.2.2	Body test (Test 1)				
5.2.3	Valve seat test (Test 2)				
5.2.4	Coating tests				
6. GEARBOXES					
6.1	Design				
6.1.1	Gearbox				
6.1.2	Gearbox selection				
6.1.3	Geared valves				
6.2	Coatings				
6. 3	Markings				
7. MARKING AND PACKAGING					
7.1	Body Markings				
7.2	Valve Key and Spindle Extension Markings				
7.3	Direction of Closure for Handwheels and Caps				
7.4	Packaging				

TABLE 12.1B: SPS 272 TECHNICAL COMPLIANCE SCHEDULE 1B

Resilient Seated Gate Valves					
Section/Clause		**Noted**	**Compliance**		**Comments**
			Yes	**No**	
1. SCOPE AND GENERAL					
1.1	Scope				
1.2	Referenced Documents				
1.3	Definitions and Notation				
1.4	Designation of Size				
2. MATERIALS AND COMPONENTS					
2.1	General				
2.2	Non-metallic Materials				
3. DESIGN					
3.1	Gate Valve				
3.2	Gearbox				
3.3	End Connections PN16 Valves				
	End Connections PN25 Valves				
3.4	Lockout Devices				
4. COATINGS					
4.1	General				

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5. TESTING					
5.1	General				
5.2	Notification of Testing				
5.3	Access to the Place of Manufacture				
5.4	Place of Manufacture other than WA				
5.5	Performance Test Requirements				
5.5.1	Production Tests				
5.5.2	Coating Tests				
5.5.3	Test Certificates				
6. MARKING AND PACKAGING					
6.1	Marking				
6.2	Packaging				
6.2.1	General				
6.2.2	Identification Tag				
6.2.3	Marking of Packaging				
7. MANUALS					
7.1	Format and Language				
7.2	Content				
8. SPARE PARTS AND SPECIAL TOOLS					
8.1	Spare Parts				
8.1.1	Interchangeability				
8.1.2	Availability				
8.2	Special Tools				
9. TRANSPORTATION, HANDLING AND STORAGE					
9.1	General				
9.2	Preservation of Product in Storage				
10. QUALITY ASSURANCE					
10.1	Certification				
10.1.1	Certification of Product				
10.1.2	Quality System				
10.1.3	Product Re-verification				
10.2	Compliance and Acceptance				
10.2.1	Means of Demonstrating Compliance				
10.2.2	Acceptance Criteria				
10.3	Non-compliant Product				
10.3.1	General				
10.3.2	Manufacturing Repairs (In-process)				
10.3.3	Product Warranty				
10.3.4	Product Repair				

Name of Supplier:

Signature: Date:

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When requested by the Corporation, the Supplier shall provide the information required by Technical Compliance Schedule 2 as shown in **TABLE 12.2**.

TABLE 12.2: TECHNICAL COMPLIANCE SCHEDULE 2

Resilient Seated Gate Valves					
1.	**SUPPLIER'S REPRESENTATIVE**				
1.1	Full name				
1.2	Postal address				
1.3	Facsimile number				
1.4	Email address				
1.5	Phone number				
1.6	Mobile number				
2.	**QUALITY ASSURANCE**				
2.1	Extent of Third Party Accreditation of Supplier				
2.2	Extent of Third Party Accreditation of Manufacturer				
2.3	Details of Certificates and Verification Reports attached		(Yes/No)		
2.4	Certification Mark obtained		(Yes/No)		
2.5	Corporation authorisation received		(Yes/No)		
3.	**TECHNICAL INFORMATION**				
3.1	Valve and gearbox detail drawing supplied		(Yes/No)		
3.2	Details of the manufacturer's ITPs supplied.		(Yes/No)		
3.3	Details of servicing facilities in Perth supplied.		(Yes/No)		
3.4	Additional pamphlets and drawings in conjunction with the technical literature supplied.		(Yes/No)		
4	**MATERIALS**		**MATERIAL**	**STANDARD**	**GRADE**
4.1	Body				
4.2	Bonnet and seal retaining housing (where applicable)				
4.3	Seal retainer				
4.4	Gate core				
4.5	Gate rubber				
4.6	Gate nut				
4.7	Spindle				
4.8	Spindle cap and handwheel				
4.9	Fasteners				
4.10	Flat gaskets				
4.11	O-rings				
4.12	Gearbox body				
4.13	Gear shafts				
4.14	Gears				
4.15	Shaft bushes				
4.16	Indicator gears				
4.17	Protective coating				
5.	**VALVE DESIGN AND MANUFACTURE**				
5.1	Manufacturer's name				
5.2	Place of manufacture				
5.3	Model				
5.4	Type				
5.5	Size	mm			
5.6	Pressure classification (PN)	kPa			
5.7	Maximum operating temperature	°C			
5.8	End connection – flange standard				
5.9	Maximum allowable flow velocity	m/sec			
5.10	Allowable operating pressure	kPa			

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5.11	Maximum allowable operating pressure	kPa	
5.12	Number of turns to fully open the valve		
5.13	Maximum torque to seat the valve	Nm	
5.14	Valve maximum running torque	Nm	
5.15	Flow coefficient (maximum opening)	kV	
5.16	Minimum waterway diameter		(Yes/No)
5.17	Gate intrusion into the waterway		(Yes/No)
5.18	Full engagement of spindle thread in the nut with gate closed		(Yes/No)
5.19	Spindle thread type		
5.20	Direction of closure when facing the operator		
5.21	Type of spindle seals		
5.22	Spindle seal retainer fail-safe locking feature		
5.23	Thrust bearing type and location		
5.24	Support feet provided		(Yes/No)
5.25	Mass of valve and gearbox	kg	
6.	**GEARBOX DESIGN AND MANUFACTURE**		
6.1	Manufacturer's name		
6.2	Place of manufacture		
6.3	Model		
6.4	Type of reduction		
6.5	Ratio		
6.6	Rated maximum output torque	Nm	
6.7	Input torque required for maximum output torque	Nm	
6.8	Efficiency	%	
7.	**PERFORMANCE TESTS**		
7.1	Body test pressure	kPa	
7.2	Valve seat test pressure	kPa	
7.3	Coating test to be performed		(Yes/No)

Name of Supplier:

Signature: Date:

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13 Appendix C: Material Master Records (Informative)

The following Material Master Records (MMR) comprise Corporation catalogue numbers that are unique to the particular products described for the purposes of Corporation activities or work.

MMR	PURCHASE ORDER LONG TEXT
18769	Valve, Gate; Sluice; DN80; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18770	Valve, Gate; Sluice; DN80; PN16; Ductile Cast Iron Body; Resilient Seated; Socketed Ends; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18771	Valve, Gate; Sluice; DN100; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18772	Valve, Gate; Sluice; DN100; PN16; Ductile Cast Iron Body; Resilient Seated; Socketed Ends; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18773	Valve, Gate; Sluice; DN150; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18774	Valve, Gate; Sluice; DN150; PN16; Ductile Cast Iron Body; Resilient Seated; Socketed Ends; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18775	Valve, Gate; Sluice; DN200; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18776	Valve, Gate; Sluice; DN200; PN16; Ductile Cast Iron Body; Resilient Seated; Socketed Ends; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18777	Valve, Gate; Sluice; DN250; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18778	Valve, Gate; Sluice; DN250; PN16; Ductile Cast Iron Body; Resilient Seated; Socketed Ends; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18779	Valve, Gate; Sluice; DN300; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
18780	Valve, Gate; Sluice; DN300; PN16; Ductile Cast Iron Body; Resilient Seated; Socketed Ends; Thermal Bonded Polymeric Coating (Internal & External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
20214	Valve, Gate; Sluice; DN375; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
20215	Valve, Gate; Sluice; DN400; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
20216	Valve, Gate; Sluice; DN450; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.

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MMR	PURCHASE ORDER LONG TEXT
20217	Valve, Gate; Sluice; DN500; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
20218	Valve, Gate; Sluice; DN600; PN16; Ductile Cast Iron Body; Resilient Seated; Flanged to AS 4087 Figure B5; Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
21243	Valve, Gate; Sluice; DN100; PN21; Ductile Cast Iron Body; Resilient Seated; Flanged to EN1092 (PN25), Drilled to AS 2129 Table F (PN21); Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
21244	Valve, Gate; Sluice; DN150; PN21; Ductile Cast Iron Body; Resilient Seated; Flanged to EN1092 (PN25), Drilled to AS 2129 Table F (PN21); Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
21245	Valve, Gate; Sluice; DN200; PN21; Ductile Cast Iron Body; Resilient Seated; Flanged to EN1092 (PN25), Drilled to AS 2129 Table F (PN21); Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
21246	Valve, Gate; Sluice; DN250; PN21; Ductile Cast Iron Body; Resilient Seated; Flanged to EN1092 (PN25), Drilled to AS 2129 Table F (PN21); Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.
21247	Valve, Gate; Sluice; DN300; PN21; Ductile Cast Iron Body; Resilient Seated; Flanged to EN1092 (PN25), Drilled to AS 2129 Table F (PN21); Thermal Bonded Polymeric Coating (Internal and External) to AS/NZS 4158; Ungeared; Anti-Clockwise Closing.

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COATING SPECIFICATION

THERMAL BONDED POLYMERIC COATINGS ON STEEL AND CAST IRON VALVES AND FITTINGS

COATING SPECIFICATION: G2 **ISSUE: 3** **DATE: JULY 2019**

1.0 SCOPE

This document summarises the procedure for the application of a factory applied Thermal Bonded Polymer coating also known as Fusion Bonded Epoxy (FBE) to Steel or Cast Iron Valves and Fittings in accordance with AS 4158.

Refer Design Standard, DS 95 (Standard for the Selection, Preparation, Application, Inspection and Testing of Protective Coatings on Water Corporation Assets) for additional information or clarification.

It shall be read in conjunction with Water Corporation surface preparation specification **A1 - Surface Preparation for the application of Protective Coatings on Steel or Cast Iron**.

2.0 PURPOSE

FBE coating is widely used for valves, pipe elbows, joints etc. in potable water and wastewater applications. For potable water applications the coating shall also have AS 4020 (Testing of products for use in contact with drinking water) approval. This specification can be used for atmospheric corrosivity categories A to E as described in AS 2312.

3.0 DEFINITIONS

ACA: Australasian Corrosion Association.

Contractor: The service provider or its sub-contractor who will undertake the works.

Corporation: The Water Corporation and the Principal for the purposes of externally contracted asset delivery.

DFT: Dry Film Thickness.

ITP: The detailed Inspection and Test Plan(s) for the Works.

NACE: National Association of Corrosion Engineers.

Spark Testing: Testing of the continuity of a fully-cured coating film for evidence of defects, pin holes, holidays (misses) or damage.

Superintendent: The Superintendent for the contract, as defined in the conditions of contract, who is appointed by the Water Corporation to manage/oversee the work under the contract on behalf of the Water Corporation.

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FOI 26-292 - Document 27

COATING SPECIFICATION

THERMAL BONDED POLYMERIC COATINGS ON STEEL AND CAST IRON VALVES AND FITTINGS

COATING SPECIFICATION: G2 **ISSUE: 3** **DATE: JULY 2019**

TDFT: Total Dry Film Thickness.

Works: The surface preparation, coating application and inspection to be undertaken by the contractor to which this coating specification applies.

4.0 SURFACE PREPARATION

4.1 Blast cleaning of the surfaces shall be carried out to produce a uniform metallic appearance, a surface profile which provides satisfactory anchorage for the coating, as per paint manufacturer's recommendation and be otherwise compatible with the coating to be applied.

5.0 COATING MATERIALS

5.1 Coating materials used for attaining the specified standard shall be selected in accordance with Appendix 3 of DS-95- commonly used coatings in potable water and wastewater infrastructures unless approved otherwise by the Team Leader – Asset Durability. This approval is required before coating commences.

5.2 Coating specifications inclusive of datasheets, coating application, method statements and ITP's shall be submitted to the Principal for approval at least 10 working days prior to commencement of the work.

5.3 Application and curing of protective coatings shall be carried out in accordance with the coating manufacturer's recommended practice for the on-site conditions.

5.4 Recommended drying times between coats for on-site conditions shall not be exceeded

6.0 ATMOSPHERIC CONDITIONS

6.1 Prior to and during coating application, the contractor shall record details pertaining to environmental conditions including ambient and surface temperature, relative humidity and dew point.

7.0 COATING APPLICATION

7.1 After the casting has been heated to the coating manufacturers recommended temperature, the coating powder is applied directly to the casting surface by either automatic dipping of the component or hand spraying.

7.2 The coated components are allowed to cool, baking the coating on the substrate to produce a hard, tough coating surface.

8.0 COATING THICKNESS

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FOI 26-292 - Document 27

COATING SPECIFICATION

THERMAL BONDED POLYMERIC COATINGS ON STEEL AND CAST IRON VALVES AND FITTINGS

COATING SPECIFICATION: G2 ISSUE: 3 DATE: JULY 2019

8.1 The minimum coating thicknesses for the thermoset coating on the internal surface (in contact with water) is 350 microns and external surface is 300 microns, Appendix D - Table D1, AS 4158.

8.2 The minimum coating thicknesses for the thermoplastic coating on the internal surface (in contact with water) is 250 microns and external surface is 200 microns, Appendix D - Table D1, AS 4158

9.0 COATING FINISH

9.1 The finished coating shall be of uniform thickness, colour, appearance and gloss. It shall be fully cured, insoluble, adherent, coherent and free from holidays, laps, sags, blistering, checking, wrinkling, overspray, patchiness and any other defects that may impair the performance and/or appearance of the coating.

10.0 COATING APPLICATOR/PERSONNEL QUALIFICATION

10.1 Work shall only be carried out by a competent person.

10.2 The work shall be undertaken by an approved Water Corporation Corrosion Control Panel Services member, unless approved otherwise by the Team Leader – Asset Durability.

10.3 The Applicator's Coating Supervisor shall possess as a minimum one of the following certifications:

- ACA - Coating Inspector; or
- NACE - CIP Level I Coating Inspector.

10.4 The coating contractor shall nominate a Coating Inspector as their Quality Control Officer to carry out inspections, submit the ITP, undertake the required testing and maintain appropriate records for all work performed.

The Applicator's Coating Inspector shall possess as a minimum one of the following certifications:

- ACA - Coating Inspector; or
- NACE - CIP Level I Coating Inspector.

11.0 INSPECTION AND TESTING OF COATING

11.1 **Visual Testing** - Coatings shall be visually examined for surface defects and any discontinuity arising after curing shall be recorded.

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FOI 26-292 - Document 27

11.2 **Spark Testing** - The finished, fully cured coating subjected to buried or immersed conditions shall be holiday tested in accordance with AS 4158 Table 3.3.

11.3 **Adhesion Testing** - Adhesion testing is only required on the Valves. Testing shall be carried out in accordance with AS 4158 Section 3.0.

11.3.1 The results of all adhesion tests shall be submitted to the Superintendent as part of the overall quality control documentation.

11.3.2 Finished coating thickness shall be determined using suitable instruments standardised (zeroed) on a smooth uncoated metal plate in accordance with AS 3894.3.

12.0 REPAIR OF A DEFECTIVE COATING AND RETESTING

12.1 Defective coatings allowance shall be in accordance with Table 3.3 of AS 4158.

12.2 Defects such as pinholes, cracks, blisters, voids, foreign inclusions and irregular profile peaks shall be marked for repair and retested upon full cure of the repaired coating.

13.0 RECORDING AND REPORTING

13.1 Following testing a report shall be submitted by the Contractor. The Contractor shall keep detailed records and reports including the following:

- Environmental conditions (relative humidity, dew point etc.);
- Surface preparation;
- Surface profile;
- Coating application;
- Coating testing; and
- General failure.

13.2 To supplement these records, prior to any works commencing, an Inspection Test Plan (ITP) shall be forwarded to the Water Corporation for review a minimum of 10 working days prior to the commencement of work.

14.0 CONTRACTOR'S RESPONSIBILITY

14.1 The Contractor shall supply all necessary plant, equipment, materials and labour, prepare the surface and apply and maintain the protective coating in accordance with this specification.

14.2 The preceding inspection clauses shall not relieve the Contractor of their responsibility to supply materials and perform work in accordance with the requirements of any overriding contract documentation.

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FOI 26-292 - Document 27

COATING SPECIFICATION

THERMAL BONDED POLYMERIC COATINGS ON STEEL AND CAST IRON VALVES AND FITTINGS

COATING SPECIFICATION: G2 **ISSUE: 3** **DATE: JULY 2019**

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FOI 26-292 - Document 27

Asset Planning and Delivery Group
Engineering

WELDING AND JOINING SPECIFICATIONS

WS-2 THERMOPLASTICS

DRAFT

VERSION 2
REVISION 0

JULY 2020

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FOI 26-292 - Document 27

FOREWORD

This Specification has been prepared to inform Corporation staff, designers and service providers of the requirements of the Corporation's standard for thermoplastic welding, welding and joining workmanship and quality assurance related to welded assemblies. These requirements are based on Industry best practice as well as extensive design and field experience gained over time by the Corporation, as an asset owner of a wide range of assets constructed from a wide range of materials.
The Specification is intended for reference and use in the following typical procurement scenarios:

- Capital funded infrastructure asset design and construction work;
- Operationally funded asset procurement, design and construction work;
- Private developer funded subdivision services to be taken over by the Corporation;
- Procurement of welded products and services for period contracts and minor projects.

The text of this Specification should not be modified for project applications. Where a text variation is considered necessary to accommodate particular project needs and where authorised at an appropriate Corporation process level, the project specific modification should be documented only in the project specification.

Proposals for incremental improvement of or deviation from, the technical welding requirements of this Specification should be directed to the Senior Principal Engineer - Mechanical, Engineering – Field Services and shall be subject to consultation with the appropriate Corporation process stakeholders who may be impacted by the proposals.

The aim of this specification is to stipulate the requirements for conventional processes i.e. butt fusion, electro fusion, hot air and extrusion welding used for the joining in the broader sense, of Polyethylene, Polypropylene, PVC and ABS materials. Where alternative materials and processes are considered a full appraisal of the same will need to be conducted and approved by the Corporation.

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Head of Engineering

This document is prepared without the assumption of a duty of care by the Water Corporation. The document is not intended to be nor should it be relied on as a substitute for professional engineering design expertise or any other professional advice.

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FOI 26-292 - Document 27

DISCLAIMER

This Standard is intended solely for application to the acquisition of water infrastructure in Operating Areas in Western Australia where the Water Corporation has been licensed to provide water services subject to the terms and conditions of its Operating License.

This Standard is provided for use only by a suitably qualified professional design engineer who shall apply the skill, knowledge and experience necessary to understand the risks involved and undertake all infrastructure design and installation specification preparation work.

Any interpretation in this Standard that deviates from the requirements specified in the project design drawings and construction specifications shall be resolved by reference to and determination by the design engineer.

The Corporation accepts no liability for any loss or damage that arises from anything in the Standard including loss or damage that may arise due to the errors and omissions of any person.

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REVISION STATUS
The revision status of this standard is shown section by section below:

REVISION STATUS						
SECT.	VER./ REV	DATE	PAGES REVISED	REVISION DESCRIPTION (Section, Clause, Sub-Clause)	RVW	APRV
1	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
2	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
3	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
4	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
5	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
6	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
7	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
8	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
9	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
10	1/0 (A)	15/03/13	All	New Version	KR	BG
	1/5	01/05/17	30	10.1.8: Fast fusion machines not permissible.	GB	DV
	1/5	01/05/17	31	Added Sec 10.1.8.1: BFJ Cooling Cycle	GB	DV
	2/0	28/01/20	All	New Version	GB	DV
11	1/0 (A)	15/03/13	All	New Version	KR	BG

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FOI 26-292 - Document 27

REVISION STATUS						
SECT.	VER./ REV	DATE	PAGES REVISED	REVISION DESCRIPTION (Section, Clause, Sub-Clause)	RVW	APRV
	1/1 (B)	05/12/13		Sec 11.2.1: Hydrostatic – Pipeline Testing Requirements Sec 11.7.1.4: Air Pressure Testing – Pressure Stabilisation Time Amended from 5 min. to 2min.	KR/ ED	BG
	1/2 (C)	05/05/14		Sec 11.4.1: Hydrostatic Pressure Test – Verification of Inconclusive Results from Pressure Rebound Method by using Pressure Water Loss method	KR	BG
	1/4 (D)	20/12/15		Sec 11.4.1: Hydrostatic pressure testing limited to single nationally accepted test method in accordance with AS/NZS 2033		
	2/0	28/01/20	All	New Version	GB	DV
12	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
13	1/0 (A)	15/03/13	All	New Version	KR	BG
	2/0	28/01/20	All	New Version	GB	DV
App A	1/0 (A)	15/03/13	All	New Version	KR	BG
App B	1/0 (A)	15/03/13	All	New Version	KR	BG
	1/1 (B)	05/12/13		Dual Pressure – Low fusion – Minor changes to align with POP003	ED	BG
	2/0	28/01/20	All	New parameter templates – BFJ and EFJ	JP	DV
App C	1/0 (A)	15/03/13	All	New Version	KR	BG

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FOI 26-292 - Document 27

WELDING AND JOINING SPECIFICATION
WS-2 THERMOPLASTICS

CONTENTS

1 SCOPE 8

2 REFERENCES 8

3 DEFINITIONS 11

4 STANDARDS AND CODE 13

4.1 Australian and International Standards 13
4.2 Corporation Standards 13
4.3 Industry Standards 13

5 MATERIALS AND JOINING PROCESSES 14

5.1 PVC-U, PVC-M, PVC-O & PVC-C Pressure Pipes 14
5.2 PVC-U Non Pressure Pipes 14
5.3 Plasticised PVC and PVC Membrane 15
5.4 Polyethylene Pressure Pipe 15
5.5 Polyethylene Membrane 16
5.6 Polypropylene Pressure Pipe 16
5.7 Polypropylene Membrane 17
5.8 ABS (Acrylonitrile Butadiene Styrene) Pressure and Non Pressure Pipe 17
5.9 Sheet Materials 17

6 APPROVAL TO COMMENCE WORK 18

7 QUALITY ASSURANCE 18

7.1 Contractor / PWSP Organisational Responsibilities 18
7.2 PWSP Quality Management System Requirements 19
7.3 PWSP Capabilities 19
7.4 Welded Joint Traceability 20
7.5 Manufacturers Material Data Report 20

8 QUALIFICATION AND DOCUMENTATION OF WELDING AND JOINING PROCEDURES 21

8.1 Butt Fusion Welding (ISO 21307) 21
8.2 Electro Fusion Welding 21
8.3 Extrusion Welding 22
8.4 Hot Air Welding 23
8.5 Hot Wedge Welding 23
8.6 Solvent Cement Welding 23
8.7 Welding of Membrane 24
8.8 Welding of Sheet 24
8.9 Environmental Conditions for Fusion Welding 24
8.10 Planning for successful fusion welding 24

9 PERSONNEL TRAINING AND QUALIFICATION 26

9.1 Joining of PE – Butt Fusion and Electro fusion welding 26
9.2 Solvent Cement Welding and Joining of PVC and ABS Pipelines 26
9.3 Extrusion Welding 26
9.4 Hot Air Welding 26
9.5 Membrane Welding 27
9.6 Plastics Welding and Joining Supervisor 27
9.7 Re-assessment of welding / joining personnel qualifications 27

10 WORKMANSHIP STANDARDS AND EQUIPMENT 28

10.1 Polyethylene Pipe Work 28

DRAFT

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FOI 26-292 - Document 27

10.2 Solvent Cement Joining of PVC and ABS Pipework 32
10.3 Joining of Membrane and Liners 33
10.4 Plastic Lining – Reinforced Concrete Pipes 37

11 INSPECTION AND TESTING 38

11.1 Inspection and Test Plans 38
11.2 Pipe Butt Fusion Welding - BFJ 39
11.3 Electrofusion Pipe Joints – EFJ 39
11.4 Hydrostatic testing of welded pipelines 41
11.5 Hot Air Welding and Extrusion Welding 41
11.6 Solvent Welding 41
11.7 Membrane and Liner Welding 41

12 CONSUMABLES, MAINTENANCE, SERVICING AND CALIBRATION 48

13 WELDING SAFETY 49

13.1 General 49
13.2 Portable and Handheld Tools 49
13.3 Hot Work 49
13.4 Working in a Confined Space 49
13.5 Safe Working with Coatings and Wrapping 49
13.6 Working Hours and Fatigue Management 50
13.7 Working at Heights 50
13.8 Solvents and Fire Hazard 50
13.9 Inhalation and Fumes 50
13.10 Specific Risk Related to Thermoplastics 50
13.11 Handling and Disposal of Solvents 50
13.12 Disposable of Thermoplastic Waste 51

APPENDIX A - WELDING DOCUMENTATION REQUIREMENTS 52

APPENDIX B: BUTT WELDING TRACEABILITY REPORT/REGISTER 55

APPENDIX C - INSPECTION RELEASE FORM 57

DRAFT

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FOI 26-292 - Document 27

1 Scope

This technical specification sets out the requirements for the fabrication and welding of thermoplastics materials that are or are intended to be Corporation assets.

This specification is limited to:

- Polyethylene, including pressure pipe and flexible liner materials;
- PVC including unplasticised PVC pressure and non-pressure pipe and plasticised PVC liner materials;
- Polypropylene including pressure pipe and flexible liner materials; and
- ABS pressure and non-pressure pipe.

This specification sets out requirements for the conventional methods of welding and joining thermoplastics materials using butt fusion, electro-fusion, hot wedge, hot air extrusion welding and solvent welding jointing processes.

Alternative processes other than those stated shall not be used unless authorized by the Corporation.

The construction standards nominated in project specific drawings and specifications shall apply in assessing compliance with workmanship quality requirements.

DRAFT

2 References

The following standards, specifications and other documents are referenced in or related to this technical specification:

AS1674.1	Safety in welding and allied processes - Fire precautions;
AS 1674.2	Safety in welding and allied processes – Electrical;
AS 3894.1	Site testing of protective coatings - Non-conductive coatings - Continuity testing - High voltage ('brush') method;
AS/NZS 1254	PVC-U pipes and fittings for stormwater and surface water applications;
AS /NZS 1260	PVC-U pipes and fittings for drain, waste and vent applications (this standard applies to PVC sewer pipes);
AS 1462.1	Methods of test for plastics pipes and fittings Method 1: Method for determining the dimensions of pipes and fittings
AS/ NZS 1477	PVC Pipes and fittings for pressure applications;
AS /NZS 2032	Installation of PVC pipe systems;
AS /NZS 2033	Installation of polyethylene pipe systems;
AS /NZS 2566.2	Buried Flexible Pipeline - Installation;
AS /NZS 3518	Acrylonitrile butadiene styrene (ABS) pipes and fittings for pressure applications;
AS/NZS 3879	Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS and ASA pipes and fittings;
AS/NZS 4020	Testing of Products for use in contact with drinking water;

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FOI 26-292 - Document 27

AS/NZS 4129	Fittings for polyethylene (PE) pipes for pressure applications;
AS/NZS 4130	Polyethylene (PE) pipes for pressure applications;
AS/NZS 4131	Polyethylene (PE) Compounds
AS/NZS 4765	Modified PVC (PVC-M) pipes for pressure applications;
AS/NZ ISO 3834.3	Quality requirements for fusion welding of metallic materials - Standard quality requirements;
AS/NZS ISO 9001	Quality management systems – Requirements;
ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120
ASTM D2855	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D6365	Standard Practice for the Non-destructive Testing of Geomembrane - Seams using the Spark Test;
ASTM F439	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80;
ASTM F441	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80;
ASTM F493	Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings;
DVS 2007-25	Welding of thermoplastics – heated tool butt welding PVC-U;
DVS 2207-3	Hot gas welding of thermoplastic sheets and pipes;
DVS 2207-3(sup)	Hot gas welding of thermoplastic sheets and pipes - welding parameters;
DVS 2208-1	Machines and devices for the heated tool welding of pipes, piping parts and panels;
DVS 2209-1	Welding thermoplastic materials, extrusion welding procedures – characteristics;
WSA 01	Polyethylene Pipeline Code;
WSA 113	Industry Standard for Reinforced Concrete Pipes with Flexible Thermoplastic Linings;
WSA 117	Industry standard for Acrylonitrile Butadiene Styrene (ABS) compounds, pipes and fittings for drainage and sewerage;
ISO 11413	Plastics pipes and fittings -- Preparation of test piece assemblies between a polyethylene (PE) pipe and an Electrofusion fitting;
ISO 12176-1	Plastic pipes and fittings – Equipment for fusion jointing of polyethylene systems – Part 1: Butt Fusion;
ISO 12176-2	Plastics pipes and fittings – Equipment for fusion jointing polyethylene systems – Part 2: Electrofusion;

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ISO 12176-4	Plastics pipes and fittings – Equipment for fusion jointing polyethylene systems – Part 4: Traceability coding;
EN 13100	Non-destructive testing of welded joints of thermoplastics semi-finished products, visual examination;
ISO 13953	Polyethylene (PE) pipes and fittings -- Determination of the tensile strength and failure mode of test pieces from a butt-fused joint;
ISO 13954	Plastics pipes and fittings -- Peel decohesion test for polyethylene (PE) Electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm;
ISO 13955	Plastics pipes and fittings – Crushing decohesion test for polyethylene (PE) electrofusion assemblies;
ISO 13956	Plastics pipes and fittings - Determination of cohesive strength-tear test for Polyethylene (PE) assemblies;

DIN EN ISO 15874 Plastic piping systems for hot and cold water installations

ISO 21307	Plastic pipes and fittings – Butt fusion jointing procedures for polyethylene (PE) pipes and fittings used in the construction of gas and water distribution systems;
ISO/TS 10839	Polyethylene pipes and fittings for the supply of gaseous fuels – Code of practice for design, handling and installation.
BS EN 12814	Testing of welded joints of thermoplastic semi-finished Part 1: Products. Bend test;
GRI* GM 13	Standard Specification, Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes;
GRI* GM 17	Standard Specification, Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes;
GRI* GM 18	Standard Specification, Test Methods, Test Properties and Testing Frequency for Flexible Polypropylene Non-reinforced (FPP) and Reinforced (FPP-R) Geomembranes;
GRI* GM 19	Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes;
AWWA M25	Flexible- Membrane Covers and Linings for Potable- Water Reservoirs;
AWWA D130	Geomembrane materials for Potable Water Applications;
PMB	Plastics, Rubber and Cablemaking Training Package;
POP Guidelines	All current guidelines published by PIPA.

Note* - Geosynthetic Research Institute

Corporation Specifications and Standards

SPS 115	Unplasticised Polyvinylchloride Pipe for Pressure Applications
SPS 116	Modified Polyvinylchloride Pipe for Pressure Applications

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SPS 125	Polyethylene and Polypropylene Pipe and Pipe Fittings
SPR	Strategic Products Register – Water, Wastewater and Drainage Systems
S151	Prevention of Falls Standard
HSEAA-P-143	Falls
HSEEA-P-124	Confined Space
WC-OSH 135	Working in a Flammable Gas Area
HSEAA-P-134	Hot Work

3 Definitions

In this Technical Specification unless the context requires otherwise:

ABS means Acrylonitrile Butadiene Styrene;

Butt fusion jointing (BFJ) means a welding process where the pipe ends to be welded are heated against a hot plate and then brought together under pressure to form the weld;

Clearance to Work (CTW) is a document which provides approval to commence work.

Corporation means the Water Corporation and the Principal for the purposes of externally contracted asset delivery;

Contractor means the person bound to carry out and complete the work under contract (WUC)

Designer means the person or entity contracted to design, document and specify workmanship requirements for Corporation infrastructure assets;

Electrofusion jointing (EFJ) is where the pipe ends are inserted into a socket fitting with implanted electrical heating elements and when an electrical current is applied the socket and pipe surfaces fuse together.

Engineering Design Process means the process to be applied by Designers to the design of Corporation infrastructure assets;

Extrusion welding means a welding process where a compatible polymer to the base material is melted and extruded from the welding gun onto the preheated base material to form a weld;

Heated Tool Butt Welding means a welding process where the sheet or other profiled section ends to be welded are heated against a hot plate and then brought together under pressure to form the weld;

Hot air welding means a welding process which uses a stream of heated air to heat and melt both the thermoplastic parent material and the welding consumable to form the weld;

Hot wedge welding is a semi-automatic thermal technique which melts the two opposing geomembrane surfaces to be seamed by running a hot metal wedge or knife between them. Pressure is applied to the top or bottom geomembrane, or both, to form a continuous bond. Seams of this type can be made with dual bonded tracks separated by a non-bonded gap. These seams are referred to as dual hot wedge seams or double-track seams.

Hot work is defined as welding, thermal or oxygen cutting and /or heating including fire or spark producing operations that may increase the risk of fire or explosion.

HSCR High Stress Crack Resistant polyethylene pipe has a high resistance to Slow Crack Growth (SCG).

ITP means the project/contract Inspection and Test Plan(s);

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JAS/ANZ means Joint Accreditation System of Australia & New Zealand;

MAOP means Maximum Allowable Operating Pressure;

Mechanical Coupling means Fittings, such as end connectors intended to join polyethylene pipe systems. AS 4129 and the Corporation's DS 31-01 shall be referred to for further description;

Membrane means a polymer material with a thickness up to and including 3mm which meets the requirements of AWWA D130 and AWWA M25;

MDR means Manufacturer's Material Data Report;

NATA means National Association of Testing Authorities;

PE means Polyethylene;

Pilot Test Weld means the pre-production weld made on site by a qualified welder using a qualified procedure / parameter card for a given pipe / material and thermoplastic welding machine/ equipment;

PIPA means Plastics Industry Pipe Association (Australia);

PP means Polypropylene;

PPE means personal protective equipment;

Preferred Supplier Agreement means the agreement between the Water Corporation and PWSP;

PWSP means Plastics Welding Service Provider that would undertake installation, welding and jointing;

PVC means Polyvinyl Chloride;

PVC-U means unplasticised PVC;

PVC-C means chlorinated PVC;

PVC-M means modified PVC;

RTO means, Registered Training Organisation that is registered by the Australian Skills Quality Authority (ASQA) (or in some cases a state regulator) to deliver vocational education and training (VET) services;

Schedule means Schedule of Quality Assurance Requirements and PWSP's Notifications & Submissions;

Sheet means polymer materials which are greater than 3mm thick;

Socket fusion welding means a welding process where a socket tool is used to preheat the external surface of the pipe and internal surface of the socket. The socket is then pushed onto the pipe to form the weld;

Solvent welding is a process that requires the application of volatile cleaning solvent(s), and the application of a solution of polymer in volatile solvent(s), that partially softens the mating surfaces of the thermoplastics components. On assembly, the welded joint bond strength increases as the solvents evaporate and are absorbed into joint interface materials and as the solvent cement polymerizes;

Specified means specified in the project specification or project drawings;

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SPS means a published Water Corporation Strategic Product Specification;

SPR means a published Water Corporation Products and Equipment Register (Strategic Products Register)

SDR means the standard dimension ratio or the ratio of the pipe diameter to wall thickness;

Technical Specification means this technical specification;

Thermoplastic materials soften when heated and harden when cooled. They can withstand many heating and cooling cycles;

TQ means technical query relating to the work specification;

Welder also referred to as the "**Operator**" means the competent person(s) qualified to join thermoplastics;

Welding Procedure and **Parameter Card** is a document that describes how welding is to be carried out in production and is required for each thermoplastics welding operations. It provides sufficient details on welding parameters to enable any competent person to apply for the delivery of a weld of acceptable quality. The amount of details and the level of controls on a Welding Procedure and Parameter card depend on the application and criticality of the joint to be welded. A welding procedure and Parameter card is developed following successful mechanical testing of a welded joint that meets the requirements of the applicable standards;

WSAA means Water Services Association of Australia;

Work for the purposes of this Technical Specification means the fabrication, welding or repair work to be undertaken by the PWSP to which this Technical Specification applies.

Note:
AS/NZS 4129 and AS/NZS 4130 shall be referred to for a comprehensive list of definitions.

4 Standards and Code

4.1 Australian and International Standards

All installation, welding and joining shall comply with the Standards and Codes of Practice specified for the project work.

The applicable edition of standards/codes shall be those that are current two calendar weeks prior to the date of a work brief or, in the case of tendered work, the tender closing date.

4.2 Corporation Standards

Installation and welding workmanship shall comply with this Technical Specification. Designers shall, by reference to Corporation Design Standards and by copying/adapting Corporation standard drawings, provide the PWSP with project drawings, design details and workmanship specifications that enable the PWSP to produce workshop drawings and fabrication details in sufficient detail to deliver fit for purpose welded thermoplastics assets of the specified quality.

4.3 Industry Standards

The Water Corporation recommends the use WSA 01, Polyethylene Pipe Code and PIPA procedural guidelines as reference material only. Except as may otherwise be specifically authorized, these reference materials shall not supersede any requirement of project specifications.

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5 Materials and Joining Processes

5.1 PVC-U, PVC-M, PVC-O & PVC-C Pressure Pipes

Where specified[1], PVC-U pressure pipes and fittings (PN rated) suitable for solvent weld jointing, shall comply with AS/NZS 1477. Schedule 80 PVC-U pipes and fittings shall comply with ASTM D1785 and ASTM D1784 respectively. PVC-M pipe shall comply with AS/NZS 4765; Oriented PVC pipe (PVC-O) shall not be solvent joined. PVC-C pipes and fittings shall comply with ASTM F441 (pipes), ASTM F439 (fittings).

Only pipes and fittings listed on Water Corporations Strategic Product Register and in compliance with SPS 115 (PVC-U) and SPS 116 (PVC-M) may be used.

PVC-U and PVC-M solvent welded jointing work shall comply with the requirements of AS/ NZS 2032 and this technical specification.

Solvent cements and priming fluid for PVC-U and PVC-M (PN rated) shall be type P complying with AS / NZS 3879 and manufacturer's recommendation. For PVC-C, priming fluids and solvent cements shall comply with ASTM F493 and manufacturer's recommendation. Solvent cements used with **Schedule 80** piping shall be the gap filling type as recommended by the piping manufacturer.

PVC pipes and fittings shall only be used if they are less than 12 months old from date of manufacture. If it can be demonstrated that pipes greater than 12 months old have been suitably stored away from UV and are not damaged or locally deformed, they may be used as determined by the Corporation on a project-by-project basis, subject to the quality of supporting documentary evidence provided.

Note 1 – The use of solvent weld jointed PVC pressure pipe is usually limited to chemical and process pipework, higher temperature (PVC-C) and generally small diameter (< DN 80) pipework applications.

5.2 PVC-U Non Pressure Pipes

PVC-U non pressure pipes and fittings shall comply with AS/NZS 1260 for drain waste and vent applications and AS/NZS 1254 for stormwater and surface water applications. Solvent cements and priming fluids for PVC-U shall comply with AS/NZS 3879 and manufacturer's recommendations.

Only pipes and fittings listed on Water Corporations Strategic Product Register may be used.

Solvent cement for PVC fittings with tapered or interference socket design shall be type N. For sockets with parallel or low interference socket design, type G solvent cement shall be used.

PVC-U solvent welded jointing work shall comply with the requirements of AS/ NZS 2032 and this technical specification.

PVC fittings of the injection moulded type shall be used in preference to the fabricated type.

Only non-pressure PVC-U pipe and fittings up to and including DN 300 in diameter shall be solvent weld jointed.

PVC pipe and fittings shall only be used if less than 12 months old from date of manufacture. The use of PVC pipe older than 12 months may be considered where stored under cover, undamaged and not deformed in any way, as determined by the Corporation on a project-by-project basis, subject to the quality of the supporting documentary evidence provided.

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5.3 Plasticised PVC and PVC Membrane

PVC compounds shall comprise of high molecular weight polyvinyl chloride combined with plasticisers, stabilisers and pigments so as to be permanently flexible. Polyvinyl chloride shall constitute not less than 99% by mass of the resin used. The PVC compound shall not contain copolymer resins or fillers such as calcium carbonate.

Physical Property	Test Method	Acceptable Limits
Tensile strength (both longitudinal and transverse to key)	ASTM D412 (Refer Note 1)	17.25 MPa minimum
Elongation at break (both longitudinal and transverse to key)	ASTM D412 (Refer Note 1)	225% minimum
Hardness	Shore Durometer D at 20°C ASTM D2240	54 minimum 62 maximum
Plasticiser permanence (24 hours at 90°C on 50 mm diameter disc)	ASTM D1203 Method B	1.0% maximum
Water absorption at 24 hours (sample size 75 mm x 25 mm by thickness of sheet)	ASTM D570	0.10% maximum
Water soluble matter at 24 hours	ASTM D570	0.05% maximum
Tear strength (both longitudinal and transverse to key)	ASTM D1004	80 N/mm minimum

Note 1: Specimens for tensile testing shall be prepared and tested using Die B.

Table 1: PHYSICAL PROPERTY REQUIREMENTS OF PLASTICISED PVC

Plasticised PVC for use in drinking water applications shall meet the requirements of AS/NZS 4020 for the proposed surface area to volume ratio.

The chemical resistance of plasticised PVC in wastewater applications shall meet the requirements of WSA 113 - Industry Standard for Reinforced Concrete Pipes with Flexible Thermoplastic Linings.

Joining of plasticised PVC shall be by hot air welding or extrusion welding and in accordance with this technical specification.

PVC liners / membranes used to line reinforced concrete pipes shall comply with the requirements of WSA 113.

5.4 Polyethylene Pressure Pipe

Only pipes and fittings listed on the Strategic Product Register may be used. Polyethylene pressure pipe and fittings shall comply with SPS 125.

Jointing of PE pipe shall be in accordance with Table 2 below.

Pipe Diameter	Allowable Jointing Technique	Preferred Jointing Technique
≤ DN 90	Mechanical coupling, EFJ	Mechanical coupling
> DN 90 ≤ DN 450	BFJ, EFJ[1]	BFJ
> DN 450	BFJ, EFJ[1]	BFJ

[1] Use of EFJ to be referred to *Principal* for approval

Table 2: JOINING TECHNIQUES FOR PE PIPE

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The designer and the PWSP shall only use the BFJ welding process to join PE pipes. The proposed use of EFJ welding shall be raised in a written technical query for each situation, for consideration for approval by the Principal.
The BFJ procedures shall comply with ISO 21307 and this specification. POP 003, as issued by PIPA, should be used for guidance on the butt fusion jointing of PE pipe and fittings.

The pressure rating of PE fittings intended for a PE pipeline shall be equal to or greater than the rated pressure of the specified pipe. The derated pressure ratings of fabricated and molded PE pipe fittings shall be derived by reference to POP 006, as issued by PIPA. The safe pressure ratings of PE pipe fittings are usually lower than those of PE pipe of equivalent material and wall thickness.

PE fittings shall be transported, handled and stored on site in accordance with the relevant requirements of AS/NZS 2033, POP 005 guideline and published requirements of the manufacturer.

Fittings shall be protected by means of under-cover storage or by covering with an appropriate material - such as hessian - that will not entrap heat in the vicinity of the stored fittings. Black plastics or other non-permeable sheeting shall not be a permissible shade material. Larger fittings shall be stored in the proper orientation to prevent them from going out of round. Fittings that have been prematurely removed from their packaging shall not be used.

5.5 Polyethylene Membrane

Polyethylene membranes shall comply with the material requirements of the:

- Geosynthetic Research Institute Standard Specification GM 13: Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes; or
- Standard Specification GM 17: Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

Joining of the membrane shall be by single or dual track hot wedge welding and extrusion fillet welding. Welded seams shall be in accordance with GRI – GM 19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes and this technical specification.

Polyethylene liners / membranes used to line reinforced concrete pipes shall comply with the requirements of WSA 113.

5.6 Polypropylene Pressure Pipe

Welded polypropylene pipe shall be used only in pressure applications unless otherwise specified.

Polypropylene pipe and fittings shall comply with DIN EN ISO 15874 - Plastic piping systems for hot and cold water installations.

Jointing of PP shall be in accordance with Table 3

Pipe Diameter	Allowable Jointing Technique	Preferred Jointing Technique
≤ DN 125	Socket Fusion, EFJ, BFJ	Socket Fusion, BFJ
> DN 125 ≤ DN 250	EFJ, BFJ	BFJ
> DN 250	BFJ	BFJ

Table 3: JOINING TECHNIQUES FOR PP PIPE

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Socket, electrofusion and butt fusion welding of PP pipe and fittings shall be in accordance with DVS 2207 part 11.

As far as practicable the designer and the PWSP shall only use socket fusion and BFJ welding process to join PP pipes. The proposed use of EFJ welding shall be raised in a written technical query for each situation and approved by the Principal's designer.
The pressure class of fittings shall be equal to or greater than the pressure class of the specified pipe.

5.7 Polypropylene Membrane

Polypropylene membranes shall comply with the material requirements of the Geosynthetic Research Institute Standard Specification GM 18, Test Methods, Test Properties and Testing Frequency for Flexible Polypropylene Non-reinforced (fPP) and Reinforced (fPP-R) Geomembranes.

Joining of the membrane shall be by single or dual track hot wedge welding and extrusion fillet welding. Welded seems shall be in accordance with GRI – GM19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes and this technical specification.

5.8 ABS (Acrylonitrile Butadiene Styrene) Pressure and Non Pressure Pipe

Pipes and fittings shall comply with AS/NZS 3518, ABS pipes and fittings for pressure applications and WSA117 - Industry Standard for ABS compounds, pipes and fittings for drainage and sewerage. Solvent cement and priming fluids for ABS pipe and fittings shall comply with AS 3691.

Pipes and fittings shall be third-party certified by an accredited certifier under the StandardsMark, or WaterMark schemes or acceptable equivalent.

ABS pipe and pipe fitting solvent welded jointing work shall comply with the requirements of AS/ NZS 3690 and this technical specification.

Only pipe and fittings up to and including DN 300 in diameter shall be solvent weld jointed.

5.9 Sheet Materials

Sheet materials shall be either PVC-U or PE.

PVC-U sheet material shall consist of only PVC to which additives such as lubricants, pigments and stabilizer shall be added to enable the material to be manufactured into sheet. The total additives shall not exceed 20 parts per hundred by weight of the PVC content.

Polyethylene sheet material compounds shall be manufactured from polyethylene containing antioxidant, UV stabilizers and pigments necessary for their manufacture into sheet materials. Polyethylene sheet shall contain 2.25% ± 0.25% by mass of carbon black to provide UV resistance.

For both PVC and PE sheet materials:

- all additives shall be evenly dispersed; and
- the material shall have the required chemical resistance for the proposed application and operating environment(s).

Joining of sheet materials shall be by either:

1 heated tool butt welding in accordance with DVS 2007-25, Welding of thermoplastics – heated tool butt welding PVC-U; or

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FOI 26-292 - Document 27

2 extrusion welding (PE) in accordance with DVS 2209-1, Welding thermoplastic materials, extrusion welding procedures – characteristics; or
3 hot air welding (PE and PVC) in accordance with DVS 2207-3, Hot air welding of thermoplastic sheets and pipes and DVS 2207-3 (Supplement). Hot air welding of thermoplastic sheets and pipes - Welding parameters; or
4 heated tool butt welding in accordance with DVS 2007-1 for welding of HDPE thermoplastics sheets.
5 automated sheet butt welding machine in accordance with DVS 2208-1: *Machines and devices for the heated tool welding of pipes, piping parts and panels* for welding of HDPE thermoplastics sheets.

6 Approval to Commence Work

The PWSP shall formally request Corporation approval 10 working days prior to the planned commencement of thermoplastics installation and jointing work. Installation and joining work shall not be permissible prior to Corporation approval of the following:

- The Quality Plan as defined in **QUALITY ASSURANCE**;
- A schedule of qualified welding procedures and parameter cards as defined in **WELDING PROCEDURE** and **PARAMETER CARD**.
- Where a qualified welding procedure is not current or available for the project, the welding procedure shall be verified by the preparation of test welds. Test welds shall be produced and tested as required in Section 11 and witnessed by the Corporation;
- Current Equipment Maintenance and Calibration details inclusive of but not limited to: pressure gauges, temperature monitoring instruments and electrofusion machines;
- Individual welding qualifications and welder register;
- PWSP Supervisor qualifications and documented statement of experience;
- Material test certificate register and reports;
- Certificates of Compliance;
- Inspection & Test Plan (ITP) shall be provided to control quality of the works;
- Job Safety Analysis (JSA) or Job Hazard Analysis (JHA), whichever is appropriate; and
- Clearance to Work Permit (CTWP).

Note: Where a PWSP is required to carry out emergency repairs for the purposes of unplanned service interruptions, the requirement for a JSA or JHA shall apply but the requirement for prior formal approval to commence work, whilst being highly desirable, may be relaxed by negotiation on a job by job basis. This notwithstanding, the PWSP shall provide all required documentation within a week of job completion.

7 Quality Assurance

The PWSP shall apply the principles of AS/NZS ISO 3834.3 Quality requirements for fusion welding of metallic materials and this technical specification.

Note: While the above standard applies to welding of metallic materials the principles that underlie the standard are transferable to thermoplastics material welding.

7.1 Contractor / PWSP Organisational Responsibilities

The Contractor / PWSP shall establish a quality management system in accordance with Section 7.2 of this technical specification. The installation, welding and jointing management systems shall be such that they address the manufacturing and installation criteria and the information that is to be provided with the MDR.

The Contractor shall review and approve all QA documentation from the PWSP prior to submission to the Principal.

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FOI 26-292 - Document 27

It is also the responsibility of the Contractor to ensure an approved 'work pack' is available at the weld face for the particular job being undertaken.

Pilot test weld/s shall be witnessed by the Water Corporation or approved and accredited PWSP's supervisor prior to commencement of all works. Test weld/s shall be made on full lengths of pipe (or as deemed specific to the project and approved by the Principal) using Welding Procedures as defined in Section 5. Test weld/s shall be carried out on test pieces from:

- all proposed site welding machines.
- all welders involved in the work and
- different pipe and fitting compounds.

Where stipulated weld samples shall be produced and tested in accordance with Section 11 of this technical specification.

Not less than 10 working days prior to commencement of the works, the PWSP shall nominate a suitably qualified supervisor, who shall be responsible for the co-ordination of fabrication of fittings, welding / joining and field installation of pipe assembles. The supervisor shall have delegated authority to coordinate all work, organise testing where applicable and be fully responsible for the implementation of the quality management system.

7.2 PWSP Quality Management System Requirements

The PWSP shall establish a quality management system for installation, welding and jointing work elements that comply with ISO 9001.

Quality Management accreditation to AS/NZS ISO 9001 shall only be acceptable where the same is issued by an accredited certification body. Certification issued by other bodies shall be referred to the Corporation for acceptance.

7.3 PWSP Capabilities

The PWSP shall demonstrate that:

1. Thermoplastic welder/s are qualified with records, to PMB competencies for the specified work;
2. Documented welding and joining procedures specifications are in accordance with the welding standard specified with hard copies available onsite;
3. There is a documented welding / joining procedure for repairing defective work that complies with specified requirements;
4. Plant and equipment are maintained, calibrated and in good working order to prepare, execute and deliver the contract in a timely and safe manner;
5. A quality control system is in place to manage documentation such as welding / joining specifications, weld procedure approval records and welder approval certificates;
6. A system is in place to control inspection and testing prior to, during and after welding work;
7. A system is in place to maintain calibration of all equipment specific to the installation, welding and jointing of thermoplastics;
8. A written procedure for controlling and rectifying non-conforming product, for acceptance by the Corporation, is provided prior to construction;
9. An Inspection Release Certificate as per Appendix C is completed prior to the dispatch of any fabricated item to site. Copies of Inspection Release Certificates shall be included in the MDR; and
10. A system of monitoring weld traceability. Semi-automated systems where applicable shall use data loggers where jointing data shall be downloaded and submitted to the Principal on a daily basis or at the discretion of the Principal.

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FOI 26-292 - Document 27

7.4 Welded Joint Traceability

The PWSP shall maintain traceability demonstrating the welder identification number performing the welding / jointing work corresponding with construction chainage and weld mapping as stipulated on the project plans. This shall be made available to the Principal on request. Refer also to 10.1.8 item 7.

The location of welded joints tested by destructive testing shall be shown in the traceability documentation.

Equipment for fusion jointing of polyethylene systems shall comply with the requirements of ISO 12176-4.

7.5 Manufacturers Material Data Report

At the completion of a project the PWSP shall submit a Manufacturers Material Data Report (MDR) to the Contractor prior to submission to the Corporation for review and approval. The MDR shall be compiled concurrently during construction and be available onsite to review against pipe and fittings as they arrive for the project. The following list / index should be used as a guide in compiling the MDR.

1. Section A - Inspection and test plans;
2. Section B - Inspection release certificates;
3. Section C – Parameter cards and welding procedure;
4. Section D - As built drawings;
5. Section E - Fabricated item record list;
6. Section F - Dimensional check records;
7. Section G - Register of welder qualification records;
8. Section H - Site welding / joining traceability;
9. Section I - Destructive testing report of welds;
10. Section J - Non-conformance reports and deviations;
11. Section K - Material test certificate register and reports;
12. Section L - Certificates of Compliance;
13. Section M - TQ (Technical Query) and approvals;
14. Section N - Statutory documentation including design certification; and
15. Section P - Photographic records of critical connections.

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FOI 26-292 - Document 27

8 Qualification and Documentation of Welding and Joining Procedures

As required per section 7 Quality Assurance, the PWSP shall work to a welding procedure and parameter card for a given material and process. Welding and joining procedures shall be qualified prior to the commencement of welding on site. Welding and joining procedures shall be seen as a communication and auditing / inspection tool of the work being carried out, all welding and joining procedures related to the work shall be available at the work site.

An example of welding documentation requirements is detailed in Appendix A.

A welding procedure and parameter card shall be provided for each of the following welding techniques:

8.1 Butt Fusion Welding (ISO 21307)

The welding process requires the square ends of two pipes or fittings to be heated via a heater plate, removing the heater plate when the correct bead up size/time is achieved, bringing the ends together in a timely manner and allowing the joint to cool whilst maintaining the fusion faces under a predetermined pressure based on the approved welding parameter force.

The butt fusion parameter card shall have as a minimum the following information, (also refer to Appendix B for typical example):

1. Pipe diameter;
2. SDR (Standard Dimensional Ratio);
3. PN rating;
4. Material type, manufacturer and date of manufacture;
5. Joint surface preparation;
6. Joint surface treatment / cleaning compounds c/w batch numbers;
7. Procedure unique identification;
8. Fusion machine type, cylinder area;
9. Fusion machine serial No;
10. Fusion parameters as per ISO 21307 – Low / High;
11. Ambient temperature range;
12. Heater plate temperature;
13. Drag Pressure;
14. Bead up pressure;
15. Bead size;
16. Heat soak pressure;
17. Heat soak time;
18. Welding pressure;
19. Cooling times;
20. Welder Name;
21. Welder ID #;
22. Project Description;
23. Supervisor's / PWSP endorsement; and
24. Machine calibration date.

8.2 Electro Fusion Welding

8.2.1 Couplings

The welding process requires the square ends of two pipes or fittings to be fitted into an EFJ coupling, simultaneously heating the interface between the pipe outer diameter and the coupling socket inner diameter by

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FOI 26-292 - Document 27

energising the electrical resistance conductors embedded in the coupling. The plasticised material from the pipe and coupling fuse together and a strong bond is achieved by allowing adequate cooling time under adequate restraint.

10 days prior to the works being undertaken the following information shall be supplied as a minimum:

1. Brand name, type, size and pressure rating of EF couplings;
2. Material type, manufacturer and date of manufacture;
3. Ambient Temperature range;
4. Joint surface preparation;
5. Mechanical Peeler type and details;
6. Joint surface treatment / cleaning compounds c/w batch numbers;
7. Cooling time;
8. Type and brand of welding equipment / transformer to be used. All machinery and equipment shall comply with the coupling manufacturers recommendations;
9. Documentation on maintenance, servicing and calibration of equipment; and
10. Re-rounding clamp and aligning clamp methodologies.

8.2.2 Top Load Branch Saddle

Operators shall have demonstrated competency & experience with the sizes & types of branch saddles being installed with documented experience of constructing load branch saddle joints of the same fitting type & size.

Installers are to be equipped with the correct equipment to ensure all joints are prepared in accordance with both the manufacturers & industry guidelines POP001.

This is to ensure factors including surface preparation, cleaning, permissible joint geometry, control of welding environment & welding parameters are correctly managed.

The equipment to be used for the preparation & installation of a branch saddle is required to be compatible to the brand/manufacturer of the branch saddle that is to be installed.

All pipes to be checked for dimensional conformance & ovality prior to saddle installation.

8.3 Extrusion Welding

The welding process requires a polymer welding filler material with the same composition and melt flow index as the base material, the welding filler material is heated and applied to the weld joint via a nozzle or shoe, the joining faces are heated by hot gas generally air and the joining pressure is applied via the welding shoe. Welding is achieved using a fully automated or semi-automated process.

The extrusion welding procedure at a minimum shall stipulate the following:

1. Material type and thickness;
2. Air / air flow rate in litres/min;
3. Air / air temperature with lower and upper limits;
4. Type of welding gun as applicable to the type of thermoplastic;
5. Surface preparation method and cleaning measures;
6. Cleaning compounds of the weld surfaces prior to welding;
7. Travel speed that will dictate the overheating / underheating;
8. Distance between nozzle and joining face;
9. Environmental conditions prior to and during welding; and
10. Type and grade of material welding shoe.

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8.4 Hot Air Welding

The welding process requires a welding filler material with the same composition and melt flow index as the base material. The filler material and the joining faces are heated by hot air, generally air pressure is applied via clamps or pinning the thermoplastic material to concrete or like structures and allowing adequate time for the joint to cool to allow for a fusion bond prior to removal of the clamping pressure. Welding is achieved mostly by a manual process of heating and feeding the filler material.

The hot air welding procedure at a minimum shall stipulate the following:

1. Air / air flow rate in litres/min;
2. Air / air temperature with lower and upper limits;
3. Type of welding gun as applicable to the type of thermoplastic;
4. Type, preparation and cleaning measures;
5. Cleaning compounds of the weld surfaces prior to welding;
6. Material type and thickness;
7. Travel speed that will dictate the overheating / under-heating;
8. Distance between nozzle and joining face;
9. Environmental conditions prior to and during welding; and
10. Type and grade of material of the welding shoe.

8.5 Hot Wedge Welding

The welding process requires the interface between lapping membrane surfaces to be heated simultaneously using an electrically heated wedge. As the heated wedge moves forward and melts the mating faces pressure is applied to the membrane surfaces just behind the heated wedge to create the fusion weld.

The hot wedge welding procedure shall at a minimum stipulate the following:

1. Material type and thickness;
2. Type of welding equipment as applicable to the type of thermoplastic;
3. Surface preparation method and cleaning measures;
4. Cleaning compounds of the weld surfaces prior to welding;
5. Travel speed that will dictate the overheating / underheating;
6. Welding shoe temperature with lower and upper limits;
7. Nip Roller pressure; and
8. Environmental conditions prior to and during welding.

Horizontal tee seams shall be no closer than 1.5m from the toe of the slope.

8.6 Solvent Cement Welding

The welding process requires the surfaces to be joined to be coated with chemically active solvent cement, which softens and plasticises the surfaces to be joined. When joined together the two parts bond almost immediately. As the cement cures the joint strengthens to provide a fully bonded joint.

The solvent cement joining procedure shall at minimum stipulate the following:

1. Material type;
2. Type of primers and solvent cements;
3. Type of joint – parallel or interference fit for pipe or lap joint for membrane;
4. Surface preparation method and cleaning measures;
5. Priming compounds of the weld joints prior to welding;
6. Clamping arrangements; and
7. Curing time.

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Note: For other than water and wastewater applications, the Designer should confirm that the chemical resistance of the cured solvent cement is equivalent to that of the pipe material

8.7 Welding of Membrane

The welding of membranes depends on the material type but the following methods can be used singularly or in combination:

- Hot wedge welding;
- Extrusion welding; and
- Solvent welding.

8.8 Welding of Sheet

The welding of sheet depends on the material type but the following methods can be used singularly or in combination:

- Butt fusion welding;
- Extrusion welding; and
- Hot air welding.

8.9 Environmental Conditions for Fusion Welding

The thermoplastic fusion welding process is sensitive to weather and climatic conditions and, as such, the welding process needs to be carried out in clean, dry and draft free conditions. To manage these aspects the following is required:

1. Where necessary, use a weather shelter or cover to keep moisture and dust away from the surfaces being welded;
2. When temperatures fall near or below 10ºC during welding, special precautions shall be undertaken. For BFJ at a minimum the pipes ends to be joined shall be pre-heated for 10 sec per mm of wall thickness or as per manufacturer's recommendation using radiated heat from the heater plate that is positioned at 50mm from the pipe edges to be joined. The PWSP shall apply the materials manufacturer's recommendations for all other joining processes; and
3. Cover the remote open ends of the pipes being welded to avoid draughts. Air can be drawn through open ends and pass over the surfaces being welded, cooling them prematurely, which can result in a brittle weld.
4. Where the air temperature is hotter or colder than the ground temperature, tensile stresses may form due to contraction or expansion of the pipe as it adjusts to the ground temperature. To minimize these stresses, final closing / tie-in connections shall be undertaken when the pipeline has stabilized to the final service temp of 20ºC unless otherwise specified. Refer also to AS/NZS 2566.2, Section 5 for further details.

8.10 Planning for successful fusion welding

To ensure the integrity of the welds the following procedures shall be adopted:

1. Select a qualified welding contractor referred to as the PWSP in this specification. A qualified PWSP shall have –
    - Demonstrated experience in the type of fusion welding;
    - Suitably sized equipment which has been maintained in good condition with calibration status documentation available for temperature and pressure measurement;
    - Qualified welders who have an up to date log, detailing project and welding experience.

2. Assess the proposed welding procedures –

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- Carry out pilot test welds on the actual pipe/fitting poly compound materials to be used for the contract and have these destructively tested to meet the specified performance requirements (testing and minimum performance requirements are detailed in Section 11 – Inspection and Testing);
- Determine and document the agreed welding parameters, procedures, and welding equipment (this may also include the use of welding tents, pipe end covers etc.);
- The agreed welding parameters, procedures and welding equipment then become the contract requirements and should not be varied without additional evaluation and testing.

3. Determine quality control and assurance requirements including but not limited to –
   - Maintaining a detailed welding log for each joint (Appendix A);
   - Destructive testing of a percentage of joints as per clause 11.2.2;
   - Assessment of weld bead (for butt fusion welding) if called for by the Designer or Principal.

4. Continuously review process and results.

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FOI 26-292 - Document 27

9 Personnel Training and Qualification

All welding and joining shall be carried out by suitably qualified welders who have satisfactorily completed a welding / joining course for the process(es) that are intended to be used in construction.

Personnel engaged in the joining of thermoplastics materials shall be trained and certified through an RTO to PMB Competency Standards.

9.1 Joining of PE – Butt Fusion and Electro fusion welding

Thermoplastic welders shall have the following minimum qualifications and experience:

1. Butt Fusion Welding (PE) - PMBWELD 301;
2. Electrofusion Welding (PE) - PMBWELD 302;
3. Electrofusion branch saddles (PE) – training provided by saddle manufacturers;
4. Training needs to be complemented with a minimum field experience of 6 months continuous welding providing evidence of test welds over this period in either butt fusion or electrofusion welding, including the equipment, skills and processes as required in construction.
5. For pipe sizes larger than DN315 mm, test reports and previous project log sheets shall be submitted for review to provide evidence of the competency obtained in welding of larger pipe diameters with relevant specific experience on all welding machine(s) to be used on the project.

9.2 Solvent Cement Welding and Joining of PVC and ABS Pipelines

Personnel engaged in the solvent cement welding and joining of PVC or ABS pipe shall have:

1. Successfully completed the PVC Pipe Handling and Installation program through the South Metropolitan Tafe, Rockingham campus or other acceptable equivalent program delivered by an accredited RTO; and
2. Minimum of 3 months field experience in solvent cement welding and joining PVC and 3 months field experience in solvent cement welding and joining ABS piping or work under direct supervision of a competent person.

9.3 Extrusion Welding

Personnel engaged in welding and joining of thermoplastics materials shall have the following minimum qualifications and experience:

1. Extrusion Welding (PE) - PMBWELD 309 (Extrusion Welding); and
2. Minimum of 6 months experience in welding of thermoplastic membrane / linings and sheeting providing evidence of test welds and log sheets on previous projects over this period.

9.4 Hot Air Welding

Personnel engaged in hot air welding of PVC or PE sheet shall have the following minimum qualification and experience:

1. Successfully completed an approved course through an accredited RTO or approved product manufacturer;

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2. Successfully completed and certified to PMBPROD287, Weld Plastic Materials; and
3. Minimum of 6 months experience in welding of thermoplastics as applicable.

9.5 Membrane Welding

Personnel engaged in geomembrane welding shall have the following minimum qualification and experience:

1. Be a Certified Welding Technician (CWT) in accordance with the International Association of Geosynthetic Installers (IAGI) program and governed by the specific IAGI Proctor Manual for that membrane.

2. The welder shall have installed a minimum of 10 projects and seamed a minimum of 90,000 sq. metres of material.

9.6 Plastics Welding and Joining Supervisor

The supervisor shall have the same minimum qualifications as the welders and in addition shall have a minimum of 2 years' experience in welding, installation and plastic weld testing standards and methods.

9.7 Re-assessment of welding / joining personnel qualifications

Welding and joining personnel who have not produced any fusion joint in the previous 12 months shall be re-qualified. Evidence of continuity of skills can be made available via QA documentation and records of previous projects where the welder was actively engaged in producing fusion joints in thermoplastic materials.

Re-qualification may be carried out by completing a refresher course through an RTO.

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FOI 26-292 - Document 27

10 Workmanship Standards and Equipment

10.1 Polyethylene Pipe Work

10.1.1 Pipe Jointing Requirements

Weld Jointing of polyethylene pipes shall be undertaken by personnel experienced in working with polyethylene pipe as stipulated in Section 9 of this specification. The PWSP shall provide evidence that personnel are qualified to joint and install the pipe, using welding techniques. Work shall not commence until the PWSP has provided evidence and documentation as required by Section 6. Pilot welds shall be made and tested in accordance with Section 11 of this specification and requirements outlined by the Water Corporations modular construction specification PE - Polyethylene Pipelines, section PE11.3.1 prior to the start of pipe jointing work and with results submitted to the Corporation for approval.

10.1.2 Transportation of Pipe

Pipes and pipe fittings shall be loaded and unloaded in such a manner so as to avoid shock or damage. Non-abrasive webbing type slings shall be used to handle pipe coils or bundles. Pipes and fittings shall not be dropped, dumped or scraped along hard surfaces which may score or notch them. The supplier of the pipes, i.e. manufacturer, contractor or PWSP shall ensure that pipes and pipe fittings to be supplied comply dimensionally with the specified manufacturing standards and are not cut, kinked, or otherwise damaged during loading, transportation and unloading operations.

10.1.3 Storage of Pipe and Fittings

Pipe storage sites and layouts shall be in accordance with manufacturer's recommendations and shall be secure and provide protection against physical damage to the pipes. Pipes shall be stored on level sand mounds, preferably clean sand, free of sharp objects which could damage the pipe. Stacking of polyethylene pipe shall be limited to a height that will not cause excessive permanent deformation of the bottom layer of pipe under anticipated temperature conditions. Permanent deformation shall not exceed the ovality limits in AS/NZS 4130. Where necessary, the pipe shall be stored above ground on suitably constructed pallets, sand mounds or equivalent in an approved manner. In addition to these requirements the PWSP shall also adhere to storage requirements specified in AS 2566.2, or AS 2033.

Pipes exceeding 24 months of age from the date of manufacture shall not be used for construction of pipelines unless approved by the Corporation. Pipes showing irregularities or abnormalities shall not be used under any circumstances.

Sand and other materials shall be prevented from entering the pipes.

The inside of the pipe ends shall be inspected immediately prior to joining to ensure that sand or foreign matter has not entered the pipe. Any foreign matter found in the pipe shall be removed.

NOTE 1: Products shall be stored in original product packaging in accordance with the published requirements of the manufacturer, prior to installation.
NOTE 2: Pipe fittings and jointing materials should be stored separately and under cover. Individual discrete or loose pipe components should be stored in original product packaging, prior to their installation.

10.1.4 Handling of Materials

PE pipes and fittings shall at all times be handled in a manner that does not over stress the pipe.

PE pipes and fittings shall not be damaged by dragging over sharp objects. Ropes, fabric, or rubber protected slings and straps shall be used when handling pipes. Chains, steel cables, or hooks shall not be used.

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Spreader bars or beams can be used for lifting pipes 6 metres in length or longer. Slings (soft or roller) shall be used for handling/lifting the pipeline and shall be positioned away from butt fused joint positions. Pipes and fittings shall be loaded and unloaded by lifting in such a manner as to avoid shock or damage, in accordance with the manufacturer's handling specification. A pipe or fitting that is dropped during loading or unloading operations shall be subject to inspection and rejection where damaged. A damaged or buckled section of pipe shall be removed and replaced with undamaged pipe.

Open ends of installed pipeline sections shall be secured by blanking off at night and during lengthy work stoppages. Waterproof nightcaps of an acceptable design and material - excluding cloth or paper based - shall be fabricated, and fastened to open pipe ends with ducting tape to provide wind resistance and prevent ingress of natural precipitation.

Wherever practicable, pipe shall be raised, physically aligned and supported so as to facilitate emptying of residual fluids by gravity through open pipe ends.

PWSP safety procedures shall provide for the safe unpacking and handling of coiled pipe including its release from packing bands and any tendency to forcefully recoil or uncoil.

10.1.5 Acceptability of Damaged Pipe and or Materials

The Water Corporation shall be notified immediately by the main Contractor for damage to pipe or materials as described below:

- Sections of pipe and pipe fittings other than EFJ fittings with cuts or gouges that reduce the wall thickness by more than 10 percent and kinked pipe or pipe fitting sections shall be cut out, removed and the remaining pipe ends (but not pipe fitting) shall be rejoined. Repair of cuts and gouges in pressure pipes that reduce the wall thickness by more than 10 percent shall not be permissible.

- Pipe scratches or notches that extend into the pipe wall by more than 2% but less than 10% of its thickness and are less than 100 mm in length shall be repaired by extrusion welding where the notch is sharp.

- Shallow well profiled (e.g. rounded) gouges that do not represent a sharp notch effect and where the loss in wall thickness is between 2 -10% may be accepted without repair subject to inspection and evaluation by the Corporation – including referral to the pipe manufacturer as necessary.

10.1.6 Pipe Assembly

If space permits, pipe shall be welded / fused together in one length.

Pipe shall be placed on suitable pipe rollers before pulling into pipe trench to minimize damage to pipe.

The external dimensions of pipe ends and the internal dimensions of EFJ pipe fittings to be joined by fusion processes shall be measured and checked for dimensional fit in good time prior to commencement of pipeline installation work. The method for determining these dimensions shall be in accordance with AS/NZS 1462.1 with a misalignment tolerance of 0.1% of the wall thickness as defined by ISO/TS 10839 clause 8.3.2.2. Where delivered pipe ovality or other dimensional characteristics do not comply with those prescribed by the manufacturing standard for the pipe or pipe fitting, this should be rectified by replacement with dimensionally compliant product or by submission to the Corporation of an acceptable remedial work method proposal. Where, for example, pipe has been ovalised as a result of storage, transportation or other cause, remedial proposals shall provide for the use of re-rounding and alignment clamps during the electro-fusion process in accordance with pipe manufacturer or industry (PIPA) EF jointing and pipe re-rounding guidelines.

Rotating mechanical surface peelers shall be used to prepare the surfaces of the pipe ends to be fused with electrofusion fittings. It is critical that all oxidized pipe surfaces be removed in order for fusion to take place. The peeling process requires the outer oxidized pipe skin be removed to ensure adequate bonding of the pipe in

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accordance with manufacturers recommendations. Peeling procedure shall be as per EF fitting manufacturer's specification.

Hand scrapers shall not be permissible.

Both rerounding and aligning clamps for electrofusion fittings shall both be used during welding and cooling processes. Cooling shall be considered complete only when welded fittings have reached ambient temperature. Adequate witness marks shall be provided during assembly to enable monitoring of EFJ weld movement.

Temporary shelter tarpaulins or equivalent shall be provided on the ends of pipes to be joined by an EFJ weld to allow for temperature equalization of pipe ends and the packed / boxed couplings.

EFJ welded pipe strings welded outside the pipe trench shall not be handled or lifted for installation purposes until the last welded pipe joint cools down to ambient temperature.

When coiled pipe is used, a minimum of 1 metre of straight PE pipe of the same SDR shall be BFJ to the start and end of the coil (and fitting if within the coiled area). This is required to reduce stresses on the pipe ends during EFJ or BFJ.

10.1.7 Pipe Rollers

Pipelines shall be adequately supported by rollers, side booms or "dollies" (refer illustration) and monitored during installation so as to prevent over stressing or buckling during the pullback operation. Such support / rollers shall be spaced (relevant to ambient temperatures) at a maximum of 10 metres centers, and the rollers to be comprised of a non-abrasive material arranged in a manner to provide support to the bottom and bottom quarter points of the pipeline allowing for free movement of the pipeline during pullback. Pipeline surface damaged shall be repaired by the PWSP before pulling operations resume.



10.1.8 Jointing Process

Joints between plain end pipes and pipe fittings shall be made by BFJ. The proposal to use EFJ as an alternative shall be raised in a written technical query, for each situation, for review and consideration for approval by the Principal.

BFJ shall be carried out to comply with the requirements of ISO 11414, ISO 12176-1 and ISO 21307. BFJ shall be carried out predominantly outside the pipe trench. Joining of pipe strings in the trench is permitted however there shall always be one end of the pipe free to move to ensure the required drag is achieved.

Butt fusion welding can be carried out only with pipe or fittings of the same SDR unless a suitable transition piece, approved by the manufacturer, is used or the pipe end is transitioned to the acceptance of the manufacturer.

EFJ shall be carried out to comply with the requirements of POP001.

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FOI 26-292 - Document 27

Extrusion welding for joining of Polyethylene pipe ends for pressure applications shall not be permissible.

Use of a fast fusion cooling process during welding shall not be permissible.

All pipes shall be carefully examined for damage and other defects immediately before being installed. Ends to be butt welded shall be examined with particular care.

The removal of weld beads post welding using BFJ shall be as specified by the designer, this requirement shall be project specific. Where de-beading is required a procedure is to be submitted for approval by the Principal.

Defective pipe shall not be used. Care shall be taken to remove all sand and other material from the inside of the pipes before they are lowered into the trench.

BFJ test welds shall be allowed to cool to ambient temperature prior to test samples being cut out to ISO 13953 standard dimensions.

During welding and joining operations, the PWSP shall ensure:

1. All surfaces are clean and free of contaminants prior to assembly and welding.;
2. Surfaces prepared for assembly and welding shall be wiped with isopropanol having a minimum concentration of 90% and a lint free cloth. Use of methylated spirits, acetone, methyl ethyl ketone (MEK) or other solvents is not permitted.
3. Pipe ends shall be blanked off during the welding process.
4. A shelter shall be used during the welding process when the weld area has the potential to be effected by environmental conditions;
5. Protect against contamination such as dust, sand and rain;
6. The welder shall work to the procedure parameters in relation to the heating cycle, cooling cycles (refer Section 10.1.8.1) and joint restraint requirements for each joint type to be welded;
7. No tapping of saddles should occur or movement of the pipe until the required cooling times has elapsed and hydrotesting of the weld joint has been carried out (refer Section 10.1.8.1);
8. Weld map, traceability of welding joints to welders correlating to the chainage on construction drawing shall be maintained;
9. Welding procedure documentation including manufacturer's instructions, shall be available on site;
10. Welder identification number to be embedded on all weld joints completed in the case of butt fusion welded joints;
11. Welder identification number to be written in white permanent marker on the completed electro fusion welded coupling;
12. The date and time the joints is completed and the cooling time shall be written on the joints to avoid premature handling and potential joint failure;
13. A pilot test weld for each operator, welding machine, pipe diameter, rated SDR as per table 4 (11.1.1) and pipe material compound type with a record of the parameter values for each weld shall be made. Pilot test welds shall be destructively tested to the testing requirements;
14. Provide QA documentation / certification for shop fabricated / vendor purchased fittings; and
15. Marking of fabricated fittings shall correspond with the certification documentation and requirements in accordance with AS/NZS 4129.

10.1.8.1 BFJ Cooling Cycle

Rough handling of the pipe prior to the appropriate cooling cycles being completed is detriment to the integrity of the welded joint. Rough handling can include excessive pulling or bending of the pipe; pressure testing; stresses induced by backfilling and burying; lifting the pipe by not using appropriate placed spreader bars; dragging the pipe out of the machine along the ground; or not using pipe roller supports along its length.

To protect the joint from rough handling and ensuring optimum joint strength for butt fusion welds, the following rules shall be applied under all circumstances:

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FOI 26-292 - Document 27

- for BFJ made in accordance with the *single **low**-pressure fusion jointing* procedure, cooling times shall be in accordance with ISO 21307 where t6 shall be the minimum cooling time IN the machine without pressure. *(The exception to this rule is for pipe end welds, inclusive of fittings, where t6 can be out of the machine).*

- for BFJ made in accordance with the *single **high**-pressure fusion jointing* procedure, cooling times shall be in accordance with ISO 21307 with an additional allowance of 30 minutes minimum cooling time in the machine.

10.2 Solvent Cement Joining of PVC and ABS Pipework

Where solvent welding is required the jointing procedure shall be as follows:

1. Select the appropriate type of solvent cement for the pipe material, for pressure and non-pressure applications and for tapered or parallel sockets, as specified by the pipe and pipe fittings manufacturer. Check the 'use by' date of solvent cement and discard if expired;
2. Cut the spigot end square and remove all burrs and sharp edges outside and inside. Chamfer pipe ends with a 15º bevel or in accordance with the pipe manufacturer's recommendations;
3. Mark the spigot with a witness mark (e.g. pencil line or other method that does not physically damage the pipe) at a distance equivalent to the internal depth of the socket. Scoring or etching of the pipe shall not be permissible;
4. Dry the area between the witness mark and spigot end, then clean and degrease with a clean cloth moistened with the pipe or fitting manufacturer's specified priming fluid. Dry, clean and degrease the interior of the socket in a similar way. Repeat until the surface appears matt to observe;
5. Use clean, suitably sized brushes or applicators, which shall not contaminate the solvent cement, to evenly coat the joints with solvent cement. Apply a coating of solvent cement evenly to the internal surface of the socket for the full engagement length, and then to the external section of the spigot up to the witness mark. Solvent shall be brush applied, brush strokes shall be parallel to the pipe to prevent air entrapment. (Solvent cement should not be applied in a circumferential manner as it increases the likelihood of air entrapment when pipes/fittings are joined). Use the minimum amount of solvent cement necessary to fully solvent weld the joint socket, to minimize excess solvent accumulation and solvent extrusion into the pipeline bore when jointed;
6. Insert the spigot close to, but not beyond, the witness mark. Do not use excessive force. Firmly restrain the joint for the minimum period recommended by the pipe manufacturer;
7. Where accessible, excess solvent cement should be removed from both internal and external joint surfaces; and
8. Allow welded joints to cure for 24 hrs. Maintain the pipeline free of water for at least 1 hr. and do not pressurize for at least 24 hrs after welding the last joint.

NOTES:

a) Burrs and protruding edges on the spigot can cause the solvent cement to be wiped from the surface of the socket and affect dimensional compatibility. This will result in a weaker joint, which might leak.
b) Reference should be made to suppliers of special or rapid-curing solvent cements to determine pipe material compatibility and minimum curing time requirements.
c) For sound jointing of pipes of 100 mm diameter and above, mechanical assistance may be required. Under most conditions, a lever placed against the protected end of the pipe will be sufficient.
d) ASTM D2855 provides an acceptable alternative solvent cement jointing methodology that specifies chamfering of the pipe spigot end.

To minimize the risk of making poor joints, the following precautions shall be observed:

1. Ensure that the end of the pipe is in the socket squarely, and in the same alignment and grade as the preceding pipes or fittings;
2. Solvent cements and priming fluids shall be stored away from direct heat sources and shall be kept in tightly sealed containers when not in use to prevent loss of solvent and lower cement bond strengths.

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FOI 26-292 - Document 27

3. Solvent cements have a limited shelf life and shall be used in strict accordance with the manufacturer's instructions;
4. Dilution or thinning of solvent cement with priming/cleaning fluid shall not be permissible;
5. Ensure that excessive solvent cement does not enter pipes or pipe fittings when applying solvent cement to joint surfaces. Wipe excess solvent cement from the outside and where possible, the inside of joints when made;
6. Prevent any spilt solvent cement from contacting the pipe or fittings. Immediately wipe any spillage off the affected parts;
7. Keep jointing surfaces dry during solvent application work;
8. Keep joints dry and free from ice; allow extra curing time to compensate for the lower temperature. Restrain joints for longer periods at lower temperatures. Refer to the manufacturer for installation requirements when temperatures fall below 0°C; and
9. Adhere to any additional requirements stipulated by the pipe manufacturer in making the joint.

10.3 Joining of Membrane and Liners

The following sections are intended to address the workmanship requirements of membrane and liners other than thermoplastic liners used in reinforced concrete pipes. The requirements for reinforced concrete pipe linings are stated in Section 10.4 of this specification.

10.3.1 Seaming Equipment and Products

Approved methods for field seaming are thermal fusion (hot wedge, hot air, or combination) seaming and extrusion seaming. Proposed alternate methods shall be documented and submitted to the Corporation for approval. Only apparatus that has been specifically approved by make and model shall be used. The PWSP shall use appropriately calibrated measuring equipment to ensure that required temperatures are being achieved.

The PWSP shall submit all documentation to the Corporation.

10.3.1.1 Fusion Seaming

Fusion seaming must be done with automated self-propelled machines. The fusion seaming machines shall be equipped with gauges giving hot wedge temperatures.

Temperature, speed, and nip roll pressure settings shall be verified by the PWSP prior to each seaming period. Nip roll and wedge geometries shall be such as to minimize residual stresses at the edge of the seam, i.e. to minimize reduction in stress cracking resistance of the geomembrane.

The PWSP shall log ambient conditions, geomembrane temperatures, seaming apparatus temperatures and speeds, equipment serial number, and welder initials.

The Corporation or delegate will verify that:

- the PWSP maintains the agreed number of operable seaming machines on-site;
- equipment used for seaming does not damage the geomembrane;
- for tee seam intersections, all edge flaps are cut back to the edge of the outer-most peel-tested track of the seam prior to seaming;
- electric generators and fuel containers are placed on a smooth protective layer with bunding such that no damage occurs to the geomembrane;
- a smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage;
- the geomembrane is protected from damage in heavily-trafficked areas; and
- build-up of moisture between the sheets is prevented. To accomplish this, a movable protective layer may be used directly below each overlap of geomembrane that is to be seamed.

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10.3.1.2 Extrusion Seaming

Extrusion-seaming apparatus shall be equipped with gauges giving the relevant temperatures of the apparatus such as the temperatures of the extrudate, nozzle, and preheat air.

The PWSP shall provide documentation (including QC certificates) regarding the welding rod or resin pellets to the Project Manager and the Corporation or delegate, that show that the resin is the same PE resin as the geomembrane itself. Other seaming resins must be approved by the Corporation or delegate.

The PWSP shall log apparatus temperatures, extrudate temperatures, ambient conditions, and geomembrane temperatures at appropriate intervals.

The Corporation or delegate will verify that:

- the PWSP maintains the agreed number of operable seaming machines on-site;
- equipment used for seaming will not damage the geomembrane;
- the extruder is purged prior to seaming until all heat-degraded extrudate has been removed from the barrel;
- feed resin is maintained clean and dry;
- the electric generator and fuel containers are placed on a smooth intermediate layer with bunding such that no damage occurs to the geomembrane;
- a smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage; and
- the geomembrane is protected from damage in heavily trafficked areas.

10.3.2 Seam Preparation

The Corporation or delegate will verify that:

- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, foreign material, and any mechanical damage;
- if seam overlap grinding is required, the process is completed according to the Manufacturer's instructions but within 30 minutes of the seaming operation, and in a way that does not damage the geomembrane;
- the abrading does not remove more than 10 percent of the thickness of the geomembrane, and the resulting abrasion marks are covered by the finished extrusion bead;
- any visible abrasion marks, after seaming, are essentially perpendicular to the direction of the seam;
- the abrading does not introduce damaging gouges in the geomembrane; and
- seams /panels are aligned with a minimum of wrinkles and "fishmouths".

10.3.3 Weather Conditions for Seaming

The following protocols shall be observed during seaming:

- Unless authorized in writing by the Corporation, no seaming shall be attempted at geomembrane temperatures below -0°C or above 75°C;
- Below a geomembrane temperature of 5°C, the need for pre-heating and additional testing should be discussed with the Corporation or delegate;
- In all cases, the geomembrane in the seaming area shall be dry and protected from wind and airborne particulates; and
- Geomembrane temperatures shall be measured with a surface temperature thermocouple or a calibrated infrared pyrometer.

If the PWSP wishes to use methods which may allow seaming at geomembrane temperatures below 0°C or above 75°C, the PWSP shall demonstrate (by testing trial seams) that such methods produce seams which are entirely equivalent to seams produced at geomembrane temperatures above 0°C and below 75°C, and that the overall quality of the seam and durability of the geomembrane are not adversely affected. In addition, the PWSP shall

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prepare written certification that states that the seaming procedure does not cause any physical or mechanical modification to the geomembrane that will generate any short or long-term damage to the geomembrane liner.

10.3.4 Overlapping and Temporary Bonding

The Corporation or delegate will verify that:

- the panels of geomembrane have an overlap of approximately 100 mm, sufficient to allow peel tests to be performed on the inner track of the seam;
- there is a free flap at the edge of the top geomembrane a minimum of approximately 10 mm wide, to allow a peel test to be performed on the outer track of the seam;
- no solvent or adhesive is used unless the product is approved in writing by the Corporation;
- any procedure used to temporarily bond adjacent panels together does not damage the geomembrane. In particular, the temperature of hot air at the nozzle of any spot seaming apparatus shall be controlled such that the geomembrane is not damaged. "Damage" includes a loss in durability.
- temporary bonds do not interfere with the ability to perform shear and peel tests on the actual production seam.

If protective layers of geomembrane are placed on the barrier layer geomembrane for any purpose (e.g. puncture protection in drainage trenches), they shall not be tack or spot welded to the barrier layer. They shall be fully welded, except a small pressure relief segment, along the complete periphery of the protective layer or they shall not be welded at all.

10.3.5 Trial Seams

Trial seams shall be made by each machine/welder combination on strips of geomembrane to verify that seaming can be successfully performed. Such trial seams shall be made at the beginning of each seaming period (i.e., at the beginning and middle of each working shift), but at least once every four hours, for each seaming apparatus/welder combination used in the seaming period. In addition, a new trial seam shall be conducted when a welding apparatus has been restarted after being switched off. A trial seam shall also be made in the event that the geomembrane temperature changes more than 25°C since the last passing trial seam. Trial seams shall be made under the same conditions as production seams shall be made. When geomembrane temperatures are below 5°C or higher than 75°C more frequent trial seams may be required. In general, trial seams shall be conducted as follows:

The trial seam sample shall be at least 1.5 m long by 0.3 m wide with the seam centred lengthwise. Seam overlap shall be as indicated in Section 10.3.4. The Corporation or delegate will observe all trial seam procedures.

Four specimens, each 25 mm wide and a minimum of 150 mm long, shall be cut from the centre section of the trial seam sample by the PWSP. Two specimens shall be tested in shear and two in peel using a calibrated field tensiometer. They should meet project specifications. If any specimen fails, the entire operation shall be repeated. If the second trial seam fails, the seaming apparatus and seamer shall not be approved for production seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The remainder of the successful trial seam sample shall be assigned a number and marked accordingly by the PWSP Supervisor, who shall also log the date, time, geomembrane temperature, number of seaming unit, settings, name of seamer, and pass or fail description.

A trial seam shall also be prepared by each seaming machine/welder at the completion of seaming each day to determine whether changes in seam quality might have occurred during the last part of the seaming period.

10.3.6 General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the PWSP shall be as follows:

- For fusion seaming, a movable protective layer of thermoplastic may be placed directly below each overlap of geomembrane that is to be seamed. This is to help prevent any moisture build-up between the sheets to be seamed;

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- If required, a firm substrate may be provided by using a flat board, or other similar hard surface placed directly under the seam overlap;
- Fishmouths or wrinkles at the seam overlaps shall be cut along the peak of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane material extending a minimum of 150 mm beyond the cut in all directions. The end of the cut should be rounded;
- If seaming operations are carried out at night, adequate illumination shall be provided;
- Seaming shall extend to the outside edge of panels placed in the anchor trench.

Each seam shall be labelled with the seaming machine number, the welder's initials, machine temperature and speed settings, date, time, and direction seamed. The Corporation or delegate will monitor the above seaming procedures, and will inform the Project Manager of any unsatisfactory deviations from standard practice.

10.3.7 Defects and Repairs

10.3.7.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the PWSP and the Corporation for identification of defects, protruding and penetrating objects, lack of subgrade support, overheating, overgrinding, holes, blisters, undispersed raw materials, scratches and gouges, and any sign of contamination by foreign matter. To facilitate the examination the geomembrane surface shall be kept clean by the PWSP or as agreed at a pre-installation Meeting.

10.3.7.2 Evaluation

Each suspected defect in-seam and non-seam areas shall be non-destructively tested using an appropriate method, such as vacuum box testing. Additional test methods, such as electrical methods and infrared thermography, may also be used. The position of each sample that fails to pass non-destructive testing shall be marked by the PWSP's Supervisor and shall be repaired. Repair work shall not be acceptable until destructive and nondestructive test results have confirmed compliance with specified requirements.

10.3.7.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be by agreement between the PWSP and the Corporation.

The procedures available include:

- Patching, used to repair all penetrating holes, tears, undispersed raw materials, and contamination by foreign matter;
- Spot beading, used to repair small surface scratches, or other minor, localized non-penetrating flaws; and
- Capping with a strip of geomembrane, used to repair long lengths of failed seams.
- Surfaces of the geomembrane which are to be repaired shall be abraded no more than 30 minutes prior to the repair;
- All surfaces must be clean, free of all particulate matter, and dry at the time of the repair;
- All seaming equipment used in repairing procedures must be approved;
- The repair procedures, materials, and techniques shall be subject to advance approval of the specific repair by the Corporation or delegate;
- Patches and caps shall extend at least 150 mm beyond the edge of the defect, and all corners of patches shall be rounded with a radius exceeding 75 mm;
- The geomembrane below large caps should be appropriately cut to avoid fluid entrapment between the two sheets and resultant pressure increases (that stress the seams) as the liner is covered;
- Sharp ends of slits and cuts in the geomembrane should be rounded before patches are placed over them; and

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- No more than one extrusion bead at any location shall be used to make a repair - multiple beading (more than two beads at any one location) is not permitted and must be replaced with a patch.

10.3.7.4 Verification of Repairs

Each repair shall be numbered and logged. Each repair shall be non-destructive tested using one of the methods described in Section 11.7 or another approved method. Repairs which pass the non-destructive test shall be considered acceptable. Failed tests shall require the repair to be redone and retested until a passing test results.

10.3.7.5 Large Wrinkles

When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the Corporation or delegate will observe the sizes and distribution of geomembrane wrinkles. The PWSP shall seek agreement with the Corporation or delegate which wrinkles should be cut and re-seamed. The seam thus produced shall be tested like any other seam.

10.4 Plastic Lining – Reinforced Concrete Pipes

The joining and or repair of PVC or PE liners where used in reinforced concrete pipes shall comply with WSA 113.

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FOI 26-292 - Document 27

11 Inspection and Testing

11.1 Inspection and Test Plans

Inspection and testing forms an integral part of the welding system. It ensures all parts of the pipeline including the material manufacture, design, and installation have been carried out in accordance with this code of practice. The PWSP shall ensure that the appropriate inspections and testing are carried out during the works.

Inspection and Test Plans shall be designed, approved and implemented for the required parts of the works including materials handling, installation and commissioning. Inspection and Test Plans (ITP) shall as a minimum include:

1. Description and item number of the activity;
2. Description of each test, examination (visual and holiday spark method) or inspection to be performed;
3. Responsible persons;
4. Reference documents, controlling specifications and procedures;
5. Acceptance criteria;
6. Verifying documents or check sheets; and
7. Provision for Hold, Witness, Verify and Review points.

ITPs shall be applied to specified sections of the works so as to allow sign off in discreet stages, not just at final completion. ITPs shall be approved and cover all stages of the works.

NOTE: The ITP itself may also be used as a check sheet.

11.1.1 Weld testing - Butt and Electrofusion joints

Joining pipes and fittings by electrofusion or butt welding shall be to an approved joining procedure that has been qualified by destructive testing in accordance with ISO 13954 "Plastics pipes and fittings - Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm" and ISO 13953 "(Polyethylene (PE) pipes and fittings - Determination of the tensile strength and failure mode of test pieces from a butt-fused joint)" respectively.

Qualified Procedures may be grouped by diameter to reduce the amount of qualification testing. The recommended groupings are shown in table 4 below. The exception to this rule shall be for EFJ coupling welds where **all** pipes sizes shall be individually tested inclusive of electrofusion saddle welds.

Procedure Qualification Test Pipe Diameter and for each SDR	Type of Joining Process	Qualifies for Sizes
Any ≤ DN 225	Butt Weld	Any ≥ DN90 to DN225
Any > DN 225 to DN 355	Butt Weld	Any > DN 225 to DN 355
Any > DN 355 to DN 450	Butt Weld	Any > DN 355 to DN 450
Any > DN450	Butt Weld	**All** pipe sizes shall be individually tested.
Any ≥ DN90	Electrofusion Couplings and Electrofusion Saddle Welds	**All** pipe sizes shall be individually tested.

Table 4: Weld testing qualification requirements

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FOI 26-292 - Document 27

11.2 Pipe Butt Fusion Welding - BFJ

11.2.1 Visual Examinations

Pipe joints made by butt fusion welding shall be visually inspected by the PWSP's supervisor prior to requesting the Corporation's representative to audit and provide acceptance of the same. *POP014 – Assessment of Polyethylene Welds* shall be used as the industry guideline for visual inspection.

Weld beads shall be uniform and symmetrical without sharp notches and shall also comply with the requirements of POP014. Pipe joints deemed by the Corporation not to meet these criteria shall be removed and re-welded.

11.2.2 Mechanical / Destructive Tests - BFJ

The PWSP shall provide samples of BFJ for destructive weld evaluation testing as follows. This shall apply for each welder and for each welding machine used on the job and repeated for any subsequent changes:

1. Pilot test/s weld joint in accordance with table 4. (Results for any test welds need to be reviewed prior to undertaking any production welds. To do so shall be at the Contractors/PWSP own risk);
2. One (1) production joint test weld in every 50 pipe joints maximum. If the project has less than 50 pipe joints then a single production joint test weld is required; and
3. Where testing reveals defects as determined by the test requirements, then welds either side of the weld that failed shall be cut out and tested. Testing shall continue till the PWSP can demonstrate the welds meet the testing requirements.

The test sample shall be prepared in accordance to ISO 13953. The test sample shall be joined with a *butt fusion* weld using the particular welding machinery, welders and welding process nominated by the PWSP for the particular PE pipeline project. Test samples shall be identified by pipe OD, SDR, PE material composition grade, date, chainage /location, welder number, machine and welding conditions at the time of welding.

BFJ weld samples shall be submitted by the PWSP for destructive testing to an approved NATA registered testing laboratory. The testing criteria shall be tensile fracture testing to ISO 13953. Bend testing to BS EN 12814 Part 1 is required where the specific installation includes deflection of the pipe or as deemed necessary by the Principal.

The PWSP shall pay for all testing and associated costs and shall provide the Corporation with the test results within 10 days of the test being undertaken or it shall be deemed as non-compliant.

The acceptance criteria for tested weld samples shall be in accordance with ISO 13953. The PWSP shall reinstate all butt fusion welds from the area of the pipeline represented by the test sample and identified from testing as not meeting the acceptance criteria.

All re-welds shall be inspected by the PWSP and shall be to the acceptance of the Corporation.

11.3 Electrofusion Pipe Joints – EFJ

11.3.1 Visual Examinations

Pipe joints made by electrofusion welding shall be visually inspected by the PWSP's supervisor prior to requesting the Corporation's representative to audit the same. *POP014 – Assessment of Polyethylene Welds* shall be used as the industry guideline for visual inspection.

Couplings and saddles that indicate alignment or deflection errors, short circuiting, exposed wires, failure of coupling melt indicators and or melt outside the weld zone shall be cut out and re-welded. Pipe joints deemed by the Corporation not to comply with the requirements of POP014 shall be re-welded.

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11.3.2 Mechanical / Destructive Tests – EFJ Couplings

The PWSP shall provide samples of EFJ Couplings for destructive weld evaluation testing as follows. This shall apply for each welder and welding machinery used on the job and repeated for any subsequent changes:

1. Pilot test/s weld joint shall be carried out in accordance with table 4. (Results for any test welds shall be reviewed prior to undertaking any production welds.);
2. One (1) production joint test weld in every five (5) EF joints; and
3. Where testing reveals defects as determined by the test requirements, then welds either side of the weld that failed shall be cut out and tested. Testing shall continue till the PWSP can demonstrate the welds meet the testing requirements.

The samples shall consist of two pipe lengths joined with an electrofusion weld made on site using welding machinery and welders engaged in the pipeline and the welding process. Test samples shall be cut such that there is a minimum of 300mm of pipe protruding either side of the coupling joint. Test samples shall be identified by pipe OD/SDR, PE grade, date, chainage / location, welder number, machine and welding conditions at the time of welding.

Electrofusion pipe weld samples shall be submitted by the PWSP for testing to an approved NATA registered testing laboratory. Electrofusion coupling welds shall be tested for Peel de-cohesion in accordance with requirements of ISO 13954.

Electrofusion saddle joints shall be tested in accordance with ISO 13954 or ISO 13955.

The PWSP shall pay for all testing and associated costs and shall provide the Corporation with test results within 10 days of the test being undertaken or it shall be deemed as non-compliant.

The acceptance criteria for tested weld samples for EFJ shall be 100% ductile at the plane of the fusion zone or 100% ductile at the pipe or coupling as outlined in ISO 13954.

11.3.3 Mechanical / Destructive Tests - EFJ Saddles

The PWSP shall provide samples of EFJ Saddles for destructive weld evaluation testing as follows. This shall apply for each welder, welding machinery and different manufacturer's EF couplings used on the job and repeated for any subsequent changes:

1. Pilot test/s weld joint shall be carried out in accordance with table 4. (Results for any test welds shall be reviewed prior to undertaking any production welds.);
2. One (1) production joint test weld in every ten (10) EFJ Saddles; and
3. Where testing reveals defects as determined by the test requirements, then welds either side of the weld that failed shall be cut out and tested. Testing shall continue till the PWSP can demonstrate the welds meet the testing requirements.

11.3.4 Field Pressure Test – EFJ Saddles

The PWSP shall undertake a field pressure test on each welded saddle between the saddle and pipe OD in accordance with manufacturer's requirements. The test shall be witnessed by a WC representative prior to removal of the coupon. Formal notification shall be provided to WC a minimum of 3 days prior to test being undertaken.

Where testing reveals defects, investigate and rectify cause of failure prior to resumption of welding. The defective saddle shall be left in place unless otherwise directed.

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11.4 Hydrostatic testing of welded pipelines

11.4.1 Pipeline testing requirements

Pipeline installation, construction and testing requirements are specified in project documents including technical workmanship specifications. In the absence of pressure testing requirements, testing shall be undertaken in accordance with Water Corporation's PT modular specification.

The Contractor / PWSP shall pay for all testing and associated costs and shall provide the Corporation with the test results within 10 days of the test being undertaken or it shall be deemed as non-compliant.

11.5 Hot Air Welding and Extrusion Welding

11.5.1 Visual Examination

Pipe joints made by hot air welding shall be visually inspected by the PWSP's supervisor prior to requesting the Corporation's representative to audit the same. All welded joints shall meet the requirements of DVS 2202-1, evaluation group 2. Joints in sheet and membranes deemed by the Corporation not to meet these criteria shall be re-welded. The cost of remedial works shall be the responsibility of the PWSP.

11.5.2 Mechanical Destructive Testing

Destructive tests are only required of test samples to qualify a procedure or provide assurance on the application of a process.

Following the completion of the weld and allowing enough time to cool, the area at the toes of the newly made weld need to be tested.

11.5.3 High Voltage Spark Testing

Following visual examination and repairs of production welds where necessary, all welded joints shall be tested with high voltage spark testing. Testing to be carried out in accordance with AS 3894 or as specified by the thermoplastic supplier. The test voltage parameters need to be agreed by the PWSP and the Corporation during submission of quality plans and the ITP. Prior to testing each spark tester shall be calibrated using a calibrated and certified Crest Meter. The Crest meter shall be calibrated at a frequency of no greater than two years.

A permanent record shall be prepared and made available to the Principal for review and approval for the spark testing of works completed noting compliance.

11.6 Solvent Welding

Pipelines shall be pressure tested as per the requirements of the project specifications.

11.7 Membrane and Liner Welding

The following sections are intended to address the testing requirements of membrane and liners other than thermoplastic liners used in reinforced concrete pipes. The requirements for reinforced concrete pipe linings are stated in Section 11.7.3 of this specification.

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11.7.1 Nondestructive Seam Continuity Testing

11.7.1.1 Concept

The PWSP shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), spark test, or other approved method. Vacuum testing, air pressure testing and spark testing are described in Sections 11.7.1.3, 11.7.1.4 and 11.7.1.5 respectively. The purpose of non-destructive testing is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. Non-destructive testing shall not be permitted unless there is adequate illumination.

The PWSP Supervisor shall:

- Observe all non-destructive testing;
- Record location, date, test unit number, welder, and outcome of all testing;
- Log and inform the Corporation or delegate of any required repairs.

The PWSP shall complete any required repairs in accordance with Section 10.3.7.3.

The PWSP Supervisor shall:

- Observe the repair and re-testing of the repair;
- Mark on the geomembrane that the repair has been successfully made and tested; and
- Document the results.

The following procedures shall apply to segments of seams that cannot be non-destructively tested:

- All such seam segments shall be cap-stripped with the same type of geomembrane material, or
- All such seam segments shall be very carefully prepared and welded by the master seamer under the observation of the consultant.
- If the seam is accessible to testing equipment prior to final installation (e.g. after prefabrication), the seam shall be non-destructively tested prior to final installation.

The seaming and cap-stripping operations must be observed for proper procedures by the PWSP Supervisor.

The PWSP shall write the details of each seam non-destructive test on the geomembrane. For air pressure tests this shall include the initials of the tester, the date, start time and pressure, end time and pressure, and pass or fail result. For vacuum testing this shall include the initials of the tester, the date, and pass or fail result. For spark testing this shall include the initials of the tester, the date, voltage setting, and pass or fail result. When a test fails, the number of the appropriate repair shall also be recorded on the geomembrane.

11.7.1.2 Submittals

Prior to any non-destructive testing, the PWSP shall submit to the Corporation calibration certificates for all pressure gauges to be used during vacuum and air pressure testing, or shall otherwise demonstrate that all gauges are in satisfactory working condition.

11.7.1.3 Vacuum Box Testing

The equipment shall be comprised of the following:

- A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole, valve assembly, and a vacuum gauge;
- A vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
- A pressure/vacuum hose with fittings and connections;
- A soapy solution that does not cause environmental stress cracking in the geomembrane, and
- A soap solution applicator.

The following procedure shall be followed:

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- For fusion seams (not normally tested with a vacuum box), cut off the free flap with an approved cutter (so that the lower geomembrane is not damaged) prior to testing the seam;
- Energize the vacuum pump and reduce the tank pressure to approximately 5 kPa gauge;
- With a soapy solution, wet a strip of geomembrane which is wider and longer than the vacuum box;
- Place the box over the wetted area;
- Close the pressure relief valve and open the vacuum valve;
- Ensure that a leak-tight seal is created;
- Examine the geomembrane seam through the viewing window for the presence of soap bubbles (large bubbles, or fine froth) for a period of not less than 5 seconds;
- If no bubbles or foam appear after 5 seconds, close the vacuum valve and open the pressure relief valve. Move the box over to the adjoining section of seam, with some overlap, and repeat the process;
- All areas where soap bubbles appear shall be marked and repaired in accordance with Section 10.3.7; and
- Excess soap solution shall be cleaned or rinsed off the geomembrane and seam.

11.7.1.4 Air Pressure Testing

The following procedure is applicable to those seaming processes which produce a double track seam with a central channel.

The equipment shall be comprised of the following:

- An air pump equipped with a pressure gauge capable of generating and sustaining a pressure between 160 and 280 kPa mounted on a cushion to protect the geomembrane;
- A pressure hose with fittings and connections;
- A sharp hollow needle, or other approved pressure-feed device attached to a pressure gauge; and
- Clamps or other devices to seal the ends of the seam to be tested.

The following procedures shall be followed:

- Seal both ends of the seam to be tested;
- Insert the pressure-feed device into the channel of the seam;
- Energize the air pump to a pressure between 165 and 275 kPa (depending on geomembrane thickness) as indicated in Table 5, close the valve, and allow the temperature of the air in the channel, and thus the pressure, to stabilize for about 2 minutes;

Geomembrane Thickness		Minimum Pressure		Maximum Pressure	
(mm)	(in.)	(kPa)	(psi)	(kPa)	(psi)
1.0	0.040	165	24	240	35
1.5	0.060	185	27	275	40
2.0	0.080	205	30	275	40

Table 5: AIR CHANNEL TEST PRESSURES FOR HDPE GEOMEMBRANES

- Verify that the stabilized pressure is within the required range and note the pressure loss after a further 2 minutes. If loss of pressure exceeds the amount indicated in Table 6, or if the pressure does not stabilize, locate the faulty area and repair it in accordance with Section 10.3.7

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Geomembrane Thickness		Maximum Pressure Drop	
(mm)	(in.)	(kPa)	(psi)
1	0.040	28	4.0
1/5	0.060	21	3.0
2.0	0.080	14	2.0

Table 6: ALLOWABLE PRESSURE LOSS IN AIR CHANNEL TEST

- Verify that the full length of the seam section has been tested by observing the air pressure gauge for a decrease in pressure when the seal at the end of the channel away from the air pump is removed. If there is a blockage in the channel, the entire seam must be capped, with cap seams being non-destructively tested, or the location of the blockage must be found and the untested part of the seam must be properly tested and
- Remove the needle or other approved pressure-feed device and seal the hole using extrusion welding or an approved process.

NOTE: A decrease in the geomembrane temperature (e.g. due to clouds /over cast day) shall also cause a reduction in air channel pressure.

11.7.1.5 Spark Testing

Spark Testing performed according to ASTM D6365 or AS 3894 is frequently used in awkward positions and extrusion welds that cannot be tested by vacuum box testing. Occasionally it is used on long extrusion seams as the primary non-destructive test method. The same general test method can also be applied to the geomembrane panels themselves when they are manufactured with an electrically conductive bottom surface layer.

For seams, a copper wire or tape is placed within the geomembrane overlap, just to the inside of the centre of the extruded bead. The wire is exposed at one end of the seam or it is buried in the conductive subgrade.

Prior to testing, a trial calibration seam must be made to confirm the minimum voltage required to discharge across a hole in the seam between the search electrode and the copper wire.

The test procedure is as follows:

- Connect the negative (ground) electrode of the testing equipment to the end of the copper wire, or to a grounding rod if the copper wire is buried in the subgrade;
- Connect the positive electrode to the wire brush or other type of search electrode;
- Clean all debris and moisture from the seam area;
- Apply a potential difference, as determined in the calibration test, between the electrodes. ASTM D6365 and AS 3894 recommends the following equation to determine the required potential difference:
  - $V = 250\sqrt{T}$ where T is the thickness in microns
- Sweep the wire brush electrode over the surface of the seam, maintaining contact with the extruded bead and the top of the lower geomembrane at the edge of the bead;
- Monitor for audible and/or visible spark discharges that are indicative of a defect. Mark defects for repair. Spark testing must not be performed when the liner is wet.

11.7.1.6 Visual Examination

Air pressure, vacuum box, and spark testing methods apply only to seams. PWSP personnel shall continuously visually examine the geomembrane panels for the presence of other penetrating and non-penetrating defects and shall continuously feel for protuberances when walking on the geomembrane.

Visual examination should take advantage of low angles of sunlight and early morning condensation on the geomembrane.

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11.7.2 Destructive Testing

Destructive seam tests shall be performed at selected locations and shall be guided by ASTM D6392. The purpose of these tests is to evaluate seam bond strength and the effects of seaming on the adjacent geomembrane. Seam strength testing shall be done as the seaming work progresses, not at the completion of seaming.

11.7.2.1 Location and Frequency

The Corporation or delegate will select locations where seam samples shall be cut out for laboratory testing. Those locations shall be established as follows:

- A minimum frequency of one sample for every 150 m of seam made by each extrusion machine/welder combination and each fusion machine each day - unless a different frequency is stated in the project specifications.
- Conditions under which testing frequency may be increased or decreased as the project progresses shall be agreed upon by the PWSP and the Corporation.
- Test locations shall be determined during seaming at the Corporation's discretion. Selection of such locations may be prompted by suspicion of overheating, contamination, offset seams, or any other evidence of imperfect seaming;
- If trial seams are not made at the end of the day one sample for destructive testing shall be removed from the last seam made by each seaming machine at the end of each working day.

The PWSP will not be informed in advance of the locations where the seam samples will be taken.

Test frequencies may be increased or decreased at the Corporation's discretion depending on the consistency of the test results.

11.7.2.2 Sampling Procedure

Samples shall be cut by the PWSP as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material.

The PWSP's Supervisor shall:

- Observe sample cutting;
- Assign a number to each sample, and mark it accordingly; and
- Record the sample location on the layout drawing.

All holes in the geomembrane resulting from destructive sample removal shall be immediately repaired in accordance with repair procedures described in Section 10.3.7. The continuity of the new seams in the repaired area shall be tested according to Section 11.7.1.

11.7.2.3 Size of Samples

At a given sampling location, two types of samples shall be taken by the PWSP, (refer sketch below). First, two pairs of specimens for field peel and shear testing shall be taken. Each of these specimens shall be 25 mm wide by at least 150 mm long, with the seam centred across the width.

The distance between these two pairs of specimens shall be 0.8 m. If both pairs of specimens pass the field tests described in Section 11.7.2.4, a sample for laboratory testing shall be taken. The sample for laboratory testing shall be located between the two pairs of specimens taken for field testing. Unless determined otherwise at the Preconstruction Meeting, or in the Project Specifications, the destructive sample shall be 0.3 m wide by 0.8 m long with the seam centred lengthwise.

The sample shall be cut into two parts and distributed as follows:

- one portion, measuring 0.3 m x 0.5 m, to the PWSP for QC laboratory testing;
- one portion, measuring 0.3 m x 0.3 m, to the Corporation to be retained for further testing if required.

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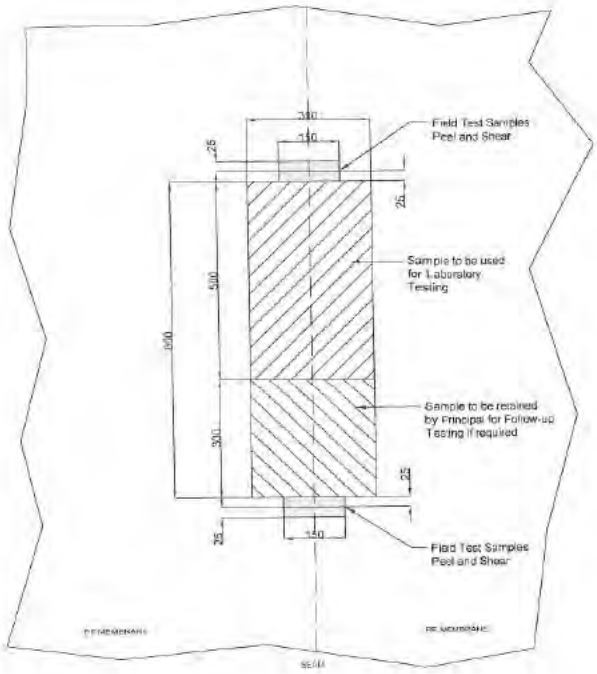


Figure 1: Membrane Sample Dimensions

11.7.2.4 Field Testing

The four 25 mm wide specimens mentioned in Section 11.7.2.3 shall be tested in the field, by calibrated gauge tensiometer, one of each pair in peel and one in shear. If any field test specimen fails to pass the criteria of Table 7 and the project specifications, then the procedures outlined in Section 11.7.2.5 shall be followed.

The Corporation shall witness - field tests and mark all samples and portions with their unique sample number.

If the two pairs of specimens meet the project specifications, the sample qualifies for testing in the nominated laboratory; if they fail, the seam should be repaired in accordance with section 10.3.7.

Parameters	Criteria
Peel Strength	Fusion seam > 70% Extrusion seam > 65% Minimum specified* geomembrane yield strength
Seam Separation	Zero
Shear Strength	> 95% minimum specified* geomembrane yield strength
Elongation	> 100% of distance between edge of seam and nearer grip
Location of Failure	Outside the weld

Table 7: SEAM SPECIMEN TEST (ASTM D4437) SPECIFICATIONS

* The yield strength specified by the Manufacturer, which is usually the population average value, less 2 standard deviations.

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11.7.2.5 Procedures if Destructive Sample Fails

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the testing laboratory, or on the field tensiometer.

The PWSP has two options:

1. Reconstruct the seam between the nearest passing destructive test locations on each side of the failed sample; or
2. Trace the seaming path to an intermediate location (3 m minimum from the failed test location in each direction) and take a small sample for an additional field test at each location. If these additional samples pass tensiometer testing, then full destructive test samples should be taken. If these laboratory destructive test samples pass the tests, then the seam should be reconstructed between these locations by capping. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

If a fusion-type seam fails destructive testing and the Installer chooses to repair the seam, the only acceptable repair method is as described in Section 10.3.7.

Applying topping (bead of extrudate) is not an approved method of capping any seam unless it can be shown that this procedure will not reduce the stress rupture resistance of the seam below 75% of that of the parent geomembrane.

Only seams bounded by two locations from which samples passing laboratory destructive tests have been taken shall be considered acceptable. An additional destructive test sample shall be taken from repair seams when the length of a reconstructed seam exceeds 50 m. This sample must pass destructive testing or the procedure outlined in this section must be repeated. The PWSP shall document all actions taken in conjunction with destructive test failures.

11.7.3 Plastic Lining – Reinforced Concrete Pipe

Testing of weld joints and repair of PVC or PE liners in reinforced concrete pipes shall comply with WSA 113.

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12 Consumables, Maintenance, Servicing and Calibration

Surfaces prepared for assembly and welding, including welding equipment shall be wiped with an isopropanol solution having a minimum concentration of 90% and a lint free cloth. Use of methylated spirits, acetone, methyl ethyl ketone (MEK) or other solvents is not permitted.

All equipment shall be well maintained and kept in a clean condition both in stores and all times at site. Equipment shall be serviced and calibrated regularly. The frequency at which this is carried out shall be different for individual items of equipment and will depend on usage but shall be at least once every twelve (12) months.

Equipment that has been repaired resulting from damage or modification shall be serviced and calibrated on completion of repair or modifications regardless of the last calibration date. Servicing shall be carried out but not limited to the heater plate, the hydraulic or pneumatic unit, the frame / clamp unit, trimming tools, electro-fusion welding generator, pressure gauges and data loggers. Welding machines and associated equipment shall always be in good working order. Frequent breakdowns are unacceptable with the particular machinery being quarantined and removed from site.

Pressure gauge calibration shall be certified by a NATA laboratory or NATA traced master gauge. Electronic or written records of appropriate servicing and calibration reports shall be kept and made available on request.

Infrared non-contact thermometers shall be calibrated by comparison to a Certified (NATA Endorsed Test Report) test thermometer sensor, using a black body source. Checking interval against a reference device at the temperature of use shall be every 6 months. Electronic or written records of appropriate servicing and calibration shall be kept and made available on request.

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13 Welding Safety

13.1 General

The Contractor / PWSP shall ensure that all employees have completed the relevant induction process for working on Water Corporation sites. A Job Safety Analysis (JSA) shall be in place for every task.

The Water Corporation strongly supports the use of *WTIA Tech Note 7- Health and Safety in Welding*.

13.2 Portable and Handheld Tools

All portable or handheld electrical tools that are intended to be moved when in operation shall be protected by an RCD (Residual Current Device).

The RCD shall be:

- In-built to a generator set; or
- Built into the construction site switchboard; or
- Built into the switchboard or the power outlet of an established premises; or
- A portable RCD that is plugged directly into the power socket outlet.
- Inspected and tagged quarterly by a competent person.
- Protective guards shall not be removed during use of the hand tool.

All electrical tools shall have the quarterly electrical test tags.

13.3 Hot Work

Plastic welding of the type described in this Specification is deemed 'Hot Work', and shall be carried out in accordance with

- the Water Corporation's procedure HSEAA-P-134 "Hot Work' (and applying the associated Hot Work Permit where there is a credible fire risk); and
- AS1674.1- Part 1 Fire Precautions; and
- the West Australian Bush Fire Act 1954 and FESA Act 1998

Hot work MUST not proceed when a Total Fire Ban (TFB) is in place. If the work is considered essential and must be undertaken on a TFB day, the Supervisor must notify the Operations Manager who must enact a Total Fire Ban exemption in order to conduct hot work. Refer to Section 7.6 of the HSEAA-P-134 "Hot Work' procedure for further guidance.

13.4 Working in a Confined Space

Where work is intended to be carried out in a confined space, all personnel carrying out the activity shall be suitably trained and qualified to work in a confined space and shall comply with the Water Corporation Safe Working in Confined Space Procedure – HSEAA-P-124 'Confined Space' procedure.

13.5 Safe Working with Coatings and Wrapping

When replacing existing steel pipes with PE pipes and there is a requirement to cut out the old section of pipe, personnel need to be aware that some older pipe coatings as described below may present a health risk.

Some bitumen based pipe wrapping materials have been found to contain asbestos fibres. These fibres are physically stable but may present a risk to health if disturbed during the process of removal of the coating or handling.

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The external coatings of all buried steel pipe coated in coal tar enamel or other bitumen based material manufactured prior to 1985 shall be treated as containing asbestos and procedures for safe removal, handling and disposal shall accordingly apply.

This and other work that involves asbestos containing materials shall be carried out in accordance with the Water Corporation Safety Procedure HSEAA-P-131 'Working with Asbestos'.

13.6 Working Hours and Fatigue Management

All personnel undertaking work shall be aware and adhere to the Water Corporation Fatigue Management & Working Hours Standard S333 and Western Australia legislative acts.

13.7 Working at Heights

All personnel undertaking work shall be aware and adhere to the Water Corporation Prevention of Falls Standard S151 and procedure HSEAA-P-143 'Falls'.

13.8 Solvents and Fire Hazard

All personnel undertaking work shall be aware and adhere to the manufacturer's recommendations and the Material Safety Data Sheets (MSDS) in the handling and use of solvents. MSDS's for all solvents or chemicals used in the welding processes shall be kept onsite and available at all times. Whilst handling solvents the appropriate PPE as determined by the JSA shall be used.

Thermoplastic faces to be joined by welding shall be thoroughly cleaned of any solvent residue prior to the joint being assembled as remnant solvent could have the potential to start a fire especially in EFJ joints.

13.9 Inhalation and Fumes

The PWSP shall ensure adequate ventilation during welding of thermoplastics. When using Hot Air welding the welder shall at a minimum use a P2 flame retardant respirator.

13.10 Specific Risk Related to Thermoplastics

All thermoplastics are flammable. The temperature at which they ignite and the ferocity with which they burn varies, but all release toxic fumes as they decompose. Never leave material on or near a combustible heat source such as open fires of any kind. Store thermoplastics away from work areas where possible. Always keep fire extinguishers or at least a bucket of sand in the workshop/ work area.

Many thermoplastics release fumes when overheated during machining. Use of an appropriate coolant will help to avoid this.

13.11 Handling and Disposal of Solvents

Solvents and adhesives can also produce potentially dangerous fumes which require exhausting. Fumes can cause nausea, irritability, drowsiness or in extreme cases, coma.

Solvents need to be stored away from any source of combustion. Machining acrylic results in high dust levels. Liquid coolant helps absorb dust in certain processes, but grinding, sanding, filing or hand shaving / sawing, must be done in well-ventilated area with appropriate protective equipment.

Any excess or unused solvents shall be removed from site and disposed of at a registered chemical disposal site.

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13.12 Disposable of Thermoplastic Waste

All swarf, shavings and offcuts produced during the welding and/or fabrication process shall be collected and disposed of to a registered plastics recycler.

Burial of waste thermoplastic materials is not permitted.

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Appendix A - Welding Documentation Requirements

SPECIFICATION WS-2: Installation, Welding and Jointing Thermoplastics

1.0 QUALITY ASSURANCE SYSTEM

Quality Assurance Systems Allowed:

		Yes/No
1.1	AS/NZS ISO 9001	
1.2	AS/NZS ISO 3834.3	
1.3	Other International System	

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
7	Detailed Welding management system	Details for assessment	Type of system	Accept/Reject Within 10 working days	

Sub-Contractor to be used: Yes ☐ No ☐

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
7	Sub-Contractor full Details	Details for assessment	Sub-Contractors to be used.	Accept/Reject Within 10 working days	

Intent to use Alternative Processes Yes ☐ No ☐

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
8	Welding Process/s	Intent to use alternative processes.	Before development of welding procedure.	Accept/Reject Within 10 working days	

10 Days Prior to Planned Commencement of Works.

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
7	Quality Plan	As detailed	Approved	Yes/No	
7	Qualification of Welding Procedures	Schedule of qualified procedures		Accept/Reject	
8	Welding Procedure Sheet (WPS)	All major parameters/essential variables and as per 7.2 advise copies held available to workplace.		Accept/Reject	

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Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
8	PWSP	Nominate qualified person responsible.		Accept/Reject	
9	PWSP details	Qualification/ certification and experience, records.		Yes/No	
8	Welding Inspector	Qualification, certification and experience.		Yes/No	
9	Welding Supervisor	Qualification, certification and 2 years relevant experience.	Acceptance	Yes/No	
9	Welder qualified to Qualified Welding procedures	Details for each welder	Acceptance	Yes/No	
9	Welder qualification, certification, etc.	Qualification/ certification and experience, records.	Acceptance.	Yes/No	
11	Inspection/Test Plan	Inspection + Test Plans (ITP's)		Accept/Reject	

Before Welding Commences

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
6	Commencement	Request approval to commence	All Pre conditions met	Yes/No	

Identification and Traceability after Welding Done

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
7.4	Identification of welders to welds.	Records	Work Done	Accept/Reject	

Testing

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
11	Testing	Test Certificates (destructive or non-destructive)	Work Done NATA Acquitted. Lab.	Accept/Reject Compliance	
11	Pilot weld testing	Test Results	Work Done	Witness and Accept/Reject	
7.5 & 11	Testing records	Supply as part of MDR	Work & Tests done	Accept/Reject Compliance	

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Requalification when Essential Variables fall outside Standard/Code Limits

Clause	Item	Submission	Precondition	WC Approval/Outcome	Plan/ Actual Dates
8.11	New Procedure	Qualification of New Welding Procedure	Change after work commences	Accept/Reject Review/Release Hold Pt.	

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Appendix B: Butt Welding Traceability Report/Register

(as per ISO 21307:2017 and WS2)

Project Number:				Project Name:									Sheet No:	of
HDPE Welding Panel Company:				Butt Welding Procedure:	Single Low Fusion		High Fusion Pressure							
Welding Operator /ID number:														
PWSP/Supervisor:														
Welding Machine:				Serial Number:			Temperature gun S/N / calibration date:							
Cylinder Area: (mm^2)		Welding Machine calibration date:					Cleaning Fluid Manufacture / Date /MSDS:							
							Pipe Manufacture / Date Manufactured:							
Pipe Material				Pipe Size DN		SDR		PN		Average Wall Thickness:			mm	

Welding Parameters (pressure in bar, time in minutes & seconds, temperature in Celsius)

Pipe Weld Number and Date Welded	Ambient Temp (deg C)	Cleaning Wipes / Fluid Batch No.	Axial mis-alignment weld joint (mm)	Welding Machine ID / No.	Heater Plate Temp all welds (deg C)	Weld Location / Chainage	Weld Soak Pressure and Time (Bar) (Minutes / Seconds)	Bead Size (mm)	Heater Plate removal time (Secs)	Welding Fusion Pressure + Drag (Bar)	T5 Weld cool time in clamps under pressure (Mins)	T6 Weld cool time in clamp without pressure. (Mins)	Pipe Wall Thickness (mm)
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/													
/													
/													
/													
/													
/													
/													
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/													
/													
/													

Welding Technician Signature / Date: _____ PWSP QA/QC Signature / Date: _____ Template WS-2

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Appendix C - Inspection Release Form

IRC No. ……

SHEET ……. OF …….

INSPECTION ASSIGNMENT No. ……..…

INSPECTOR'S NAME …… PROJECT No. ……..…….

PROJECT ……..

SUPPLIER ……..……

SUBCONTRACT/ORDER No. ……..……REV ……..……

SUBSUPPLIER ……

SCOPE OF WORK …… ……..

ADDRESS ……..……...

MATERIALS RELEASED

P.O. ITEM No.	QTY ORDERED	QTY RELEASED	DESCRIPTION	ITEM CODE	HEAT / BATCH / CAST No.	TEST CERT No.

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TQ's, NCR's, PUNCHLISTS ETC …… …… …… …… DESTINATION OF MATERIALS …….. …… …….. …… ……..	COMPANY SIGNATURE	DATE
	CLIENT SIGNATURE	DATE
THIS CERTIFICATE IS A CLEARANCE FOR SHIPMENT ONLY AND DOES NOT RELIEVE THE SUPPLIER OF ITS CONTRACTURAL OBLIGATIONS.		

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FOI 26-292 - Document 27

Appendix H – Main Road Western Australia Documents

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mainroads WESTERN AUSTRALIA

SPECIFICATION 404

CULVERTS

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REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
Clause 404.40.3	Update reference to AS 1597.2 Section 5	PDE	19/10/2020
Whole document	Removal of concrete requirements and replacement with reference to relevant concrete specification. Clause numbers for Contract Specific Requirements updated.	PDE	15/10/2020
References 404.87.03	Added AP-R575-18 Added design procedure requirements for plastic flexible pipe and fitting products.	PDE	25/03/2020
404.02	Added reference to Specification 203 and National Code of Practice for the Safe Removal of Asbestos	SRE	21/10/2019
404.03	Added new definition for Asbestos Containing Material	SRE	21/10/2019
404.41	Added requirements relating to Asbestos Containing Material (ACM)	SRE	21/10/2019
Guidance Note 17	Additional Guidance Note relating to Specification 203 Occupational Safety and Health	SRE	21/10/2019
Whole document	Reformatted	SCO	19/04/2017
Annexure 404A & 404B	Table 404A2, 404B1 and reference to AS/NZS 4058 amended	SRE	06/04/2016
404.40.01	Missing Horizontal & Vertical Tolerances introduced	SRE	29/05/2013
Clause 404.87	Discontinuation of the use of Polypropylene Pipes	SRE	12/11/2012
Whole document	Reference to AS 1597 amended	SRE	24/07/2012
References	Changed WS SP43 to ATIC SP43 throughout document	SRE	28/07/2011
References 404.10 404B.04.02 & 404C.05.02 404B.04.03 Annexure 404D	Added AS/NZS 2350 and WS SP43 Type GP Cement Major amendments for compliance for cement used and registration requirements Reference to WS SP43 Added Concrete Request for Registration form	SRE	29/05/2009
Whole document	Major amendments relate to approach for small box culverts installed in 'aggressive' ground environment. New plastic culverts added. Multiple minor amendments made throughout document	SRE	26/06/2008
404C.07.03, 404C.07.04	Change minimum clear cover description.	CMPM	29/11/2006

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FOI 26-292 - Document 27

CONTENTS

Clause **Page No**

GENERAL 6
404.01 Scope 6
404.02 References 6
404.03 Definitions 8
404.04 – 404.05 NOT USED 8

PRODUCTS AND MATERIALS 8
404.06 Reinforced Concrete Pipes 8
404.07 Corrugated Metal Pipes 9
404.08 Reinforced Concrete Boxes 10
404.09 Reinforcement & In-Situ Concrete 10
404.10 Cement Stabilised Backfill 11
404.11 Select Bedding Material 11
404.12 Joint Sealant 11
404.13 – 404.30 NOT USED 11

INSTALLATION 11
404.31 General 11
404.32 Trench Excavation 11
404.33 Blasting 12
404.34 Protection of Foundation Surfaces 12
404.35 Bedding 12
404.36 Damage 12
404.37 Backfill and Compaction 13
404.38 Pavement Reinstatement 14
404.39 Traffic 15
404.40 Culverts 15
404.41 Existing Culverts 17
404.42 Damage to Existing Structures 18
404.43 Pegging of Culverts 19
404.44 Trench Excavation for Culverts 19
404.45 End Treatments 19
404.46 Formwork 19
404.47 Outlet Drains 20
404.48 Rock Protection 20
404.49 Drainage Structures 20
404.50 Stormwater Drains 20
404.51 – 404.80 NOT USED 20

AFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

AS–BUILT AND HANDOVER REQUIREMENTS 20
404.81 As-Built Information 20
404.82 – 404.90 NOT USED 20

CONTRACT SPECIFIC REQUIREMENTS 20
404.91 – 404.102 NOT USED 20

ANNEXURE 404A 21
Construction Requirements 21

ANNEXURE 404B 24
Precast Reinforced Concrete Pipes 24

GENERAL 24
404B.01 Scope 24
404B.02 Terminology and Standards 24

PRODUCTS AND MATERIALS 24
404B.03 Pre-Cast Units 24
404B.04 Reinforcement and Concrete 25
404B.05 Joint Materials 25

MANUFACTURE, HANDLING AND STORAGE 25
404B.06 Cover to Reinforcement 25

INSPECTION AND TESTING 25
404B.07 Routine Testing 25
404B.08 Defects 27
404B.09 Non-Conformance 28

ANNEXURE 404C 29
Pre-Cast Reinforced Concrete Box Culverts 29

GENERAL 29
404C.01 Scope 29
404C.02 Terminology and Standards 29

PRODUCTS AND MATERIALS 29
404C.03 PRE-CAST UNITS 29
404C.04 Formwork 30
404C.05 Reinforcement and Concrete 30

MANUFACTURE, HANDLING AND STORAGE 31
404C.06 Concrete 31
404C.07 Reinforcement and Cover 32
404C.08 Casting Methods 34

AFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

404C.09 Handling of Pre-Cast Units 34
404C.10 Delivery and Storage 34

INSPECTION AND TESTING 36
404C.11 Minimum Testing Frequency 36
404C.12 Defects 36

AFT

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FOI 26-292 - Document 27

SPECIFICATION 404

CULVERTS

GENERAL

404.01 SCOPE

1. The work under this SPECIFICATION consists of the supply and installation of reinforced concrete pipes (RCPs) and reinforced concrete boxes (RCBs) culverts, corrugated steel pipe (CSP) and corrugated aluminium pipes (CAP) culverts, reinforced concrete end treatments for culverts and the supply and installation of RCP stormwater drains.

404.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian Standards

AS 1012	Methods of Testing Concrete
AS 1289.6.3.3	Methods of Testing Soils for Engineering Purposes – Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Perth Sand Penetrometer Test
AS 1379	SPECIFICATION and Supply of Concrete
AS 1397	Steel Sheet and Strip – Hot Dipped Zinc Coated or Aluminium/Zinc Coated
AS 1478	Chemical Admixtures for Concrete, Mortar and Grout
AS 1597	Pre cast Reinforced Concrete Box Culverts
AS 1646	Elastomeric Seals for Waterworks Purposes
AS 1761	Helical Lock-Seam Corrugated Steel Pipes
AS 1762	Helical Lock-Seam Corrugated Steel Pipes – Design and Installation
AS 3610	Formwork for Concrete
AS 3972	Portland and Blended Cements
AS 5100.5	Bridge Design – Concrete

Australian/New Zealand Standards

AS/NZS 2041	Buried Corrugated Metal Structures
AS/NZS 2350	Methods of Testing Portland and blended cements
AS/NZS 2566.1	Buried Flexible Pipelines – Structural Design

DRAFT

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FOI 26-292 - Document 27

AS/NZS 2566.2	Buried Flexible Pipelines – Installation
AS/NZS 3725	Design for Installation of Buried Concrete Pipes
AS/NZS 3750.9	Paints for Steel Structures – Organic Zinc-Rich Primer
AS/NZS 4058	Pre-cast Concrete Pipes (Pressure and Non-Pressure)
AS/NZS 4130	Polyethylene (PE) Pipes for Pressure Applications
AS/NZS 4671	Steel Reinforcing Materials
AS/NZS 5065	Polyethylene and Polypropylene Pipes and Fittings for Drainage and Sewerage Applications

Other Standards

AASHTO M196-92 / ASTM B745	Corrugated Aluminium Pipe for Sewers and Drains
AASHTO M197-01 / ASTM B744	Aluminium Alloy Sheet for Corrugated Aluminium Pipe
AASHTO M246-05/ ASTM A742	Steel Sheet, Metallic-Coated and Polymer Pre-coated, for Corrugated Steel Pipe
NOHSC:2002	National Code of Practice for the Safe Removal of Asbestos

Austroads Research Report

AP-R575-18	Design of Buried Flexible Pipes

MAIN ROADS Test Methods

WA 115.2	Particle Size Distribution: Abbreviated Method for Coarse Soils
WA 133.1	Dry Density/Moisture Content Relationship: Modified Compaction – Fine and Medium Grained Soils
WA 133.2	Dry Density/Moisture Content Relationship: Modified Compaction – Course Grained Soils
WA 910.1	Chlorides and Total Soluble Salts in Soil and Water

Main Roads SPECIFICATIONS

SPECIFICATION 201	QUALITY SYSTEMS
SPECIFICATION 203	SAFETY AND HEALTH MANAGEMENT
SPECIFICATION 204	ENVIRONMENTAL MANAGEMENT
SPECIFICATION 302	EARTHWORKS
SPECIFICATION 402	SURFACE DRAINS AND LEVEES
SPECIFICATION 405	DRAINAGE STRUCTURES
SPECIFICATION 406	ROCK PROTECTION
SPECIFICATION 410	LOW STRENGTH INFILL
SPECIFICATION 501	PAVEMENTS

AFT

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FOI 26-292 - Document 27

SPECIFICATION 503	BITUMINOUS SURFACING
SPECIFICATION 504	ASPHALT SURFACING
SPECIFICATION 819	FALSEWORK
SPECIFICATION 820	CONCRETE FOR STRUCTURES
SPECIFICATION 821	FORMWORK
SPECIFICATION 822	STEEL REINFORCEMENT
SPECIFICATION 828	PRECAST CONCRETE MEMBERS
SPECIFICATION 901	CONCRETE – GENERAL WORKS

404.03 DEFINITIONS

1. Culvert end treatments shall include endwalls or headwalls, wingwalls, cut-off walls and aprons. ***End Treatments***

2. Stormwater drains consist of reinforced concrete pipes connecting drainage structures such as inlets, manholes and catchpits as shown on the Drawings. ***Stormwater Drains***

3. Unless otherwise stated, Clauses within this SPECIFICATION, that reference RCP culverts are also applicable to RCPs installed to carry stormwater from drainage structures. ***RCP Stormwater Drains***

4. Where this SPECIFICATION refers to 'Aggressive' ground conditions, as defined in Annexure 404A, it includes environmental conditions where additional protective measures to culverts are required in accordance with Table 404A2. ***Aggressive Ground Conditions***

5. 'Culway' installations refer to culverts associated with traffic monitoring equipment. ***Culway***

6. Asbestos Containing Material (ACM) has the same meaning as detailed in the National Code of Practice for the Safe Removal of Asbestos ***Asbestos Containing Material***

404.04 – 404.05 NOT USED

PRODUCTS AND MATERIALS

404.06 REINFORCED CONCRETE PIPES

1. Concrete pipes for culverts shall be pre-cast reinforced concrete pipes (RCPs) to the Classes shown on the Drawings. ***RCPs***

2. Concrete pipes shall be manufactured, tested and inspected in accordance with the requirements of Annexure 404B. ***Manufacture***

3. Concrete pipe shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

4. Joint types shall be as specified in Annexure 404A. ***Joint Types***

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FOI 26-292 - Document 27

5. Rubber ring joints shall be provided for all spigot and socket pipes, unless otherwise shown on the Drawings. ***Rubber Ring Joints***

6. Rubber ring gaskets required for jointing spigot and socket concrete pipes shall conform to the requirements of AS 1646. ***Rubber Ring Gaskets***

404.07 CORRUGATED METAL PIPES

404.07.01 GENERAL

1. Corrugated metal pipes with diameter greater than 750mm, or individual units that are to be joined to form a single barrel, shall be supplied with a unique identifying number for post installation shape measurement and reassembly purposes where applicable.

2. Corrugated metal pipes with diameter greater than 750mm shall be supplied with indelible markings defining the internal diameter vertically (through the obvert and invert) and horizontally at intervals as specified in SPECIFICATION 201 QUALITY SYSTEMS. The manufacturer shall provide internal measurements taken at each set of indelible markings to an accuracy of ± 5mm, cross referenced to the unique identifying number detailed in this Clause.

3. Corrugated metal pipe shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2

404.07.02 CORRUGATED STEEL PIPES

1. Corrugated steel pipe culverts shall be supplied to the corrugation size and steel thickness in accordance with this Clause. ***CSPs***

2. The corrugated steel pipes shall be a spirally wound type. ***Spirally Wound***

3. Corrugated steel pipes shall conform to AS 1761.

4. The steel thickness shall be 2.0mm for 450mm diameter, 2.5mm for 600mm to 1500mm diameter, and 3.0mm for 1650mm to 2100mm diameter. ***Steel Thickness***

5. The corrugations shall be 68mm x 13mm for up to and including 1500mm diameter, and 125mm x 25mm for 1650mm to 2100mm diameter. ***Corrugation***

6. All pipes shall be manufactured from Grade 250 steel plate to AS 1397.

7. All corrugated steel pipes cut during the manufacturing process for bevel or skew installations shall have their cut surfaces treated in accordance with Clause 404.36 - 'Damage'. ***Cut Surfaces***

404.07.03 CORRUGATED ALUMINIUM PIPES

1. Corrugated aluminium pipe shall be fabricated from Alclad 3004-H34 in accordance with AASHTO M197-01. Raw material coil width shall be 650mm or greater to maximise lock seam spacing. ***CAP Base Material***

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FOI 26-292 - Document 27

2. Manufacture shall be in accordance with AASHTO M196-92 to the tolerances shown in AS 1761, and shall incorporate a staked, double offset lock-seam joint. ***Manufacture***

3. The structural design procedure shall be in accordance with AS 1762, modified to suit the aluminium section properties of Alclad 3004-H34 with regard to metal strengths and flexibility, which are as follows: ***Design***

   a. Modulus of Elasticity (E) = 69 000 MPa
   b. Yield Stress = 165 MPa
   c. Flexibility factor = 0.46 mm/N

4. The aluminium thickness shall be 2.0mm for up to and including 450mm diameter, 2.5mm for 600mm to 1500mm diameter, and 3.0mm for 1650mm to 2400mm diameter. ***Aluminium Thickness***

5. The corrugations shall be 68mm x 13mm for up to and including 1500mm diameter, and 125mm x 25mm for 1650mm to 2400mm diameter. ***Corrugation***

6. Dissimilar metals shall not be permitted to be in direct contact with aluminium pipe. ***Dissimilar Metals***

404.08 REINFORCED CONCRETE BOXES

1. Reinforced concrete box culvert units with spans up to and equal to 1200 mm shall be manufactured, tested and inspected in accordance with Annexure 404C and AS 1597.1. ***RCBs (Spans ≤ 1200mm)***

2. Reinforced concrete box culvert units with spans of 1500 mm and greater shall be manufactured, tested and inspected in accordance with Annexure 404C and AS 1597.2. ***RCBs (Spans ≥ 1500mm)***

3. Reinforced concrete box culvert units shall be manufactured to suit the in-situ conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

4. Joint sealant for masking external joints shall be a 150mm wide joint sealant complying with this SPECIFICATION. ***Joint Sealant***

404.09 REINFORCEMENT & IN-SITU CONCRETE

404.09.01 REINFORCEMENT

1. Reinforcing steel shall conform to the requirements of SPECIFICATION 822 STEEL REINFORCEMENT.

404.09.02 IN-SITU CONCRETE

1. The supply of in-situ concrete for base slabs and end treatments shall conform to requirements of Annexure 404A – Table 404A3.

2. The supply and placement of all N Class concrete shall be in accordance with SPECIFICATION 901 CONCRETE – GENERAL WORKS. ***N Class Concrete***

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FOI 26-292 - Document 27

3. The supply and placement of all S Class concrete shall be in accordance with SPECIFICATION 820 CONCRETE FOR STRUCTURES. ***S Class Concrete***

404.10 CEMENT STABILISED BACKFILL

1. Cement stabilised backfill material shall consist of basecourse material, or other suitable material approved by the Superintendent, stabilised in the proportion of 100kg of Type GP Cement to one cubic metre of uncompacted backfill material. ***Mix Proportions***

2. Water for cement stabilisation shall be clean and potable. ***Water***

404.11 SELECT BEDDING MATERIAL

1. Select bedding material shall be basecourse material, or other suitable material approved by the Superintendent, containing less than 20% by mass of material retained on the 37.5mm sieve as determined by MRWA Test Method WA 115.2.

404.12 JOINT SEALANT

1. Acceptable joint sealant for masking external joints are Flash Tac Scotch Wrap No.50 and Rock Wrap 3000 or a suitable equivalent approved by the Superintendent.

404.13 – 404.30 NOT USED

INSTALLATION

404.31 GENERAL

1. The installation of pipes and box culverts shall include all trench excavations, construction and backfill to the details shown on the Drawings and as described in this SPECIFICATION.

404.32 TRENCH EXCAVATION

1. Trenches shall be excavated to the width shown in the Drawings with vertical sides throughout where the excavation is up to 1.5m deep.

2. Where the excavation is greater than 1.5m deep, the trench shall be excavated in accordance with the requirements of the Drawings. Any loose or disturbed material shall be removed from the walls of the trench. ***Trench > 1.5m Deep***

3. All spoil material from excavations, including excavations for end treatments and rock protection, shall be disposed of as specified in SPECIFICATION 302 EARTHWORKS. ***Spoil Material***

4. Excavations shall be kept free from water until work below ground level is sufficiently set or protected. Dewatering operations shall be undertaken in accordance with SPECIFICATION 204 ENVIRONMENTAL MANAGEMENT , and water discharged from trenches shall in no circumstances be disposed of to sanitary sewers. ***Dewatering***

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FOI 26-292 - Document 27

5. Trench excavations in rock, including excavation for end treatments, shall be carried out in accordance with SPECIFICATION 302 EARTHWORKS. ***Rock***

404.33 BLASTING

1. Any requirement for blasting shall be carried out in accordance with SPECIFICATION 302 EARTHWORKS. ***Blasting***

404.34 PROTECTION OF FOUNDATION SURFACES

1. The exposed surface at the bottom of the excavation shall be adequately protected from disturbance by the Contractors operations or by the action of storm water or ground water. Where required, dewatering shall be undertaken in accordance with the requirements of SPECIFICATION 204 ENVIRONMENT. Any disturbance shall be reinstated to the requirements of Clause 404.35 – 'Bedding' by the Contractor at no cost to the Principal. ***Exposed Surface***

404.35 BEDDING

1. Culverts shall be bedded as detailed on the Drawings.

2. Excavation for culverts, bedding and end treatments shall be undertaken to the extent shown on the Drawings. ***Extent of Excavation***

3. Unless shown otherwise on the Drawings, the culverts and end treatments shall be bedded on the in-situ foundation material that has been compacted to the requirements specified for 'Embankment Foundation' in SPECIFICATION 302 EARTHWORKS, with a frequency of testing in accordance with SPECIFICATION 201 QUALITY SYSTEMS.

4. Select bedding material shall be constructed to the dimensions shown in the Drawings. Select bedding material shall be compacted to the Characteristic Dry Density Ratio specified for 'Embankment Construction' in SPECIFICATION 302 EARTHWORKS, with a frequency of testing in accordance with SPECIFICATION 201 QUALITY SYSTEMS. ***Select Bedding Material***

5. Provisions shall be made to accommodate pipe socket/connections to ensure pipes are fully supported along the barrels.

404.36 DAMAGE

1. Pre-cast concrete pipes and box culvert units shall be handled and installed in such a manner that no non-conforming cracking or other non-conforming defect occurs that is outside acceptable limits given in Annexure 404B and 404C as applicable. Damaged pipe and box culverts shall be assessed and repaired or replaced in accordance with Annexure 404B or 404C as applicable at no cost to the Principal. ***Damaged Concrete Units***

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FOI 26-292 - Document 27

2. Corrugated steel pipe culvert units shall be handled and installed in such a manner as to prevent damage to the zinc coating. Areas on culvert units where zinc coating has been damaged shall be cleaned of rust and painted with two coats of zinc-rich organic priming paint complying with AS/NZS 3750.9. Where other coatings such as polymer pre-coats are used, then damage to those coats shall be repaired in accordance with the manufacturer's recommendations. Such surface repairs shall be undertaken at no cost to the Principal. Where damage occurs, other than to the surface coating then the damaged units shall be replaced at no cost to the Principal. ***Damaged CSPs***

3. Corrugated aluminium pipe culvert units shall be handled and installed with care to prevent damage to the pipe wall and seamed joints. Damaged pipe units shall be replaced at no cost to the Principal. ***Damaged Aluminium Pipes***

404.37 BACKFILL AND COMPACTION

404.37.01 GENERAL

1. **Prior to backfilling the Contractor shall certify to the Superintendent that compliance has been achieved with all specified requirements.** ***HOLD POINT***

2. The backfill requirements for all culverts shall be as detailed in the Drawings. Unless otherwise shown on the Drawings backfill material, other than cement stabilised backfill shall be embankment material placed and compacted to the requirements specified for 'Embankment Construction' in SPECIFICATION 302 EARTHWORKS, with a frequency of testing in accordance with SPECIFICATION 201 QUALITY SYSTEMS. Backfill levels on each side of any conduit shall not differ by more than 150mm. The Contractor shall ensure that the backfill placement does not damage the end treatments. ***Backfill***

3. The dimensional requirements relating to backfill shall be as shown on the Drawings. ***Extent***

4. All sheeting, struts, braces, and similar temporary supports shall be entirely removed from the trench prior to backfilling. Removal shall be effected in such a way so as not to disturb or displace the culvert. ***Removal of Bracing***

5. Appropriate precautions, such as the use of holding-down straps, shall be taken to ensure that corrugated metal pipe culvert barrels do not 'float' during the backfilling process, particularly during vibration of the backfill. ***Metal Culvert 'Float' Precautions***

6. The Contractor shall ensure that the equipment used during compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with AS/NZS 3725 for reinforced concrete pipes, AS 1597 for reinforced box culverts or AS 1762 for corrugated steel pipes. ***Compaction Equipment***

7. No backfill shall be placed behind in-situ wingwalls or headwalls within seven days of concrete being placed in the wingwalls or headwalls. ***Concrete Strength***

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FOI 26-292 - Document 27

404.37.02 CEMENT STABILISED BACKFILL

1. Cement stabilised backfill material to culverts shall be as specified in Clause 404.10 – 'Cement Stabilised Backfill' and shall be placed to the limits and dimensions as shown on the Drawings. ***Material***

2. Only sufficient water shall be mixed with the stabilised material to facilitate compaction. ***Water***

3. Cement stabilised backfill material shall be placed within 90 minutes of mixing the cement with water. The stabilised backfill shall be compacted during placement using pneumatic or mechanical rotary type immersion vibrators. The cement stabilised material shall be vibrated until all excess water and air are expelled. ***Placing***

4. During placing of cement stabilised backfill the backfill levels on each side of any conduit shall not differ by more than 150mm. Backfill placement shall not damage the culverts or end treatments. ***Placement***

5. Immersion vibrators shall be of the rotary out of balance type with a frequency of not less than 10 000 cycles per minute. Before the commencement of each backfill, sufficient vibrators and spares shall be available and tested. The number of vibrators required for a given rate of placing cement stabilised material shall be as specified in Table 404.01 and shall be continuously used during the process. ***Vibrators***

TABLE 404.01 NUMBER OF VIBRATORS

Rate of Placing Cement Stabilised Material m^3 per Hour	Working Vibrators Required	Standby Vibrators Required
Up to 4	1	1
4 to 8	2	1

404.38 PAVEMENT REINSTATEMENT

1. Where a culvert is constructed under an existing road pavement, the pavement on the existing road shall be reinstated by the construction of the appropriate pavement layers with thicknesses as shown on the Drawings. ***Reinstatement***

2. The edges of the excavation shall be saw cut straight and parallel to the line of the culvert or stormwater drain and the excavation backfilled to the requirements of Clauses 404.31 – 'General' and 404.37 'Backfill and Compaction' respectively. The pavement layer(s) shall be constructed to the relevant requirements of SPECIFICATION 501 PAVEMENTS. ***Edges & Pavement***

3. Bituminous surfacing and asphalt shall be applied in accordance with the requirements of SPECIFICATION 503 BITUMINOUS SURFACING and SPECIFICATION 504 ASPHALT SURFACING respectively, with the top surface finished level with the surrounding existing sealed surface. ***Surfacing***

4. A waterproof seal shall be provided between the new and the old surfaces. ***Waterproof Seal***

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FOI 26-292 - Document 27

404.39 TRAFFIC

1. The Contractor shall repair or replace any culvert damaged by construction backfill or Public Traffic in accordance with the requirements of Clause 404.36 – 'Damage', at no cost to the Principal. ***Damage***

2. Construction traffic with greater than legal wheel or axle loading, as defined by the Road Traffic (Vehicle Standards) Regulations 2002 shall not be permitted to travel over culverts.

404.40 CULVERTS

404.40.01 GENERAL

1. Batter slopes at culverts shall be evenly transitioned over a length of 10m from the edge of the wingwall to match culvert wingwall slopes.

2. All culverts shall be constructed to the correct alignment and cross sectional shape and shall conform to dimensions, levels and other details specified or shown in the Drawings. ***Alignment***

3. Inlet and outlet invert levels shall be as shown in the Drawings plus or minus 10mm. Inverts shall be smooth and of uniform gradient throughout each culvert length. ***Invert Levels Tolerance***

4. Any culvert which is not true to line, level or grade, or shows settlement after laying, or which is damaged during backfilling, compaction or subsequent operations, shall be removed by the Contractor and replaced at no cost to the Principal. ***Misalignment or Damage***

5. On completion of installation no diameter measured across the indelible markings on metal culverts shall differ from the supplied preinstalled dimension by more than 5 percent. Testing frequency shall be in accordance with SPECIFICATION 201 QUALITY SYSTEMS. ***Metal Culvert Diameter Tolerances***

6. Where shown on the Drawings, metal culverts shall be anchored to an in-situ concrete collar. ***Metal Culverts Anchorage***

7. All culverts shall be flushed clean from end to end on completion of the installation and maintained in proper working order for the duration of the Contract. ***Flushing***

8. Culverts shall be laid with the connections kept clean and shall be laid with the inverts true to the lines and levels shown on the Drawings and to the following tolerances:

a.	Horizontal alignment	± 25mm	± 25mm
b.	Vertical level	± 10mm	± 10mm

9. The Contractor shall seal the ends of the culverts with a temporary plug to exclude water, sand or other deleterious materials caused from work under the Contract unless otherwise approved by the Superintendent.

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FOI 26-292 - Document 27

404.40.02 CONCRETE PIPE CULVERTS

1. Pipe laying shall proceed up-grade with the pipe sockets at the higher end of the pipes.

2. Rubber ring joints shall be lubricated in accordance with the manufacturer's recommendations. Pipe handling shall be carefully controlled to avoid disturbing the rubber ring and to ensure that it is free from dirt and other foreign materials. Any rubber ring so disturbed shall be removed, cleaned and re-lubricated before refitting. ***Rubber Rings***

3. Care shall be taken to properly align the pipe before the joint is forced home. During the jointing operation the pipe shall be partially supported in a suitable manner to minimise unequal lateral pressure on the rubber ring and to maintain concentricity until the rubber ring is properly seated. ***Jointing***

4. Flush jointed concrete pipes shall be installed in accordance with the manufacturer's recommendations, with the rubber jointing bands and pipe joints being kept free from dirt and foreign materials. ***Flush Joints***

5. The installation and jointing recommendations provided by the pipe manufacturer shall be followed at all times. Sufficient pressure shall be applied in making the joint to ensure proper seating and sufficient restraint shall be applied to ensure that the line does not creep until backfill material can be placed and thoroughly compacted around the pipe. At the end of the work day the last pipe shall be blocked in an effective manner to prevent creep. ***Manufacturer's Recommendations***

404.40.03 CONCRETE BOX CULVERTS

1. Unless otherwise detailed in the Specification or Drawings, installation of all pre-cast reinforced concrete boxes shall comply with the requirements of AS 1597.2 Section 5 - Installation. ***Concrete Boxes***

2. All box culverts shall be installed on a cast in-situ concrete base slab. Pre-cast concrete bases shall not be used. ***In-situ Base Slabs***

3. Reinforced concrete box culvert units shall be placed in position on a mortar bed in accordance with the Drawings. Unless specified otherwise on the Drawings, cement mortar is to be 0.4 : 1, water : cement ratio by mass and 3 : 1, sand : cement ratio by mass.

4. **Cement stabilised backfill shall not be placed until the cement mortar used to seal culvert crown units has cured for 48 hours.** ***HOLD POINT***

5. The base slab construction for Box Culverts shall comply with the following requirements: ***Base Slab:***

    a. Dimensions shall be within 10mm of those shown on the Drawings. Surface irregularities shall be less than 5mm abrupt and 8mm over a 3 metre straight edge. ***Tolerances***

    b. No construction equipment or public traffic is permitted to travel or work on or over the concrete base slab within seven days of the placement of concrete in the base slabs. ***Traffic Use***

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FOI 26-292 - Document 27

c. The Contractor shall not operate any plant directly on the concrete base slabs without prior approval from the Superintendent. ***Plant Use***

d. Reinforced concrete box culvert units shall not be placed on concrete base slabs within 24 hours of completing the concrete base slabs.

6. Box Culverts with a span of 1200mm or greater shall have shear keys as shown on the Drawings and constructed in accordance with this Specification. ***Shear Keys***

404.40.04 CORRUGATED STEEL PIPE CULVERTS

1. Installation of helical lock-seam corrugated steel pipes shall comply with the requirements of this Specification, the Drawings, and AS 1762. ***Helical Lock-Seam Corrugated Steel Pipes***

2. Where corrugated steel pipes are to be cut in-situ to suit end treatments the cut surfaces shall be treated in accordance with Clause 404.36 – 'Damage' for damaged corrugated steel pipe.

404.40.05 CORRUGATED ALUMINIUM PIPE CULVERTS

1. Installation of corrugated aluminium pipes shall comply with the requirements of this Specification, the Drawings and AS 1762. ***Aluminium Pipes***

404.41 EXISTING CULVERTS

404.41.01 REMOVAL & BACKFILL

1. Where detailed on the Drawings, existing culverts shall be removed. ***Redundant Culverts***

2. Existing culverts nominated by the Principal as requiring demolition or removal that contain or potentially contain asbestos are nominated in SPECIFICATION 203 SAFETY AND HEALTH MANAGEMENT. Management of these existing culverts shall be in accordance with SPECIFICATION 203 SAFETY AND HEALTH MANAGEMENT. ***Asbestos Containing Material***

3. If an existing culvert does not contain Asbestos Containing Material and is deemed suitable for re-use by the Superintendent, it can be used for sidetracks. When the sidetrack is no longer in use, or if there is no sidetrack, removed culverts shall be stored or disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the Local Government Authority. ***Use of Existing Culverts for Sidetracks***

4. Where damage to the concrete that exposes the reinforcement or any cracking which exceeds 0.1mm wide occurs then those damaged culvert units shall be disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the Local Government Authority. Minor chipping of the concrete may be repaired by the Contractor using an approved repair mortar and the culverts will be considered to be undamaged. ***Damaged Fittings***

5. If the removed culvert is not being replaced, the void remaining shall be filled and compacted with embankment material. ***Backfilling***

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FOI 26-292 - Document 27

6. The embankment material shall be placed and compacted to the requirements for embankment construction in SPECIFICATION 302 EARTHWORKS, with a frequency of testing in accordance with SPECIFICATION 201 QUALITY SYSTEMS.

404.41.02 LOW STRENGTH INFILL

Low Strength Infill

1. Where indicated on the Drawings, redundant existing culverts and associated drainage structures located under roadways which are to be retained in their existing location shall be entirely filled in-situ in accordance with SPECIFICATION 410 LOW STRENGTH INFILL. The open ends of any remaining pipe runs and apertures left in remaining drainage structures shall be permanently sealed off to exclude water, sand or other material.

404.41.03 CULVERT EXTENSIONS

Culvert Extensions

1. Construction of culvert extensions to existing culverts shall be in accordance with the relevant construction requirements for new culverts, except that extension of a culvert shall normally be completed before associated earthworks at the same location.

2. Trench excavation for the culvert extension shall be carried out as required. Where the invert level of the culvert extension is lower than the existing ground level, the in-situ material shall be excavated to the width shown on the Drawings for new culverts.

Asbestos Containing Material

3. Where the existing culvert is nominated in SPECIFICATION 203 SAFETY AND HEALTH MANAGEMENT , prior to disturbing the existing culvert or endwall in any way, the Contractor shall adhere to the requirements of SPECIFICATION 203 SAFETY AND HEALTH MANAGEMENT relating to Asbestos Containing Material.

4. Where the existing culvert and culvert endwalls do not contain Asbestos Containing Material, the culvert endwalls shall be broken out as required and the old endwall material removed to spoil areas. Care shall be taken not to damage retained culvert conduit.

5. Unless shown otherwise on the Drawings, the existing culvert barrel shall be excavated back to a minimum of 500mm from the end of the culvert. Prior to backfilling, the joint between the existing and the new conduit shall be masked with a suitable joint sealant in accordance with Clause 404.12 – 'Joint Sealant'.

6. The gradient of the culvert extension shall match the gradient of the retained portion of the existing culvert, or where required the extension shall be laid to a specified invert level. Culvert extensions shall be thoroughly jointed with the existing culvert so as to provide a continuous structure with no internal projections to impede the flow of water.

End Treatments

7. End treatments to extensions shall be constructed as for new culverts.

404.42 DAMAGE TO EXISTING STRUCTURES

Damage

1. Any damage to any culvert, end treatment or any other structure during the Contract shall be repaired by the Contractor at no cost to the Principal.

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FOI 26-292 - Document 27

404.43 PEGGING OF CULVERTS

1. **Prior to any clearing at culvert locations, the Contractor shall peg the centreline of the culvert at the inlet and outlet inverts and peg the extent of the clearing required for associated Works for the Superintendents verification and adjustment as required.** ***HOLD POINT***

404.44 TRENCH EXCAVATION FOR CULVERTS

1. Except for culvert extensions, no culvert shall be laid until the embankment at the point of laying has been brought to a level 600mm above all points along the top of the culvert, or to the subgrade level, whichever is the lesser, and compacted. Where pipes with spigot and socket joints are used then measurement shall be taken from the top of collar. ***Embankment Height***

404.45 END TREATMENTS

404.45.01 IN-SITU CONSTRUCTION

1. Unless otherwise shown on the Drawings, all culvert end treatments shall be constructed of cast in-situ concrete, or where applicable of mortared rock pitching in accordance with the Drawings. ***Construction***

2. The dimensions of the end treatments shall be within 10mm of those shown on the Drawings when measured in accordance with AS 3610. ***Tolerances***

3. Surface irregularities of the concrete end walls, wing walls, cut off walls and aprons shall be less than 5mm abrupt and 8mm over a 3 metre straight edge. ***Surface Irregularities***

4. Unless otherwise shown on the Drawings, concrete shall be in accordance with Annexure 404A – Table 404A3 and shall conform to the requirements of Clause 404.09 – 'Reinforcement and In-situ Concrete'. ***Concrete***

5. Unless otherwise shown on the Drawings, mortar for mortared rock pitching shall comprise a 6 to 1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source. ***Mortar***

404.45.02 PRE-CAST CONCRETE END TREATMENTS

1. The use of commercially available pre-cast end treatments shall not be permitted. ***Pre-cast End Treatments***

404.46 FORMWORK

1. All formwork used to form and support the concrete shall conform to the requirements of SPECIFICATION 821 FORMWORK. Associated requirements for false-work shall conform to the requirements of SPECIFICATION 819 FALSEWORK.

2. The tolerances of formwork for concrete construction of all end treatments shall be as follows: ***Tolerances***

    a. Variation in cross-sectional dimensions + 5mm

    b. Variation in overall dimensions + 10mm

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FOI 26-292 - Document 27

c. Variation in surface level + 5mm

404.47 OUTLET DRAINS

1. Construction of culvert inlet and outlet drains shall be in accordance with the Drawings and SPECIFICATION 402 SURFACE DRAINS AND LEVEES.

404.48 ROCK PROTECTION

1. Where shown on the Drawings, culverts shall have rock protection.

Rock Class

2. Unless otherwise shown on the Drawings, dimensions and class of rock for rock protection shall be as specified in the Culvert Schedule and shall be constructed in accordance with the requirements of SPECIFICATION 406 ROCK PROTECTION.

404.49 DRAINAGE STRUCTURES

1. Supply and installation of drainage structures such as inlets, manholes and catchpits shall be in accordance with the Drawings and SPECIFICATION 405 DRAINAGE STRUCTURES.

404.50 STORMWATER DRAINS

Flushing

1. On completion of the entire system all pipes shall be flushed clean from end to end and left in proper working order.

404.51 – 404.80 NOT USED

AS–BUILT AND HANDOVER REQUIREMENTS

404.81 AS-BUILT INFORMATION

1. As-Built Drawings shall include the following information for culverts:

   a. Material type.
   b. Length.
   c. Culvert Skew Angle.
   d. Inlet and Outlet Invert Levels.
   e. Nominal diameter for pipes or span and height for RCBs.
   f. Number of barrels.

404.82 – 404.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

404.91 – 404.102 REFER TO GUIDANCE NOTES

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FOI 26-292 - Document 27

ANNEXURE 404A

CONSTRUCTION REQUIREMENTS

404A1. GROUND CONDITIONS (Clause 404.03)

1. 1 In-situ ground conditions with respect to the manufacture and installation of culverts shall be classed in accordance with Table 404A1:

CULVERT TYPE AND MATERIAL	GROUND CONDITION/EXPOSURE CLASS
Reinforced Concrete Pipe	AGGRESSIVE[1]
Reinforced Concrete Box	As per standard drawings for box culverts
Corrugated Steel Pipe	AGGRESSIVE
Corrugated Aluminium Pipe	NON-AGGRESSIVE
HDPE Pipe	Preferable for saline environments[2]

Table 404A1 – In-situ Ground Conditions

(Delete the culvert types and conditions which are **not** applicable. **Refer also to Guidance Note 5**, and delete this note)

[1] Ground condition "AGGRESSIVE" is described in Clause 4.8 of AS5100-2017.

[2] This will be subject to asset management/regional preference.

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FOI 26-292 - Document 27

1. 2 Requirements for culvert units installed in ground conditions identified as 'Aggressive' (refer to Table 404A1) shall be in accordance with Table 404A2:

CULVERT TYPE AND MATERIAL	REQUIREMENTS
Reinforced Concrete Pipe (all sizes)	Minimum cover to reinforcement shall be in accordance with AS/NZS 4058 for 'Marine' conditions
Reinforced Concrete Box (Span up to 1200mm)	(Refer to **Guidance Note 5.2** for interim treatment options available to Project Managers. Insert the required treatment here and delete this note)
Reinforced Concrete Box (Span ≥ 1500mm)	(Refer to **Guidance Note 5.2** for interim treatment options available to Project Managers. Insert the required treatment here and delete this note)
Corrugated Steel Pipe (all sizes)	(Refer to **Guidance Note 5.3** for treatment options available to Project Managers. Insert the required treatment here and delete this note)

Table 404A2 – Requirements for Culvert Units Installed in Aggressive Ground Conditions

(this Table can be used for multiple types of culverts. Delete the culvert type which is **not** applicable and delete this note)

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FOI 26-292 - Document 27

404A2. CONCRETE PIPE JOINTS (Clause 404.03)

2.1 The type of culvert joints to be supplied for Precast Reinforced Concrete Pipes shall be:

- Flush Joints
- Spigot and Socket Joint

(Delete the joint type which is not applicable, and delete this note)

404A3. IN-SITU CONCRETE STRENGTH (Clause 404.09)

Culvert Type	Culvert Span / Diameter	Concrete Class[3]
Reinforced Concrete Box (RCB)	≤ 1200mm	N40
Reinforced Concrete Box (RCB)	> 1200mm	S50
Reinforced Concrete Pipe (RCP)	< 1500mm	N40
Reinforced Concrete Pipe (RCP)	≥ 1500mm	S50
Corrugated Steel Pipe (CSP)	< 1500mm	N40
Corrugated Steel Pipe (CSP)	≥ 1500mm	S50

TABLE 404A3 – In-Situ Concrete Strength for Base Slabs and End Treatments

(Delete the type(s) and class(es) which is/are not applicable. **Refer also to Guidance Note 10**, and delete this note)

[3] Concrete class "N" or "S" type shall also depend on ground condition and exposure classification.

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FOI 26-292 - Document 27

ANNEXURE 404B

PRECAST REINFORCED CONCRETE PIPES

GENERAL

404B.01 SCOPE

1. This Annexure is for the supply and delivery of precast reinforced concrete pipes. The Contractor must nominate the nominal effective length of the units with the tender.

404B.02 TERMINOLOGY AND STANDARDS

1. Unless otherwise specified, material and manufactured articles and workmanship shall conform to the relevant Australian Standards. Where conflict occurs between this Annexure and the relevant Australian Standard this Annexure shall take precedence.

PRODUCTS AND MATERIALS

404B.03 PRE-CAST UNITS

1. The pipes shall be manufactured, tested and accepted in accordance with the requirements of AS/NZS 4058, except where otherwise varied by this Annexure.

2. The pipes shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1 in accordance with the requirements of Table 404A2 — ***Ground Conditions***

3. The nominal internal pipe diameters to be supplied shall include those diameters between 300mm and 4200mm given in the Culvert Schedule and/or the Schedule of Rates. — ***Pipe Diameter***

4. This Annexure applies to the following load classes as described in AS/NZS 4058: — ***Load Classes***

    a. Standard pipe classes 2, 3 and 4 are available as stock items.

    b. Extra strength pipe classes 6, 8, 10 and 12 are also available from pipe manufacturers as required.

5. The Class of pipe shall be as shown on the Drawings.

6. The type of joints to be supplied shall be as specified in Clause 404A2 — ***Joint Types***

7. Information to be supplied by the purchaser and the supplier shall be in accordance with AS/NZS 4058. — ***Purchasing***

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FOI 26-292 - Document 27

404B.04 REINFORCEMENT AND CONCRETE

404B.04.01 CONCRETE GENERAL

1. Concrete shall be cast and cured to produce a sound, dense and durable concrete.

2. Concrete shall have a surface finish equivalent to a steel trowel finish for internal surfaces. External surfaces shall have as a minimum a Class 3 finish in accordance with AS 3610. The internal and external surfaces of pipes shall not be coated unless otherwise specified. ***Surface Finish***

3. N-Class Concrete shall be produced in accordance with the requirements of SPECIFICATION 901 and S-Class Concrete shall be produced in accordance with the requirements of SPECIFICATION 820.

404B.04.02 REINFORCEMENT

1. Reinforcing steel shall conform with the requirements of SPECIFICATION 822 STEEL REINFORCEMENT.

404B.05 JOINT MATERIALS

1. Where rubber joint rings are to be supplied by the Contractor, they shall comply with AS 1646. ***Rubber Joint Rings***

MANUFACTURE, HANDLING AND STORAGE

404B.06 COVER TO REINFORCEMENT

1. Unless otherwise stated in Annexure 404A – Table 404A2, the minimum concrete cover to reinforcement for precast pipes shall be in accordance with AS/NZS 4058 for 'Normal' environment.

2. Unless otherwise stated in Annexure 404A – Table 404A2, the minimum concrete cover to reinforcement for precast concrete box culvert and all other in-situ concrete element shall be in accordance with AS 5100.5 - 2017.

3. Nibs shall be supplied to all reinforcement spacers that intrude into the specified cover. Where pipes are spun or roller compacted then nibs shall be mild steel. Where pipes are wet cast then nibs shall be stainless steel. ***Nibs***

INSPECTION AND TESTING

404B.07 ROUTINE TESTING

1. The following specified tests are required in addition to those specified in AS/NZS 4058, Table 5.1:

    a. ultimate load

    b. water absorption

    c. cover

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FOI 26-292 - Document 27

d. dimensional accuracy

e. joint assembly test (where appropriate)

2. Testing Procedures and Minimum Testing Frequencies shall be in accordance with Table 404B1.

3. Tests shall be carried out in accordance with AS/NZS 4058.

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FOI 26-292 - Document 27

TABLE 404B1 – MINIMUM TESTING FREQUENCY

The minimum testing frequency for materials used in concrete shall be in accordance with the requirement of MRWA Specification 201.

Process	**Quality Verification Requirement**	***Minimum Testing Frequency***
Precast Reinforced Concrete Drainage Pipes	Load Testing - as per AS/NZS 4058 and Clause 404B.07 of the Specification	**In accordance with AS/NZS4058 Appendix A, Section A4.1 and A4.2**
	Cover to Reinforcement - As per AS/NZS 4058 and Clause 404B.06 of the Specification	***In Accordance with AS/NZS 4058 Appendix A, Section A4.6***
	Inspection for Defects - as per AS/NZS 4058 and Clause 404B.08 of the specification	***Visual inspection all units***
	Absorption Testing - as per AS/NZS 4058 and Clause 404B.07 of the specification	***In accordance with AS/NZS 4058 Appendix A, Section A4.4***
	Dimensional Accuracy as per AS/NZS 4058	***In accordance with AS/NZS 4058 Appendix A, Section A4.7***
	Joint assembly Test as per AS/NZS 4058	***In accordance with AS/NZS 4058 Appendix A, Section A4.5***

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404B.08 DEFECTS

1. Unless otherwise specified within this Clause, pipe defect types identified in AS/NZS 4058, Clause 3.3 – 'Workmanship and Finish' shall not be acceptable. Selected Extracts from AS/NZS 4058, Table 3.6, are shown in the tables below.

2. Where specified below as Acceptable, finishing and repairs to defects shall be in accordance with AS/NZS 4058 Clause 3.3.

404B.08.01 PIPE WALL

1. The following Pipe Wall defects as defined in AS/NZS 4058, Clause 3.4 shall be deemed acceptable subject to the Acceptability of Defects shown below:

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FOI 26-292 - Document 27

Defect	Acceptability
Type 1	Acceptable after repair
Type 2	Acceptable after repair
Type 4	Acceptable after repair
Type 5	Acceptable after repair

404B.08.02 JOINT SURFACE

1. The following Joint Surface defects as defined in AS/NZS 4058, Clause 3.4 shall be deemed acceptable subject to the Acceptability of Defects shown below:

Defect	Acceptability
Type 4	Acceptable after repair
Type 5	Acceptable after repair

404B.09 NON-CONFORMANCE

1. Pipes shall be deemed nonconforming when they fail to satisfy all the manufacturing and testing requirements of AS/NZS 4058 and this Specification with modifications as specified in this Annexure. Non-conforming units shall be rejected and replaced at no cost to the Principal.

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FOI 26-292 - Document 27

ANNEXURE 404C

PRE-CAST REINFORCED CONCRETE BOX CULVERTS

GENERAL

404C.01 SCOPE

1. This Annexure is for the supply and delivery of pre-cast reinforced concrete box culvert sections. Nominal spans and heights of the pre-cast units shall be as shown on the Drawings. The units shall be supplied in lengths of 1.2m or 2.4m. The Contractor must nominate the length of the units with the tender.

404C.02 TERMINOLOGY AND STANDARDS

1. The term 'pre-cast units' where used in this Annexure shall include the pre-cast reinforced concrete crown sections.

2. Unless otherwise specified material and manufactured articles and workmanship shall conform to the relevant Australian Standards. Where conflict occurs between this Annexure and the relevant Australian Standards this Annexure shall take precedence.

PRODUCTS AND MATERIALS

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404C.03 PRE-CAST UNITS

1. For culvert units up to 1200mm span the following shall apply:

    a. pre-cast units have been designed by Main Roads Western Australia and the minimum design requirements are detailed on Drawing Number 1930-0666.

    b. pre-cast units shall be manufactured in accordance with the requirements of AS 1597.1, except where otherwise varied by this Specification.

    c. the recommended nominal internal dimensions for the 1200 x 1200 culvert units are:

        - 1200mm width;
        - and1200mm depth,

        In accordance with AS 1597.1, Figure 2.1. The effective waterways area shall not be less than 1.44 m2.

    d. the height of fill, including pavement, between the trafficable surface of the road and the top of the culvert unit, shall be in accordance with the MRWA standard drawing 1930-0666.

2. For culvert units of 1500mm span, the following shall apply:

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FOI 26-292 - Document 27

a. pre-cast units have been designed by Main Roads Western Australia and the minimum design requirements are detailed on Drawing Number 0530-1470.

b. manufactured in accordance with AS 1597.2.

3. All pre-cast concrete box units shall be manufactured to suit the in-situ ground conditions as specified in Annexure 404A – Table 404A1, in accordance with the requirements of Table 404A2.

4. The type of units required for the Contract are as listed in the Culvert Schedule or the Schedule of Rates/Bill of Quantities.

5. Tenderers shall submit with their Tender's full details of proposed concrete dimensions and reinforcement to meet the minimum design requirements as detailed on Drawing Number 0530-1470 (for spans 1500mm and greater) and Drawing Number 1930-0666 (for spans up to 1200mm).

6. Information to be supplied by the purchaser and the supplier shall be in accordance with AS 1597.2.

404C.04 FORMWORK

1. All formed concrete surfaces to the pre-cast units shall have a smooth, dense and dust free concrete finish.

2. Form joint marks shall be unobtrusive and concrete surfaces shall be free from blowholes deeper than 5mm. The allowable extent of blowholes per unit area shall be as for Class 3 formwork in AS 3610. Maximum allowable surface irregularities shall be nil abrupt or 3mm over the width of the surface.

3. Form lubricants used shall be of the non-staining type and shall have no detrimental effects on the concrete.

4. The unformed surface of the pre-cast units shall be wood floated to produce a uniform surface without surface pitting or cavities. Maximum allowable surface irregularities shall be nil abrupt or 5mm over the width of the surface.

5. For culvert units of 1500mm span and larger, the design of all formwork shall be in accordance with SPECIFICATION 821 FORMWORK.

404C.05 REINFORCEMENT AND CONCRETE

404C.05.01 CONCRETE GENERAL

1. Concrete shall consist of a mixture of cement and water and coarse aggregate and fine aggregate. In its finished state concrete shall be sound and dense and durable and free from honeycombing and shall have the strength and other properties specified.

2. Pre-cast reinforced concrete box culvert units shall be sampled and tested for water absorption in accordance with Appendix F of AS/NZS 4058. The calculated water absorption of each unit shall not exceed 6.5 percent.

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FOI 26-292 - Document 27

3. All concrete shall be produced in accordance with the requirements of Specification 820 for S – Class or Specification 901 for N-Class based on the concrete class requirement.

404C.05.03 SECONDARY CEMENTITIOUS ADDITIVES

1. Cast in-situ structures including base slabs and end treatments, constructed in seawater or saline groundwater environments, shall use concrete containing 25% fly ash and at least 5% silica fume.

404C.05.05 ADMIXTURES

1. The use of admixtures in the concrete for the purpose of maintaining workability will be permitted. The use of admixtures for the purpose of reducing cement will not be permitted. If the Contractor proposes to use any admixtures in the concrete then details of these shall be submitted with the tender.

2. Any admixture to be used by the Contractor shall comply with the requirements of AS 1478.

3. Where specified in Annexure 404A – Table 404A2 the Contractor shall use culvert units containing an approved admixture in accordance with the following requirements:

    a. concrete shall contain a time-proven effective Hydrophobic Pore-blocking Ingredient (HPI) system, used strictly in accordance with the manufacturer's instructions and providing a hydrophobic cement matrix throughout, as well as dispersed polymer particles suitable for use as a pore- blocking agent.

4. The following hydrophobic pore-blocking ingredient system products are acceptable for use on MRWA projects: ***Approved HPIs***

    i. Everdure Caltite (Cementaid) Or similar approved product.
    ii. Admix C-5000 (Xypex) Or similar approved product.

404C.05.07 REINFORCEMENT

1. Reinforcing steel shall conform to the requirements of SPECIFICATION 822 STEEL REINFORCEMENT.

MANUFACTURE, HANDLING AND STORAGE

404C.06 CONCRETE

404C.06.01 MIX DESIGN

1. All S and N-Class concrete for the works shall be in accordance with the requirement of Specification 820 and Specification 901.

AFT

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FOI 26-292 - Document 27

404C.06.02 TRIAL MIXES

1. If a Contractor has not previously supplied box culverts to Main Roads Western Australia, or has changed the concrete mix design of any culverts, the Contractor shall submit details of the concrete mix design and shall, at the Contractor's own expense, prepare a trial mix for the required class of concrete using the plant to be used for concrete in the works.

404C.06.07 PLACING

1. Placing and compaction of concrete shall be in accordance with the requirement of Specifications 820 and 828.

404C.06.08 CURING AND PROTECTION

1. Curing of concrete shall be in accordance with the requirement of Specification 820

404C.07 REINFORCEMENT AND COVER

1. Reinforcement for the pre-cast units shall be fabricated and fixed in accordance with the requirements of Specification 822.

2. Reinforcement in the areas of the haunches shall be well anchored to resist stresses which occur during manufacture, handling, transporting and installation of the pre-cast units.

3. The minimum clear cover to the reinforcement for culvert units up to 1200mm span shall be as specified on Drawing Number 1930-0666.

4. The minimum clear cover to the reinforcement for culvert units 1500mm span and larger shall be as specified on Drawing Number 0530-1470.

5. Reinforcement shall be hard drawn steel wire or Grade 500N hot rolled deformed steel bars conforming to AS/NZS 4671. The minimum amount of main reinforcement shall be not less than 0.5% of the cross-sectional area of the walls or deck.

6. Where spacers or bar chairs are used to support reinforcement they shall be made of either plastic, concrete or stainless steel. No mild steel spacers shall be used.

7. For Culvert Units of 1500mm span and larger with fill depths up to 4.5 metres the following additional requirements shall apply:

    a. The Contractor shall detail the reinforcement to satisfy the requirements of this Annexure and Drawing Number 0530-1470.

    b. The Contractor will be required to provide reinforcement to each face of the pre-cast section. The minimum quantity of main reinforcement required at each face is given on the Drawings. The spacing between main reinforcing bars shall not exceed 200mm.

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FOI 26-292 - Document 27

c. Transverse distribution reinforcement is required to each face and shall not be less than 15 per cent of the main reinforcement taken over the same length. The spacing of the distribution reinforcement shall not exceed 300mm and the diameter of the bars shall not be smaller than 8mm.

d. Spot welding of the reinforcement for the sole purpose of cage fabrication will be allowed. The electrodes must be of the low hydrogen type.

e. Where spacers or bar chairs are used to support reinforcement, they shall not be placed in zones of high stress in the corners and mid span regions.

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FOI 26-292 - Document 27

TABLE 404.

404C.08 CASTING METHODS

1. The methods of manufacture shall be so designed to ensure that tolerances comply with AS 1597. The units shall be free from honeycombing and cracks and spalling. The ends of the units shall be free from any grout loss.

2. Moulds shall be designed to permit stripping without causing damage to the pre-cast units.

3. Pre-cast units shall not be removed from the casting mould until the concrete has attained compressive strength of not less than 15 MPa.

4. Each pre-cast unit shall be suitably marked with a number and a date of casting and size dimensions. The concrete test specimens shall be marked with the date sampled and the batch they represent.

404C.09 HANDLING OF PRE-CAST UNITS

404C.09.01 LIFTING SYSTEM

1. The lifting system for the pre-cast units shall be of the 'Swift-lift' type as marketed by Alan H Reid Pty Ltd, or Ramset 'Pin Head Anchors', or similar approved.

2. The number and size and location of the anchors to be cast into each pre-cast unit shall be as specified by the manufacturer of the lifting system.

3. The Supplier shall provide a set of lifting slings with each truck load of units despatched from his Works for unloading the units at the specified delivery site. The lifting slings will remain the property of the Supplier and return with the delivery truck. Cranage for lifting the units at the site will be provided by the Supplier.

404C.09.02 HANDLING AND LOADING

1. The pre-cast units shall be handled and loaded in such a manner so as not to cause damage to the units.

404C.10 DELIVERY AND STORAGE

1. Completed pre-cast units shall not be transferred from the place of manufacture until:

    a. For Culvert Units up to 1200mm span – the 28 day minimum compressive strength of concrete has been achieved.

    b. For Culvert Units 1500mm span or larger – the 28 day minimum compressive strength of concrete has been achieved. If an additional storage period has been specified then the units shall be stored at the Manufacturer's works for the nominated period and then delivered to site.

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FOI 26-292 - Document 27

2. The Contractor shall be responsible for the supply and delivery of units to site and the condition of the pre-cast units following delivery shall be in accordance with the requirements of this Annexure.

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FOI 26-292 - Document 27

INSPECTION AND TESTING

404C.11 MINIMUM TESTING FREQUENCY

1. Testing Procedures and Minimum Testing Frequencies shall be in accordance with Table 404C3.

2. The minimum testing frequency for materials used in concrete shall be in accordance with the requirement of MRWA Specification 201.

TABLE 404C3 – MINIMUM TESTING FREQUENCY

Process	Quality Verification Requirement	Minimum Testing Frequency
Pre-cast Reinforced Concrete Boxes	Cover to Reinforcement - as per AS 1597 and Clause 404C.07	In accordance with AS 1597
	Inspection for Defects - as per AS 1597 and Clause 404C 12	Visual inspection all units
	Absorption Testing – methodology as per AS/NZS 4058, applied to RCBs	In accordance with AS/NZS 4058 Appendix A, paragraph A3.4
	Dimensional Accuracy as per AS 1597	In accordance with AS 1597

404C.12 DEFECTS

1. Defects in culvert units, links and base slabs shall be classified by type as identified in AS 1597.

2. The following defects shall be deemed acceptable subject to the Acceptability of defects shown below:

Defect	Acceptability
Type 1	Acceptable*
Type 4	Acceptable after repair

* For culvert spans 1500mm and greater the acceptable crack width shall be no greater than 0.1mm

3. No other defect types will be accepted.

4. Chipped sections shall be repaired to the equivalent of the original condition using an epoxy mortar approved by the Superintendent.

5. Surface cracks shall be measured using a feeler gauge.

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FOI 26-292 - Document 27

404C.13 NON-CONFORMANCE

1. Culverts shall be deemed non-conforming if they do not meet the requirements of this Annexure and shall be rejected and replaced at no cost to the Principal.

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FOI 26-292 - Document 27

GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to downloaded Specifications shall be made using *Track Changes*, to clearly show added/deleted text.

2. If all information relating to a clause is deleted, the clause number should be retained and the words "NOT USED" should be inserted.

3. The proposed documents with tracked changes shall be submitted to the Project Manager for review, prior to printing the final batch of documents. When this final printing is carried out, the tracked changes option is to be turned off.

4. Before printing accept all changes in the document, turn off Track Changes and refresh the Table of Contents.

5. The Custodian of this specification is Senior Road Engineer.

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1. NON-HELICAL CORRUGATED STEEL PIPE (Clause 404.91)

1.1 Clause 404.91 shall be included under Contract Specific Requirements where non-helical corrugated steel pipe is to be used on a project.

2. PRECAST CONCRETE END TREATMENTS (Clause 404.92)

2.1 Clause 404.92 shall be included under Contract Specific Requirements where precast concrete end treatments are to be permitted on a project.
The Project Manager should be aware that pre-cast concrete end treatments generally do not meet the geometric requirements shown on the Drawings. Advice should be sought from MRWA's Structures Engineering Branch where, apron lengths, headwall heights, or wall thicknesses fall outside the dimensions shown on the Drawings.

3. CULWAYS (Clause 404.93)

3.1 Clause 404.93 shall be included under Contract Specific Requirements where Culways are to be installed.

4. STOCK AND FAUNA UNDERPASSES (Clause 404.94)

4.1 Clause 404.94 shall be included under Contract Specific Requirements where stock or fauna underpasses are to be installed.

5. GROUND CONDITIONS (Annexure 404A)

5.1 The ground conditions shall be classified as 'AGGRESSIVE' or' NON-AGGRESSIVE' to allow the correct culvert units to be supplied. Item 1 of Clause 404A1 should be completed accordingly (Note that with the exception of Corrugated Aluminium Pipes the default ground condition is set as Aggressive). Aggressive ground conditions include environments where:

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FOI 26-292 - Document 27

a. for reinforced concrete pipes – the interior surface of the pipeline is subject to tidal flow, openly exposed to direct wave action or wind driven salt-spray, or where the concentration limits applicable to some environmental constituents, detailed in AS/NZS 4058 Appendix E have been exceeded; or

b. for reinforced concrete boxes – the exposure classification is defined as B2, C or U in accordance with AS 5100.5 Table 4.3; or

c. for corrugated steel pipe – as detailed in AS/NZS 2041 Appendix C.

Where the chemical composition of the soil is unknown then guidance should be sought from MRWA's Structures Engineering Branch. Where any doubt exists the default condition shall be set as 'Aggressive'.

5.2 On larger projects where it may be uneconomical to classify soil conditions along the entire length as 'Aggressive' then Clause 404A1 Item 1 should be amended as per the following example:

a. The in-situ ground conditions with respect to the manufacture and installation of culverts shall be taken as 'Non-aggressive' except for the following locations, which shall be taken as 'Aggressive'.

Chainage	Culvert Type and Material	Ground Conditions
12290-13000	RCP	AGGRESSIVE
13005-14130	CSP	NON-AGGRESSIVE

Table 404A1 - Locations of 'Aggressive' Ground Conditions

Additionally the above Table information should be provided on the Culvert Schedule under the column titled 'Ground Conditions'. This will assist in the management of the assets in the future. Note, it is intended to only include this information in one location and that should be in the Culvert Schedule. The existing Annexure Item 1 would therefore become:

b. For details on ground conditions refer to Culvert Schedule.

5.3 Where culverts are to be used in 'Aggressive' ground conditions then direction on additional requirements should be inserted into Annexure 404A – Table 404A2 (under 'Requirements' column) as follows:

a. for reinforced concrete pipes – default requirements has been inserted and is applicable only where the environment can be defined as 'marine' in accordance with AS/NZS 4058. Where the pipeline is openly exposed to wind driven salt-spray, or direct wave action, or where the environmental constituent limits as defined in AS/NZS 4058 Appendix E have been exceeded, then direction on minimum cover should be sought from the Concrete Pipe Association of Australia and inserted into Annexure 404A, Table 404A2 as applicable.

b. for reinforced concrete boxes– the Project Manager has two options:
   i. Where the preferred method of protection is by concrete admixtures, add the following item to the Table;

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FOI 26-292 - Document 27

'Culvert units shall contain an approved Hydrophobic Pore-blocking Ingredient (HPI) system in accordance with Clause 404C.05.05'.

Alternative products to those listed in Clause 404C.05.05 shall not be used. Manufacturers of alternative products shall make a submission to MRWA's Structures Engineering Branch for acceptance and inclusion within the clause.

ii. The Project Manager may choose to substitute reinforced concrete pipes or large span RCB units in place of small span RCB units. Where substituting with pipes the Project Manager should seek confirmation from the Designer that the pipe(s) have as a minimum the same hydraulic capacity as the box unit(s) they are replacing. Where any substitution is proposed there are no additional special requirements for Annexure 404A Table 404A2.

c. for corrugated steel pipes – the Project Manager has two options:

i. Where the preferred method of protection is by means of a surface protection, details of the particular protection (i.e. brand name) should be added. Surface protection treatments shall be approved by MRWA's Structures Engineering Branch prior to its use.

ii. Where the preferred method of protection is by increasing the base metal thickness, then add the following Clause:
'All corrugated steel pipes shall have the base metal thickness increased to (…….) mm'. (Insert base metal thickness here)

6. JOINT TYPE FOR RCPs (Annexure 404A, Item 2)

6.1 Select the required joint type for RCPs.

7. ANNEXURE 404C

8. BOX CULVERTS FOR STORMWATER DRAINS (Clause 404.95)

8.1 Clause 404.95 shall be included under Contract Specific Requirements where Reinforced Concrete Boxes (RCBs) are intended to be used for connecting stormwater drainage pits.

9. REINFORCEMENT DETAILS FOR BOX CULVERTS

9.1 Where box culverts are to be used then the following relevant Drawings must be included within the Contract documents:

a. Where large culverts (Span ≥ 1500mm) are used include Drawing No. 0530-1470.

10. IN-SITU CONCRETE CLASS FOR END TREATMENTS (Annexure 404A and Clause 404.96)

10.1 Where the Contract does not include any bridgeworks or there are not high numbers of culverts 1500mm or greater then the requirement to use concrete class 'S50 to SPECIFICATION 820 CONCRETE FOR STRUCTURES' for base slabs and end treatments of large pipes and box culverts may be relaxed. In this case Table 404A3 of Annexure 404A should be amended as follows:

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FOI 26-292 - Document 27

Culvert Type	Culvert Span / Diameter	Concrete Class
RCB's and RCP's	All sizes	N40

TABLE 404A3 – In-situ Concrete Strength for Base Slabs and End Treatments

10.2 Additionally, Clause 404.96 should be added to Contract Specific Requirements, which has the added benefit that the bulk of culvert contract documents may be reduced by not having to unnecessarily include SPECIFICATIONS 819 and 821.

11. PLASTIC FLEXIBLE CULVERTS (Clause 404.97)

11.1 Flexible pipes may be considered in remote locations where the cost of transport becomes prohibitive, due to their light weight, or where conditions are aggressive, due to their inert nature to most naturally occurring chemicals.

11.2 Clause 404.97 should be added under Contract Specific Requirements where, the use of plastic flexible culverts, are permitted on a project.

11.3 Note that Section 2.0 'Minimum Testing Frequency' within SPECIFICATION 201 Quality Systems, will need to have the product/process 'Corrugated Metal Pipe' (under sub-section 2.3 'Drainage') amended to read "'Plastic Flexible Pipe'.

11.4 Unless otherwise recommended by the manufacturer, where plastic flexible culverts are to be used in ground conditions that would ordinarily be classified as 'Aggressive' for concrete culverts, Clause 404A1 (Annexure A) should be amended to "NOT USED". This is because the materials used in plastic flexible culverts are typically inert in such conditions.

11.5 Where in-situ concrete is proposed:

a. N40 in-situ concrete used for pipe diameter with < 1500mm.

b. N50 in-situ concrete used for pipe diameter with ≥ 1500mm

11.6 Alternative products to those listed in Clause 404.97.03 **shall not** be used. Manufacturers of alternative products shall make a submission to MRWA's Structures Engineering Branch for acceptance and inclusion within the clause.

12. SUPPLY & DELIVERY OF RCPs (Annexure 404B and Clauses 404.98 and 404.99)

12.1 SUPPLY

Where the contract is for Supply & Delivery of Reinforced Concrete Pipes, Clause 404.98 should be added and Clause 404B.09 should be added to the end of Annexure 404B.

12.2 QUALITY SYSTEM REQUIREMENTS

Where Supply Contracts for RCPs incorporate Quality System requirements, Clause 404.99 should also be added and Clause 404B.10 should be added to the end of Annexure 404B.

13. SUPPLY & DELIVERY OF RCBs (Annexure 404C, and Clauses 404.100 and 404.101)

13.1 SUPPLY

Where the contract is for Supply & Delivery of Reinforced Concrete Boxes, Clause 404.100 should be added and Clause 404C.15 should be added to the end of Annexure 404C.

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FOI 26-292 - Document 27

13.2 QUALITY SYSTEM REQUIREMENTS

Where, the Supply Contracts for RCB's incorporate Quality System requirements, Clause 404.101 should also be added and Clause 404C.16 should be added to the end of Annexure 404C.

14. DEWATERING (Clause 404.32.4)

14.1 Where the requirement for dewatering exists then Clause 204.94 in SPECIFICATION 204 – ENVIRONMENT (SPECIFICATION 204 Guidance Notes) shall be added to the Contract Specific Requirements of that document.

15. LOW STRENGTH INFILL (Clause 404.41.02 and Clause 404.92)

15.1 In certain situations such as road widening, redundant existing drainage located under the verge may ultimately become located under the roadway. If this occurs then Clause 404.102 shall be added to the Contract Specific Requirements of that document.

16. CONSTRUCTION TRAFFIC OVER CULVERTS (Clause 404.39)

16.1 The Superintendent may choose to allow construction traffic with greater than the legal wheel or axle loading to pass over culverts. Prior to approval the Contractor should provide suitable evidence stating that damage to the culvert unit(s) shall not occur, either in the form of:

a. the culvert manufacturer's approval; or
b. the outputs from the Concrete Pipe Association of Australia's 'Pipe Class' software,

17. SCHEDULE OF EXISTING CULVERTS THAT MAY CONTAIN ASBESTOS CONTAINING MATERIAL (ACM) in SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH

17.1 In the schedule in SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH include culverts that are being removed or substantially disturbed where the culvert is manufactured from a concrete (or similar) product (i.e. excluding circular steel pipes) and:

a. there is reasonable grounds to believe that they were constructed in 2003 or earlier (refer to IRIS and/or As Constructed Drawings for further information); and

b. testing of the culvert for ACM has not been conducted or testing has confirmed the presence of ACM.

17.2 For circular culverts, include diameters

17.3 For box culverts, include horizontal and vertical sizes.

17.4 In comments column, minimum detail should state whether testing for ACM has been conducted and if it has been conducted, confirm the presence of ACM, along with reference to further information.

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FOI 26-292 - Document 27

CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style "H2 SP" so it appears in the Table of Contents.

404.91 NON-HELICAL CORRUGATED STEEL PIPE

1. Non-helical corrugated steel barrels shall either be a nestable or multi-plate bolted type.

2. Non-helical galvanised steel barrels shall conform to AS/NZS 2041.

3. Corrugation size for non-helical corrugated steel pipe shall be in accordance with Table 1.1 of AS/NZS 2041. ***Corrugations***

4. The Contractor shall ensure that the equipment used during compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with AS/NZS 2041 for non-helical corrugated steel pipes. ***Compaction Equipment***

5. Installation of non-helical corrugated steel pipes shall comply with the requirements of this SPECIFICATION, the Drawings and AS/NZS 2041.

404.92 PRE-CAST CONCRETE END TREATMENTS

1. Where specified in the Culvert Schedule, the Contractor shall use pre-cast concrete end treatments. The pre-cast concrete end treatments shall comply with the following minimum requirements:

    a. The end treatments shall be placed on a concrete bed consisting of Class N40 concrete, not less than 50mm thick and be restrained against movement, including overturning.

    b. Where not incorporated into the pre-cast unit, the concrete bed shall be constructed with a 150mm wide by 450mm deep cut off wall unless otherwise specified in the Culvert Schedule.

404.93 CULWAYS

1. Backfill requirements for Culways shall consist of cement stabilised backfill as specified in Clause 404.10 – Cement Stabilised Backfill to the level of the top of box culvert. Where the cover to subgrade surface is less than 600mm then the backfill material over the culverts shall be basecourse quality. Where the cover to the subgrade surface is greater than 600mm then the upper 600mm layer of backfill material shall be basecourse quality and the remaining lower layer shall be sub base quality material to the required thickness. Basecourse and sub base quality material shall be in accordance with SPECIFICATION 501 PAVEMENTS. Backfill over Culways shall be compacted in accordance with this Specification.

DRAFT

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FOI 26-292 - Document 27

404.94 STOCK AND FAUNA UNDERPASSES

1. Where reinforced concrete box culverts are to be used as underpasses for stock or native fauna then the approaches to both ends of the culvert shall consist of a 300mm thick layer of embankment quality material to the dimensions and grades as shown on the Drawings.

404.95 BOX CULVERTS FOR STORMWATER DRAINS

1. The requirements of this Specification applicable to Reinforced Concrete Boxes (RCB's) used as culverts also apply to RCBs installed to carry stormwater from drainage pits.

2. Stormwater drains consist of reinforced concrete pipes or reinforced concrete boxes connecting drainage structures such as inlets, manholes and catchpits as shown on the Drawings.

404.96 IN-SITU CONCRETE CLASS FOR END TREATMENTS

1. All formwork used to form and support the concrete shall conform to the requirements of AS 3610.

404.97 PLASTIC FLEXIBLE CULVERTS

404.97.01 GENERAL

Scope

1. The work to be executed under this SPECIFICATION consists of the supply and installation of plastic flexible pipes for use on Main Roads projects culverts only in accordance with AS/NZS 2566.2.

404.97.02 DEFINITIONS

1. Culverts shall also include fittings as recommended by the manufacturer.

404.97.03 PLASTIC FLEXIBLE PIPES AND FITTINGS

1. Plastic flexible pipes and fittings for use on Main Roads projects culverts are limited to Polyethylene (PE) only.

2. Polyethylene (PE) plastic flexible pipes and fittings shall be manufactured, tested and inspected in accordance with AS/NZS 4130 and AS/NZS 5065.

3. The structural design procedure shall be in accordance with AS/NZS 2566.1 and the Austroads Research Report AP-R575-18 Design of Buried Flexible Pipes.

404.97.04 JOINT SEALANTS AND JOINT TYPES

1. Joint sealants used for coupling of pipe segments shall be in accordance with AS/NZS 2566.2 Appendix F – 'Methods of Jointing'.

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FOI 26-292 - Document 27

404.97.05 TRENCH EXCAVATION

1. Except for culvert extensions, no culvert shall be laid until the embankment at the point of laying has been brought to a level 600 mm above all points along the top of the culvert conduit, or to the subgrade level, whichever is the lesser, and compacted. Measurement shall be taken from the top of collar or in the case of flexible pipes with ribs from the top of the rib.

Embankment Height

404.97.06 DAMAGE

1. Plastic reinforced pipes shall be handled and installed in such a manner so as to prevent damage to the pipes. Damage shall be assessed in accordance with the Acceptance Criteria detailed in AS 2566.2. Where approved by the Superintendent, damaged units shall be repaired in accordance with manufacturer's requirements. Where damaged units are unable to be repaired then they shall be replaced at no cost to the Principal.

Damaged Plastic Units

2. Where approved by the Superintendent, minor damage to culverts may be repaired in accordance with the manufacturer's recommendations.

Minor Repair

404.97.07 COMPACTION

1. The Contractor shall ensure that the equipment used during the compaction of backfill does not damage the culvert. Limitations on the type of compaction equipment, and cover to be provided to the top of the culvert shall be determined in accordance with Clause 5.5.2 "Protection of Pipeline" AS/NZS 2566.2 and satisfy the manufacturer's published requirements.

2. Appropriate precautions, such as the use of holding down straps shall be taken to ensure that plastic pipe culverts barrels do not 'float' during the backfilling process, particularly during vibration of the backfill

Plastic Culvert 'Float' Precautions

404.97.08 PIPE SHAPE POST INSTALLATION

1. Variations allowed in the internal diameter of installed culverts shall be in accordance with AS/NZS 2566.2. Testing frequency shall be in accordance with SPECIFICATION 201 QUALITY SYSTEMS.

404.97.09 HANDLING

1. Plastic flexible pipes shall be loaded, carted, unloaded and stored in accordance with AS/NZS 2566.2 Section 2 – 'Transportation, Handling and Storage.' Damaged pipes shall be assessed and repaired or replaced in accordance with AS/NZS 2566.2 Section 3 – 'Pipeline Components Acceptance Criteria' and the manufacturer's requirements at no cost to the Principal.

404.98 SUPPLY AND DELIVERY OF RCPs - DELIVERY

1. Insert the following clauses at the end of Annexure 404B, and delete highlighted text:

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FOI 26-292 - Document 27

404B.09 DELIVERY

1. Batches of pipes for delivery which comply with AS/NZS 4058 manufacturing and testing requirements and the Technical Specification shall be acceptable for delivery.

404B.09.01 SUPPLY ONLY CONTRACTS

1. The Principal will give the Contractor two weeks notice of when pipes for non-aggressive environments will be required for delivery. The Principal will give the Contractor six weeks notice of when pipes for aggressive environments or for extra strength load classes (i.e. Load Class 6 and higher) will be required for delivery. Completion of any order will depend on the size of pipe and the number required and shall be agreed with the Principal when the order is placed.

2. The Principal will be responsible for delivering the pipes to site. The Contractor shall be responsible for loading the precast pipes onto the truck supplied by the Principal.

404B.09.02 SUPPLY AND DELIVERY CONTRACTS

1. The Contractor shall supply and deliver to site, and offload the pipes at the site when delivery is included in the Price Schedule.

2. The Principal will provide the Contractor with a minimum of two weeks notice prior to the required delivery date.

404.99 SUPPLY AND DELIVERY OF RCPs – QUALITY

1. Insert the following clauses at the end of Annexure 404B, and delete highlighted text:

404B.10 QUALITY SYSTEM REQUIREMENTS

404B.10.01 QUALITY SYSTEM REQUIREMENTS FOR CRITICAL SUBCONTRACTS

1. The subcontracts listed below shall require the subcontractor to have a Certified Quality System in accordance with SPECIFICATION 201 QUALITY SYSTEMS.

    a. Cement
    b. Aggregate
    c. Reinforcement
    d. RCP Rubber Joint Rings

404B.10.02 TRACEABILITY

1. Traceability shall apply to the following processes:

    a. Concrete – the trace shall start at the batching plant at the start of manufacture.

DRAFT

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FOI 26-292 - Document 27

b. Precast concrete drainage pipes – batches shall have a unique identification.

404B.10.03 PROCESS CONTROL AND SPECIAL PROCESSES

1. A copy of the following process descriptions or procedures shall be submitted to the Superintendent at least one week prior to commencing each work process.

   a. Reinforcement – measures that ensure strict adherence to the requirements for cover to reinforcement in accordance with Clause 5 of the Specification for the Supply of RCPs (Annexure 404B).

   b. Concrete Manufacture – manufacturing procedures that ensure the production of a uniform quality concrete with minimum variation in workability and strength. Testing of the moisture content of the aggregate as dictated by weather and variations in the material supplied will be necessary to achieve this.

   c. Concrete Transport, Placing and Curing – procedures for handling, placing and compaction of concrete that ensure the production of a sound and durable product.

404.100 SUPPLY AND DELIVERY OF RCB - DELIVERY

1. Insert the following clauses at the end of Annexure 404C, and delete highlighted text:

404C.15 DELIVERY

1. Batches of RCBs for delivery which comply with AS 1597 manufacturing and testing requirements and the Specification shall be acceptable for delivery.

404C.15.01 SUPPLY ONLY CONTRACTS

1. The Principal will give the Contractor two weeks notice of when RCBs will be required for delivery. Completion of any order will depend on the size of RCB and the number required and shall be agreed with the Principal when the order is placed.

2. The Principal will be responsible for delivering the RCBs to site. The Contractor shall be responsible for loading the precast RCBs onto the truck supplied by the Principal.

404C.15.02 SUPPLY AND DELIVERY CONTRACTS

1. The Contractor shall supply and deliver to site, and offload the RCB's at the site when delivery is included in the Price Schedule.

2. The Principal will provide the Contractor with a minimum of two weeks notice prior to the required delivery date.

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FOI 26-292 - Document 27

404.101 SUPPLY AND DELIVERY OF RCB – QUALITY

1. Insert the following clauses at the end of Annexure 404C, and delete highlighted text:

404C.16 QUALITY SYSTEM REQUIREMENTS

404C.16.01 QUALITY SYSTEM REQUIREMENTS FOR CRITICAL SUBCONTRACTS

1. The subcontracts listed below shall require the subcontractor to have a Certified Quality System in accordance with SPECIFICATION 201 QUALITY SYSTEMS.

    a. Cement

    b. Aggregate

    c. Reinforcement

404C.16.02 TRACEABILITY

1. Traceability shall apply to the following processes:

    a. Concrete - the trace shall start at the batching plant at the start of manufacture.

    b. Precast concrete box culverts - batches shall have a unique identification.

404C.16.03 PROCESS CONTROL AND SPECIAL PROCESSES

1. A copy of the following process descriptions or procedures shall be submitted to the Superintendent at least one week prior to commencing each work process.

    a. Reinforcement - measures that ensure strict adherence to the requirements for cover to reinforcement in accordance with Clause 404C.07 of the Specification for the Supply of RCBs (Annexure 404C).

    b. Concrete Manufacture - manufacturing procedures that ensure the production of a uniform quality concrete with minimum variation in workability and strength. Testing of the moisture content of the aggregate as dictated by weather and variations in the material supplied will be necessary to achieve this.

    c. Concrete Transport, Placing and Curing - procedures for handling, placing and compaction of concrete that ensure the production of a sound and durable product.

DRAFT

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FOI 26-292 - Document 27

404.102 REDUNDANT CULVERTS

1. Where indicated on the Drawings, any redundant culvert and associated drainage structure which are to be retained in its existing location shall be entirely filled in in-situ, in accordance with SPECIFICATION 410 LOW STRENGTH INFILL. The open ends of any remaining pipe runs and apertures left in drainage structures shall be permanently sealed off to exclude water, sand or other material.

DRAFT

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FOI 26-292 - Document 27

AMENDMENT CHECKLIST

Specification No. **404** Title: **CULVERTS** Revision No: _____

Project Manager: _____ Signature: _____ Date: _____

Checked by: _____ Signature: _____ Date: _____

Contract No: _____ Contract Description: _____

ITEM	DESCRIPTION	SIGN OFF
Note: All changes/amendments must be shown in Tracked Changes mode until approved.		
2.	Project Manager has reviewed Specification and identified Additions and Amendments.	
3.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (Refer Specification Guidance Notes for guidance).	
4.	Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16.	
5.	Standard clauses amended? **MUST SEEK** approval from Manager Contracts	
6.	Clause deletes shows as **"NOT USED"**.	
7.	Appropriate **INSPECTION AND TESTING** parameters included in Spec 201 (Text Methods, Minimum Testing Frequencies verified).	
8.	**ANNEXURES** completed (refer Specification Guidance Notes).	
9.	**HANDOVER** and **AS BUILT** requirements addressed.	
10.	Main Roads QS has approved changes to **SMM**.	
11.	Project Manager certifies completed Specification reflects intent of the design.	
12.	Completed Specification – independent verification arranged by Project Manager.	
13.	Project Manager's review completed.	
14.	**SPECIFICATION GUIDANCE NOTES** deleted.	
15.	**TABLE OF CONTENTS** updated.	
16.	**FOOTER** updated with Document No., Contract No. and Contract Name.	
17.	Supporting information prepared and submitted to Project Manager.	
Further action necessary:		

Signed: _____ *(Project Manager)* Date: _____

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mainroads WESTERN AUSTRALIA

SPECIFICATION 405

DRAINAGE STRUCTURES

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REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
405.02	Added reference to National Code of Practice for the safe removal of Asbestos	SRE	21/10/2019
405.03	Added new definition for Asbestos Containing Material	SRE	21/10/2019
405.36,405.37, 405.38,405.39	Added requirements relating to Asbestos Containing Material (ACM)	SRE	21/10/2019
Guidance Note 4	Additional Guidance Note relating to Specification 203 Occupational Safety and Health	SRE	21/10/2019
405.02, 405.29, 405.31, 405.33.2, 405.34.01.3, 405.34.01.5, 405.34.02.2	Standards and clauses updated	SRE	20/03/2019
Whole document	Reformatted	SCO	01/05/2017
Guidance Notes	Amended note incorrectly shown as Clause	SRE	24/06/2011
Whole document	Updated / amended referenced documents. Amended compressive strength for bricks and amended wall thickness requirements. Revised Clauses for consistency with Specification 404.	SRE	06/02/2009
Whole document	Complete revision of Issue No 2.2 to new format	MCP	01/08/2006

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FOI 26-292 - Document 27

CONTENTS

Clause **Page No**

GENERAL 5

405.01 Scope 5
405.02 References 5
405.03 Definitions 6
405.04 – 405.05 NOT USED 6

PRODUCTS AND MATERIALS 6

405.06 Concrete 6
405.07 Reinforcement 6
405.08 Manholes, Gullies and Catchpits 6
405.09 Select Bedding Material 7
405.10 – 405.25 NOT USED 7

INSTALLATION 7

405.26 General 7
405.27 Excavations 8
405.28 Blasting 8
405.29 Protection of Foundation Surfaces 8
405.30 Bedding 8
405.31 Handling of Precast Units 9
405.32 Backfill and Compaction 9
405.33 Pavement Reinstatement 9
405.34 Drainage Structures 9
405.35 Step Irons 11
405.36 Removal of Existing Drainage Structures 11
405.37 Damage to Existing Structures 12
405.38 Adjustments of Existing Gully Grates And Manhole Covers 12
405.39 Breaking into an Existing Structure 13
405.40 New Structure with Existing Pipes 13
405.41 Cleaning 13
405.42 Stormwater Drains 13
405.43 – 405.80 NOT USED 13

AS BUILT AND HANDOVER REQUIREMENTS 13

405.81 – 405.90 NOT USED 13

CONTRACT SPECIFIC REQUIREMENTS 13

405.91 – 405.99 NOT USED 13

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FOI 26-292 - Document 27

ANNEXURE 405A 17

Existing Drainage Structures 17

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FOI 26-292 - Document 27

SPECIFICATION 405

DRAINAGE STRUCTURES

GENERAL

405.01 SCOPE

1. The work under this specification consists of the supply and installation of minor road drainage structures including gullies, manholes and catchpits.

405.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian/New Zealand Standards

AS/NZS 1554.1	Structural steel welding - Part 1: Welding of steel structures
AS/NZS 3679.1	Structural steel - Part 1: Hot-rolled bars and sections
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)
AS/NZS 4456.4	Masonry units and segmental pavers and flags - Methods of test - Method 4: Determining compressive strength of masonry units
AS/NZS 4456.10	Masonry units and segmental pavers and flags - Methods of test - Method 10: Determining resistance to salt attack
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

Main Roads Test Methods

WA 115.2	Particle Size Distribution: Abbreviated Method for Coarse and Medium Grained Soils

Other Standards

NOHSC:2002	National Code of Practice for the Safe Removal of Asbestos

Main Roads Specifications

Specification 201	QUALITY SYSTEMS

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FOI 26-292 - Document 27

Specification 203 OCCUPATIONAL SAFETY AND HEALTH

Specification 204 ENVIRONMENTAL MANAGEMENT

Specification 302 EARTHWORKS

Specification 404 CULVERTS

Specification 410 LOW STRENGTH INFILL

Specification 501 PAVEMENTS

Specification 503 BITUMINOUS SURFACING

Specification 504 ASPHALT SURFACING

Specification 901 CONCRETE - GENERAL WORKS

405.03 DEFINITIONS

1. Asbestos Containing Material (ACM) has the same meaning as detailed in the National Code of Practice for the Safe Removal of Asbestos — ***Asbestos Containing Material***

405.04 – 405.05 NOT USED

PRODUCTS AND MATERIALS

405.06 CONCRETE

1. All in-situ concrete shall be supplied in accordance with Specification 901 CONCRETE - GENERAL WORKS unless otherwise detailed. — ***Supply***

405.07 REINFORCEMENT

1. Reinforcing steel shall conform to the relevant requirements of AS/NZS 4671 for both Plain Steel Reinforcing Bars and Hard Drawn Steel Wire Reinforcing Fabric. — ***Steelwork***

2. The cleaning, binding, fixing and tying of all reinforcement shall be completed as specified in Specification 901 CONCRETE - GENERAL WORKS. — ***Fixing***

405.08 MANHOLES, GULLIES AND CATCHPITS

405.08.01 MANHOLE, GULLY AND CATCHPIT COVERS AND FRAMES

1. Manhole, gully and catchpit covers and frames shall be manufactured from pre-cast concrete and mild steel plates to the shapes and sizes shown in the Drawings. — ***Covers & Frames***

2. Mild steel plates and sections shall be of Grade 300 steel in accordance with AS/NZS 3679.1. — ***Steel Grade***

3. All welds shall be 6 mm continuous fillet welds in accordance with AS/NZS 1554.1 unless otherwise detailed on the Drawings. — ***Welds***

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FOI 26-292 - Document 27

4. All mild steel components shall be hot dipped galvanised after fabrication in accordance with AS/NZS 4680. ***Galvanising***

5. Manhole, gully and catchpit covers should be flush with the frame with a maximum allowable vertical tolerance of ± 3 mm. ***Tolerances***

6. Manhole, gully and catchpit covers shall fit tightly within their frames with the total gap between the cover and their frame in any direction not be greater than 5 mm

405.08.02 MISCELLANEOUS STEEL DETAILS

1. Miscellaneous steel details such as gully hoods shall be manufactured from mild steel conforming to AS/NZS 3679.1and where required, hot dipped galvanised conforming to the requirements of AS/NZS 4680 except that the zinc coating shall weigh not less than 600 grams per square metre of actual surface area. ***Steel***

405.08.03 BRICKS

1. All bricks shall be 230 mm x 110 mm x 76 mm nominal size, sound, hard, well burnt and true to shape and dimensions. All bricks shall be solid brick having durability classification 'Exposure' in accordance with AS/NZS 4456.10 and have minimum characteristic unconfined compressive strength of 16 MPa in accordance with AS/NZS 4456.4. ***Size & Strength***

405.08.04 PRECAST CONCRETE LINERS

1. Pre-cast liner segments shall be manufactured as concrete pipes to AS/NZS 4058.

2. Reinforcement shall be the same as that for the equivalent Class '2' RCP, but shall be circular. ***Reinforcement***

3. Pre-cast concrete liner wall thickness shall as a minimum permit concrete cover to reinforcement to be in accordance with Specification 404 – CULVERTS for reinforced concrete pipes (RCPs). ***Wall Thickness***

4. Load testing will not be required. ***Load Testing***

405.09 SELECT BEDDING MATERIAL

1. Select bedding material shall be basecourse material, or other suitable material approved by the Superintendent, containing less than 20% by mass material retained on the 37.5 mm sieve as determined by MRWA Test Method WA 115.2

405.10 – 405.25 NOT USED

INSTALLATION

405.26 GENERAL

1. The installation of drainage structures shall include all excavations, construction and backfill to the details shown on the Drawings and as described in this Specification.

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FOI 26-292 - Document 27

405.27 EXCAVATIONS

1. The hole for the installation of the drainage structure shall be excavated to the extent permitting installation in accordance with the Drawings, with vertical sides throughout where the excavation is up to 1.5 metres deep. ***< 1.5m Depth***

2. Where the excavation is greater than 1.5 metres deep, the hole shall be excavated in accordance with the Drawings for pipes having trench excavation greater than 1.5 metres deep. Any loose or disturbed material shall be removed from the walls of the excavation. ***> 1.5m Depth***

3. All spoil material from excavations shall be disposed of in accordance with Specification 302 EARTHWORKS. ***Unsuitable Material***

4. Excavations shall be kept free from water until work below ground level is sufficiently set or protected. Dewatering operations shall be undertaken in accordance with Specification 204 ENVIRONMENT, and water discharged from trenches shall in no circumstances be disposed of to sanitary sewers. ***Dewatering***

5. Excavation in rock shall be carried out in accordance with Specification 302 EARTHWORKS.

405.28 BLASTING

1. Any requirement for blasting shall be carried out in accordance with Specification 302 EARTHWORKS. ***Blasting***

405.29 PROTECTION OF FOUNDATION SURFACES

1. The exposed surface at the bottom of each excavation shall be adequately protected from any disturbance by the Contractor's operations or any action from stormwater and groundwater. Where required, dewatering shall be undertaken in accordance with the requirements of Specification 204 ENVIRONMENT. Any disturbance shall be reinstated to the requirements of Clause 405.30 'Bedding' by the Contractor at no cost to the Principal. ***Exposed Surface***

405.30 BEDDING

1. Unless shown otherwise on the Drawings, drainage structures shall be bedded on the in-situ foundation material, which has been compacted to the requirements specified for 'Embankment Foundation' in Specification 302 EARTHWORKS, with a testing frequency in accordance with Specification 201 QUALITY SYSTEMS. ***In-situ Bedding***

2. In-situ bedding material deemed unsuitable by the Superintendent shall be removed to the depth as directed and replaced with a suitable bedding material prior to the laying of the base slab. ***Unsuitable Material***

3. The bedding material shall be compacted to the Characteristics Dry Density Ratio as specified for 'Embankment Construction' in Specification 302 EARTHWORKS, with a testing frequency in accordance with Specification 201 QUALITY SYSTEMS. ***Select Bedding Material***

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FOI 26-292 - Document 27

405.31 HANDLING OF PRECAST UNITS

1. Pre-cast units shall be handled and installed in such a manner that no non-conforming cracking or any other non-conforming defect occurs outside the acceptable limits given in Specification 404 CULVERTS Annexure 404B. Damaged pipe and box culverts shall be repaired or replaced in accordance with Annexure 404B and Annexure 404C at no cost to the Principal. ***Damaged Concrete Units***

405.32 BACKFILL AND COMPACTION

1. **Prior to backfilling the Contractor shall certify to the Superintendent that compliance has been achieved with all specified requirements.** ***HOLDPOINT***

2. Unless otherwise shown on the Drawings backfill material up to sub-grade level shall be embankment material placed and compacted to the requirements as specified for 'Embankment Construction' in Specification 302 EARTHWORKS, with a testing frequency in accordance with Specification 201 QUALITY SYSTEMS. ***Below Subgrade***

3. Unless otherwise shown on the Drawings backfill material above sub-grade level shall be pavement material placed and compacted in accordance with Specification 501 PAVEMENTS, with a testing frequency in accordance with Specification 201 QUALITY SYSTEMS. ***Above Subgrade***

4. Backfilling and compaction of stormwater drains shall be carried out in accordance with Specification 404 CULVERTS. All conduits connecting to the drainage structure that are damaged by the backfilling and compaction processes used by the Contractor, shall be repaired or replaced at no cost to the Principal. ***Damage***

405.33 PAVEMENT REINSTATEMENT

1. Where a structure is constructed within an existing road pavement, the pavement on the existing road shall be reinstated by the construction of the appropriate pavement layers with thicknesses as shown in the Drawings. ***Reinstatement***

2. The edges of the excavation shall be saw cut straight and the excavation backfilled to the requirements of Clauses 405.26 'General' and 405.32 'Backfill and Compaction' respectively. The pavement layer(s) shall be constructed to the relevant requirements of Specification 501 PAVEMENTS. ***Edges & Pavement***

3. Bituminous surfacing and asphalt shall be applied in accordance with requirements of Specification 503 BITUMINOUS SURFACING and Specification 504 ASPHALT SURFACING respectively, with the top surface finished level with the surrounding existing sealed surface. ***Surfacing***

4. A waterproof seal shall be placed between the new and the old surfaces. ***Waterproof Seal***

405.34 DRAINAGE STRUCTURES

405.34.01 GENERAL

1. Drainage structures shall be installed as the Works proceed and shall be effectively sealed at joints and connection point against the ingress of water and other kinds of materials.

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FOI 26-292 - Document 27

2. Drainage structures shall be constructed for details and location as specified in the Drawings to a horizontal tolerance of ± 25 mm. The bases shall be placed on firm uniformly compacted and finished bedding as specified in Clause 405.30 BEDDING. ***Tolerances***

3. Inlet and outlet invert levels shall be as shown in the Drawings to a vertical tolerance of ± 10 mm. ***Level Tolerances***

4. The finished level of manholes, gullies and catchpits should be flush with the finished level of surrounding area. The maximum allowable vertical tolerance is ± 3 mm ***Finished Surface Tolerance***

5. Any drainage structure which is not true to line, or level, or shows settlement after laying, or which is damaged during backfilling, compaction or subsequent operations, shall be removed by the Contractor and replaced at no cost to the Principal. ***Replacement***

405.34.02 IN-SITU CONCRETE DRAINAGE STRUCTURES

1. Unless otherwise shown on the Drawings, all in-situ concrete shall be Class N32, supplied and placed in accordance with Specification 901 CONCRETE - GENERAL WORKS and to the details shown on the Drawings. ***Concrete***

2. The base concrete slab shall be laid first. Pipes entering the structure shall be trimmed to length if necessary, supported on the slab and secured at their correct location and level and the walls built up around them. Any reinforcement exposed at the ends of the cut pipes shall be treated with an approved Epoxy mortar.

3. All inlet and outlet pipes shall be solidly grouted in place to affect a watertight closure using a cement mortar of one (1) part Portland cement and three (3) parts sand. ***Grouting***

4. Special care shall be taken to bring the top of the walls to a good finish so that the cover slabs may be accurately seated with a minimum thickness of mortar bed. ***Finish***

5. All holes shall be completely filled with cement mortar consisting of one (1) part Portland cement and three (3) parts sand and all joints neatly pointed inside and outside. ***Holes***

6. On completion of the walls to the required height the reinforced cover slab may be placed in position. The opening in the cover slab shall be closed with a suitable temporary cover before backfilling is completed. ***Cover Slab***

7. All sheeting braces and similar temporary supports shall be entirely removed from the excavation prior to backfilling. Removal shall be effected in such a way so as not to disturb or displace the drainage structure. ***Temporary Support***

8. No backfill shall be placed behind in-situ drainage structures within seven days of concrete being placed. ***Concrete Strength***

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FOI 26-292 - Document 27

405.34.03 BRICK CONSTRUCTION

1. Unless otherwise detailed on the Drawings the provisions relating to in-situ concrete drainage structures shall apply to drainage structures of brick construction where such method is a specified alternative.

2. Bricks shall be well wetted before use and every course shall be set in a full bed of cement mortar with all joints solidly filled. Walls shall be properly bonded, fair faced and flush pointed internally. ***Pointing***

3. No bats or broken bricks will be allowed, except where necessary for closers. Mortar joints shall not be thicker than 10 mm, but some variation is permissible where brickwork is used to adjust the height and slope of catchpit and gully frames. ***Mortar Thickness***

405.34.04 PRECAST CONCRETE LINERS

1. Unless otherwise detailed on the Drawings the provisions relating to in-situ concrete drainage structures shall apply to those of precast concrete liner construction wherever relevant.

2. Holes of sufficient size to accommodate entry and exit pipes shall be cut or punched out in accordance with the manufacturer's published requirements without cracking the liner or causing unnecessary damage. The hole to accommodate the pipe shall be no greater than the pipe diameter plus 100 mm. Cement mortar, or an approved Epoxy mortar shall be used in sealing around holes formed in structures to accommodate entry and exit conduits. ***Liner Holes***

405.35 STEP IRONS

1. Where the depth of manholes and gullies are greater than one metre, step irons shall be provided at 300 mm intervals in height unless otherwise shown on the Drawings.

405.36 REMOVAL OF EXISTING DRAINAGE STRUCTURES

1. Where detailed on the Drawings, redundant drainage structures located under roadways shall be removed. ***Removal***

2. Existing drainage structures nominated by the Principal as requiring demolition or removal that contain or potentially contain asbestos are nominated in SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH. Management of these existing drainage structures shall be in accordance with SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH. ***Asbestos Containing Material***

3. If an existing drainage structure does not contain Asbestos Containing Material it shall be disposed of by the Contractor to the Contractor's disposal site, or an authorised waste disposal site or a site approved by the relevant Local Government Authority.

4. Voids left from the removal of a drainage structure, not intended to be replaced shall be backfilled and compacted with embankment quality material in accordance with Specification 302 EARTHWORKS or Pavement Material in accordance with Specification 501 PAVEMENTS, as required by this Specification. ***Voids***

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FOI 26-292 - Document 27

405.37 DAMAGE TO EXISTING STRUCTURES

1. If during construction of the Works, the Contractor causes damage to any drainage structure that is not to be removed or disturbed, the Contractor shall adhere to the requirements of SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH relating to Asbestos Containing Material.

2. Where the existing drainage structure does not contain Asbestos Containing Material, the Contractor shall repair the damage or replace the damaged drainage structure to the requirements of this Specification at no extra cost to the Principal.

405.38 ADJUSTMENTS OF EXISTING GULLY GRATES AND MANHOLE COVERS

1. Where existing gully grates and manholes need to have the levels adjusted to suit the Works, level adjustments up to a maximum of 50 mm are acceptable by using an approved mortar.

405.38.01 PRE-CAST LINERS

1. For adjustments greater than 50 mm either spacer rings, cutting of the existing liner or cutting of additional nominal length liners shall be used. The Contractor shall adhere to the requirements of SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH relating to Asbestos Containing Material for all cutting of existing liners. All cutting of either the existing liner or the spacer rings shall be undertaken such that the cuts are square to the length.

2. The reinforcement exposed at the ends of the cut liners shall be treated with an approved Epoxy mortar.

405.38.02 BRICK STRUCTURES

1. For level adjustments from 60 mm to 86 mm, 50 mm high bricks shall be used.

2. For level adjustments greater than 86 mm, additional 76 mm high bricks shall be added to the structure up to a maximum of six courses. Alternatively a conversion slab and precast spacer rings and/or liners can be used to adjust the levels.

405.38.03 CONCRETE CAST IN-SITU STRUCTURES

1. For level adjustments from 60 mm to 86 mm, 50 mm high bricks shall be used.

2. For level adjustments greater than 86 mm, additional 76 mm high bricks shall be added to the structure up to a maximum of six courses. Alternatively a conversion slab and precast spacer rings and/or liners can be used to adjust the levels.

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FOI 26-292 - Document 27

405.39 BREAKING INTO AN EXISTING STRUCTURE

1. Where shown on the Drawings existing drainage structures shall be broken into and new pipes installed. The Contractor shall adhere to the requirements of SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH relating to Asbestos Containing Material for all breaking into existing drainage structures.

2. When breaking into the structure, holes of sufficient size to accommodate the new pipes shall be cut or punched out without causing any unnecessary damage to the structure. The hole to accommodate the pipe shall be no greater than the pipe diameter plus 100 mm. Cement mortar or an approved Epoxy mortar shall be used in sealing holes around the new pipe to affect a watertight closure.

3. Any damage to the structure during the installation of new pipes shall be repaired by the Contractor at no cost to the Principal.

405.40 NEW STRUCTURE WITH EXISTING PIPES

1. Drainage structures shall be constructed on existing drainage lines where shown on the Drawings. The Contractor shall adhere to the requirements of SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH relating to Asbestos Containing Material for all breaking into existing drainage lines.

2. When breaking into existing drainage lines, cutting of the existing pipes shall be made square to the pipe.

3. The reinforcement exposed at the ends of the cut pipes shall be treated with an approved Epoxy mortar.

405.41 CLEANING

1. **Prior to the Superintendent's inspection and commissioning, all drainage structures shall be completely cleaned of any material left over as a result of the construction process upon completion of the Works.** ***HOLD POINT***

405.42 STORMWATER DRAINS

1. Supply and installation of connecting stormwater drains shall be in accordance with the Drawings and Specification 404 CULVERTS

405.43 – 405.80 NOT USED

AS BUILT AND HANDOVER REQUIREMENTS

405.81 – 405.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

405.91 – 405.99 NOT USED

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FOI 26-292 - Document 27

GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to downloaded Specifications shall be made using *Track Changes*, to clearly show added/deleted text.

2. If **all** information relating to a clause is deleted, the clause number should be retained and the words **"NOT USED"** should be inserted.

3. The proposed documents with tracked changes shall be submitted to the Project Manager for review, prior to printing the final batch of documents. When this final printing is carried out, the tracked changes option is to be turned off.

4. Before printing accept all changes in the document, turn off *Track Changes* and refresh the Table of Contents.

5. The Custodian of this specification is Senior Road Engineer (Drainage).

---

1. WALL THICKNESS (Clause 405.08.04.3)

1.1. Where Specification 404 CULVERTS (Annexure 404A) specifies that the in-situ ground conditions for Reinforced Concrete Pipe are "Aggressive" the minimum concrete cover to steel reinforcement shall be 20 mm in accordance AS/NZS 4058. As such 900 mm diameter liners should not be used in aggressive environment as the typical wall thickness does not allow 20 mm cover to be achieved. In such circumstances 1050 mm diameter liners should be specified instead.

2. PRECAST CONCRETE LINERS (Clause 405.34.04.2)

2.1. There is a practical limit as to the number and size of holes which can be safely punched into the walls of the liner to accommodate entry and exit drainage conduits without compromising wall strength. Where the manufacturer's published requirements differ to those shown on the Drawings then the Contractor shall use the more stringent requirements.

3. DEWATERING (Clause 405.27.4 and/or 405.29.1)

3.1. Where the requirement for dewatering exists then Clause 204.94 in Specification 204 – ENVIRONMENT (Specification 204 Guidance Notes) shall be added to the Contract Specific Requirements of that document.

4. SCHEDULE OF EXISTING DRAINAGE STRUCTURES AND PIPES THAT MAY CONTAIN ASBESTOS CONTAINING MATERIAL (ACM) in SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH

4.1. In the schedule in SPECIFICATION 203 OCCUPATIONAL SAFETY AND HEALTH include existing drainage structures and pipes that are being removed or substantially disturbed where the drainage structure or pipe is manufactured from a concrete (or similar) product (i.e. excluding brick and blockwork drainage structures, PVC, HDPE and circular steel pipes) and:

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FOI 26-292 - Document 27

a. there is reasonable grounds to believe that they were constructed in 2003 or earlier (refer to IRIS and/or As Constructed Drawings for further information); and

b. testing of the drainage structures and pipes for ACM has not been conducted or testing has confirmed the presence of ACM.

4.2. For drainage structures, include diameters and depths

4.3. For pipes, include diameters.

4.4. In comments column, minimum detail should state whether testing for ACM has been conducted and if it has been conducted, confirm the presence of ACM, along with reference to further information.

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FOI 26-292 - Document 27

CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style "H2 SP" so it appears in the Table of Contents.

1. RE-USEABLE REDUNDANT DRAINAGE STRUCTURES

The following Clause concerns the removal and storage of re-usable redundant drainage structures. If required, Clause 405.91 should be added and Annexure 405A as shown below also needs to be inserted on a separate page following Clause 405.91 and completed:

405.91 RE-USABLE REDUNDANT STRUCTURES

1. Where redundant drainage structures are located under roadways, such structures shall be removed by the Contractor, and if deemed suitable for re-use by the Superintendent, shall be delivered to the storage area nominated in Annexure 405A.

2. Damaged or unusable drainage structures shall be disposed of by the Contractor to the Contractors disposal site approved by the Superintendent. ***Damaged***

2. LOW STRENGTH INFILL FOR REDUNDANT STRUCTURES

The practice of infilling redundant drainage structures with low strength infill should be discouraged as the locations of redundant structures are rarely monitored and subsequent service checks are not likely to show their location, resulting in unnecessary delays if exposed in future works. Should their removal not be possible, then Clause 404.92 below should be added:

405.92 LOW STRENGTH INFILL

1. Where detailed on the Drawings, redundant drainage structures shall be filled with low strength concrete infill in accordance with Specification 410 LOW STRENGTH INFILL.

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FOI 26-292 - Document 27

ANNEXURE 405A

EXISTING DRAINAGE STRUCTURES

1. STORAGE OF REMOVED STRUCTURES

1.1 Removed and reusable drainage structures shall be transported and neatly stacked at the following location:

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FOI 26-292 - Document 27

AMENDMENT CHECKLIST

Specification No. **405** Title: **DRAINAGE STRUCTURES** Revision No: _____

Project Manager: _____ Signature: _____ Date: _____

Checked by: _____ Signature: _____ Date: _____

Contract No: _____ Contract Description: _____

ITEM	DESCRIPTION	SIGN OFF
Note: All changes/amendments must be shown in Tracked Changes mode until approved.		
1.	Project Manager has reviewed Specification and identified Additions and Amendments.	
2.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (Refer Specification Guidance Notes for guidance).	
3.	Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16.	
4.	Standard clauses amended? **MUST SEEK** approval from Manager Contracts	
5.	Clause deletes shows as **"NOT USED"**.	
6.	Appropriate **INSPECTION AND TESTING** parameters included in Spec 201 (Text Methods, Minimum Testing Frequencies verified).	
7.	**ANNEXURES** completed (refer Specification Guidance Notes).	
8.	**HANDOVER** and **AS BUILT** requirements addressed.	
9.	Main Roads QS has approved changes to **SMM**.	
10.	Project Manager certifies completed Specification reflects intent of the design.	
11.	Completed Specification – independent verification arranged by Project Manager.	
12.	Project Manager's review completed.	
13.	**SPECIFICATION GUIDANCE NOTES** deleted.	
14.	**TABLE OF CONTENTS** updated.	
15.	**FOOTER** updated with Document No., Contract No. and Contract Name.	
16.	Supporting information prepared and submitted to Project Manager.	
Further action necessary:		

Signed: _____ *(Project Manager)* Date: _____

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SPECIFICATION 406

ROCK PROTECTION

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FOI 26-292 - Document 27

SPECIFICATION 406

ROCK PROTECTION

REVISION REGISTER

Date	Clause Number	Description of Revision	Authorised By
20/09/2017	Table 406.1	Added Half Tonne	A/SWE
12/12/2016	Whole Document	Reformatting	SCO
28/11/2016	Table 406.1	Renaming of Rock Class	SWE
03/03/2009	Table 406.1	Column 4 removed "Minimum" from the title.	SWE
01/08/2006	Whole document	Complete revision of Issue No 3 to new format	MCP

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FOI 26-292 - Document 27

CONTENTS

Clause **Page No**

GENERAL 4
406.01 Scope 4
406.02 References 4
406.03 – 406.05 NOT USED 4
PRODUCTS AND MATERIALS 5
406.06 Source Rock 5
406.07 Rock Fill for Gabions and Mattresses 6
406.08 Rock Supply by Principal 7
406.09 Geotextile Lining 7
406.10 Gabions 8
406.11 Mattresses 9
406.12 Selvedges 9
406.13 Lacing/Tying and Connecting Wire 10
406.14 – 406.25 NOT USED 10
CONSTRUCTION 10
406.26 Geotextile Lining 10
406.27 Rock Protection 11
406.28 Rock Pitching 12
406.29 Installation of Gabions and Mattresses 13
406.30 – 406.80 NOT USED 14
AS BUILT AND HANDOVER REQUIREMENTS 14
406.81 – 406.90 NOT USED 14
CONTRACT SPECIFIC REQUIREMENTS 14
406.91 – 406.99 NOT USED 14
ANNEXURE 406A 15
Supply of Rock by Principal 15

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FOI 26-292 - Document 27

SPECIFICATION 406

ROCK PROTECTION

GENERAL

406.01 SCOPE

1. The work under this specification consists of the supply and construction of all types of rock protection linings and rock pitching.

406.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian Standards

AS 1141.22	Methods for Sampling and Testing Aggregates: Method 22: Wet/Dry Strength Variation
AS 1726	Geotechnical Site Investigations
AS 2758.4	Aggregates and Rock for Engineering Purposes Part 4: Aggregates for gabions baskets and wire mattresses
AS 3704	Geotextiles – Glossary of Terms
AS 3705	Geotextiles – Identification, Marking and General Data
AS 3706	Geotextiles – Method of Tests

Other Standards & Publications

AUSTROADS Waterway Design, A Guide to the Hydraulic Design of Bridges, Culverts and Floodways. Publication No. AP-23/94
AUSTROADS Guide to Geotextiles. Publication No. AP-3/90

MAIN ROADS Specifications

Specification 302 EARTHWORKS

406.03 – 406.05 NOT USED

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PRODUCTS AND MATERIALS

406.06 SOURCE ROCK

Properties

1. Source rock for rock protection and rock pitching shall consist of clean, sound, durable, hard rock. Rock used shall be fresh to slightly weathered and of very high to extremely high strength, as defined in AS 1726. Rock that is laminated, fractured, porous or otherwise physically weak is unacceptable. Flat slab-like rock pieces, with the breadth or thickness less than one third its length, should be avoided due to poor interlocking and easy dislodgement by flow where not grouted.

Rock Pitching

2. Limestone (calcarenite) used for rock pitching shall be moderately strong to strong, with reference to the Clark and Walker Classification System for cementation and strength.

- Unconfined Compressive Strength (UCS) shall not be less than 12.5 MPa, and
- Calcium Carbonate Content ($CaCO_3$) shall not be less than 80% in accordance with Test Method WA 915.1.

Rock Type and Size

3. Rock for use in bridgeworks shall be to the details shown on the Bridgeworks Drawings. For roadworks and drainage works, rock shall conform to the details given in Table 406.1.

HOLD POINT

4. Prior to delivery to site, the Contractor shall certify to the Superintendent that the rock conforms to the specified requirements for its intended use. Test results shall be reported on NATA endorsed documents.

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TABLE 406.1 Rock Protection and Rock Pitching (General Requirements)

Rock Class	Rock Size (m) *	Approximate Rock Mass (kg)	Percentage of Rock Larger than Rock Size in the Second Column	Typical Use (Examples Only)
Facing (Type B)	0.40 0.30 0.15	100 35 2.5	0 50 90	Culvert Outlets
Light	0.55 0.40 0.20	250 100 10	0 50 90	Floodway Batters
Quarter Tonne	0.75 0.55 0.30	500 250 35	0 50 90	Floodway Batters
Half Tonne	0.90 0.70 0.40	1000 450 100	0 50 90	Floodway Batters
One Tonne	1.15 0.90 0.55	2000 1000 250	0 50 90	Floodway Batters
Two Tonne	1.45 1.15 0.75	4000 2000 500	0 50 90	Floodway Batters
150 Rock Pitching	0.15 x 0.15 x 0.15		100	Landscaped Slopes (Typically Limestone)
400 Rock Pitching	0.40 x 0.40 x 0.20		60	Landscaped Slopes (Typically Limestone)

* Assuming a specific gravity of 2.65 and spherical shape for Facing, Light, Quarter Tonne, Half Tonne, One Tonne and Two Tonne.

406.07 ROCK FILL FOR GABIONS AND MATTRESSES

Rock Type

1. Rock fill for gabions and mattresses shall be produced or derived from dense, hard, durable and clean rock in accordance with AS 2758.4. It shall be resistant to weathering actions of air and water and shall be free from cracks and other structural defects.

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2. Rock used for rock fill shall be fresh to slightly weathered and of very high to extremely high strength, as defined in AS 1726. The rock fill shall be clean, angular, and durable and of uniform quality, free from dust, clay, dirt and other deleterious material and free from an excess of flat or laminate pieces. For gabions the minimum rock size shall be 100mm and the maximum rock size shall be 250mm. For mattresses the minimum rock size shall be 75mm and the maximum rock size shall be two-thirds the thickness of the mattress, or 250mm, whichever is the lesser. The rock supplied shall have a range of sizes and a degree of angularity to ensure mechanical interlocking between rocks. ***Properties***

3. When determined in accordance with AS 1141.22, the aggregate wet strength shall not be less than 100kN and the wet/dry strength variation shall not exceed 35%. The rock may be crushed so as to produce the aggregate suitable to test by AS 1141.22.

4. Prior to delivery to site, the Contractor shall certify to the Superintendent that the rock fill conforms to the specified requirements for its intended use. Test results shall be reported on NATA endorsed documents. ***HOLD POINT***

406.08 ROCK SUPPLY BY PRINCIPAL

1. Where some or all the rock protection requirements are supplied by the Principal, details are provided at Annexure 406A. The Contractor shall supply any additional rock that is required for the works. ***Annexure 406A***

406.09 GEOTEXTILE LINING

1. The geotextile for rock protection shall be a non-woven fabric consisting of long chain synthetic polymer fibres, composed of at least 95% by mass of polyester or polyolefins (polypropylene, polyethylene), bonded by needle punching, heat or chemical bonding processes or combinations thereof. Bonded fibres must be capable of retaining their relative position in the geotextile. The polymer fibres shall be rot proof, chemically stable and have low water absorbency. The geotextile shall have a high ultraviolet resistance such that when tested in accordance with AS 3706.11 shall have retained strength of at least 50% after 672 hours of test exposure. The geotextile shall be free of any flaws or defects that may adversely affect the mechanical or physical properties of the fabric. ***Geotextile***

2. Each roll of geotextile shall be provided with a suitable covering to protect the fabric against moisture and ultraviolet radiation, and marked in conformance with AS 3705. ***Supply***

3. Prior to installation, the geotextile rolls shall be stored on site under a protective cover and supported off the ground. The Contractor shall take appropriate measures to protect the geotextile from damage. This includes adhering to any other recommendations on method of storage set by the supplier/manufacturer. ***Storage***

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FOI 26-292 - Document 27

4. Prior to the use of geotextile, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the geotextile complies with all the requirements of this specification for intended use. Test results shall be reported on NATA endorsed documents.

HOLD POINT

5. The Contractor shall also certify that the geotextile delivered to site meets the Specification requirements. Sampling, conditioning and statistical analysis of results for each batch of geotextile shall be carried out in accordance with AS3706.1. Sampling frequency shall be in accordance with Appendix A of AS 3706.1. The conformance testing shall include determining the mean weight (mass per unit area) of the geotextile, in accordance with AS 3706.1.

Sampling and Testing

406.09.01 GEOTEXTILE FOR ROCK PROTECTION

1. The Equivalent Opening Size (EOS) of the geotextile shall be less than 200 µm, mean value determined in accordance with AS 3706.7. The Geotextile Strength Rating (G) shall be greater than 4500, as defined in AUSTROADS "Guide to Geotextiles" where $G = (L \cdot h_{50})^{0.5}$. L (in Newtons) is the characteristic value of burst strength (CBR Plunger Method) for the batch tested determined in accordance with AS 3706.1 and AS 3706.4. h_{50} (in mm) is the characteristic puncture resistance (Drop Cone Method) value for the batch tested determined in accordance with AS 3706.1 and AS 3706.5. The characteristic values of L and h_{50} shall be calculated as the mean value less 0.83 standard deviation. If appropriate, the minimum G rating may be reduced to 2000 where the nominal maximum particle size of the rock is no greater than 200 mm.

EOS and G Rating

406.09 02 GEOTEXTILES FOR GABIONS AND MATTRESSES

1. All gabions and mattresses shall be laid on geotextile filter lining as per the Drawings.

2. The Equivalent Opening Size (EOS) of the geotextile shall be less than 200 µm, mean value determined in accordance with AS 3706.7. The Geotextile Strength Rating (G) shall be greater than 2000, as defined in AUSTROADS "Guide to Geotextiles" where $G = (L \cdot h_{50})^{0.5}$. L (in Newtons) is the characteristic value of burst strength (CBR Plunger Method) for the batch tested determined in accordance with AS 3706.1 and AS 3706.4. h_{50} (in mm) is the characteristic puncture resistance (Drop Cone Method) value for the batch tested determined in accordance with AS 3706.1 and AS 3706.5. The characteristic values of L and h_{50} shall be calculated as the mean value less 0.83 standard deviation.

EOS and G Rating

406.10 GABIONS

1. Details of gabions shall be as shown on the Drawings.

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2. The gabions supplied by the Contractor shall be flexible, woven, galvanised PVC coated steel wire mesh boxes to the overall dimensions as specified on the Drawings. Alternative equivalent or improved methods of corrosion protection such as Zinc-Aluminium alloy and polyethylene coatings are acceptable.

Corrosion Protection

3. Gabions shall have a hexagonal mesh with nominal size of 80mm x 100 mm. The minimum steel core wire diameter for the mesh shall be 2.7 mm.

Mesh Size and Wire Diameter

4. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabion plus 100 millimetres.

Cells

5. Prior to use, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the gabions, selvedges and lacing wire comply with all the requirements of this specification for its intended use.

HOLD POINT

406.11 MATTRESSES

1. Details of rock mattresses shall be as shown on the Drawings.

2. The mattresses supplied by the Contractor shall be flexible, woven, galvanised PVC coated steel wire mesh boxes to the overall dimensions as specified on the Drawings. Alternative equivalent or improved methods of corrosion protection such as Zinc-Aluminium alloy and polyethylene coatings are acceptable.

Corrosion Protection

3. Mattresses shall have a hexagonal mesh with nominal size of 60mm x 80mm. The minimum steel core wire diameter for the mesh shall be 2.0mm for mattresses with less than 350mm depth and 2.4mm for 350 to 550mm depth.

Mesh Size and Wire Diameter

4. Each mattress shall be divided by diaphragms into cells across the width of the unit and at not more than 1m centres or as shown on the Drawings.

Cells

5. Prior to use, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the mattresses, selvedges and lacing wire comply with all the requirements of this specification for its intended use.

HOLD POINT

406.12 SELVEDGES

1. All edges of the gabions, mattresses, diaphragms and end panels shall be selvedged with a continuous wire, thicker than the corresponding wire of the gabion, mattress or diaphragm, to give the mesh rigidity when subjected to tension.

Edge Selvedge

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FOI 26-292 - Document 27

2. The selvedging must be such that the mesh will not unravel. In addition, the strength of the connection between the galvanised selvedge wire and the mesh shall be equal to or greater than the breaking strength of the mesh. ***Properties***

3. The minimum steel core wire diameter shall be 3.4mm for gabions, 2.4mm for mattresses less than 350mm depth and 3.0mm for mattresses between 350 to 550mm depth. ***Wire Diameter***

406.13 LACING/TYING AND CONNECTING WIRE

1. Lacing/tying and connecting wire must be supplied with the gabions and mattresses to perform all the wiring operations required for the construction of the gabions or mattresses on site. ***Lacing***

2. The minimum steel core wire diameter, for lacing/tying and connecting either gabions or mattresses, shall be 2.2mm. ***Wire Diameter***

3. Where the selvedge has to be fastened to the cut ends of the mesh, its diameter shall be 3.4mm, and it shall be attached by binding the cut ends of the mesh about it so that a force of not less than 8 330N applied in the same plane as the mesh, at a point on the selvedge of a mesh sample of length 1 000mm, is required to separate it from the mesh. ***Fastening***

406.14 – 406.25 NOT USED

CONSTRUCTION

406.26 GEOTEXTILE LINING

1. The correct geotextile filter lining shall be supplied to suit unconfined rock protection, or for use with gabions and mattresses. ***Lining Types***

2. The period between initial laying out and complete cover of the geotextile with rock embankment protection, gabions or mattresses shall not exceed 14 days. Where possible and practical, geotextile shall be placed just ahead of associated advancing construction work and covered by relevant construction materials or suitable protective sheeting within 48 hours of being placed. ***Exposure***

3. Any geotextile allowed to remain exposed to sunlight for a period greater than 14 days shall be removed and replaced at no cost to the Principal. ***Prolonged Exposure***

4. The geotextile shall be laid in full roll widths as supplied with the length of the fabric laid in the direction of stream flow. Adjacent strips shall be overlapped a minimum of 500mm. ***Laying and Overlap***

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5. The Contractor shall take every reasonable care to ensure that the geotextile is not damaged during installation and cover placement operations. The laid geotextile shall be subjected only to pedestrian traffic. ***Care***

6. Any geotextile torn shall be replaced or patched by the laying over of an additional piece of geotextile extending a minimum of 1m from the extremities of the tear. The fabric shall be held down by rocks or other suitable means to prevent movements before placement of the rock embankment protection, gabions or mattresses. ***Repair***

406.27 ROCK PROTECTION

1. Rock protection shall be supplied to the specified classes of rock, and shall comprise hard, clean rock spalls or cobbles obtained from the excavation of a uniform type and colour and grading as specified in Clause 406.06, placed to the dimensions, shape and extent shown on the Drawings. ***Class of Rock***

2. Excavation for any required trenching for the placement of rock protection shall be constructed to the line, level and dimensions shown on the Drawings. Surplus, oversize and unsuitable material from excavations shall be disposed of in accordance with Specification 302 EARTHWORKS. ***Excavation***

3. The rock spalls shall be firmly placed into position to the required lines and levels with a minimum of voids and shaped to suit the drain grades or batter slopes to the following tolerances and compacted with at least 4 passes of a crawler tractor of mass not less than 11 tonnes: ***Placement***

(a) Batter slopes shall be smoothly shaped to a uniform plane; ***Tolerances***

(b) The dimensions of the rock layer shall not be less than that shown in the Drawings. Local surface irregularities of the finished surface shall not vary from the prevailing batter slope by more than +100mm or -50mm measured at right angles to the slope except for culvert outlet protection which shall not vary by more than +0mm or -100mm;

(c) On floodways, no rock shall project above the shoulder and pavement level.

4. Rock protection shall present a generally uniform finish with flat surfaces of larger individual spalls, facing uppermost, comprising the finished surface and thoroughly keyed to the adjoining rocks. ***Finish***

5. Care shall be taken during placement to prevent sand filling voids between the rocks. ***Voids***

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6. Where grouted rock protection is specified, individual rock spalls shall be placed on a mortar bed and voids between spalls filled with mortar, as detailed in the Drawings. The size of the voids shall not exceed 50mm in any direction. ***Mortar***

7. Mortar for grouting shall comprise a 3:1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source. ***Mortar Mix***

406.28 ROCK PITCHING

406.28.01 SAMPLE PANELS

1. Prior to the commencement of rock pitching, the Contractor shall prepare a sample panel of each type of rock pitching required in the Works, each at least 1.5m high x 2m long, for the Superintendent's approval. ***HOLD POINT***

2. The samples shall display rock colour, texture, grain, surface treatment, rock size and jointing detail. The sample shall remain until the completion of stonework in the Works. ***Display***

3. The standard of construction approved for the samples shall be maintained throughout the Works. ***Standard***

406.28.02 CONSTRUCTION

1. The finished rockwork on sloping rock pitching shall present a uniform surface matching adjacent slopes. The finished surface shall be thoroughly cleaned of all excess mortar and other debris. ***Sloping Rockwork***

2. Transitions from pitched batter slopes to pitched level surface shall be in the form of a smooth vertical curve to both top and toe conforming to the dimensions and form as indicated on the Drawings. ***Slope Transition***

3. Unless otherwise shown on the Drawings, the rocks shall be set level and flush for a lateral distance of 1.0m when located adjacent to other paving materials such as kerbs, paths and manholes. ***Paving Transition***

4. Rocks at the top and toe of batter slopes shall be securely underpinned with mortar to prevent any vertical movement. No mortar shall be visible after adjacent finished levels have been restored. Voids shall be filled with mortar from the bottom to within 10mm of the exposed face of the rock. ***Mortar Work***

5. Mortar shall comprise a 3:1 mix of builder's sand and ordinary Portland cement, with all sand being from the same source. Where limestone is used for rock pitching, mortar shall comprise a 3:1:1 mix of builder's sand, builders lime, and ordinary Portland cement, with all sand being from the same source. ***Mortar Mix***

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FOI 26-292 - Document 27

406.29 INSTALLATION OF GABIONS AND MATTRESSES

Assembly

1. The assembly and erection of the gabions and mattresses shall conform to the following and the manufacturer's recommendations. Prior to assembly, the wire mesh of the gabion or mattress shall be opened out flat on the ground and stretched as much as possible to remove all kinks and bends, and checked to make sure that all creases are in the correct positions for forming the box.

Panels

2. The gabion or mattress shall be assembled individually by lifting the side and end panels into vertical position to form a rectangular box, ensuring that the tops of all four sides are level.

Lacing

3. The four corners of the gabion or mattress box shall be wired together with lengths of lacing wire supplied. Starting at the top, the end of the wire shall be secured by twisting it around the selvedges and through each mesh in turn using alternate single and double loops. The wire at the bottom shall be secured with the lacing wire turned to the inside of the box on completion. The diaphragm panels shall also be secured in a similar fashion.

Staking

4. The assembled empty gabion or mattress boxes shall be positioned in the structure. The end or side from which work is expected to proceed shall be secured either to completed work or by stakes driven into the ground at the corners. These stakes must be secure and reach at least to the top of the gabion or mattress.

Gabion Stretching

5. For gabions, the opposite end or side of the box shall be stretched using crowbars or a small winch and secured top and bottom by stakes placed at the corners, fixed at the bottom and tied back at the top. Lacing to adjacent boxes and filling shall be carried out whilst gabion boxes are under tension.

Mattress Alignment

6. For mattresses, movement of the rockfill inside the cells, either due to gravity or flowing current, should be kept to a minimum. Mattresses on slopes shall be placed such that the long dimension lies up and down the slope i.e. internal diaphragms at right angles to the direction of the slope. In watercourses, the long dimension of the mattress should be aligned with the direction of flow i.e. internal diaphragms at right angles to the direction of flow. The boxes shall be wired together along all adjoining edges and at diaphragm points.

Filling

7. The gabion boxes shall be filled one third full and horizontal interval bracing inserted (approximately 0.30m apart) to prevent excessive bulging and distortion of the completed structure. This procedure shall be repeated when the box is two thirds full. For both gabions and mattresses, final filling shall be to a level 25 to 50mm above their tops to allow for subsequent settlement.

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8. Closing and lacing down of lids for both gabions and mattresses shall proceed as soon as practicable after filling operations. The lids shall be stretched tight over the filling with suitably design closing tools and laced securely through each mesh along all edges, ends and diaphragms. The ends of all lacing wires shall be turned into the box on completion of all lacing operations. ***Final Lacing***

406.30 – 406.80 NOT USED

AS BUILT AND HANDOVER REQUIREMENTS

406.81 – 406.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

406.91 – 406.99 NOT USED

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FOI 26-292 - Document 27

ANNEXURE 406A

SUPPLY OF ROCK BY PRINCIPAL

1. ROCK SPALL DETAILS

1.1 Rock spalls supplied by the Principal are to the following details:

Location of Stockpile/Dumpsite	Type (eg Granite)	Class (eg Facing)	Quantity (m^3)	Cost ($/m^3$)

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SPECIFICATION 406 GUIDANCE NOTES

DELETE THESE GUIDANCE NOTES FROM FINAL DOCUMENT AFTER USING FOR REFERENCE

All edits to downloaded TDP documents shall be tracked (most word processing software allows this to be done automatically). Deletions shall be struck through e.g. ~~example~~. Insertions shall be in italics e.g. *example*. If **all** information relating to a clause is deleted then the clause number should be retained and the words "**NOT USED**" should be inserted.

The proposed documents with tracked changes shall be submitted to the Project Manager for review, prior to printing the final batch of documents. When this final printing is carried out, the tracked changes option is to be **turned off**.

The Custodian of this specification is the Senior Waterways Engineer.

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1. ANNEXURE 406A – SUPPLY OF ROCK BY PRINCIPAL

1.1 Insert details into Table where some or all the rock requirement is being supplied by the Principal.

1.2 If not applicable, delete table and insert “NOT APPLICABLE FOR THIS CONTRACT”.

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SPECIFICATION AMENDMENT CHECKLIST

Specification Name: No: **406** Revision No: _____ Title: **ROCK PROTECTION**

Project Manager: Name: _____Signature: _____Date:_____

Checked By: Name: _____Signature: _____Date:_____

Contract No: _____Contract Description:_____

ITEM	DESCRIPTION	SIGN OFF
Note:	*All changes/amendments **must** be shown in Tracked Change mode until approved.*	
1.	Project Manager has reviewed Specification and identified Additions and Amendments.	
2.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? – Contract specific materials/products/clauses added? (Refer Specification Guidance Notes for guidance).	
3.	Any unlisted Materials/Products proposed and approved by the Project Manager? – if "Yes" provide details at 15.	
4.	Standard Clauses amended? – **MUST SEEK** approval from MCP.	
5.	Clause deletions shown as 'NOT USED'.	
6.	Appropriate **INSPECTION & TESTING** parameters included in Spec 201 (Test Methods, Minimum Testing Frequencies verified).	
7.	**ANNEXURES** completed (Refer Specification Guidance Notes).	
8.	**HANDOVER** and **AS BUILT** requirements addressed.	
9.	Main Roads QS has approved changes to **SMM**.	
10.	Project Manager certifies completed Specification reflects intent of the design.	
11.	Completed Specification – independent verification arranged by Project Manager	
12.	Project Manager's review completed.	
13.	**SPECIFICATION GUIDANCE NOTES** deleted.	
14.	**TABLE OF CONTENTS** updated.	
15	Supporting information prepared and submitted to Project Manager.	
Further action necessary:		

Signed: _____ *(Project Manager)* Date: _____

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FOI 26-292 - Document 27

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FOI 26-292 - Document 27

SPECIFICATION 407

KERBING

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FOI 26-292 - Document 27

REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
407.06 & 407.37.4	Concrete strength grade changed from N20 to N32	PDERS	19/09/2019
Whole document	Reformatted	SCO	17/04/2017
Guidance Notes	Change of Specification custodian	RDSM	11/07/2007
Whole document	Complete revision of Issue No 3.0 to new format	MCP	01/08/2006

DRAFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

CONTENTS

Clause **Page No**

407.01 Scope ... 4
407.02 References ... 4
407.03 Definitions ... 4
407.04 –407.05 NOT USED ... 5

PRODUCTS AND MATERIALS ... 5
407.06 Concrete ... 5
407.07 Joint Fillers and Sealants ... 5
407.08 Curing Compounds ... 5
407.09 Kerb Backfill ... 5
407.10 – 407.25 NOT USED ... 5

CONSTRUCTION ... 5
407.26 General ... 5
407.27 Setting Out ... 6
407.28 Surface Preparation ... 6
407.29 Extruded Kerbs ... 6
407.30 Kerb Openings ... 6
407.31 Curing ... 6
407.32 Joints ... 7
407.33 Tolerances ... 7
407.34 Special Features ... 7
407.35 Backfilling ... 7
407.36 Medians and Traffic Islands ... 7
407.37 Kerb Repairs ... 8
407.38 – 407.80 NOT USED ... 8

AS BUILT AND HANDOVER REQUIREMENTS ... 8
407.81 – 407.90 NOT USED ... 8

CONTRACT SPECIFIC REQUIREMENTS ... 8
407.91 – 407.99 NOT USED ... 8

DRAFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

SPECIFICATION 407

KERBING

GENERAL

407.01 SCOPE

1. The work under this specification consists of the supply of materials and construction of all types of extruded concrete kerbs and all associated works, all as shown on the Drawings.

407.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Australian Standards

AS 2876	Concrete Kerbs & Channels (Gutters) - Manually or Machine Placed

MAIN ROADS Test Methods

WA 110.1	Moisture Content: Convection Oven Method
WA 110.2	Moisture Content: Microwave Oven Method
WA 134.1	Dry Density Ratio

MAIN ROADS Specifications

Specification 302	EARTHWORKS
Specification 406	ROCK PROTECTION
Specification 505	SEGMENTAL PAVING
Specification 901	CONCRETE - GENERAL WORKS

MAIN ROADS Standard Drawings

9331-0376	Kerb Types
9331-0377	Kerb Treatments

407.03 DEFINITIONS

1. Filler - Elastic, tight fitting, non-rotting, non-absorbent material used to provide firm backing, against which the sealant can be tooled off. Filler shall also prevent the sealant from adhering to the bottom of the joint and cause the sealant to fail during the expansion of joints.

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FOI 26-292 - Document 27

2. Sealants - Material used to seal expansion joints to prevent penetration of destructive materials.

407.04 –407.05 NOT USED

PRODUCTS AND MATERIALS

407.06 CONCRETE

1. Concrete shall be Class N32 supplied in accordance with the requirements of Specification 901 CONCRETE - GENERAL WORKS, and shall have a maximum aggregate size of between 6.7mm and 19mm and a slump not exceeding 100mm. ***Class***

2. Unless otherwise stated herein, all concrete materials used in the construction of kerbs shall be as described in Specification 901 CONCRETE - GENERAL WORKS.

407.07 JOINT FILLERS AND SEALANTS

1. Joint fillers shall comprise either a closed cell polyethylene rod of 10 mm diameter, or a strip of poly urethane foam 12mm wide. ***Filler***

2. Joint sealing compound for surface sealing shall be a grey butyl mastic sealant. ***Sealer***

407.08 CURING COMPOUNDS

1. Concrete curing compounds shall be based on an aliphatic alcohol for application in spray form.

407.09 KERB BACKFILL

1. Kerb backfill material shall consist of an embankment quality material in accordance with Specification 302 EARTHWORKS.

407.10 – 407.25 NOT USED

CONSTRUCTION

407.26 GENERAL

1. Kerbs on straight alignments exceeding 10m and on curves of radii exceeding 3m shall be placed by an extrusion machine. ***Machine Placed***

2. Where the kerb is on a straight line of 10m or less, or on a radius of 3m or less, or where the lack of clearance prevents the kerb being placed by an extrusion machine, the section of kerb may be hand placed. Hand placed kerb shall be rodded and shaped, to give a finished kerb meeting the requirements of this Specification. ***Hand Placement***

3. The shape and dimensions of the kerb shall be in accordance with the Drawings. ***Shape & Dimensions***

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FOI 26-292 - Document 27

407.27 SETTING OUT

1. Setting out of the kerb shape, profile and alignment shall be carried out on the rear of the kerb. Spikes and nails shall not be driven into the pavement surface.

407.28 SURFACE PREPARATION

1. The surface to receive kerbing shall normally be a bituminous aggregate seal. ***Receiving Surface***

2. The Contractor shall clean the area between the receiving surface and the new kerb of all loose sand, stones, dust and other foreign matter and shall wet the surface with water immediately prior to placement of the new kerbing. ***Cleaning***

407.29 EXTRUDED KERBS

1. Extruded kerbs shall be laid by a suitable extrusion machine. No dowels are required. ***Machine Laid***

2. Extruded kerbs shall be dense with regular sides, edges and chamfers finished to a fine surface free from blow holes and dragging and shall be impervious. Finishing with grout will not be permitted. ***Finish***

3. The constituents of the concrete mix shall be as described in Specification 901 CONCRETE - GENERAL WORKS. The mix for extruded kerbs shall be designed by the Contractor, who shall prepare, place and compact trial mixes using the same extrusion machine as will be used in the Works. ***Concrete Mix***

407.30 KERB OPENINGS

1. Kerb openings shall be located and installed in accordance with the Drawings. ***Openings***

2. Any associated rock protection shall be in accordance with Specification 406 ROCK PROTECTION. ***Rock Protection***

407.31 CURING

1. All exposed faces of the completed kerb shall be kept permanently wet for the curing period of a minimum 72 hours after placing. Concrete maybe cured by spraying with approved curing compounds. ***Concrete Protection***

2. Any water applied shall not cause erosion of the concrete surface.

3. The concrete shall be protected within 15 minutes after completion of casting the kerb.

4. The kerb shall be protected from rain for at least twenty four (24) hours following placement. ***Rain***

5. The kerb shall be protected from traffic for a period of twelve (12) hours following placement. ***Traffic***

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FOI 26-292 - Document 27

407.32 JOINTS

1. Immediately after placing the kerbing, contraction joints shall be formed by grooving the exposed faces of the kerbs. Contraction joints shall be formed at spacings not exceeding 4m. ***Contraction***

2. Not less than 24 hours nor more than 72 hours after placing of concrete, expansion joints shall be constructed at the mid point between contraction joints by sawing a 6 mm wide gap through the full cross section of the kerb. Kerb cutting shall be carried out with water to minimise dust in the sawing process. ***Expansion Joints***

3. An approved joint filler shall then be forced into the sawn joint such that a 12 mm deep space remains to the concrete surface. This space shall be completely filled with an approved joint sealant such as Sikaflex construction polyurethane joint sealant or equivalent approved by the Superintendent and used as per manufacturer's instructions. ***Fillers & Sealants***

407.33 TOLERANCES

1. All kerbing shall be placed within 20mm of its true plan position on the ground, and the rate of deviation from its true line shall not exceed 1 in 300. The road face and the back face of the finished kerbing shall be parallel. ***Tolerances***

2. The profile of finished kerbing shall not be less than that shown in the Drawings. ***Kerb Depth***

3. The top surface shall be parallel to the ruling grade of the pavement and shall be free from depressions exceeding 5mm when measured from a 3m long straight edge. ***Top Surface***

407.34 SPECIAL FEATURES

1. Special features such as pram ramps, transitions, and end treatments shall be formed into the kerbing as required according to the details shown on the Drawings.

407.35 BACKFILLING

1. Where required, the area behind kerbs shall be backfilled with suitable select fill quality material or as directed by the Superintendent and compacted in accordance with the Specification 302 EARTHWORKS. The surface shall be constructed to the finished lines and levels shown in the Drawings. ***Material***

2. Any kerb sections dislodged during backfilling or otherwise misaligned shall be removed and re-laid at no cost to the Principal. Care shall be taken in backfilling to ensure that no damage, defacement or staining is caused to the kerbs and that the compaction requirements of the Specification are achieved. ***Damage***

407.36 MEDIANS AND TRAFFIC ISLANDS

1. Merging noses, approach noses, ramps, traffic island infill slabs, and other areas of medians and traffic islands as shown in the Drawings shall be constructed of insitu concrete. ***In-Situ***

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FOI 26-292 - Document 27

2. The thickness of concrete shall exceed 100mm, except where otherwise detailed in the Drawings. The level of concrete infill shall be within +5mm and -0mm of the surrounding surface level. ***Thickness***

3. Select fill material shall be placed following the installation and setting of associated kerbing prior to placing of concrete slab, except where otherwise detailed in the Drawings, in accordance with Specification 302 EARTHWORKS. The backfill material shall be supplied, placed, levelled and compacted by the Contractor. ***Backfill***

4. The finished surface of the concrete shall true and even without projections or irregularities and shall have a deep brush textured finish. ***Finish***

5. An expansion joint 10mm wide shall be constructed between the extruded kerbing and the concrete infill. Approved joint filler shall be forced into the joint such that a 12mm deep groove remains. This groove shall be filled, after cleaning, with an approved joint sealant. ***Expansion***

6. Immediately after placing concrete, tooled contraction joints shall be formed at 2m maximum intervals. Joint edges shall be neatly pointed. ***Contraction***

7. Grabrail and bollard sleeves, where required, shall be cast into ramps or concrete infill in accordance with the Drawings. ***Sleeves***

8. Paving unit infill to such areas shall be constructed in accordance with Specification 505 SEGMENTAL PAVING. ***Paving Units***

407.37 KERB REPAIRS

1. Broken or damaged kerbing shall be removed and disposed of to the Contractor's spoil site at no cost to the Principal. ***Damaged Kerbing***

2. The exposed concrete repair surface shall be roughened to remove all laitance and expose the aggregate to provide a thorough bond with concrete cast subsequently. The roughened surface shall be cleaned with water to remove loose chips and foreign material. ***Repair***

3. Immediately before fresh concrete is cast against the existing surface, the existing surface shall be thoroughly wetted. ***Wetting***

4. Class N32 concrete or rapid setting concrete products of like strength, shall be placed and compacted in accordance with Specification 901 CONCRETE – GENERAL WORK. ***Placement***

407.38 – 407.80 NOT USED

AS BUILT AND HANDOVER REQUIREMENTS

407.81 – 407.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

407.91 – 407.99 NOT USED

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FOI 26-292 - Document 27

GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to downloaded Specifications shall be made using *Track Changes*, to clearly show added/deleted text.

2. If **all** information relating to a clause is deleted, the clause number should be retained and the words **"NOT USED"** should be inserted.

3. The proposed documents with tracked changes shall be submitted to the Project Manager for review, prior to printing the final batch of documents. When this final printing is carried out, the tracked changes option is to be turned off.

4. Before printing accept all changes in the document, turn off *Track Changes* and refresh the Table of Contents.

5. The Custodian of this specification is Senior Road Engineer.

---

1. TEMPORARY KERBING – Clause 407.91

If temporary kerbing is required, particularly if to be left in place after the completion of the Works pending a later addition to or finalisation of the road design, Clause 407.91 (see over) could be added to the Section CONTRACT SPECIFIC REQUIREMENTS.

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CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style “H2 SP” so it appears in the Table of Contents.

407.91 TEMPORARY KERBING

1. Temporary kerbing shall be installed where shown on the Drawings in accordance with the requirements for permanent kerbing. Temporary kerbing shall be laid on a bond breaker membrane between the kerbing and the surface to prevent adhesion to the surface and to assist future removal.

2. When the concrete has set, a suitable fill material shall be placed between the permanent kerbing and the temporary kerbing, and left flush with the top of the kerbing.

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FOI 26-292 - Document 27

AMENDMENT CHECKLIST

Specification No. **407** Title: **KERBING** Revision No:_____

Project Manager:_____ Signature:_____ Date:_____

Checked by: _____ Signature:_____ Date:_____

Contract No: _____ Contract Description:_____

ITEM	DESCRIPTION	SIGN OFF
Note: All changes/amendments must be shown in Tracked Changes mode until approved.		
1.	Project Manager has reviewed Specification and identified Additions and Amendments.	
2.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (Refer Specification Guidance Notes for guidance).	
3.	Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16.	
4.	Standard clauses amended? **MUST SEEK** approval from Manager Contracts	
5.	Clause deletes shows as **"NOT USED"**.	
6.	Appropriate **INSPECTION AND TESTING** parameters included in Spec 201 (Text Methods, Minimum Testing Frequencies verified).	
7.	**ANNEXURES** completed (refer Specification Guidance Notes).	
8.	**HANDOVER** and **AS BUILT** requirements addressed.	
9.	Main Roads QS has approved changes to **SMM**.	
10.	Project Manager certifies completed Specification reflects intent of the design.	
11.	Completed Specification – independent verification arranged by Project Manager.	
12.	Project Manager's review completed.	
13.	**SPECIFICATION GUIDANCE NOTES** deleted.	
14.	**TABLE OF CONTENTS** updated.	
15.	**FOOTER** updated with Document No., Contract No. and Contract Name.	
16.	Supporting information prepared and submitted to Project Manager.	
Further action necessary:		

Signed: _____ *(Project Manager)* Date:_____

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SPECIFICATION 501

PAVEMENTS

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FOI 26-292 - Document 27

REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
References	Amended title of AS 2008	MME	20/02/2020
References	Added WA 144.1		
Table 501.02	Amended CBR criterion for Gravel Subbase		
Table 501.06	Amended CBR criterion for CRB Subbase		
501.13.2	Amended title of AS 2008		
501.45.01	Added General		
501.45.03	Amended		
501.47	Amended		
Table 501A1	Added pavement layer and dry density ratios. Amended Other Basecourse Materials		
Table 501A3	Amended		
Guidance Note 2	Amended		
Guidance Note Tables	All reference numbering has been amended		
Guidance Note 2.2	Additions and Amendments		
Table 501.G23	Added		
Guidance Note 2.3	Amended GER Gravel Specifications		
Guidance Note 2.4	Added Kimberley Region Gravel Specifications		
Guidance Note 2.5	Added Pilbara Region Gravel Specifications		
Guidance Note 2.6	Added Mid West Gascoyne Region Gravel Specifications		
Guidance Note 2.7	Added Great Southern Region Gravel Specification		
Guidance Note 7	Added 7.3 Final Trim		
Guidance Note 15	Amended to clarify when testing is required		
Guidance Note 17	Added Pavement Material Selection		
Table 501.15	Amended Resilient Modulus criterion for Ferricrete Basecourse		
Table 501.16	Amended Resilient Modulus criterion for Ferricrete Basecourse		
Guidance Note 17	Added advice regarding material selection		
501.26.9	Added Final Trim		
		MME	29/06/2018
References	Added WA 142.2 & WA 142.3		
Table 501.02	Amended CBR criterion for Gravel Subbase		
501.05	Added Sustainability Considerations		
Table 501.06	Amended CBR criterion for CRB Subbase		
Tables 501.08, 501.10, 501.13, 501.15, 501.16	Included vertical modulus criterion		
501.29.04	Added trimmings clause		
501.41.5	Amended Hold Point		
501.46	Amended		

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FOI 26-292 - Document 27

501.47	Amended		
Table 501A3	Amended Basecourse Dryback (sprayed seal) criterion		
Table 501A8	Amended PSD criterion		
Guidance Notes	Amended Notes 8, 10.4, 11 & 12		
Guidance Note 15	Added Note 15 for Basecourse vertical modulus		
Guidance Note 2.3	Added GER Basecourse and Subbase specifications		
Guidance Note	Added Note 16 for Reclaimed Pavement Sub-Base		
Whole Document	Reformatted	SCO	22/05/2017
501.09	Add Crushed Rock Sub-Base Material	PM	22/03/2017
Table 501.11	Amended UCS criteria		
501.28	Amended maximum Basecourse thickness		
501.29.01, 501.30.02 & 501.30.07, 501.95.07, 501.95.11	Amended compaction moisture		
501.30.08, 501.95.09 Guidance Notes 10.3 & 11.4	Amended rework requirements		
Guidance Note 1	Amended limitations on Ferricrete use		
Guidance Note 2	Add Wheatbelt Region Gravels		
Guidance Note 11.3	Amended Lime demand requirements		
Tables 501.G01, 501.G02 & 501.16	Amended design traffic limits		

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FOI 26-292 - Document 27

CONTENTS

Clause **Page No**

GENERAL 6
501.01 Scope 6
501.02 References 6
501.03 Definitions 8
501.04 NOT USED 9

PRODUCTS AND MATERIALS 9
501.05 Sustainability considerations 9
501.06 Water 9
501.07 Gravel Subbase Supplied by the Contractor 9
501.08 Crushed Limestone Subbase Supplied by the Contractor 11
501.09 Crushed Rock Base Subbase Supplied by the Contractor 11
501.10 Gravel Basecourse Supplied by the Contractor 13
501.11 Crushed Rock Base Basecourse Supplied by the Contractor 15
501.12 Hydrated Cement Treated Crushed Rockbase Basecourse Supplied by the Contractor 17
501.13 Bitumen Stabilised Limestone Basecourse Supplied by the Contractor 19
501.14 CEMENT FOR STABILISED PAVEMENTS 21
501.15 Cement for HCTCRB 22
501.16 – 501.25 NOT USED 22

CONSTRUCTION 23
501.26 General 23
501.27 Dryback requirements 23
501.28 Spreading 23
501.29 Compaction 24
501.30 Cement stabilisation 25
501.31 Blend areas 29
501.32 Drainage layer 29

DRAFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

501.33 – 501.40 NOT USED 30

ACCEPTANCE 31

501.41 General 31

501.42 Compaction 31

501.43 Dryback 31

501.44 Layer width 32

501.45 Surface shape 32

501.46 Surface levels 32

501.47 Surface finish 33

501.48 – 501.50 NOT USED 33

MAINTENANCE 33

501.51 Maintenance of compacted layers 34

501.52 – 501.80 NOT USED 34

AS BUILT AND HANDOVER REQUIREMENTS 34

501.81 – 501.90 NOT USED 34

CONTRACT SPECIFIC REQUIREMENTS 34

501.91 – 501.99 NOT USED 34

ANNEXURE 501 A 35

Construction requirements 35

ANNEXURE 501 B 39

Cementitious materials for concrete 39

DRAFT

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FOI 26-292 - Document 27

SPECIFICATION 501

PAVEMENTS

GENERAL

501.01 SCOPE

1. The work under this specification consists of the supply of materials and construction of all types of unbound granular and modified granular Pavement Layers, including stabilisation of layers.

501.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are shown below:

Australian Standards

AS 1141	Methods for Sampling and Testing Aggregates
AS 1160	Bitumen Emulsion for Construction and Maintenance of Pavements
AS 1289	Methods of Testing Soils for Engineering Purposes
AS 1672	Limes and Limestones for Building
AS 2008	Bitumen for Pavements
AS 2350	Methods of Testing Portland and Blended Cements
AS 3705	Geotextiles - Identification, Marking and General Data
AS 3706	Geotextiles - Methods of Test
AS 3972	Portland and Blended Cement

Austroads Test Methods

AG:PT/T053	Determination of Permanent Deformation and Resilient Modulus Characteristics of Unbound Granular Materials Under Drained Conditions

MAIN ROADS Publications

Road Note No 5	Interim Guide to Prediction of Pavement Moisture for Strength Assessment of Granular Basecourse and Sub-Base Materials

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FOI 26-292 - Document 27

Road Note No 8	Statistically Based Quality Control for Density in Road Construction
Road Note No 9	Procedure for the Design of Flexible Pavements
6706-02-133	Water to be used in Pavement Construction

MAIN ROADS Test Methods

WA 0.1	Random Sample Site Location
WA 100.1	Sampling Procedures for Soil and Granular Pavement Materials
WA 105.1	Preparation of Disturbed Soil and Granular Pavement Material Samples
WA 110.1	Moisture Content: Convection Oven Method
WA 110.2	Moisture Content: Microwave Oven Method
WA 115.1	Particle Size Distribution: Sieving and Decantation Method
WA 115.2	Particle Size Distribution: Abbreviated Method for Coarse Materials
WA 120.2	Liquid Limit: Cone Penetrometer Method
WA 122.1	Plasticity Index
WA 123.1	Linear Shrinkage
WA 133.1	Dry Density/Moisture Content Relationship: Modified Compaction Fine and Medium Grained Soils
WA 133.2	Dry Density/Moisture Content Relationship: Modified Compaction Coarse Grained Soils
WA 134.1	Dry Density Ratio
WA 136.1	Moisture Ratio (Percent)
WA 140.1	Maximum Dry Compressive Strength
WA 141.1	California Bearing Ratio
WA 142.2	Main Roads WA Supplement to AG:PT/T053
WA 142.3	Main Roads WA Supplement (HCTCRB) to AG:PT/T053
WA 143.1	Determination of the Unconfined Compressive Strength of Laboratory Compacted Specimens
WA 143.2	Determination of the Unconfined Compressive Strength of Hydrated Cement Treated Crushed Rock Base
WA 144.1	Foreign Material

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FOI 26-292 - Document 27

WA 216.1 Flakiness Index

WA 220.1 Los Angeles Abrasion Value

WA 220.2 Los Angeles Abrasion Value of Crushed Limestone

WA 313.2 Surface Profile: Three Metre Straight Edge

WA 324.2 Dry Density and Moisture Content: Nuclear Method

WA 330.1 Layer Thickness: Direct Measurement

WA 717.1 Dispersion of Bitumen in Soil

WA 730.1 Bitumen Content and Particle Size Distribution of Asphalt and Stabilised Soil: Centrifuge Method

WA 910.1 Chlorides and Total Soluble Salts in Soils and Water

WA 915.1 Calcium Carbonate Content

MAIN ROADS Specifications

Specification 100 GENERAL REQUIREMENTS

Specification 201 QUALITY SYSTEMS

Specification 302 EARTHWORKS

Specification 303 PITS AND QUARRIES

Specification 503 BITUMINOUS SURFACING

Specification 504 ASPHALT SURFACING

Specification 510 FULL DEPTH ASPHALT PAVEMENT

Australian Technical Infrastructure Committee (ATIC) Specification

SP43 CEMENTITIOUS MATERIALS FOR CONCRETE

501.03 DEFINITIONS

1. The portion of the road placed above the design Subgrade level including shoulders. ***Pavement***

2. A portion of the pavement placed and compacted as an entity. ***Pavement Layer***

3. One or more layers of material usually constituting the uppermost structural element of a pavement on which the surfacing may be placed. ***Basecourse***

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FOI 26-292 - Document 27

4. The material laid on the Subgrade and below the Basecourse either for the purpose of making up the additional pavement thickness required, to prevent intrusion of the Subgrade into the base, or to provide a working platform. ***Sub-Base***

5. The trimmed or prepared portion of the formation on which the pavement is constructed. The Subgrade may comprise in situ or imported materials. ***Subgrade***

501.04 NOT USED

PRODUCTS AND MATERIALS

501.05 SUSTAINABILITY CONSIDERATIONS

1. Materials for road pavements shall be managed under the sustainability hierarchy of REDUCE, REUSE and RECYCLE.

2. Unless defined otherwise, the materials described in this specification shall be sourced from pits or quarries of natural materials, and shall be blended, crushed or processed as applicable to produce a homogenous material. These materials are a finite resource and waste shall be reduced to a minimum. ***Reduce***

3. Where practical, redundant pavement materials should be recovered and reused, or otherwise recycled to the highest level use practical. Reused materials shall be processed to produce a homogenous material and shall meet the specified applicable requirements for sub-base or basecourse. ***Reuse***

4. This specification also includes manufactured materials sourced from recycled Construction & Demolition Waste. Recycled materials for pavement construction shall be blended, crushed or processed as applicable to produce a homogenous material by a recycling premises licensed by DWER. Recycled materials shall only be included in materials which are designated as recycled. ***Recycle***

501.06 WATER

1. Water used in any pavement construction or pavement material manufacture process shall comply with the requirements of Main Roads Western Australia publication 6706-02-133 “Water to be used in Pavement Construction” and shall be clean and substantially free from detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water sources classified by the relevant Water Authority as potable water shall be exempt from this requirement**.** ***Water***

501.07 GRAVEL SUBBASE SUPPLIED BY THE CONTRACTOR

1. Gravel Subbase material shall consist of durable pebble in soil mortar. The material shall be free from cobbles greater than 75.0mm and free from clods, stumps, roots, sticks, vegetable matter or other deleterious materials. ***General***

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FOI 26-292 - Document 27

2. The Subbase material shall meet the grading requirements shown in Table 501.01 when tested in accordance with Test Method WA 115.1. The grading of material passing the 75.0mm sieve shall vary from coarse to fine in a uniform and consistent manner. The material shall not be gap graded as represented by the grading crossing from the maximum limit for one sieve size to the minimum limit for another sieve size.

Particle Size Distribution

TABLE 501.01 PARTICLE SIZE DISTRIBUTION (GRAVEL SUBBASE)

AS Sieve Size (mm)	% Passing by mass Minimum and Maximum Limits
75.0	100
37.5	80 - 100
19.0	50 - 100
9.5	36 - 81
4.75	25 - 66
2.36	18 - 53
1.18	13 - 43
0.425	8 - 32
0.075	3 - 19

TABLE 501.02 OTHER ACCEPTANCE LIMITS (GRAVEL SUBBASE)

Test	Limits	Test Method
Liquid Limit	30.0% Maximum	WA 120.2
Plasticity Index	10.0% Maximum	WA 122.1
Linear Shrinkage	4.0% Maximum	WA 123.1
California Bearing Ratio (Soaked 4 days with 6.75kg Surcharge) at 94% of MDD and 100% of OMC	30 - 60% Minimum See Guidance Notes and delete this Note	WA 141.1
Secondary Mineral Content in Basic Igneous Rocks	25% Maximum	AS 1141.26
Accelerated Soundness Index by Reflux	94% Minimum	AS 1141.29

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FOI 26-292 - Document 27

501.08 CRUSHED LIMESTONE SUBBASE SUPPLIED BY THE CONTRACTOR

1. The source material for the supply of crushed limestone shall be free of organic material, clay lumps, cap rock or any other foreign material deleterious to its performance in the pavement. ***General***

2. The material shall comply with the grading limits shown in Table 501.03 when tested in accordance with Test Method WA 115.1 ***Particle Size Distribution***

TABLE 501.03 PARTICLE SIZE DISTRIBUTION (CRUSHED LIMESTONE SUBBASE)

AS Sieve Size (mm)	% Passing by Mass Minimum and Maximum Limits
75	100
19	55 – 85
2.36	35 – 65

3. The material shall also comply with the limits shown in Table 501.04. ***Other Acceptance Limits***

TABLE 501.04 OTHER ACCEPTANCE LIMITS (CRUSHED LIMESTONE SUB-BASE)

Test	Limits	Test method
Los Angeles Abrasion Value of Crushed Limestone	20% Minimum, 60% Maximum	WA 220.2
Calcium Carbonate Content	60% Minimum	WA 915.1
California Bearing Ratio (Soaked 4 days with 6.75kg Surcharge) at 94% of MDD and 100% of OMC	50% Minimum	WA 141.1

501.09 CRUSHED ROCK BASE SUBBASE SUPPLIED BY THE CONTRACTOR

1. All crushed rock base Subbase shall consist of a uniform blended mixture of coarse and fine aggregate. The mixture shall be free from vegetable matter, lumps of clay, overburden or any other deleterious matter. **General**

2. The Particle Size Distribution of the material when tested in accordance with Test Method WA 115.1 shall comply with the requirements shown in Table 501.05. ***Particle Size Distribution***

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FOI 26-292 - Document 27

3. The crushed rock base subbase shall also meet the other limits as shown in Table 501.06. The Secondary Mineral Content in Basic Igneous Rock test is only applicable to basic igneous rock. The Accelerated Soundness Index test is only applicable to basic igneous rock.

Other Acceptable Limits

TABLE 501.05 PARTICLE SIZE DISTRIBUTION (CRUSHED ROCK BASE SUBBASE)

AS 1152 Sieve Size (mm)	% Passing by Mass Target Grading	% Passing by Mass Minimum and Maximum Limits
26.5	100	100
19.0	98	95 - 100
9.5	73	60 - 85
4.75	55	40 - 70
2.36	43	30 - 55
1.18	31	20 - 42
0.600	23	13 - 32
0.425	20	11 - 28
0.300	17	8 - 25
0.150	13	5 - 20
0.075	10	5 - 15

TABLE 501.06 OTHER ACCEPTANCE LIMITS (CRUSHED ROCK BASE SUBBASE)

Test	Limits	Test Method
Plasticity Index	5% Maximum	WA122.1
Linear Shrinkage	2.0% Maximum	WA123.1
California Bearing Ratio (Soaked 4 days with 6.75kg Surcharge) at 96% of MDD and 100% of OMC	70% Minimum	WA141.1
Secondary Mineral Content in Basic Igneous Rock	25% Maximum	AS 1141.26
Accelerated Soundness Index by Reflux	94% Minimum	AS 1141.29

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FOI 26-292 - Document 27

501.10 GRAVEL BASECOURSE SUPPLIED BY THE CONTRACTOR

1. Gravel Basecourse material shall consist of durable pebble in soil mortar. The material shall be free from particles having any dimension greater than 50mm and free from clods, stumps, roots, sticks, vegetable matter or other deleterious materials. ***General***

2. When the stockpiled material contains oversized material, the Contractor shall screen the stockpiles to ensure that the pavement material does not contain more than 20% by mass of material retained on a 37.5mm sieve. ***Oversized Material***

3. The screen aperture shall be selected so that only the minimum quantity of material is removed from the existing stockpile to satisfy this requirement. ***Screen Aperture***

4. Basecourse material having any dimension greater than 50mm shall be deemed oversize and shall not be delivered to the pavement construction area.

(NOTE: Check need for alternative paragraphs 1 to 4, and then delete this note – refer Guidance Note 3)

5. The Particle Size Distribution shall be determined in accordance with Test Method WA 115.1. The particle size distribution of the portion passing a 37.5mm AS sieve shall conform to the grading limits shown in Table 501.07. The grading of material passing the 37.5mm sieve shall vary from coarse to fine in a uniform and consistent manner. The material shall not be gap graded as represented by the grading crossing from the maximum limit for one sieve size to the minimum limit for another sieve size, and shall conform as closely as possible to the specified target grading. ***Particle Size Distribution***

6. The material shall also comply with the limits shown in Table 501.08. The Secondary Mineral Content in Basic Igneous Rock test is only applicable to basic igneous rock. The Accelerated Soundness Index test is only applicable to basic igneous rock. ***Other Acceptance Limits***

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FOI 26-292 - Document 27

TABLE 501.07 PARTICLE SIZE DISTRIBUTION (GRAVEL BASECOURSE)

(Gravel Basecourse is not suitable for use in freeways and controlled access highways in the metropolitan area)

As Sieve Size (mm)	% Passing by Mass Target Grading	% Passing by Mass Minimum and Maximum Limits
37.5	100	100
19.0	86	72 – 100
9.5	64	50 - 78
4.75	47	36 - 58
2.36	35	25 - 44
1.18	27	18 - 35
0.600	21	13 – 28
0.425	18	11 - 25
0.300	16	9 – 22
0.150	12	6 – 17
0.075	9	4 - 13
0.0135	6	2 - 9

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FOI 26-292 - Document 27

TABLE 501.08 OTHER ACCEPTANCE LIMITS (GRAVEL BASECOURSE)

(Gravel Basecourse is not suitable for use in freeways and controlled access highways in the metropolitan area)

Test	Limits	Test Method
Liquid Limit	25.0% Maximum	WA 120.2
Linear Shrinkage	2.0% Maximum	WA 123.1
Maximum Dry Compressive Strength	2.3MPa Minimum	WA140.1
California Bearing Ratio (Soaked 4 days with 4.5kg Surcharge) at 96% of MDD and 100% of OMC	80% Minimum	WA 141.1
Secondary Mineral Content in Basic Igneous Rock	25% Maximum	AS 1141.26
Accelerated Soundness Index by Reflux	94% Minimum	AS 1141.29
Resilient Modulus (Additional requirement if specified in Pavement Design) at 99% of MDD and 60% of OMC	See Guidance Notes and delete this note	AG:PT/T053 & WA 142.2

501.11 CRUSHED ROCK BASE BASECOURSE SUPPLIED BY THE CONTRACTOR

1. All crushed rock base (CRB) shall consist of a uniformly blended mixture of coarse and fine aggregate. The mixture of fine and coarse aggregate forming the rock base shall be free from vegetable matter, lumps of clay, overburden, or any other deleterious matter. ***General***

2. Coarse aggregate (retained 4.75mm sieve) shall consist of clean, hard, durable, angular fragments of rock produced by crushing sound unweathered rock and shall not include materials which break up when alternately wetted and dried. ***Coarse Aggregate***

3. Fine aggregate (passing 4.75mm sieve) shall consist of crushed rock fragments or a mixture of crushed rock fragments with natural sand or clayey sand. Crushed rock fine aggregate from each source shall, except as to size, comply with all the provisions specified for coarse aggregate. ***Fine Aggregate***

4. Refer to Hydrated Cement Treated Crushed Rock Base (HCTCRB) Basecourse Clauses 501.12 and 501.15 below for details on the manufacture of HCTCRB. ***HCTCRB***

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FOI 26-292 - Document 27

5. The Particle Size Distribution of the material when tested in accordance with Test Method WA 115.1 shall comply with the requirements shown in Table 501.09. The grading of material passing the 26.5mm sieve shall vary from coarse to fine in a uniform and consistent manner. The material shall not be gap graded as represented by the grading crossing from the maximum limit for one sieve size to the minimum limit for another sieve size, and shall conform as closely as possible to the specified target grading.

Particle Size Distribution

TABLE 501.09 PARTICLE SIZE DISTRIBUTION (CRUSHED ROCK BASE BASECOURSE)

AS 1152 Sieve Size (mm)	% Passing by Mass Target Grading	% Passing by Mass Minimum and Maximum Limits	
		General CRB	CRB for HCTCRB Manufacture
26.5		100	100
19.0	100	95 – 100	99 – 100
13.2	82	70 – 90	74 – 90
9.5	70	60 – 80	64 – 80
4.75	50	40 – 60	45 – 60
2.36	38	30 – 45	33 – 45
1.18	25	20 – 35	23 – 35
0.600	19	13 – 27	16 – 27
0.425	17	11 – 23	14 – 23
0.300	13	8 – 20	11 – 20
0.150	10	5 – 14	8 – 14
0.075	8	5 – 11	7 - 11

6. The Dust Ratio, defined as the ratio of the percentage passing by mass the 0.075mm sieve to the percentage passing by mass the 0.425mm sieve, shall be within the range 0.35 to 0.60.

Dust Ratio

7. The crushed rock base shall also meet the other limits as shown in Table 501.10. The Secondary Mineral Content in Basic Igneous Rock test is only applicable to basic igneous rock. The Accelerated Soundness Index test is only applicable to basic igneous rock.

Other Acceptance Limits

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FOI 26-292 - Document 27

TABLE 501.10 OTHER ACCEPTANCE LIMITS (CRUSHED ROCK BASE BASECOURSE)

Test	Limits	Test Method
Liquid Limit (Cone Penetrometer)	25.0% Maximum	WA120.2
Linear Shrinkage	2.0% Maximum 0.4% Minimum	WA123.1
Flakiness Index	30% Maximum	WA 216.1
Los Angeles Abrasion Value	35% Maximum	WA 220.1
Maximum Dry Compressive Strength	1.7MPa Minimum	WA 140.1
California Bearing Ratio (Soaked 4 days with 4.5kg Surcharge) at 99% of MDD and 100% of OMC	100% Minimum	WA141.1
Wet/Dry Strength Variation	35% Maximum	AS1141.22
Secondary Mineral Content in Basic Igneous rock	25% Maximum	AS 1141.26
Accelerated Soundness Index by Reflux	94% Minimum	AS 1141.29
Resilient Modulus (Additional requirement if specified in Pavement Design) at 99% of MDD and 60% of OMC	See Guidance Notes and delete this note	AG:PT/T053 & WA 142.2

8. Crushed rock base shall be thoroughly mixed with water using a pugmill to produce a homogeneous product suitable for placement into final position. ***Mixing***

9. Crushed rock base shall be pre-wet to greater than 95% of the Optimum Moisture Content as determined by Test Method WA 133.1. ***Pre-wetting***

501.12 HYDRATED CEMENT TREATED CRUSHED ROCKBASE BASECOURSE SUPPLIED BY THECONTRACTOR

501.12.01 MANUFACTURE OF HCTCRB

1. The hydrated cement treated crushed rock base (HCTCRB) shall be manufactured by blending 2.0 ± 0.1% by dry mass of cement with crushed rock base (CRB). The untreated CRB must comply with the requirements for CRB as specified in Clause 501.11. ***General***

2. The cement used in the manufacture of HCTCRB shall be General Purpose (Type GP). ***Cement Type***

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FOI 26-292 - Document 27

3. The HCTCRB shall be manufactured by blending water and a target 2.0 % by dry mass of cement with the CRB. The mixing process shall produce a homogeneous mixture of crushed rock base, cement and water in which the water and cement are uniformly distributed. Mixing shall be carried out as either a batch or continuous process in an approved plant. This plant shall include measuring equipment, which will determine the mass of cement added to a known mass of crushed rock base at all stages of the mixing process. The Superintendent's approval of the Tenderer's plant will be conditional on this equipment being capable of determining the mass of cement added to the Basecourse to within ± 0.1% of the dry mass of the CRB.

Blending

4. **Prior to the use of the plant proposed to be used for the modification process, the Contractor shall certify to the Superintendent that the plant is capable of determining the mass of cement added to the Basecourse to within ± 0.1% of the dry mass of the CRB.**

HOLD POINT

5. During the initial hydration period the moisture content of the mixed and stockpiled HCTCRB shall be at least 90% of the optimum moisture content (OMC) of the crushed rock base used to produce the HCTCRB. The moisture content shall be determined in accordance with Test Method WA 110.1.

Moisture Content

6. The HCTCRB shall be stockpiled at the quarry for a period of not less than 21 days after the addition of cement and water to the CRB (i.e. minimum initial hydration period).

Initial Hydration Period

7. The HCTCRB must be compacted into the pavement in its final position not less than 30 days or greater than 60 days after the addition of cement and water to the CRB (i.e. minimum and maximum construction hydration periods).

Construction Hydration Period

8. The hydrated cement treated crushed rock base shall also meet the other limits as shown in Table 501.11.

Other Acceptance Limits

TABLE 501.11 OTHER ACCEPTANCE LIMITS (HYDRATED CEMENT TREATED CRUSHED ROCK BASE SUPPLIED BY THE CONTRACTOR)

Test	Limits	Test Method
Unconfined Compressive Strength at 7-days. At the in service density condition	0.8 MPa Maximum	WA 143.2
Unconfined Compressive Strength at 28-days. At the in service density condition	1.0 MPa Maximum	WA 143.2
Vertical Modulus of the top sub-layer At the in service conditions, including in-service stress, construction hydration period, moisture and density conditions	1000 MPa Minimum 1500 MPa Maximum	Laboratory Repeated Load Triaxial Test AG:PT/T053 using internal displacement measuring device & WA 142.3

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FOI 26-292 - Document 27

501.12.02 HCTCRB TRIAL MIXES

1. The Contractor shall prepare trial mixes from each source of HCTCRB to be used in the Works. The trial mixes must cover the range of crushed rock base material and cement properties from each source that will be used to manufacture HCTCRB for the Works. The mixes must be made using the plant and degree of quality control proposed for the Works. ***Trial Mixes***

2. As a minimum the Contractor must undertake sufficient particle size distribution, LA abrasion, flakiness index, MDCS, linear shrinkage and soaked CBR tests on the crushed rock from each source to establish the range of its properties. Repeated load triaxial tests and unconfined compressive strength tests must be undertaken to establish that the HCTCRB from each source conforms to the specified acceptance limits (i.e. within the range of the source materials properties, construction hydration period, density and dryback moisture that will occur within the Works). As a minimum repeated load triaxial tests and unconfined compressive strength tests must be undertaken on samples compacted at hydration periods of 30 days and 60 days after the cement and water are added to the crushed rock base ***Laboratory Testing***

3. **Prior to the manufacture of any HCTCRB for use in the Works the Contractor must provide to the Superintendent for approval results of the trial mixes demonstrating that the HCTCRB and its constituents conform with all specified requirements. In seeking this approval the Contractor must specify the construction hydration period range that will be used in the Works. The construction hydration period must not be less than 30 days or greater than 60 days.** ***HOLD POINT***

501.13 BITUMEN STABILISED LIMESTONE BASECOURSE SUPPLIED BY THE CONTRACTOR

1. Bitumen stabilised limestone (BSL) shall be produced by the addition of 2.0% residual bitumen by dry mass of crushed limestone material. The limestone shall be free from sand, roots and other foreign material. ***General***

2. The bitumen emulsion used to stabilise (modify) the crushed limestone shall comply with the requirements of AS 1160, “Bitumen Emulsion for Construction and Maintenance of Pavements” for Grade ASS/170-60 emulsion. The emulsifier used in the manufacture of the emulsion shall be Vinsol resin. The bitumen used in the manufacture of the emulsion shall be class 170 bitumen conforming to AS 2008, Bitumen for Pavements. Tenderers shall nominate the source of supply of bitumen emulsion with their tender. The Contractor shall make arrangements for the Superintendent to sample the emulsion or any of its components at any time during normal working hours. These arrangements shall include a means of identifying lots of emulsion or the component material, which will be used in the Works. ***Bitumen Emulsion***

3. All water added during the mixing process and field moisture requirements during construction, shall contain a wetting agent such as “Teepol”, “Comprox”, or similar, which shall be added at a rate of 1 litre of wetting agent per 4000 litres of water used. ***Wetting Agent***

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FOI 26-292 - Document 27

4. All stabilised limestone shall be stockpiled for at least three days before delivery to site. The mixture shall have a moisture content of at least 95% of the Optimum Moisture Content as determined by Test Method WA 133.1. The Moisture Content shall be determined in accordance with Test Method WA 110.1 from samples taken from trucks prior to delivery. ***Moisture Content***

5. The mixing process shall produce a homogeneous mixture of limestone, bitumen and water in which the bitumen is uniformly distributed in the form of a thin film covering the particles of the crushed limestone. Mixing shall be carried out as either a batch or continuous process in a suitable plant. This plant shall include measuring equipment which will determine the mass of bitumen emulsion added to a known mass of crushed limestone at all stages of the mixing process. ***Mixing Process***

6. **Prior to the use of the plant proposed to be used for the modification process, the Contractor shall certify to the Superintendent that the plant is capable of determining the amount of bitumen emulsion added to the Basecourse to within –0.0% to + 0.2% of the dry mass of the limestone.** ***HOLD POINT***

7. **Prior to modification of the Basecourse, the Contractor shall give the Superintendent at least three (3) working days' notice of such modification.** ***HOLD POINT***

8. The Particle Size Distribution of the BSL after mixing and delivery shall be determined in accordance with Test Method WA 730.1 and shall comply with the details shown in Table 501.12. ***Particle Size Distribution***

TABLE 501.12 PARTICLE SIZE DISTRIBUTION (BSL)

As Sieve Size (mm)	% Passing by Mass Minimum and Maximum Limits
26.50	100
19.00	90 – 100
4.75	60 – 90
1.18	35 - 75

9. The Bitumen Stabilised Limestone shall also meet the other acceptance limits as shown in Table 501.13. ***Other Acceptance Limits***

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FOI 26-292 - Document 27

TABLE 501.13 OTHER ACCEPTANCE LIMITS (BSL)

Test	Limits	Test Method
Los Angeles Abrasion Value of Crushed Limestone	20.0% Minimum 60% Maximum	WA 220.2
Calcium Carbonate Content	60% Minimum	WA 915.1
Dispersion of Bitumen in Soil #	Class 1	WA 717.1
Bitumen Content – Centrifuge Method	2.0% Minimum 2.2% Maximum	WA 730.1
Resilient Modulus (Additional requirement if specified in Pavement Design) at 98% of MDD and 70% of OMC	See Guidance Notes and delete this Note	AG:PT/T053 & WA 142.2

Compliance for bitumen dispersion of any lot shall be based on the results of the assessment of 3 samples randomly selected from the lot being judged and tested in accordance with Test Method WA 717.1. All results must have a dispersion of Class 1; however the Superintendent may accept the material if one of the three samples has a dispersion of Class 2.

501.14 CEMENT FOR STABILISED PAVEMENTS

1. Cement for stabilisation of any Pavement Layer shall comply with the requirements of AS 3972, Type LH. Any sampling and testing of cement shall be in accordance with AS 2350. The cement shall be sufficiently dry to flow freely during application. ***Cement***

2. Cement for stabilisation of any Pavement Layer shall comply with the requirements of Australian Technical Infrastructure Committee (ATIC) Specification SP43. The Cementitious Material Registration Scheme (CMRS) shall be used to confirm that the cement complies to ATIC - SP43. The standard application form for CMRS registration is shown in Annexure 501B.

3. **Prior to commencing cement stabilisation the Contractor shall confirm that the cement complies with ATIC – SP43 and shall provide the CMRS registration number for the cement to the Superintendent for approval of the cement.** ***HOLD POINT***

4. The Contractor shall arrange cement delivery and have on site bulk storage facilities. The Contractor shall be responsible for all arrangements in regard to the transfer of cement between delivery vehicles, on site bulk storage facilities and cement spreaders. ***Delivery***

5. The Contractor shall use cement in approximately the chronological order in which it is delivered from the manufacturer. ***Chronological Order***

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FOI 26-292 - Document 27

6. Transportation units and storage bins for bulk cement shall be weatherproof and shall be constructed so that there is no dead storage. The Contractor shall demonstrate that the storage bins for bulk cement do not have any dead storage. If dead storage exists the bins shall be emptied completely at least once every three months. Cement delivered in bags shall be stored in weatherproof structures having floors raised above the ground. Cement that is more than three months old shall not be used. ***Storage***

7. **Prior to commencing cement stabilisation, the Contractor shall certify to the Superintendent that the cement is no more than 3 months old** ***HOLDPOINT***

501.15 CEMENT FOR HCTCRB

1. Cement for use in HCTCRB shall comply with the requirements of AS 3972, Type GP. Any sampling and testing of cement shall be in accordance with AS 2350. The cement shall be sufficiently dry to flow freely during mixing with the CRB. ***Cement***

2. Cement used for the manufacture of HCTCRB shall comply with the requirements of Australian Technical Infrastructure Committee (ATIC) Specification SP43 ATIC – SP43). The Cementitious Material Registration Scheme (CMRS) shall be used to confirm that the cement complies to ATIC - SP43. The standard application form for CMRS registration is shown in Annexure 501B.

3. **Prior to commencing the manufacture of the HCTCRB the Contractor shall confirm that the cement complies with ATIC – SP43 and shall provide the CMRS registration number for the cement to the Superintendent for approval of the cement.** ***HOLD POINT***

4. The Contractor shall use cement in approximately the chronological order in which it is delivered from the manufacturer ***Chronological Order***

5. Transportation units and storage bins for bulk cement shall be weatherproof and shall be constructed so that there is no dead storage. The Contractor shall demonstrate that the storage bins for bulk cement do not have any dead storage. If dead storage exists the bins shall be emptied completely at least once every three months. Cement delivered in bags shall be stored in weatherproof structures having floors raised above the ground. Cement that is more than three months old shall not be used. ***Storage***

6. **Prior to commencing the manufacture of the HCTCRB, the Contractor shall certify to the Superintendent that the cement is no more than 3 months old.** ***HOLDPOINT***

501.16 – 501.25 NOT USED

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FOI 26-292 - Document 27

CONSTRUCTION

501.26 GENERAL

1. Pavement construction includes the supply, placing, compacting and finishing of pavement materials in accordance with the Specifications and Drawings to the prepared Subgrade surface.

2. Pavement construction shall include construction of stabilised pavements.

3. Where a drainage layer has been constructed on the prepared Subgrade surface, the drainage layer shall be the foundation for the subsequent Pavement Layer(s). ***Drainage Layers***

4. **Prior to the construction of any pavement layer, the Contractor shall certify to the Superintendent that the underlying layer has been constructed as specified.** ***HOLD POINT***

5. Natural gravels and ferricrete, including cement stabilised natural gravels and ferricrete, shall not be used as Basecourse material for freeway pavements or future freeway pavements in the metropolitan area. ***Gravel & Ferricrete Restrictions***

6. Pavers, including those that utilise transverse augers, shall not be used for pavement construction. ***Pavers***

7. Transverse joints shall be offset from one layer to the next by not less than 5 metres. ***Transverse Joints***

8. Longitudinal joints shall be located within 300mm of the planned position of traffic lane lines or within 300mm of the centre of a traffic lane. ***Longitudinal Joints***

9. Final trim must be completed while the basecourse layer is still “green”, prior to dry back. Final trim is limited to removing no more than 20 mm of material at any point. If more than 20 mm is to be removed the Lot must be reworked to a depth of not less than 100 mm and retested. ***Final Trim***

501.27 DRYBACK REQUIREMENTS

1. Pavement construction shall not commence until the layer 150mm below the Subgrade has dried back to the requirements specified in Clause 501.43. ***Subgrade Dryback***

2. Basecourse construction shall not commence until the Sub-Base has dried back to the requirements specified in Clause 501.43. ***Sub-Base Dryback***

3. No binder shall be applied to a Basecourse lot until it has dried to the requirements specified in Clause 501.43. ***Basecourse Dryback***

501.28 SPREADING

1. Each Pavement Layer worked shall be generally parallel to the finished pavement surface and shall extend the full width of the layer. ***General***

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FOI 26-292 - Document 27

2. Sub-Base shall be worked in compacted layers not greater than 250mm nor less than 100mm. Where less than 100mm is required to be worked the underlying Sub-Base shall be scarified to such a depth that the resulting compacted thickness of the layer to be worked is not less than 100mm. ***Sub-Base Layer***

3. Basecourse shall be worked in compacted layers not more than 250mm nor less than 100mm compacted thickness. Except that HCTCRB Basecourse shall be worked in compacted layers not less than 150mm compacted, thickness. ***Basecourse Layer***

4. For in situ rehabilitation works the Superintendent may give approval for the Basecourse to be worked in a compacted layer of up to 300mm compacted, thickness. This approval shall not be unreasonably withheld, but can be withdrawn at any time if the Superintendent is not satisfied that all the requirements of the contract are being met. ***Rehabilitation Works***

501.29 COMPACTION

501.29.01 GENERAL

1. Pavement material shall be spread, mixed and compacted to achieve uniformity free from any evidence of segregation.

2. Compaction shall be carried out at a Construction Moisture Content, at any point in the Lot within the range of 90% - 110% of the Optimum Moisture Content and with a uniform compactive effort applied longitudinally and transversely to the road alignment to achieve the density as shown in Annexure 501A as well as the width, shape, level and surface finish as specified in Clauses 501.44 to 501.47. ***Construction Moisture Content***

501.29.02 HYDRATED CEMENT TREATED CRUSHED ROCK BASE (HCTCRB)

1. Compaction and trimming of HCTCRB to shape and level shall be completed within twelve (12) hours of the incorporation of the HCTCRB into the Pavement Layer. HCTCRB Basecourse shall be compacted to a Characteristic Dry Density Ratio shown in Annexure 501A, or greater. ***Timing***

2. The maximum dry density used in the calculations shall be determined on pre-treated material sampled from the Basecourse lots prior to compaction and shall be determined in accordance with Test Method WA 133.1. Pre-treatment shall comprise mixing HCTCRB material at a moisture content dry of OMC in a cement mixer with a bowl of approximately 0.06 cubic metres for 560±20 revolutions, at the construction hydration period that corresponds to that of the lot being tested. ***Sample Pre-treatment***

3. Basecourse dryback prior to bituminous surfacing shall be in accordance with Annexure 501A and shall be based on the OMC determined at Clause 501.29.02.2. ***Basecourse Dryback***

4. Bituminous surfacing of the HCTCRB shall not commence until the Basecourse stiffness has achieved a Characteristic Clegg Impact Value of 55 or greater when tested in accordance with AS 1289.6.9.1. The Clegg Impact Values shall be determined at 9 locations per lot. The locations shall be selected in accordance with WA 0.1. ***Basecourse Stiffness***

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FOI 26-292 - Document 27

5. The Characteristic Clegg Impact Value (CIVc) is defined by the expression: ***Clegg Impact Value***

   CIVc = CIV – 0.59s

   Where CIV = the mean of the results of Clegg Impact Value on the lot being assessed reported to the nearest 1.0.

   s = the standard deviation of the results of the Clegg Impact Value on the lot being assessed, calculated in accordance with Specification 201 QUALITY SYSTEMS ANNEXURE 201A 1.4 and reported to the nearest 0.1.

6. HCTCRB trimmed from a lot shall not be incorporated into another Basecourse lot. If a completed layer of HCTCRB Basecourse does not satisfy all of the requirements of the Specification and has to be reworked, the Contractor shall repeat all the requirements for HCTCRB at no cost to the Principal. Rework shall include any disturbance to the surface of the HCTCRB Basecourse during trimming to meet shape or level requirements that occurs more than twelve (12) hours after the incorporation of the HCTCRB into the Pavement Layer. The rework depth shall not be less than the full depth of the affected layer. ***Trimming, Rework***

501.29.03 BITUMEN STABILISED LIMESTONE (BSL)

1. During the construction process the bitumen stabilised limestone (BSL) shall not be ripped up and reworked more than once. If the BSL has dried back to less than 80% of OMC it shall not be reworked. BSL trimmed from one lot shall not be incorporated into another Basecourse lot. ***Trimming, Rework***

501.29.04 CEMENT STABILISED BASECOURSE GRAVEL

1. Cement stabilised gravel basecourse trimmed from one lot may be incorporated into another gravel basecourse lot provided it is uniformly spread. ***Trimming***

501.30 CEMENT STABILISATION

501.30.01 GENERAL

1. The Contractor shall cement stabilise the specified Pavement Layer with the proportion of cement and to the depth of the Pavement Layer as shown in Annexure 501A.

2. The cement stabilised Pavement Layer shall be constructed at the locations shown in Annexure 501A and to the tolerances and requirements specified for this type of pavement.

501.30.02 TRIAL SECTION

1. The Contractor shall carry out a preliminary trial of the proposed stabilising operations. The trial shall determine:

   i. the effectiveness of the plant;

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FOI 26-292 - Document 27

ii. the number of passes of the stabilising machine necessary to achieve the specified mixing; and

iii. the compacted depth of layer being worked, including the allowance for trimming to spoil and level tolerances.

2. The trial section shall be located within the Works area.

3. **Prior to conducting such a trial the Contractor shall agree with the Superintendent the location, length and width of trial section(s) within the Works.** ***HOLD POINT***

4. The Contractor shall not change the method developed during the trial without approval from the Superintendent.

501.30.03 PLANT AND EQUIPMENT

1. The spreading equipment shall be a stabilising agent spreader, which has been specifically designed for such work. The spreader shall be capable of uniformly distributing cement and accurately controlling the spread rate such that when mixing is complete, the cement content shall be in accordance with the requirements of the Spreading of Cement Clause below. The spreader shall be equipped with gates to vary the width of spread and with electronic weigh scales to give daily totals of product used. ***Cement Spreader***

2. Cutting, pulverising, mixing, adding water and spreading of mixed material shall be accomplished using a stabilising machine specifically designed for stabilisation. The stabilising rotor action shall be such that the rotor revolves in an upwards and forwards cutting direction. The rotor shall be of the recycler type and fitted with bullet teeth cutting tips. The stabilising machine shall also satisfy the following requirements: ***Stabilising Machine***

   i. It shall be capable of producing a uniformly mixed material throughout the specified depth of the work.

   ii. It shall be equipped with a variable depth of cut control, and an accurate gauge to measure depth of cut which is readily visible to the operator.

   iii. It shall have provision for adding water automatically through a system comprising a pump, flow meter, variable control valve and full width spray bar. Each nozzle on the spray bar shall be fully and independently adjustable, and the water pump shall have the capacity to supply up to 1500 litres per minute.

501.30.04 PRELIMINARY TREATMENT

1. It shall be the Contractor's responsibility to determine whether pre-ripping the in-situ pavement material is necessary. Under no circumstances shall ripping to a depth exceeding the depth to be stabilised be permitted. ***Pre-Ripping***

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FOI 26-292 - Document 27

501.30.05 SPREADING OF CEMENT

Cement Content

1. The cement stabilised Pavement Layer shall contain the proportion of cement as a percentage of the dry mass of pavement material as shown in Annexure 501A. Cement shall be spread uniformly at a controlled rate over the area to be stabilised using a suitable cement spreader.

2. The Contractor shall provide to the Superintendent daily records of the amounts of cement used and actual spread rates obtained per section treated.

Calculation Methods

3. The percentage cement shall be determined by either

   i. placing three (3) trays each of one third of a square metre in area in front of the cement spreader and measuring the mass of cement deposited on the trays for each lot, or

   ii. by use of an on-board calibrated electronic weight scale system.

   The percentage cement (P%) shall be calculated thus:

$$P = \frac{M \times 100}{A \times T \times MDD}$$

Where M = total mass of cement (kg) as determined by one of the following methods:

a) on each tray
b) on-board calibrated electronic weight scale system.

A = method a): total area of the trays (m²)
method b): total measured area spread (m²)

T = Thickness to be stabilised (mm) (including allowances for tolerances and trimming)

MDD = Maximum Dry Density of the pavement material without the addition of cement (kg/m³)

4. The percentage cement determined for each tray in accordance with this Clause shall be maintained within ± 10% by mass of the cement content specified in this Clause throughout the stabilisation works.

Calibration Requirement

5. The use of method (b) in determining the values 'M' and 'A' is subject to satisfactory calibration of the measuring device and the production of associated certification in accordance with the Contractor's Quality System. Audits on this method shall be carried out using the measuring tray method.

6. Once the cement has been spread, no other plant other than that needed for spreading, or for mixing and spreading the mixed material, shall be permitted to travel over the area to be stabilised.

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FOI 26-292 - Document 27

501.30.06 INCORPORATION OF CEMENT

1. The spreading of cement shall not proceed when rain is imminent. The spread cement shall be incorporated into the Pavement Layer immediately following the spreading operation. All spread cement shall be incorporated into the Pavement Layer within the same working day. Cement shall not be spread when the prevailing wind velocity is sufficient to make the cement particles airborne.

2. Cutting, stabilising, mixing, adding water and spreading of mixed material shall take place as a single operation within the stabilizing machine.

3. Cutting, stabilising, mixing, adding water and spreading of mixed material shall continue until the maximum size of all material (other than rock) is not greater than 25mm, and the cement and water are uniformly incorporated into the mixed material without streaks or pockets of cement.

501.30.07 COMPACTION

1. Initial compaction must be carried out using a vibratory pad-foot roller meeting the requirements of Specification 302 EARTHWORKS, Clause 302.44.4. ***Initial Compaction***

2. Compaction and trimming of the mixed material to shape and level shall be completed within six (6) hours of the completion of incorporation of cement into the Pavement Layer and shall be compacted to the Characteristic Dry Density Ratio as shown in Annexure 501A or greater. ***Time for Compaction***

3 The Contractor shall achieve and maintain the construction moisture content at any point in the Lot in the range 90% – 110% of the OMC of the stabilised material by controlling the amount of water added during the mixing process within the stabilising machine. ***Moisture Content***

501.30.08 REWORK

1. If a completed layer of cement stabilisation does not satisfy all of the requirements of the Specification and has to be reworked, the Contractor shall rework the layer without the addition of cement at no cost to the Principal. ***Rework***

2. Rework shall include any disturbance to the surface of the cement stabilized layer during trimming to meet shape or level requirements that occurs more than six (6) hours after the completion of incorporation of cement into the Pavement Layer. The rework depth shall not be less than the full depth of the affected layer.

501.30.09 CONSTRUCTION JOINTS

1. If the stabilized work is such that it cannot be completed in one continuous operation, the Contractor shall provide construction joints at each discontinuity in the operation.

2. All construction joints shall be made transverse to and/or parallel to the direction of the stabilised run, and shall be made just prior to the commencement of the next stabilised run.

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FOI 26-292 - Document 27

3. The joints shall be formed by cutting back into the compacted stabilised material to form a vertical face. The loose trimmed material shall be removed from the joint before the next section is mixed and compacted.

501.31 BLEND AREAS

Cut Edge

1. In areas denoted as “blend areas” or “match existing pavement” on the drawings, the cut edge of the existing bituminous surfacing and the wall of the excavation shall be in accordance with the requirements stated in Specification 302 EARTHWORKS.

2. The work shall comprise removal of the existing pavement to a sufficient depth to place the new pavement to the required levels, shaping and compaction.

3. Pavement shall be supplied, placed and compacted in accordance with this Specification.

4. Within the blend areas the level of the Subgrade or Pavement Layer shall be in accordance with the detail shown on the Drawings.

5. The appropriate bituminous surfacing treatment shall then be applied in accordance with Specification 503 BITUMINOUS SURFACING and, where applicable, with Specification 504 ASPHALT SURFACING or Specification 510 FULL DEPTH ASPHALT PAVEMENT, to provide a flush join and smooth transition between new and old construction, including any required matching of concrete kerbing to line and level.

501.32 DRAINAGE LAYER

501.32.01 GENERAL

1. The drainage layer shall consist of a Geotextile lining and a sand material of the material type and thickness as shown in Annexure 501A. The drainage layer shall be constructed immediately below the Pavement to the details shown in the drawings, and connected to a positive drainage system.

501.32.02 GEOTEXTILE

1. The Geotextile shall be a non-woven fabric consisting of long chain synthetic polymer fibres composed of at least 85% by mass of polyesters, polyolefins or polyamides. The fibres shall be formed into a fabric by needle punching, heat or chemical bonding processes such that they are capable of retaining their relative position in the Geotextile.

2. In addition, the fibres shall be stabilised against ultra-violet (UV) radiation and shall have low water absorbency.

3. The Geotextile shall be free of any flaws or defects that may adversely affect the mechanical or physical properties of the fabric.

Covering

4. Each roll of Geotextile shall be provided with a suitable covering to protect the fabric against moisture and ultra-violet radiation. Each roll shall be marked in conformance with AS 3705.

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FOI 26-292 - Document 27

5. Rolls shall be stored on site under a waterproof cover and shall be supported off the ground. The Contractor shall take appropriate measures to protect the Geotextile from damage. ***Storage***

6. The Geotextile shall comply with the requirements shown in Table 501A6 and Table 501A7 of Annexure 501A. ***Properties***

7. All properties represent minimum roll values, that is, the test result from any sampled roll shall exceed the minimum value in Table 501A6.

501.32.03 INSTALLATION OF GEOTEXTILE

1. The Contractor's process of installation of the Geotextile shall ensure that fabric is not damaged.

2. The initial lift thickness of fill materials placed directly over the Geotextile shall be a minimum uncompacted thickness of 300mm. The use of vibratory compaction equipment over the Geotextile should be minimized for the initial lift. ***Initial Lift***

3. Unless otherwise shown on the Drawings, the minimum overlap requirement shall be 300mm. Successive sheets of Geotextile shall be overlapped a minimum of 300mm with the upslope section overlying the down slope. ***Overlap***

4. The period of time between laying out and cover of the Geotextile shall not exceed 14 days. ***Timing***

5. Damaged areas of Geotextile may be repaired by overlaying the damaged section with a patch. The patch shall extend a minimum of 1 metre beyond the area of damage. ***Repairs***

6. The Contractor shall certify that the Geotextiles delivered to site meet the Specification requirements. Sampling, conditioning and statistical analysis of results shall be carried out in accordance with AS 3706.1. Sampling frequency shall be in accordance with Appendix A of the standard. If directed otherwise, duplicate samples shall be provided to the Superintendent. ***Sampling and Testing***

501.32.04 DRAINAGE LAYER SAND

1. The Particle Size Distribution of the drainage layer sand shall comply with the requirements shown in Table 501A8 of Annexure 501A when tested in accordance with Test Method WA 115.1. ***Particle Size Distribution***

2. The Linear Shrinkage of the drainage layer sand shall not exceed 1.0% when tested in accordance with Test Method WA 123.1. ***Linear Shrinkage***

3. Construction of the drainage layer shall be as specified for Sub-Base. ***Construction***

501.33 – 501.40 NOT USED

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FOI 26-292 - Document 27

ACCEPTANCE

501.41 GENERAL

1. Each Pavement Layer shall be constructed to the dimensions and details shown on the drawings and shall be constructed in accordance with this Specification to satisfy the criteria shown in Annexure 501A.

2. Where a pavement material has been supplied by the Contractor, the Contractor must undertake required testing of that material sampled from the stockpiles, in accordance with Specification 201 QUALITY SYSTEMS, to demonstrate that the material complies in all respects with the specified requirements. ***Stockpile Material***

3. **Prior to the construction of any Pavement Layer, the Contractor shall certify to the Superintendent that the pavement material supplied by the Contractor complies in all respects with the specified requirements.** ***HOLD POINT***

4. Where a pavement material has been supplied by the Contractor, the Contractor must undertake required testing of that material sampled from the pavement, after compaction is completed, to demonstrate that the pavement material particle size distribution and linear shrinkage complies with the specified requirements. ***Pavement Material***

5. **Prior to the application of Bituminous Surfacing, the Contractor shall certify to the Superintendent that the pavement material supplied by the Contractor complies with the specified linear shrinkage and particle size distribution after compaction into the pavement.** ***HOLD POINT***

501.42 COMPACTION

1. Each Pavement Layer shall be compacted to the Characteristic Dry Density Ratio shown in Annexure 501A or greater. ***General***

2. The Characteristic Dry Density Ratio shall be determined in accordance with Specification 201 QUALITY SYSTEMS ANNEXURE 201A 1.2.1. ***Characteristic Dry Density Ratio***

3. Where the pavement material contains more than 20% by mass of material retained on a 37.5mm sieve, the Maximum Dry Density shall be determined on that portion of the material that passes a 37.5mm sieve. ***Oversize Material***

501.43 DRYBACK

1. Each Pavement Layer and the layer 150mm below the Subgrade shall be dried back such that the Dryback Characteristic Moisture Content (DMc) is equal to or less than the proportion of the Optimum Moisture Content as shown in Annexure 501A as determined by Test Method WA 133.1 or WA 133.2 as appropriate. ***General***

2. The Dryback Characteristic Moisture Content shall be determined in accordance with Specification 201 QUALITY SYSTEMS ANNEXURE 201A 1.3. ***Dryback Characteristic Moisture Content***

DRAFT

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

FOI 26-292 - Document 27

3. Where the pavement material or the material in the layer 150mm below the Subgrade contains more than 20% by mass of material retained on a 37.5mm sieve, the Optimum Moisture Content and the Maximum Dry Density shall be determined on that portion of the material that passes a 37.5mm sieve. ***Oversize Material***

501.44 LAYER WIDTH

1. The outer top edge of any layer of the pavement shall be no closer to the road centreline and no more than 100mm further away from the road centreline than the positions shown in the drawings.

501.45 SURFACE SHAPE

501.45.01 GENERAL

1. Surface shape of Sub-Base and Basecourse must be tested in accordance with Test Method WA 313.2.

501.45.02 SUB-BASE

1. The shape of the Sub-Base in granular Pavement shall be judged to be acceptable when the maximum deviation from a 3 metre straight edge placed in any position on the surface does not exceed 10mm. ***Max Deviation 10mm***

2. The shape of the Sub-Base under Full Depth Asphalt shall be judged to be acceptable when the maximum deviation from a 3 metre straight edge placed in any position on the surface does not exceed 15mm. ***Max Deviation 15mm***

3. Additionally, for pavement widening work, the crossfall at any position on the new surface measured at right angles to the centreline shall be within 0.5% of the existing crossfall on the outer 2 metres of the adjacent traffic lane at that location. ***Widening***

501.45.03 BASECOURSE

1. The shape of the Basecourse is acceptable when the maximum deviation from a 3 metre straight edge placed in any position on the surface does not exceed 6mm. ***Max Deviation 6mm***

2. Additionally, for widening work, the crossfall measured at any position on the new surface at right angles to the centreline shall be within 0.5% of the existing crossfall or of the crossfall on the outer 2 metres of the adjacent traffic lane at that location. ***Widening***

501.46 SURFACE LEVELS

501.46.01 SUB-BASE

1. The level of the completed Sub-Base surface shall be deemed to be conforming when the level measured at any point on the surface is within +5mm, -25mm of the Sub-Base level at that point as determined from the drawings. ***Construction Sections***

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FOI 26-292 - Document 27

2. For pavement widening sections, the level of the completed Sub-Base surface shall be deemed to be conforming when the levels of the Sub-Base at its junction with the existing pavement are within +5mm, -25mm of the levels as determined from the Basecourse depth making due allowances for the effect of the existing crossfall of the pavement. ***Widening Sections***

501.46.02 BASECOURSE

1 The level of the completed Basecourse surface shall be judged to be acceptable when the level measured at any point on the surface is within the following tolerances for the Basecourse level for that point as determined from the drawings: ***Construction Sections***

   i. where final surface is asphalt - 5mm, + 10mm

   ii elsewhere - 5mm, + 20mm

2 Where the Basecourse is stabilised, the depth of stabilisation shall be deemed to be acceptable when the actual depth of the stabilised material after compaction shall nowhere depart from the specified depth by more than - 0mm, + 25mm. ***Stabilised Basecourse***

3 For pavement widening sections the level of the completed Basecourse surface shall be judged to be acceptable when the levels of the Basecourse at its junction with the existing seal are within 0mm, +5mm of the top cut edge level of the existing seal. ***Widening Sections***

501.47 SURFACE FINISH

1. Completed Pavement Layers shall be in a homogeneous, uniformly bonded condition with no evidence of layering, cracking, disintegration or surface tearing. ***Pavement***

2. The finished surface should appear as a stone mosaic interlocked with fine material and shall be dense, even textured and tightly bonded. Slurrying of fines to the surface shall be avoided.

3. Basecourse must retain the above characteristics after rotary brooming and be suitable to receive bituminous surfacing.

4. Prior to the application of a bituminous surfacing the surface of the Basecourse shall be uniformly dry.

501.48 – 501.50 NOT USED

MAINTENANCE

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FOI 26-292 - Document 27

501.51 MAINTENANCE OF COMPACTED LAYERS

1. The surface of any compacted Pavement Layer or prepared Subgrade shall be maintained in such a way as to minimise dust, prevent ravelling, erosion, deformation or any other damage to the layer resulting from environment conditions, traffic or construction activities. The layer shall be kept free from contamination until any subsequent pavement work under the Contract is commenced. ***General***

2. Completed Subgrade and Pavement Layers shall be maintained to the specified standards of surface shape, level, dryback and compaction up to the time of construction of the subsequent Pavement Layer or application of the bituminous surfacing. ***Shape, Level, Dryback, Compaction***

3. Watering shall be continued as necessary to prevent, dusting or loosening of the surface. ***Watering***

501.52 – 501.80 NOT USED

AS BUILT AND HANDOVER REQUIREMENTS

501.81 – 501.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

501.91 – 501.99 NOT USED

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FOI 26-292 - Document 27

ANNEXURE 501 A

CONSTRUCTION REQUIREMENTS

1. COMPACTION OF PAVEMENT LAYERS

1.1 Pavement Layers shall be compacted to the densities shown in Table 501A1. Compaction requirements for embankments and Subgrades can be found in Specification 302 EARTHWORKS Annexure 302B

TABLE 501A1 COMPACTION VALUES

Pavement Layer	Minimum Characteristic Dry Density Ratio % (Rc)
Drainage Layer	94%
All Principal Shared Path Pavement	94%
All Subbase (except CRB)	94% - 96% (Select appropriate value then delete this note. Refer to Guidance Notes)
Crushed Rock Base Subbase	96%
Cement Stabilised Basecourse	96%
Lime Stabilised Basecourse	96%
Bitumen Stabilised Limestone Basecourse	98%
Crushed Rock Base Basecourse	99%
Hydrated Cement Treated Crushed Rock Base Basecourse	99%
Other Basecourse Materials (final surfacing – sprayed seal)	96% - 98% (Select appropriate value then delete this note. Refer to Guidance Notes)
Other Basecourse Materials (final surfacing – asphalt)	98%

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FOI 26-292 - Document 27

2. DRYBACK OF PAVEMENT LAYERS

2.1 Pavement Layers shall be dried back to the requirements shown in Table 501A2 or Table 501A3 prior to the application of bituminous binder or the construction of the overlying layer.

TABLE 501A2 DRYBACK ON SUBGRADE OR SUBBASE LAYERS

Subgrade or Pavement Layers	Maximum Dryback Characteristic Moisture Content (DMc) as a proportion of Optimum Moisture Content
Layer 150mm below Subgrade surface (except for Perth sand)	85%
Drainage Layer	Not required
Crushed Rock Base Subbase	70%
All other Subbase	85%

TABLE 501A3 BASECOURSE DRYBACK

Basecourse Material Type	Maximum Dryback Characteristic Moisture Content (DMc) as a proportion of Optimum Moisture Content
All Basecourse with sprayed seal final surfacing (except CRB))	70 – 85% (Select appropriate value then delete this note. Refer to Guidance Notes)
CRB	60%
All Principal Shared Path Pavement	85%
All Basecourse with asphalt final surfacing (except CRB)	70%
CRB	60%

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