

Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 51

The Design and Construction of Wastewater Pumping Stations and Pressure Mains 4.5 to 180 Litres Per Second Capacity

VERSION 2
REVISION 16

JULY 2023

FOREWORD

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

[Overview of Western Australia's Work Health and Safety \(General\) Regulations 2022 \(dmirs.wa.gov.au\)](https://dmirs.wa.gov.au)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Electrical Engineering, Engineering Standards Section, Engineering.. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

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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)	RVWD.	APRV.
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1	2/10	23/07/15	11 12-13	Scope changed to include Type 180 pumping stations 1.2.13, 1.2.24, 1.2.25	PR	DV
1	2/12	30/11/16	11-18	Clauses 1.2, 1.3 and 1.4.3 revised to align with AS/DS and Clauses 1.4.4 & 1.4.5 added	ML/KR	KP
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1	2/14	30/06/19	20	1.4.3 revised	LT	KP
1	2/15	28/7/22	19	Clause 1.4.3(b) Web address for Developers manual update	KP	KP
3	2/6	04.12.12	19-20	3.3, 3.4	DM	MH
3	2/12	30/11/16	20	Clause 3.2 revised for clarity	KR	KP
3	2/14	30/06/19	23	3.2 revised	LT	KP
3	2/15	28/7/22	24	Section 3.5 added for overall pressure main profile	KP	KP
3	2/16	July 23		Clause 3.3 drawing submission requirements updated	KP	KP
3	2/16	July 23		Clause 3.5 – Requirements for section valves added	KP	KP
3	2/16	July 23		Clause 3.6 combined with Clause 4.4.10	KP	KP
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4	2/3	31.03.04	16	4.15.9 g. ref to Clause f.	VF	JB
4	2/3	31.03.04	1,2,8,15	Branch name change	VF	JB
4B	2/3	31.03.04	1	Table 4.5 length change to 30 from 50	VF	JB
4B	2/3	31.03.04	5	Figure 4.1 updated	VF	JB
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4B	2/4	31.08.06	6	Figure 4.1 updated	VF	JB
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4B	2/5	28.10.08	8	Form 4.1 added	WE	AK
4	2/6	04.12.12	24-30	4.4.3, 4.4.10, 4.7.3, 4.7.5, 4.7.6, 4.7.7, 4.7.8, 4.7.11, 4.7.12, 4.7.13, 4.8, 4.15.2, 4.15.3	DM	MH
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4	2/7	12/02/13	26	4.5 Text and Caution tag on lifting chains added	DM	MH
4	2/7	20/06/13	48	Figure 4.2 amended	DM	MH
4	2/8	23/09/13	24	Addition of 4.4.6 c.	ML	DM
4	2/8	23/09/13	36	Addition of 4.15.9 h.	ML	DM
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4	2/8	23/09/13	49	Reinsertion of Figure 4.1.	ML	DM
4	2/10	23/07/15	22 24 26 29 30 30-33 34 35 38 43 50-52 55-56	Removal of additional industrial flows Backflow prevention device location Revision of Clause 4.5 h. Revision of Clause 4.9 l Addition of Clause 4.9 m Amendments to Clause 4.10 (Emergency Provisions) Addition of Clause 4.15 Revision of Clause 4.16.2 (f) Addition of Clause 4.16.11 (Injecting Pressure Mains) Update Table 4.4 Insert Tables 4.12, 4.13, 4.14 Insert Figure 4.3, 4.4	PR	DV
4	2/12	24/10/16	25 25 27 28 29 35/36	Revision of Clause 4.4.4 Revision of Clause 4.4.5 Revision of Clauses 4.7.3, 4.7.5 & 4.7.6 Removal of Clauses 4.7.11 & 4.7.13 Revision of Clause 4.9 (m) Major Revision of Clause 4.16.3	ML/KP	KP

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			39 40 48 48 50 50 56	Removal of Clause 4.16.9(h) Revision of Clause 4.16.11€ Revision of Clause 4.16.12 Deletion of Clause 4.16.13 Addition of Table 4.15 to Clause 4.17 Table 4–5 - Note added to conversion factors table and correction of example calculation. Table 4.7 revision Tables 4.9 & 4.10 revision Table 4.15 added		
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4	2/14	30/06/19	26 32 43-44 48 68	4.2 revised to include advice on higher density development 4.7.3 revised to provide guidance on PVC pipe age requirements 4.16.8.2 revised requirements for carrier pipes in sleeves and expanded section to include detailed HDD requirements Table 4.1 updated to include design flows for high densities R220, 280, 360 and 480 Form 3.1 added to enable requests for the use of example drawings	LT	KP
4	2/15	28/07/22	32	Clause 4.7.3 Min PN for PVC changed from 12 to 16	KP	KP
4	2/15	28/07/22	32	Clause 4.7.6 Min PN for GRP changed from 12 to 16	KP	KP
4	2/15	28/07/22	45	Clause 4.16.9(f) ABS material removed. PE material added	KP	KP
4	2/15	28/07/22	68	Figure 4.5 added for example wastewater pressure main overall profile	KP	KP
4	2/16	July 23		Clause 4.4.9 updated	KP	KP
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1 INTRODUCTION, DEFINITIONS, ABBREVIATIONS AND STANDARDS

1.1 Introduction

1.1.1 Criteria

The criteria in this Standard are subject to continuous revision. Users should ensure that they are in possession of the latest version.

1.1.2 Scope

This standard contains the requirements for the design of permanent and temporary wastewater pumping stations with pump rates of 4.5 to 180 litres per second and pressure mains of DN 80 to DN 400. The minimum pump rate for Corporation pumping stations is 4.5 litres per second. The minimum size pressure main is DN 80 unless otherwise approved by the Corporation.

This Standard does not contain the requirements for vacuum pumping stations and private pumping stations and pressure mains.

1.1.3 Purpose

The Standard is intended to provide a basic reference for the design of wastewater pumping stations and pressure mains.

Guidelines for all administrative, commercial, and procedural matters for subdivision services work are explained in the Corporation's Developers Manual which can be accessed on the internet at <https://www.watercorporation.com.au/-/media/files/builders-and-developers/subdividing/developers-manual.pdf>.

1.1.4 Drawings

The attached drawings contain information that is complementary to the information contained in the text. The drawings should be read in conjunction with the corresponding parts of the text.

Design Engineers and Contract Superintendents should ensure that they have the latest issue of the drawings.

1.1.5 Brand Names

Where a particular brand name is nominated, an equivalent material or product may be substituted, only where authorised for the particular application by the Corporation.

1.1.6 Design Standards

The Design Engineer shall be responsible for the design of the works irrespective of the minimum requirements of this Standard.

1.1.7 Construction Standards

The required compliance with Australian or Corporation Standards (including this Standard) shall not preclude the use of materials and workmanship of a higher standard.

1.1.8 Access to Existing Wastewater Systems

Corporation wastewater installations shall not be accessed or entered without the prior approval of the Corporation.

1.2 Definitions

In this Standard the following words and expressions shall have the following meanings assigned to them, notwithstanding words and expressions that. These meanings do not necessarily comply with the meanings given are defined in the Water Corporation Act and other Water Corporation publications.

General Terms

1.2.1 Country Area

A non-metropolitan operating area beyond the Perth Region where the Corporation has been licensed to provide water and wastewater services.

1.2.2 Metropolitan Area

The area defined by the Perth Metropolitan Region Planning Scheme boundaries.

1.2.3 Wet Ground

Any general clay, loamy soil (including pindan sand) or any ground (soil) less than 0.6 m above estimated maximum groundwater levels.

Contractual Terms

1.2.4 Corporation

The body corporate known as the Water Corporation of Western Australia which may be represented, from time to time, by a duly appointed nominee.

1.2.5 Contract

A formal legal agreement between a Developer and a Contractor for the purpose of constructing the Works.

1.2.6 Contractor

The person or organisation duly contracted to construct the Works.

1.2.7 Contract Superintendent

The person or organisation duly appointed by a Developer to assure the delivery of the Works in accordance with the asset performance quality requirements of the Works Contract.

1.2.8 Design Engineer

An Engineer or Engineering Firm appointed by the Corporation or by a Developer to undertake a wastewater system design in accordance with Corporation requirements. An Engineer is a person qualified to be a Chartered Professional Engineer with an appropriate level of professional experience in a particular engineering discipline. An Engineering Firm is an organisation, which employs Engineers and is accountable for their professional performance.

1.2.9 Developer

A person or organisation that has entered into a formal agreement with the Corporation to provide wastewater services for land development projects.

1.2.10 Standard and Example Drawing

Standard drawings are published by the Corporation to illustrate common asset component characteristics and configurations which shall apply to all like assets. Example drawings are prepared by the Corporation to illustrate preferred asset drafting layouts and formats. Example drawings are intended to reduce the need for Design Engineers to reproduce common drafting layouts and formats for like assets for each new project. Standard and Example Drawings may be supplemented by project specific drafting features and annotations, as appropriate to each project.

1.2.11 Shall

A mandatory requirement that may be varied only by prior written agreement with the Corporation.

1.2.12 Should

A requirement that may be varied only by a justified project business case acceptable to the Corporation.

1.2.13 Sub-Contractor

A person engaged by a Contractor to execute a specified element of the Contract Works.

1.2.14 Supervisor

A person assigned by a Contractor to undertake supervision and delivery of the Works in accordance with the asset performance quality requirements of a Contract. A Supervisor shall be a licensed plumber, a certified equivalent or should preferably be eligible for membership of the Institution of Engineers, Australia. A Supervisor may be a person who has extensive supervisory experience of sewer construction that is acceptable to the Corporation.

1.2.15 Surveyor

An Engineering Surveyor who is eligible for membership of the Institute of Mining and Engineering or for membership of the Institution of Surveyors Australia.

Pumping Flow Related Terms

1.2.16 Catchment

A land area which is capable of being connected to a wastewater pumping station by means of a gravity or vacuum sewerage conveyance system, as defined by the Corporation.

1.2.17 Design Daily Flow (DDF)

The product of the population density in residential areas, the daily flow per person and the net catchment area or, in non-residential areas, the product of the flow per net hectare and the net catchment area.

1.2.18 Equivalent Storage Factor (ESF)

A factor applied to the Design Daily Flow to quantify the peak inflow rate to be expected at a pumping station. The factor will of necessity differ for each pumping station size and type based on the (different) inflow measurements for the particular pumping station size and type. The Required Emergency Storage Volume (RESV) shall be derived by applying the appropriate Equivalent Storage Factor for the particular pumping station size and type.

1.2.19 Gravity Sewer Design Flow (GSDF)

1.5 times the design daily flow (DDF).

1.2.20 Inlet Access Chamber

The upstream access chamber of a pumping station inflow sewer that is closest to the station.

1.2.21 Inlet Pipe

The inflow sewer pipe between an Inlet Access Chamber and the pumping station.

1.2.22 Minimum Available Emergency Storage Time

The calculated emergency storage time available within a pumping station catchment during peak wastewater inflow to its catchment, without overflowing to the external environment.

1.2.23 Pumping Station – Interim

A short term pumping station constructed in lieu of other planned wastewater conveyance infrastructure, pending completion or funding of the planned infrastructure.

1.2.24 Pumping Station – Permanent

A pumping station which is a required long-term component of the ultimate wastewater conveyance infrastructure planned for a particular pumped wastewater catchment.

1.2.25 Pumping Station – Temporary

A pumping station which is not a required component of the ultimate wastewater conveyance infrastructure planned for a particular wastewater catchment but which facilitates, in the short or medium term, connection of wastewater services within the catchment, pending funding of the planned infrastructure.

1.2.26 Required Emergency Storage Time (REST)

The minimum emergency storage time required to safely dispose of wastewater within a pumping station catchment, in the event of a power failure, as a contingent measure.

1.2.27 Required Emergency Storage Volume (RESV)

The additional storage volume required to store the peak inflow rate of a pumping station catchment for the duration of the Required Emergency Storage Time without overflowing to the external environment.

Pressure/Head Related Terms

1.2.28 Maximum Allowable Operating Pressure (MAOP)

The maximum allowable sustained operating pressure, including due allowance for surge pressure events, which a pipeline component can safely withstand in service under the anticipated operating conditions.

NOTE 1: Typically, plastics (PVC, PE, GRP) pressure pipe **MAOP** at 20°C is equivalent to nominal pipe PN rating, divided by 10. The MAOP of a PN 16 pipe is, typically, 1.6 MPa at 20°C but becomes progressively lower in value as pipe wall temperatures exceed 20°C.

NOTE 2: AS/NZS 4130 Appendix C design factors shall not apply to the calculation of MAOP values for PE pipe. The basic service design factor for PE pipe shall not exceed 1.25 as defined in AS/NZS 4130 Appendix B i.e. MAOP at 20°C = nominal PE pipe PN rating divided by 10. PE pipe MAOP values should be de-rated for temperature and cyclic pressures (fatigue) in accordance with the “Selection of Pipeline Material and Pressure Rating” requirements of this standard.

NOTE 3: The MAOP equivalent terminology used in AS/NZS 1477 (PVC-U pipe) and AS/NZS 4441 (PVC-O pipe) respectively are “Working Pressure, **WP**” and “Allowable Operating Pressure, **PFA**”, for standards development process reasons that have no engineering significance.

NOTE 4: The maximum allowable pressure (MAOP) rating of a steel pipeline with weld-restrained joints is the internal pressure that induces a steel pipe wall stress equivalent to **72%** of minimum steel yield stress (MYS). The MAOP value of a steel pipeline with elastomeric joints may be significantly lower, subject to joint engineering characteristics. These should be defined by reference to the pipe manufacturer and project design basis parameters.

NOTE 5: Some pipe material standards - AS/NZS 2280 for ductile iron (DI) pipes and pipe fittings, for example - define an allowable operating pressure (AOP), being the steady state operating pressure, exclusive of a dynamic or surge pressure allowance. The nominal pressure rating (PN) of DI pipe is equal to its AOP while its MAOP is 1.2 times its AOP.

1.2.29 System Design Operating Pressure

The highest internal operating pressure that a pressure pipeline system, comprising the planned ultimate pressure main and pump configuration, is expected to be subjected to during its service life. System design operating pressure, including due allowance for surge pressure events, should be calculated by the Design Engineer and should never exceed pipeline MAOP.

1.2.30 Allowable Site Test Pressure (ASTP)

The maximum allowable internal pressure that may be safely applied to an installed pipeline for the purposes of site testing to prove its integrity and watertightness for acceptance purposes.

NOTE 1: Non-metallic pipeline ASTP values should never exceed 1.25 times the lowest MAOP (or, in the case of a DI pipeline, AOP) rating of any single pipeline component.

NOTE 2: Steel pipeline ASTP should never exceed the internal pressure that induces steel pipe wall stress equivalent to 90% of minimum steel yield stress (MYS).

NOTE 3: Ductile iron pipeline ASTP should never exceed 1.25 times the lowest AOP rating of any single DI pipeline component.

1.2.31 Field (or Site) Test Pressure

The actual internal test pressure that is applied to a particular installed pipeline to prove its integrity and watertightness for acceptance purposes. Field test pressure should never exceed pipeline ASTP, as duly adjusted for elevated temperatures and cyclic pressure de-rating effects.

1.2.32 Total Developed Head (TDH)

The total head developed by a pump for a particular pumping discharge rate, comprising static, friction and velocity head components from pump suction to discharge delivery points.

1.3 Abbreviations

The following abbreviations shall have the following meanings assigned to them:

ABS	Acrylonitrile Butadiene Styrene
AHD	Australian Height Datum
AS	Australian Standard
CAR	Controlled Access Road
CI	Cast Iron
DI	Ductile Iron
Dia	Diameter
DN	Nominal Diameter

DS	Design Standard (Water Corporation)
EPD	Ethylene Propylene Diene Monomer
Fig	Figure
GRP	Glass Reinforced Plastics
L/s	Litres per second
m/s	Metres per second
MRWA	Main Roads Western Australia
MSCL	Mild Steel Cement Lined
NBR	Nitrile Rubber
NPSH	Net Positive Suction Head
PE	Polyethylene
PAW	Pedestrian Access Way
POS	Public Open Space
PVC-U	Unplasticised Polyvinyl Chloride
PVC-M	Modified Polyvinyl Chloride
PVC-O	Oriented Polyvinyl Chloride
RCPL	Reinforced Concrete Plastic Lined
ROW	Right of Way
SPS	Strategic Product Specification (Water Corporation)
SS	Stainless Steel
SWL	Safe Working Load
WWPS	Wastewater Pumping Station

1.4 Reference Documents

1.4.1 Australian and Australian / New Zealand Standards

The following Australian and Australian / New Zealand Standards, among others, may be referred to in this standard:

AS 1111.1	ISO metric hexagon bolts and screws-Product grade C-Bolts
AS 1112.3	ISO metric hexagon nuts Product grade C
AS 1214	Hot-dipped galvanized coatings on threaded fasteners
AS 1237.1	Plain washers for metric bolts, screws and nuts for general purposes - General plan (equivalent to ISO 887)
AS 1237.2	Plain washers for metric bolts, screws and nuts for general purposes - Tolerances (equivalent to 4759.3)
AS/NZS 1260	PVC-U pipes and fittings for drain, waste and vent application
AS 1275	Metric screw threads for fasteners
AS 1281	Cement mortar lining of steel pipes and fittings
AS 1449	Wrought alloy steels - stainless and heat-resisting steel plate, sheet and strip

AS/NZS 1477	PVC pipes and fittings for pressure applications
AS/NZS 1554.1	Structural steel welding-Welding of steel structures
AS/NZS 1554.3	Structural steel welding-Welding of reinforcing steel
AS 1579	Arc-welded steel pipes and fittings for water and wastewater
AS 1627.4	Metal finishing - Preparation and pre-treatment of surfaces - abrasive blast cleaning
AS 1646	Elastomeric seals for waterworks purposes
AS 1657 installation	Fixed platforms, walkways, stairways and ladders - Design, construction and
AS ISO 7.1	Pipe threads where pressure-tight joints are made on the threads - Dimensions, tolerances and designation
AS 1830	Iron castings - Grey cast iron
AS/NZS 2032	Installation of PVC pipe systems
AS/NZS 2033	Installation of polyethylene pipe systems
AS/NZS 2280	Ductile iron pressure pipes and fittings
AS 2518	Fusion-bonded low-density polyethylene coating for pipes and fittings
AS/NZS 2845.1	Water Supply - Backflow prevention devices - Materials, design and performance requirements
AS 2845.3	Water supply - Backflow prevention devices - Field testing and maintenance
AS 3500	National Plumbing and Drainage Code
AS/NZS 3518 applications	Acrylonitrile butadiene styrene (ABS) compounds, pipes and fittings for pressure
AS 3571.1	Plastics piping systems-Glass reinforced thermoplastics (GRP) systems based on unsaturated polyester (UP) resin- Part 1: Pressure and non-pressure drainage and sewerage
AS 3600	Concrete structures
AS 3690	Installation of ABS pipe systems
AS 3691	Solvent cement priming (cleaning) fluids for use with ABS pipes and fittings
AS 3735	Concrete structures for retaining liquids
AS 3776	Lifting components for Grade T chain slings
AS 4041	Pressure piping
AS/NZS 4058	Precast concrete pipes (pressure and non-pressure)
AS 4087	Metallic flanges for waterworks purposes
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 for pressure pipes and fittings
AS/NZS 4158	Thermal-bonded polymeric coatings on valves and fittings for water industry purposes
AS/NZS 4671	Steel reinforcing materials
AS/NZS 4680	Hot dip galvanized (zinc) coatings on fabricated ferrous articles

1.4.2 International Standards

ISO 3506.1	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs
ISO 3506-2	Mechanical properties of corrosion-resistant stainless steel fasteners - Part 2: Nuts
ISO 7089	Plain washers - Normal series - Product grade A
ATSM A276	Standard Specification for Stainless Steel Bars and Shapes
ATSM A380	Standard Practice for Cleaning, Descaling and passivation of Stainless Steel Parts, Equipment and systems

1.4.3 Water Corporation Documents

The following Water Corporation documents shall be read in conjunction with this Standard:

- a) External Approvals Manual
- b) Developers Manual

The Developers Manual is available on the internet at <https://www.watercorporation.com.au>.

- c) Water Services Design Standards (DS) and Strategic Product Specifications (SPS)

DS 50	Design and Construction Requirements for Gravity Sewers DN150 to DN600
SPS 106	Ductile Iron Pipe Fittings for Pressure Applications
SPS 115	Unplasticised Polyvinylchloride – PVC-U Pipe for Pressure Applications
SPS 116	Modified Polyvinylchloride – PVC-M Pipe for Pressure Applications
SPS 117	Oriented Polyvinylchloride – PVC-O Pipe for Pressure Applications
SPS 125	Polyethylene and Polypropylene Pipe and Pipe Fittings
SPS 130	Glass Reinforced Plastics Pipe and Pipe Fittings
SPS 152	Stainless Steel Repair Clamps for Waterworks Pipes
SPS 702	Precast Concrete Wastewater Pumping Stations
SPS 801	Access Covers for General Purposes
SPS 802	Prototype Assisted Lift Access Covers

- d) Engineering Design Process Manual

- e) Mechanical Design Standards (DS) and Strategic Product Specifications (SPS)

DS 30-01	Glossary - Mechanical
DS 30-02	General Mechanical Criteria – Mechanical
DS 31-01	Pipework – Mechanical
DS 31-02	Valves and Appurtenances - Mechanical
DS 32	Pump Stations – Mechanical
DS 35-01	Surge Vessels
DS 38-01	Installation – Mechanical
DS 38-02	Flanged Connections
SPS 201	Sewerage Air Release and Vacuum Break Valves
SPS 215	Reduced Pressure Zone Devices

SPS 223	Ductile Iron Swing Non-Return Valves
SPS 249	Bladder Surge Vessels
SPS 255	Copper Alloy Gate Valves
SPS 259	Knife-Gate Valves
SPS 272	Gate Valves for Waterworks Purposes - Resilient Seated
SPS 295	Penstocks
SPS 503	Submersible Sewage Pumps

f) Electrical Design Standards (DS)

DS 20	Design Process for Electrical Works
DS 21	Major Pump Station - Electrical
DS 22	Ancillary Plant and Small Pump Stations Electrical
DS 23	Pipeline AC Interference and Substation Earthing
DS 24	Electrical Drafting
DS 40-09	Field Instrumentation
DS 40-10	Typical Instrument Data Sheets
DS 26	Type Specifications – Electrical

Copies of the above Engineering Design Process Manual and of Water Services, Mechanical and Electrical DS and SPS may be obtained by contacting Engineering.StandardsEnquiries@watercorporation.com.au.

1.4.4 PIPA (Plastics Industry Pipe Association of Australia)

PIPA Guideline POP006: Derating requirements for fittings

PIPA Guideline POP007: Metal backing flanges for use with Polyethylene (PE) pipe flange adaptors

PIPA Guideline POP010A Part 1: Polyethylene pressure pipes design for dynamic stresses

PIPA Guideline POP010B Part 2: Fusion fittings for use with Polyethylene pressure pipes design for dynamic stresses

PIPA Guideline POP101: PVC pressure pipes design for dynamic stresses

1.4.5 Other References

Austrroads Bridge Design Specification

Utility Providers Code of Practice for Western Australia

MRWA Functional Road Hierarchy

2 SUBMISSION REQUIREMENTS FOR DESIGN ENGINEERS

2.1 General

- a) Works undertaken for a developer shall be submitted to the Corporation in accordance with the requirements of the “Developers Manual”.
- b) Works commissioned by the Corporation shall be submitted to the Corporation in accordance with the requirements of the commissioning brief.
- c) Prior to making your initial submission the designer must satisfy the requirements of clause 4.1.2 with regard to pressure main detention times.
- d) In addition to the information required by the “Developers Manual” the initial submission shall include the following:
 - Confirmation that water, electricity, telephone services and an all-weather access road will be available in the road reserve in front of the pumping station. This is to permit access to the site and service connections to be made as required. If it is considered that these facilities will not be available by the time they are required, details of the extensions needed to provide them and the corresponding costs above normal connection fees shall be given.
 - Copies of letters from the Department of Water and Environmental Regulation, the Local Authority and other relevant authorities confirming that the proposed emergency overflow arrangements have been accepted.

3 DRAWINGS AND SOILS INVESTIGATIONS

3.1 Introduction

This Section of the Standard specifies the Corporation's requirements for drawings and soils investigations for the construction of pumping stations and pressure mains.

3.2 Standard and Example Drawings

When the Design Engineer has determined the capacity and type of pumping station required for a specific location, electronic copies of example drawings for the pumping station size and type are available from the Corporation by contacting Design Manager and completing the APPLICATION FOR SINGLE USE OF WATER CORPORATION EXAMPLE DRAWINGS Form.

Note: As Corporation Example Drawings are subject to an ongoing improvement process, a current set of electronic drawings should be applied to each new project. New project drawings, based on example drawings acquired for use on an earlier project, will be deemed unacceptable.

3.3 General Drawing Requirements

- a) Drawings shall be configured in accordance with the nominated example drawings and shall provide all the data inputs required by the example drawings as relevant to the particular project in hand.
- b) The Design Engineer shall ensure that all drawings produced for the Corporation are in accordance with the current version of the WCX CAD Standard. Adhering to this package will ensure that drawings will be compliant with the Corporation's Drawing Management System (DMS). The WCX CAD Standard can be obtained by contacting Engineering.StandardsEnquiries@watercorporation.com.au. Electrical drawings shall be prepared in accordance with the above requirements and be in accordance with the requirements of DS 24.
- c) The final drawings shall be submitted following the drawing submission process in both pdf and AutoCAD format. For scoping phase concept drawings for developer constructed pump stations and pressure mains the Water Corporation only require pdf drawings to be submitted.
- d) Lettering shall be in upper case with a minimum height of 2.5 mm.

Levels shall be based on the Australian Height Datum (AHD).

Invert levels shall be shown to the nearest 0.01 m.

Pipe grades of 1:50 and steeper shall be shown to the nearest 0.1. Grades flatter than 1:50 shall be shown to the nearest whole number.

The invert levels, sizes and positions of existing and proposed works and obstructions shall be shown.

Existing and proposed works shall be separately identified.

Details of existing works at the discharge end of the pressure main shall be shown. When discharge is to a gravity sewer the following details shall be given of gravity sewers within of 150 m of the discharge access chamber.

- Locations, type and numbers of access chambers.
- Diameter and type of gravity sewer.
- Grade of gravity sewer.
- Locations of boundary traps and running traps.

The extent and level of any fill at the pumping station site or along the route of the pressure main shall be indicated.

The location, lot number and dimensions of the land shall be shown where applicable.

Pressure main drawings.

- "00" shall be at the pumping station and on the left hand side of the long section drawing as shown on the general arrangement drawings.
- Plan and section shall correspond.
- Section and plan horizontal scale should be 1:1000 and section vertical scale should be 1:100.
- The position of all bends, air valves, scours and valves shall be shown on the plan and section.

Demarcation points for the funding responsibility for the works shall be shown on appropriate drawings.

3.4 Catchment Plan

- a) The catchment plan shall indicate the basis of the hydraulic design for the pumping station.
- b) The scale of the catchment plan shall be as large as practicable, consistent with accommodating the route of the pressure main and the total area draining to the pumping station on the one plan.
- c) The route of the pressure main and point of discharge shall be shown on the catchment plan wherever practicable.
- d) Sub-areas within the catchment shall be defined on the basis of differing Residential Planning Codes and wet and dry areas in the catchment. Boundaries of each of the internal sub-areas shall be marked in a clearly distinguishable manner.
- e) Where the pumping station is located on a site subject to inundation the anticipated level of the 100 year flood shall be shown.
- f) A summary of storage in the pumping station and emergency overflow storages, shall be shown on the drawings and this shall include the following information:
 - The ultimate pumping storage between pump cut in and pump cut out in the pumping station.
 - The following emergency overflow storages (the consultant may have to estimate the storages for other than the initial stage):
 - i. The initial storage (other storages) and ultimate storage which will be required.
 - ii. Storage in the pumping station.
 - iii. The initial storage (and other stages) and ultimate storage in the reticulation sewers and access chambers.
 - iv. Details of any additional storage which will be required.

3.5 Overall Pressure Main Profile

An overall pressure main profile shall be developed for a pressure main that meets the following conditions

1. Longer than 3km and/or
2. Complex, in that it has many high and low points and/or downhill sections and/or
3. Carries flows >30L/s and goes through sensitive areas (potential odour and noise/vibration issues) such as built up and/or environmentally sensitive area.

Refer to Figure 4.5 for an example profile.

The overall pressure main profile shall be used to determine the need for and location(s) of section valves to ensure draining times are reasonably minimised for reactive and planned maintenance and repairs. This shall

be done in consultation with the regional operations staff and considering the sensitivity of the environment within which the pressure main is constructed.

4 DESIGN CRITERIA

4.1 Introduction and Requirements

4.1.1 Introduction

- a) This Section of the Standard sets out the criteria to be used for the design of wastewater pumping stations and pressure mains.
- b) The text does not completely specify Corporation requirements and shall be used in conjunction with the attached standard and example drawings. Design Engineers shall adhere to both the text and the drawings. If there is a conflict between the text and the drawings an interpretation should be sought from the Corporation's Engineering Business Unit.

4.1.2 Pressure Main Detention

Operational and maintenance problems have been identified in the wastewater system as the length of pressure mains combined with low flows can result in long detention times. Traditionally in an attempt to reduce detention times water was added at the pumping station. This creates operational and maintenance issues for the Water Corporation and hence other methods need to be explored.

Prior to any initial submission the designer must identify the sewerage detention time in the pressure main. When the detention time is in excess of 6 hours detention after being operational for:

- 6 months for the Metropolitan Area, or
- 12 months for the Country Regions;

The designer will need to contact the Water Corporation to discuss possible resolutions with Engineering Business Unit.

4.2 Inflow and Pumping Rate

- a) Wastewater inflows to pumping stations shall be assessed in accordance with Wastewater Standard for Design and Construction Requirements for Gravity Sewers DN150 to DN600 on which the following clauses are based.
- b) Design flows shall comply with Corporation planning. A Residential Planning Code of R15 shall be used where the local authority code is less than R15 or where no code exists. Residential planning codes for the calculation of flows shall not be less than the codes determined by the Corporation for the overall planning of the area. Where a local authority or other authority's planning codes indicate higher densities than the Corporation planning, the Design Engineer shall seek advice from the Corporation.
- c) Wastewater design flows shall be calculated from the data shown in Tables 4.1, 4.2 and 4.3 which represent minimum requirements. Where special factors or local information indicate the possibility of higher flows these shall be individually assessed.
- d) The calculation of wastewater design flows for residential areas with higher population densities than the highest densities listed in Tables 4.1 and 4.2 may be guided by the Perth Central Business Area design flow in Table 4.3.
- e) The basis for calculating flows from town and city centres other than Perth shall be evaluated in each case.

The design daily flow from the residential part of a pumping station catchment shall be the product of the population density, the daily flow per person and the net area.

The design daily flow from the non-residential part of a pumping station catchment shall be the product of the flow per net hectare and the net area.

The gravity sewer design flow shall be 1.5 times the design daily flow.

In areas where there is an existing or proposed subdivision plan the net area shall be the total area of the individual lots excluding public open space.

When broadacre catchments are being evaluated the net area for the application of zoning densities shall be obtained by deducting the area of large recreation reserves and major roads from the gross area and reducing the remaining area by 25% to allow for public open space and minor roads unless more precise areas for these are known.

The maximum wastewater inflow to a pumping station shall be the gravity sewer design flow from its own catchment plus the gravity sewer design flows into any pumping stations which discharge into the catchment.

The pumping rate for a pumping station shall be the sum of the gravity sewer design flows from pumping stations which discharge into its catchment and 1.33 times the gravity sewer design flow from its own catchment.

Where it is proposed to undertake staged development in a catchment the pumping rate at each stage of the development shall equal the cumulative required pumping rate for the stages already constructed, subject to minimum flow requirements of the pressure main.

4.3 Selection of Pumping Station Type

- a) Pumping station type designations, range of pumping rates, brief descriptions and applications are set out in Table 4.4. The table provides brief details of a range of five types of pumping stations from which a selection can be made once a pumping rate has been established.
- b) Further design information on each of the pumping station types is given in a series of clauses later in the Standard. This information should be read in conjunction with the standard and example drawings.
- c) The type of pumping station proposed shall be submitted for acceptance by the Corporation before commencement of detailed design.

4.4 General Requirements

4.4.1 Wet Well

- a) The volume of the wet well shall be based on the ultimate pumping rate. The volume between the duty pump "cut in" and "cut out" levels shall be sufficient to ensure that a pumpset will not start more than five times per hour. It should be noted that the maximum starting frequency occurs when the inflow is half the pumping rate and the wet well volume then becomes equivalent to the quantity delivered by the pumpset in three minutes. In addition to the criteria specified in this standard and relevant Water Corporation mechanical and electrical standards the following circumstances require specific considerations:
 - i. When the ultimate pump rate for the pump station is less than the nominal capacity of the Pumping Station Type (e.g. Type 40) then:
 - Design the wet well such that the full nominal capacity of the station can be achieved, and
 - Ensure that the top slab opening is capable of passing the ultimate pumps, and
 - Provide full submergence of the pump units at cut-in to ensure they are adequately cooled and not continuously exposed to corrosive gases. This is additional to the normal requirements to comply with the pump manufacturers minimum submergence and NPSH criteria.

Designers must consult with the Wastewater Conveyance Advisory Section of Engineering Business Unit of Water Corporation to obtain agreement that the potential increase in construction costs is reasonable for the benefits of making the wet well suitable for possible future capacity increases.

- i. When the ultimate pump rate forecast for the pump station is greater than the nominal capacity of the Pumping Station Type (e.g. Type 40) then:
 - Design the wet well such that the ultimate pump rate can be achieved, and
 - Ensure that the wet well opening is capable of passing the ultimate pumps, and
 - Provide full submergence of the pump units at cut-in to ensure that they are adequately cooled and not exposed to corrosive gases. This is additional to the normal requirements to comply with the pump manufacturer's minimum submergence and NPSH criteria.
- b) For a permanent pumping station where the catchment is greater than five hectares of industrial land the minimum storage shall be 2,160 litres.

4.4.2 Pump Control and Alarm Levels

Control and alarm levels are shown in Figure 4.1 and described below.

- a) The ultrasonic level transmitter measures the water level in the wet well, and the pumps are programmed to start and stop based on the following control levels. Control levels shall be designed for the ultimate pumping rate or nominal pump station capacity (whichever is greater) but where there are intermediate stages in the development the levels may be required to be adjusted to suit the inflow and pump capacity at each stage.
 - i. The ultimate duty pump cut-in level shall be 150 mm minimum below the invert level of the inlet pipe. For intermediate pumping rates, the cut-in level shall be determined by providing an operating storage equal to three minutes of the pump rate above the cut-out level.
 - ii. The change-over pump cut-in level shall be 150 mm above the duty pump cut-in level.
 - iii. The cut-out level for all pumps shall comply with the pump manufacturer's minimum submergence and NPSH requirements. The cut-out level shall be not less than 500 mm above the floor level.
 - iv. The level of pump controls (cut-in and cut-out levels) shall be set a minimum of 150 mm apart.
 - v. The minimum suction level shall be set to the minimum submergence level as specified by the pump manufacturer. This level is applicable to autoflush operating mode, which is used for automatic routine cleaning of the wet well.
 - vi. The high level alarm shall be 150 mm above the invert of the inlet pipe.
 - vii. Float balls are used to trigger alarms under the following scenarios.
 - viii. The high level alarm float ball is located in the wet well as a backup to the ultrasonic level transmitter. The level shall be set 150 mm above the invert of the inlet pipe, and typically 300 mm above the duty pump cut-in level.
 - ix. A flow to storage alarm shall be provided at all wastewater pump stations with emergency storage in accordance with Table 4.8. The float ball for this alarm shall be located in the inlet access chamber and the level set to the controlling level at which wastewater will enter emergency storage.
 - x. An emergency storage in use alarm shall be provided at wastewater pump stations with captive storage (where storage is not self-draining to the pump station) in accordance with Table 4.8. The float ball shall be installed within the emergency storage and the alarm level set at 300 mm above the level at which wastewater will enter emergency storage.
 - xi. All systems shall have a half storage alarm provided in accordance with Table 4.8. The sensor for this alarm shall be located in the inlet access chamber. This alarm shall actuate when half the storage in the system has been used. Where emergency storage is provided the alarm is set at half the total system storage not half the emergency storage.

xii. The overflow to environment alarm level shall be set at 150 mm below the controlling invert of the pipe, which overflows to the environment. This alarm shall be located in the access chamber from which the overflow occurs.

- b) For split well sites (e.g. Type 180 pump stations) an ultrasonic level transmitter and a high level float ball shall be installed in each half of the wet well.

4.4.3 Structure

- a) Reinforced concrete design for cast-in-situ pumping station structures shall be in accordance with AS 3735.
- b) Where circular precast concrete units (acceptable to the Corporation) are used in the construction of a pumping station, the segments shall be designed in accordance with Clause 4.4.3(a) and manufactured in accordance with AS 4058. Joints between units shall be kept to a minimum with the shorter unit at the top.
- c) Pumping Stations and other below ground structures on site shall be checked for flotation and the design shall follow the requirements specified in AS/NZS 1170.0 section 4.2. The Design Engineer shall check that the combinations of actions for ultimate limit states are in accordance with the minimum requirements below but shall also consider any other additional actions:
- The self-weight of the concrete structure and of the earth situated vertically above any external project of the base slab, factored by 0.9, shall exceed or equal the buoyant upthrust force of groundwater, factored by 1.2.
 - The ground water level shall be assumed to be at the finished surface level. A lower groundwater level may be used for this calculation if information is available, under these conditions the groundwater level with an annual probability of exceedance of 1 in 100 shall be used and the buoyant upthrust force shall be factored by 1.5.
 - The self-weight of ladders, pumpsets, pipework and top slab of the pumping station shall not be included in the calculation, and the pumping station shall be considered empty. The self-weight of submerged soil resisting uplift shall be reduced by its own buoyancy and the flotation calculations shall take an effective submerged weight of soil of 10 kN/m³, in the absence of more accurate information.
- d) The top of the pumping station top slab shall be a minimum of 150mm above the 100 year flood level.

4.4.4 Ladders

Fixed ladders and step irons shall not be installed in new sewerage access chambers, wet wells or other similar assets such as scour pits, valve pits, air valve pits and the like.

4.4.5 Anti-corrosion Measures

- a) Materials used in pumping station wet wells, other than concrete, shall be resistant to corrosion from wastewater and wastewater borne gases and their oxidised products e.g. hydrogen sulphides and traces of sulphuric acid in the condensates. To avoid electrolysis action stainless steel of dissimilar grades shall not be used other than for fasteners.

The Design Engineer shall specify and apply the anti-corrosion measures detailed in drawing CA01-1-3.

4.4.6 Inlet Details

- a) The inlet access chamber should be constructed within the pumping station site and shall be considered as part of the pumping station. The inlet access chamber shall be constructed generally in accordance with the requirements of Wastewater Standard for Design and Construction Requirements for Gravity Sewers DN150 to DN600.

- b) The inlet pipe shall be capable of taking the maximum wastewater inflow into the pumping station at a maximum depth of flow equal to:
 - Half full for DN 150 pipes.
 - Two thirds full for DN 225 and larger pipes.
- c) The invert level of the inlet pipe shall not exceed six meters of depth at the connection to the wet well unless specific approval is obtained from the Water Corporation.

4.4.7 Water Service

- a) A DN 40 water service shall be provided to Type 10, 40, 90 and 180 pumping stations. A DN 40 water service shall be provided to Type 6 pumping stations if required by the Corporation. Any water service must be metered.
- b) Where a water service is provided to a pumping station, a backflow prevention device complying with AS 2845.1 shall be installed as close as practical to the water meter as shown in the standard drawings.

4.4.8 Magnetic Flow Meters

- a) Magnetic flow meters shall be installed on all pumping stations except Type 6 stations. Type 6 stations will only require a magnetic flow meter if directed by the Corporation.
- b) Only magnetic flow meters acceptable to the Corporation shall be used.
- c) The design, selection and installation of magnetic flow meters shall comply with the requirements of DS40-09 and manufacturer's recommendations.

4.4.9 Signage

All pumping stations shall be provided with a public information sign attached to a cabinet. The sign shall be visible from the road and shall be in accordance with the Corporate Identity Manual - 5.4 Public information-Assets.

A "no standing anytime" sign shall be erected on either side of the pump station driveway.

Early advice shall be sought from corporate security on minimum site security requirements as additional security measures such as yellow line and "No Standing" marking on pump station driveway pavement may be required after security assessment.

4.4.10 Geotechnical Requirements

To enable tenderers and construction engineers to assess expected excavation and dewatering conditions more accurately, Design Engineers shall arrange for soils investigations to be made at pumping station sites and at appropriate intervals along routes of pressure mains.

The subsurface geotechnical and environmental characteristics at a proposed pumping station location shall be assessed by geotechnical and structural engineering specialists and the basis of pumping station design shall be verifiable by an accredited third party engineering design reviewer acceptable to the Corporation. The engineering assessment and design shall address pumping station:

- limitations of authorised precast systems and their use at the particular site being designed;
- structural and maintainability performance over a minimum 100 year life for internal and external exposure classifications of D and B2 respectively, as defined in AS 3735;
- security, stability, corrosion resistance and safe constructability for defined ground, foundation, surround and environmental conditions;
- foundation stability and support (direct-on-soil, piled, other) requirements and treatments;

- resistance to movement induced by short and long term consolidation of surround material and by uplift (buoyancy) forces;
- Each pumping station design shall include production of drawings and installation/workmanship specifications that address:
 - physical, structural and hydraulic disposition of interconnected components, penetrations, pipelines, overflow storage structures and joints that delivers the required system functionality and longevity;
 - natural and imported foundation and surround material preparation, treatment and improvement requirements;
 - foundation support (e.g. piled) system configuration and workmanship, where applicable;
 - the use of backfill materials - including excavated soil re-use wherever practicable - that are free of organic/deleterious matter, contaminants and oversize particles;
 - nominated backfill compaction parameters including an in-situ backfill density ratio no less than 95% of maximum soil dry density (MDD), determined in accordance with AS1289 5.2.1 (modified compactive effort) and AS1289 5.4.1 (dry density ratio);
 - compaction test result validation that provides for calibration of AS 1289.6.3.3 (Perth Sand Penetrometer) measured field test penetrative values against AS 1289.5.8.1 (nuclear moisture/density gauge) MDD/moisture values measured from the same soil samples at acceptable sampling intervals;
 - safe, effective and practicable installation, dewatering and environmental practices that assure people safety and stability (resistance to damage, settlement, uplift) of pumping station and interconnected components during construction, backfill and dewatering operations;
 - selection and use of safe handling, transportation, lifting and construction practices and equipment.

4.5 Pumpsets

- a) Each pumpset shall consist of a close coupled motor and centrifugal pump suitable for submerged operation in a vertical spindle configuration and shall be capable of pumping unscreened wastewater.
- b) Pumpsets and associated discharge bends and lifting chains shall comply with SPS 503.
- c) For pressure mains DN 100 and larger, pumps shall be capable of passing a 75 mm diameter sphere. For DN 80 pressure mains, pumps shall be capable of passing a 60 mm diameter sphere. Alternatively, pumps shall have open or semi-open impellers with proven non-clog performance.
- d) Where two pumpsets are required, motor controls shall be arranged so that if the duty pumpset fails to operate when required, the change-over unit will commence operation when the wastewater reaches a predetermined level in the well. Controls shall be arranged to ensure that only one pumpset will operate at any one time. The Corporation's standard control and logic circuits shall be used.
- e) To facilitate the removal of pumpsets, de-contactors may be required at pumping stations in country areas where there is no resident electrical maintenance staff. The need for de-contactors shall be verified with the relevant regional office.
- f) Selection of pumpsets shall be in accordance with the requirements of Section 7 of this Standard and the guidance provided in SPS 503.
- g) Motors shall be rated in accordance with the requirements of DS 22, Section 3.
- h) Pumps shall be supplied with stainless steel chain and fittings in accordance with the requirements of SPS 503. A cautionary tag is also required to warn operators of the potential for corrosion and possible failure of the chain. It shall read:

CAUTION.
Chain subject to possible CORROSION FAILURE.
Exercise due CAUTION when lifting pump.
INSPECT closely each time pump lifted.

4.6 Switchboards

- a) Switchboard design shall be carried out in accordance with the requirements of standard electrical drawings for small pump stations and the requirements of DS 22. Switchboard construction shall be in accordance with the relevant type specification of DS 26.
- b) The Electrical Design Engineer shall ensure that all design calculations relevant for construction of the asset and negotiations with the supply authority as outlined in DS 22, are performed and results recorded on the drawings. Particular attention should be paid to incoming supply and motor starting issues as detailed in DS 22.

4.7 Pipework, Valves and Fittings

4.7.1 General

- a) For acceptance, pipes, pipe fittings and pipe joint seals shall be new and unused. They shall not have been exposed to physical or structural (fracturing, chipping, scratching or similar) damage nor to prolonged outdoor environments including elevated temperatures and UV radiation. Suppliers shall provide due evidence of conformity with these requirements throughout supply related product storage, transportation and handling operations, if and as required.
- b) Pipes and fittings for use in pumping stations in delivery pipework and pressure mains shall comply with the requirements detailed in this Clause and in Table 4.7.
- c) Where two pumpsets are provided, the pipework and valves shall be arranged to allow for maintenance of the change-over pumpset and reflux valve without interfering with the operation of the duty unit.
- d) Pipework within the pumping station shall be sized to allow for a maximum discharge velocity of 2.5 metres per second at ultimate flow and shall have a minimum velocity of 0.75 metres per second.
- e) Pipework shall be adequately supported to prevent movement or vibration during pressure main testing and pump operation. When installed, pipework shall not be stressed.
- f) Pipework valves and fittings shall be installed or constructed in accordance with the manufacturer's latest printed requirements.

4.7.2 Mobile Pump Branch

- a) At each pumping station site a branch shall be provided to allow a mobile pump to be connected to the pressure main.
- b) The diameter of the branch shall be the same as the pressure main up to and including DN 100 pressure mains. On pressure mains larger than DN 100 and less than DN 300 the diameter of the branch shall be 100 mm. On pressure mains DN 300 and larger the diameter of the branch shall be 150 mm.
- c) The branch shall be equipped with a gate valve and dead plate or Camlock coupling as shown on the standard and example drawings.

4.7.3 Polyvinyl Chloride (PVC) Pipes and Fittings

For acceptance, PVC pipes shall generally be no older than 12 months. The use of PVC pipe with a manufacturing date over 12 months earlier than pipeline installation date may be considered by the Water Corporation on a project-by-project basis, subject to the quality of assurance (e.g. documentary evidence) provided to verify continued pipe protection from exposure to sunlight prior to its delivery to project sites.

- a) Unplasticised PVC (PVC-U), modified PVC (PVC-M) and orientated PVC (PVC-O) pressure mains shall be Series 2 in accordance with SPS 115, SPS 116 and SPS 117 respectively. The nominal pressure classification of pipe shall be no lower than PN 16.
- b) Fittings for PVC pipelines shall generally be DI, in accordance with SPS 106.

4.7.4 Mild Steel Cement Lined (MSCL) Pipes.

- a) MSCL pipes shall comply with SPS 100.
- b) Site and field welding of MSCL pipes and pipework shall comply with AS 4041.

4.7.5 Polyethylene (PE) Pipes and Fittings

- a) PE pipes and fittings shall be Series 1 in accordance with SPS 125. The nominal pressure classification of pipe shall be no lower than PN 16 at an ambient temperature of 20°C.

4.7.6 Glass Reinforced Plastic (GRP) Pipes and Fittings

- a) GRP pipe and fittings shall comply with SPS 130
- b) The nominal pressure classification and stiffness of pipe shall be no lower than PN 16 and SN 10000 respectively.

4.7.7 Elastomeric Joint Seals

- a) Elastomeric joint seals shall be polychloroprene rubber (neoprene) or styrene-butadiene rubber and shall be in accordance with AS 1646 (incorporating AS 681.1, 681.2, 681.3 and 681.4) for the nominated elastomer IRHD hardness.
- b) Joint rings shall be supplied by the original GRP pipes or GRP pipe fittings manufacturer and shall be stored in accordance with AS 1646.

4.7.8 Gate Valves

- a) DI gate valves DN 80 and larger shall be in accordance with SPS 272. End connections of the gate valves shall be flanged.
- b) Gate valves less than DN 80 shall be in accordance with SPS 255. End connections of the valves shall be threaded internally in accordance with AS ISO 7.1.

4.7.9 Swing Check Non-Return Valves

- a) Swing check non-return valves DN 80 and larger shall be resilient flap type in accordance with SPS 223.
- b) Swing check non-return valves less than DN 80 shall be in accordance with SPS 220. End connections of the non-return valves shall be threaded internally.

4.7.10 Automatic Sewerage Air Release and Vacuum Break Valves

Automatic sewerage air release and vacuum break valves shall be in accordance with SPS 201.

4.7.11 Fasteners

The Designer shall apply the fasteners standard requirements detailed in drawing CA01-1-3.

4.8 Pump Duty

- a) Pipeline system characteristic curves shall be produced to show the typical information in Figure 4.2. The pressure system maximum and minimum head characteristic curves shall be calculated using the Colebrook-White equation with roughness coefficient k values of 0.6 mm and 0.15 mm respectively. Minimum head characteristic values shall be calculated on the basis of retained pumping station wastewater being at the overflow level.
- b) The component of the developed head for the section of delivery pipework between the pump outlet and the start of the pressure main shall be calculated, using first principles or using the equivalent pipe lengths shown in Table 4.5 where applicable.
- c) The total head to be developed by pumping the required flow through the pump, delivery pipework and pressure main shall be calculated and shall form the basis for the maximum (pumping system) head curve.

4.9 Site Requirements

- a) The Corporation shall be granted a clearly defined, free and unrestricted right of occupancy and access to the site of all pumping stations. For temporary pumping stations this shall remain in force until the Corporation considers that the station is no longer required.
- b) Pumping station sites should be located as far as possible from residential properties and where possible surrounded by POS to minimise noise or odour nuisance during periods of maintenance. If the centre line of the pumping well on a proposed pumping station site is less than 30 m from the closest building alignment, the location of the site should be discussed at an early stage with the Corporation's Development Services Business Unit or Engineering Business Unit.
- c) Preference shall be given to locating pumping station sites on public open space.
- d) Sites should be situated in the lowest part of the area to be served by the pumping station. The location shall conform to long term overall planning for the sewerage system. The site selected should minimise the length of pressure main.
- e) The site should front on to a public road, and if necessary, additional land shall be provided for an access road, which shall be held by the Corporation as part of the pumping station site. The minimum width access road to a site shall be 6.0 m. with a paved width of 5.0 m.
- f) To assist with the removal of the pumpsets, the maximum distance from the roadway to the centre line of the most remote pump shall be 3.0 m.
- g) Vehicular access with sufficient parking space for a maintenance truck shall be provided at each pumping station site for maintenance purposes and to facilitate the installation and removal of equipment.
 - The access to each site shall be given individual consideration and shall be designed to minimise any traffic hazard on the public road caused by vehicles entering or leaving the site.
 - The parking space provided shall take into account the location of the pumping station relative to the public road. The centre of the pumping station shall be located at least 11.0 m from the present or future kerb line. Pedestrian traffic shall be able to pass the site at all times without encroaching on the roadway.
 - Crossovers from the road to the site shall be located and constructed to the requirements of the local authority controlling the road.
- h) Where it is necessary to provide a vehicle turning area within the pumping station site, the minimum outside turning radius shall be 12.8 m.

- i) Trafficable areas within the site shall be paved to take the loads imposed by maintenance vehicles. Design axle loads shall be the individual heavy axle load A160 as defined in AS 5100.2. The pavement design shall be specified on project design drawings and/or specifications and shall be considerate of the local availability of materials. The wearing course shall be a minimum of 40 mm thick 14G, 75 blow asphaltic concrete, as for intersections, to provide a durable surface for the tight turning movements of heavy maintenance vehicles within the site.
- j) Pavement surfaces should be bitumen sealed, kerbed and drained unless local circumstances require the use of other materials, in which case the matter shall be discussed with the Corporation. Surfaces shall be uniformly graded for stormwater runoff and shall be free of local depressions.
 - The kerbing shall be continuous mountable kerbing 150mm high by 250mm wide. The top of the kerbing shall be level with the top of the pumping station top slab. The kerbing shall not extend past the top slab, which shall be located directly adjacent to the access road.
 - The difference in the finished surface levels of the top slab (and electrical slab) and the access road shall be accommodated by grading the road pavement adjacent to the slab across the full width of the access road.
- k) Pumping station sites may need to be enclosed with a fence. If a fence is required in a residential area the fence should match the type of fencing used on adjoining properties. Where pine post and rail barrier fencing is required, removable bollards shall be provided across the access road as shown on the standard drawings.
- l) Sites shall be large enough to accommodate the pumping station, valve pits, inlet access chamber and if required, a vehicle turning area, ultimate emergency storage facilities and any embankments where filling is involved.
- m) The site size requirement shall be determined using the total Required Emergency Storage Volume (RESV) calculated as per C14.10.4 below provided by the Corporation and the available Emergency Storage Envelope. The Corporation may need more land to provide additional emergency storage in some circumstances (e.g. due to increased flow not known at the time of the pump station design), and therefore if the site is constrained with respect to future expansion, the location and size of the site shall be discussed at an early stage with the Corporation's Development Services Branch or Engineering Business Unit to determine if the proposed site size is adequate.
- n) The finished ground level of the site should be at least 500 mm above the estimated maximum ground water table.
- o) The finished level of the top slab should be 150 mm above the public road level.
- p) Earthworks on sites shall be stabilised to prevent wind or water erosion. The sites shall be suitably landscaped to conform to the immediate surroundings.
- q) The ground level surrounding the top slab shall be extended horizontally at the same level as the top slab for a minimum distance of 1.0 m then graded to ground level at a maximum slope of 3:1. Some authorities may require shallower slopes than 3:1 to blend in with the surrounding ground.
 - Where a top slab is constructed on fill, the fill adjacent to the top slab shall be extended horizontally for 1.0 m and then graded to ground level at a slope of 3:1. Some authorities may require shallower slopes than 3:1.
- r) Where an access road is constructed on fill, the fill adjacent to the road should be extended horizontally for a distance of 1.0 m and then graded to ground level at a slope of 3:1.

4.10 Emergency Provisions

4.10.1 Discharge Consequence Assessment

- a) The Design Engineer shall confirm with the Corporation the ultimate location of the pumping station and its emergency overflow location.
- b) The Corporation shall carry out a Discharge Consequence Assessment, for an emergency wastewater discharge at the WWPS, in accordance with Table 4.12.
- c) WWPS's discharges shall be categorised as either High Consequence or Low Consequence.
- d) A WWPS shall be deemed High Consequence if the discharge is assessed as having Moderate, High or Catastrophic impacts in any of the following categories:
 - Financial,
 - Environmental,
 - Reputation,
 - Compliance.
- e) This assessment shall be used to evaluate the requirements for any emergency infrastructure at the WWPS.

4.10.2 Emergency Storage Facilities

- a) Before commencing the design of emergency storage and trapped overflow facilities, the Design Engineer should consult with the Corporation to determine requirements.
- b) The Corporation shall provide the Design Engineer with the total Required Emergency Storage Volume (RESV)
- c) Emergency storage facilities shall be provided if required.
- d) Provision shall be made at all pumping stations to prevent indiscriminate surface flooding in the catchment as a result of equipment breakdown or power failure.
- e) Emergency storage facilities shall be connected in such a way that the pumping station can be isolated and serviced whilst the emergency storage facilities remain operative.
- f) Emergency storage facilities shall be accepted by the Department of Environmental Protection, the Local Authority and any other relevant authorities.

Designers must determine the availability of soft storage for overflow. This is the storage available at controlled overflow, i.e. a sump or low point where sewage can be contained once the emergency overflow storage has been filled and prior to emergency overflow. Soft storage for overflow shall not be considered part of the RESV. Designers must complete Form 4.1 contained in this design standard and submit with the final design plans. This form shall detail the requirements for operational staff in order to utilise any soft storage available (e.g. any bunding or plugging of drains required) and will be forwarded to the Region representative for inclusion in operations contingency or emergency response plans.

4.10.3 Emergency Overflow Facilities

- a) Emergency overflows shall be double trapped and provided with PVC (or similar non corrosive material) flap gates as shown on the Standard and Example Drawings.
- b) Where possible the trapped emergency overflow shall be connected to a storm water drain, watercourse or drainage sump.
- c) Trapped emergency overflow pipes shall have a minimum diameter of 150 mm and shall be capable of passing the ultimate gravity sewer design flow to the pumping station at not more than half full for DN 150 pipes and two thirds full for larger pipes.
- d) For sewers within the catchment the hydraulic grade line calculated at gravity sewer design flow shall be 500 mm below the ground level at all points. The required storage shall be contained within

the envelope between the ultimate “High Level” alarm and the level of the overflow to the environment.

- e) Should a controlled overflow be impracticable at any pumping station, the Design Engineer shall contact the Corporation to determine requirements.

4.10.4 Emergency Storage Requirements

- a) The Required Emergency Storage Time (REST), as assessed in Table 4.13, shall be provided, as a minimum, for all pumping stations.
- b) The Required Emergency Storage Volume (RESV) shall be determined from the product of the REST, the Design Daily Flow (DDF) and the Equivalent Storage Factor (ESF) obtained from the curves in Figure 4.3.

$$\text{RESV (m}^3\text{)} = \text{REST (hr)} \times \text{DDF (L/s)} \times \text{ESF} \times 3600 \text{ (s/hr)} \times 1/1000 \text{ (m}^3\text{/L)}$$

For WWPS with directly contributing upstream pumping stations:

$$\text{RESV} = 3.6 \times \text{REST}_0 \times \{(\text{DDF}_0 \times \text{ESF}_0) + (\text{DDF}_1 \times \text{ESF}_1) + \dots + (\text{DDF}_n \times \text{ESF}_n)\}$$

Where:

n = Total number of upstream pump stations

0 = Gravity catchment of pump station under consideration.

For Type 90 and 180 WWPS with directly contributing upstream pumping stations with a DDF \geq 25% of the DDF of the station under consideration, only 1 hour of the flow of these stations should be included. All other contributing stations remain as calculated above.

- c) The Required Emergency Storage Volume shall include:
- half the capacity of sewers, and
 - the capacity of the access chambers (calculated from the top of the sewers to the level of the overflow to the environment), and
 - the pumping station wet well (calculated between the level of the High Level Alarm and the level of the overflow to environment), and
 - Emergency storage tanks where provided.
- d) Since emergency storage tanks may require to be staged, provision shall be made for all future development stages, when determining Emergency Storage Volume
- e) There shall be no increase in the minimum storage provisions for WWPS located within cyclone risk areas.

4.10.5 Emergency Storage Tanks

- a) If additional emergency storage is required, below ground Emergency Storage tanks shall be provided.
- b) If required, a WWPS emergency storage tank shall have a minimum volume of 25m³.
- c) For additional emergency storage requirements up to and including 400m³, the storage should be provided using DN1800 or DN2100 concrete pipe strings. For emergency storage requirements greater than 400m³, a financial evaluation shall be made to determine whether the storage should be provided using pipe strings or a custom designed tank/s.
- d) For pump stations with a long term (>10 years) emergency storage requirement of less than 25m³ a storage tank SHALL NOT BE PROVIDED, with the exception of Low Consequence WWPS's with minimum storage requirement of 1 hour + Travel Time. In this case, any long-term storage requirement of less than 25m³ shall be provided with the minimum volume of 25m³.

- e) Where practical, the planner or designer shall aim to:
 - Provide sufficient storage to meet a minimum 10 year growth scenario.
 - Provide the long term emergency storage requirement where that requirement is less than 100m³
 - Provide the long term emergency storage requirement in not more than three stages
- f) Emergency storage tanks shall have self-draining floors graded to the pumping station for cleaning purposes.
- g) Two access chambers, placed as far apart as possible, shall be provided on each compartment of an emergency storage facility for access and ventilation purposes.
- h) All emergency storage tanks shall be provided with an air vent. This is to be located in the WWPS electrical slab where possible or in an area readily accessible for maintenance if the storage tank is located away from the WWPS site.

4.10.6 Emergency Generators

- a) The requirement for a dedicated on-site auto-start generator for the WWPS may be determined by two methods:
 - in accordance with Table 4.14, or
 - by using the simplified approach as presented in Figure 4.4

Note: Table 4.14 requires information relating to the reliability of the existing power supply.

- b) For the simplified approach, an on-site auto-start generator shall be provided for WWPS's that fall below the threshold line or for High Consequence WWPS located within a cyclone risk area.
- c) For the purposes of this standard, the cyclone risk area is defined as the zone that is within 200km of the WA coast between Coral Bay and the WA/NT border.
- d) Where $DDF < 100L/s$ a reasonableness test, for the cost of generator provision, shall apply where either:
 - 6 hours of total emergency storage, or,
 - a dedicated on-site auto-start generator set,
has the lowest capital cost.

4.10.7 Generator Connectors

All pumping stations, other than those provided with a dedicated on-site auto-start generator, shall be provided with an electrical de-contactor or a transfer switch to enable quick connection of a portable generator to the pump station switchboard.

4.10.8 SCADA

All pumping stations shall be connected to the Water Corporation's SCADA system in accordance with DS40.

4.11 Pumping Station Type 6

- a) This Clause should be read in conjunction with the Standard and Example Drawings.
- b) This type of pumping station consists of a pumpset located in a circular precast concrete access chamber which has been extended below the invert of the inlet sewer to form a wet well. The access chamber is designed so that it can be converted to a reticulation sewer access chamber when the pumping station is de-commissioned.
- c) Because of restricted access to the wet well and the absence of any change-over pumpset, this type of pumping station is only used for a temporary installation where:

- The Design Engineer has established to the Corporation's satisfaction that it will be in operation for less than one year in metropolitan regions and less than two years in country regions.
- The depth to the invert of the inlet sewer is less than 3.5 m.

When selecting a site for this type of pumping station the following requirements shall apply.

- The pumpset should be located by means of two vertical circular guide rails with automatic connection to the delivery pipework. A chain shall be attached to the unit so that it can be raised to ground level for maintenance. Pumpsets with a single square guide rail shall only be used with prior Corporation authorisation.
- The pumping station shall be accessible for maintenance.
- The pumping station shall not be located under paved areas of road reserves or in the verges of existing or proposed properties.
- Permission shall be obtained from the relevant regional manager assets.

The maximum pumping rate should be 6L/s.

The diameter of the pump delivery pipework and valves shall be the same diameter as the pressure main.

4.12 Pumping Station Type 10

- a) This Clause should be read in conjunction with the Standard and Example Drawings.
- b) This type of pumping station consists of two pumpsets located in a common wet well constructed from 1.8 m internal diameter precast concrete pipes. Valves at the pumping station shall be buried as shown on the standard and example drawings.
- c) The pumping station can be used for permanent or temporary installations.
- d) The pumpsets shall operate in the duty/ change-over mode with each unit able to perform the designed pumping duty.
- e) Each pumpset should be located by means of two vertical circular guide rails with automatic connection to the delivery pipework as the unit is lowered into place. A chain shall be attached to each unit so that it can be raised to ground level for maintenance. Pumpsets with a single square guide rail shall only be used with prior Corporation authorisation.
- f) The minimum pumping rate should be 4.5L/s and the maximum rate should normally be 10L/s but this may be exceeded in some circumstances subject to the Corporation's acceptance.
- g) The delivery pipework and valves shall be 100 mm.

4.13 Pumping Station Type 40

- a) This Clause should be read in conjunction with the Standard and Example Drawings.
- b) This type of pumping station consists of two pumpsets located in a common wet well constructed from 2.25 m internal diameter precast concrete pipes. Where the delivery pipework at the pumping station is DN 150 or larger a separate valve pit shall be provided. Where the delivery pipework at the pumping station is DN 100 the valves at the pumping station shall be buried.
- c) The pumping station can be used for permanent or temporary installations.
- d) The pumpsets shall operate in the duty/ change-over mode with each unit able to perform the designed pumping duty.
- e) Each pumpset shall be located by means of two vertical circular guide rails with automatic connection to the delivery pipework as the unit is lowered into place. A chain shall be attached to each unit so that it can be raised to ground level for maintenance.

- f) The minimum pumping rate should be 4.5L/s and the maximum rate should normally be 40L/s but this may be exceeded in some circumstances subject to the Corporation's acceptance.
- g) The minimum diameter of the pump delivery pipework and valves shall be 100 mm.

4.14 Pumping Station Type 90

- a) This Clause should be read in conjunction with the Standard and Example Drawings.
- b) This type of pumping station consists of two pumpsets located in a circular common wet well constructed of reinforced concrete with an internal diameter of 3.0 m. A separate valve pit shall be provided.
- c) The pumpsets shall operate in the duty/ change-over mode with each unit able to perform the designed pumping duty.
- d) Each pumpset shall be located by means of two vertical circular guide rails with automatic connection to the delivery pipework as the unit is lowered into place. A chain shall be attached to each unit so that it can be raised to ground level for maintenance.
- e) This type of pumping station is used for permanent or temporary installations where the proposed ultimate pumping rate is more than 40L/s and does not exceed 90L/s.
- f) The minimum diameter of the pump delivery, pipework and valves should be 200 mm.

4.15 Pumping Station Type 180

- a) This Clause should be read in conjunction with the Standard and Example Drawings.
- b) This type of pumping station consists of two pumpsets located in independent semi-circular wet wells constructed of PVC lined reinforced concrete with an internal diameter of 5.0 m and separated by a full high PVC lined reinforced concrete dividing wall. A separate valve pit shall be provided.
- c) The pumpsets shall operate in the duty/ change-over mode with each unit able to perform the designed pumping duty.
- d) Each pumpset shall be located by means of two vertical circular guide rails with automatic connection to the delivery pipework as the unit is lowered into place. A chain shall be attached to each unit so that it can be raised to ground level for maintenance.
- e) This type of pumping station is used for permanent or temporary installations where the proposed ultimate pumping rate is more than 90L/s and does not exceed 180L/s.
- f) The minimum diameter of the pump delivery, pipework and valves should be 250 mm.

4.16 Pressure Mains

4.16.1 Location

- a) All pressure mains should be constructed in public lands.
- b) Wherever practicable, pressure mains shall be constructed in road reserves.
- c) Where this is not practicable pressure mains shall be constructed in existing reserves dedicated to public purposes and provided with an easement.
- d) Pressure mains shall not be constructed in public access ways.
- e) Pressure mains constructed in private land shall be provided with reserves.
- f) Reserves and easements should be located centrally about the centre line of the pressure main unless special circumstances require otherwise. If possible arrangements shall be made for such reserves or easements to serve some other purpose in addition to accommodating the pressure main. The reserves or easements can be jointly vested with the Corporation.

- g) The minimum width of reserve for mains up to and including DN 300 shall be 3.0 m. The total width of the reserve or easement should be twice the depth plus one metre. For mains larger than DN 300 the width of the reserve shall be as required by the Corporation.
- h) In road reserves, pressure mains should be constructed on the 3.5 m alignment but this shall not be used to the exclusion of proposed reticulation sewers. If the 3.5 m alignment is not available, the main may be constructed on another alignment within the 3.0 m to 4.2 m corridor. If none of these alignments are practicable others may be used after written agreement has been obtained from the relevant utilities and authorities.
- i) Where a pressure main and a gravity sewer are within the same road reserve they shall be constructed within the same trench. The pressure main shall be located on the road centre-line side of the trench. The external barrels of pressure mains and gravity sewers shall have a minimum horizontal separation of 0.7m. Pressure mains shall have a minimum vertical separation of 150 mm from other services.

Where a pressure main will be constructed close to the boundaries of private properties in a reserve of unrestricted width such as a Public Open Space or Recreation Reserve, the pressure main shall be positioned so that the Corporation's total land requirements for access to, and protection of the main, are within the reserve and do not impose any encumbrance on the adjacent properties.

4.16.2 Pipeline Design

- a) Pipeline system maximum and minimum head characteristic curves shall be produced as described under "Pump Duty". System characteristics shall be based on total developed head including pump characteristics.
- b) Wherever practicable, pressure mains shall be designed to continuously rise.
- c) Pressure mains should be designed to optimise the number and locations of air valves.
- d) Minor head losses due to pipeline valves and fittings between the pressure main start (usually chainage 00) and its discharge point are provided for by use of a Colebrook-White roughness coefficient (k) value of 0.6 mm to derive total developed head.
- e) Where air release points are required on DN 80 to DN 250 pressure mains, manual air release points shall generally be provided.
- f) Where automatic air valves are required on DN 150 to 250 pressure mains, the invert level of the pressure main at the valve shall be at least 2.5 m below the invert level of the discharge point.
- g) Where automatic air valves are located on a pressure main DN 300 and larger, the invert level of the pressure main at the valve shall be at least 3.0 m below the invert level of the discharge point. For pressure mains DN 300 and larger, manual air release points shall not be used.
- h) Where manual air release points are used the invert level of the pressure main at the air release point shall be at least 0.5 m below the invert level of the discharge point.

4.16.3 Selection of Pipeline Material and Pressure Rating

The pipeline Design Engineer shall calculate the pipeline System Design Operating Pressure (\leq MAOP) that is appropriate to the (ultimate) pipeline and pumping configuration specified for particular projects, by reference to:

- The MAOP of all pipeline components, as defined in Clause 1.2;
- Indicative temperatures for specific WA locations and burial depths in **Table 4.11** for the purposes of deriving appropriate pipe wall temperature de-rating values;
- Temperature de-rating factors in **Table 4.10**, to derive reduced MAOP - and ASTP - values for Plastics pipe wall that have temperatures higher than 20°C;

The cyclic fatigue de-rating factors for PVC and PE pipes given in the following Plastics Industry Pipe Association Guidelines which can be accessed from pipa.com.au:

- **PVC pressure pipes:** PIPA Guideline POP101 - PVC pressure pipes – Design for dynamic stresses
- **PE pressure pipes:** PIPA Guideline POP010A Polyethylene pressure pipes – Design for dynamic stresses
- **PE fusion pipe fittings:** PIPA Guideline POP010B - Fusion fittings for use with polyethylene pressure pipes – Design for dynamic stresses

Where plastic pipeline components are simultaneously exposed to elevated temperature effects and cyclic pressure loads, the selected pipe pressure class shall be the highest of the following:

- the de-rated MAOP value derived by multiplying the nominal pipe pressure rating (PN/10 in MPa for pipe at 20°C) by the appropriate fatigue load (POP 010A for PE pipe) or cycle (POP 101 for PVC pipe) de-rating factor, **or**
- the de-rated MAOP value derived by multiplying the nominal pipe pressure rating (PN/10 in MPa for pipe at 20°C) by the appropriate temperature de-rating factor (**t**) in **Table 4.10**.

Pressure pipes and pipe fittings shall be selected from those described in Clause 4.7 with a pressure rating in excess of the calculated System Design Operating Pressure. Where PE pipe is considered for installation by trenchless (e.g. horizontal directional drilling) techniques, its wall thickness shall be at least 10% thicker than that required to safely sustain the calculated (internal) System Design Operating Pressure.

Pipeline component selection shall be supported by surge and fatigue design analyses that adequately consider the effects of pump start/stop pressure surge amplitude and frequency on the pipeline, except as may be exempted by reference to **Table 4.9**. Surge analyses shall also make appropriate provision for the evacuation of excess gas/air generated in pressurized pipeline systems in terms of air valve sizing, spacing and positioning.

The Design Engineer shall nominate pipeline MAOP and Field Test Pressure clearly and prominently on the pipeline design drawings for the benefit of those charged with commissioning and operating the pressure pipeline assets into the future.

4.16.4 Minimum Diameter

- a) Pressure main size selection shall be calculated to provide the lowest whole of life cost of the asset. Consideration shall be given to the effect on:
 - Mechanical/electrical capital cost
 - Estimated maintenance cost
 - Projected operating cost (power)

Pressure mains shall be capable of passing the maximum sphere size which will pass through the pumps discharging to the mains.

The minimum internal diameter for a permanent pressure main should be 100 mm.

The use of DN80 pipework as a permanent pressure main will only be permitted where there is a restricted outlet, i.e. pumping into a DN150 gravity sewer.

4.16.5 Minimum Velocity

The minimum velocity for a pressure main shall be 0.75 metres per second.

4.16.6 Minimum Cover

- a) The minimum cover to pressure mains shall be 1.20 m under freeways and controlled access roads. Minimum cover elsewhere should be 0.9 m.

- b) In special cases the minimum cover may be varied with the authority of the Corporation but particular conditions may apply.
- c) The cover requirements for pressure mains being designed in road reserves where road design levels are not available shall be increased by 0.3 m.

4.16.7 Minimum Grade

The minimum grade of any section of a pressure main should be 1:300 for pipe diameters up to and including 200 mm and 1:500 for larger diameter pipes. Flatter grades may be used if authorised by the Engineering Business Unit.

4.16.8 Crossings of Roads, Railways, Waterways and Other Services

The number of pressure main crossings under freeways, controlled access roads and railways shall be kept to a minimum.

- a) Pressure mains should be located so that crossings under all roads and railways are approximately at right angles to the road or railway reserve boundary.
- b) Where it is proposed to construct a pressure main crossing under freeway or controlled access road reserves, written authorisation for the crossing shall be obtained from the controlling authority.
- c) Where it is proposed to construct sewerage pressure main crossings under railway reserves, they shall be designed and constructed to comply with the requirements of the AS 4799 for the Installation of Services and Pipelines within Railway Boundaries and the requirements of the relevant railway controlling authority. Liaison with the appropriate Rail Authority is necessary at all stages.

Pressure mains constructed within freeways or controlled access road reserves shall be constructed in accordance with the requirements of the controlling authority.

Valves shall not be installed on pressure mains located within freeway, controlled access road or railway reserves.

- a) Consideration should be given to induced voltages when steel pressure mains are constructed adjacent to high voltage overhead power lines.
- b) Pipes constructed above ground shall be supported on concrete support blocks or brackets attached to the bridge structure where such is available at creek or river crossings. Where pipelines are to be carried on bridges, both pipe and support designs shall be submitted to the authority responsible for the structure and the Corporation for approval.
- c) Pipes constructed above ground shall be designed to minimise the use of support blocks and brackets
- d) Above ground wastewater pressure main crossings of major rivers and major drains shall be avoided. Where required they shall be designed to survive and remain operational for a flood not less than 1/2000 annual probability of exceedance for pressure mains servicing wastewater pump stations with a discharge consequence assessment rating of major or 1/500 annual probability of exceedance for other pressure mains.
- e) For below drain crossings, a concrete covering is required over the pipeline to prevent scouring of the drain over the pipe and also to prevent accidental impact by drain clearing equipment.

4.16.9 Trenchless Installations of Pressure Mains

This section refers to pressure mains installed using trenchless techniques. It does not exclude the use of open trenched installation where appropriate.

A full geotechnical investigation is required during design.

Any proposed trenchless techniques by the Contractor together with methodology and an installation plan shall be submitted to and approved by the Water Corporation prior to the commencement of construction.

Refer to example drawing LJ01-4-1 for guidance on how the basic information required for trenchless crossings is to be presented.

The Design Engineer, with reference to Table 4.15, shall determine:

- Which encasement and grouting arrangement below is to be used;
- The minimum specification requirements including pipe material, size, pipe class/pipe stiffness, maximum and minimum depth of cover to the top of the pipe, or the installation. The Contractor may increase the pipe class/stiffness and/or cover to suit the installation technique and equipment used.
- The installation techniques required or excluded.

a) No Encasement Pipe Installations (carrier pipe only)

The carrier pipe and joints shall be fully corrosion protected and suitably anchored, especially if joining onto an unrestrained system such as rubber ring jointed pipe system.

The carrier pipeline and associated short and long term side support shall be designed to carry all imposed loads as per the requirements of AS2566.1.

Horizontal directionally drilled (HDD) PE may be accepted on a project specific basis and as per the requirements of Table 4.15. A substantial redundant thickness of PE is required as an allowance for scratching during installation as per the requirements of Clause 4.16.3.

Installation of PE pressure mains using HDD has specific risks that shall be mitigated during the design process as well as during construction. The minimum requirements during design, where HDD is proposed shall be as per Section 3.6 of DS60 Water Supply Distribution – Pipelines Other Than Reticulation.

A project specific HDD construction specification shall be prepared and submitted as part of the design deliverables.

b) Encasement Pipe with an Un-grouted Annulus

This arrangement shall be applied where:

- The initial construction can not be carried out by open excavation or horizontal directional drilling and,
- Any future repair or replacement can not be carried out by open excavation or horizontal directional drilling and,
- It is not possible to manage flows to prevent wastewater overflow to the environment through the use of a temporary or permanent pressure main and/or tankering.

For this arrangement:

- A permanent un-grouted encasement pipe (i.e. the life of the encasement pipe including any joints shall exceed that of the carrier pipe) shall be provided to allow Water Corporation to either meet the road/rail controlling authority requirements and/or replace any damaged pipework installed within the encasement pipe in the future. Only approved jacking pipes listed on the Strategic Products Register shall be used.
- All pipe supports within the encasement pipe shall be manufactured from non-corrosive material.
- The ends of the un-grouted encasement pipe shall be sealed with suitable seal material/method to prevent soil from entering and filling up the encasement pipe. Seal material shall be selected to allow easy removal of the carrier pipe in case of a failure of the carrier pipe within the encasement pipe and avoid excessive pressure build-up within the encasement pipe causing subsequent failure of the encasement pipe and other nearby infrastructure.
- The encasement pipe shall be designed to carry all imposed loads as per the requirements of AS2566.1.

- The encasement pipe shall generally provide a minimum annulus dimension between the encasement and carrier pipes of 150 mm to make allowance for the deviation in the encasement pipe and the thickenings at the joints of the carrier pipe. This will also allow for future repair or replacement of the carrier pipe.
- For small pipelines and/or minor crossings, a smaller annulus may be acceptable if the designer/contractor can demonstrate that the pipe can be feasibly installed and prior approval is granted by the Water Corporation.
- The sewerage pressure main (i.e. carrier pipe) can be located anywhere within the encasement pipe provided it is held by supports at the correct level and grade. Normal tolerances shall apply to the sewerage pressure main.
- The carrier pipe joints shall be capable of transferring axial loads, i.e. pipe joints shall remain intact, enabling the pipeline to be installed or withdrawn. The carrier pipe and joints shall be fully corrosion protected and suitably anchored, especially if joining onto an unrestrained system such as rubber ring jointed pipe system.

Notes:

- Non-permanent encasement pipes (i.e. steel pipes) will eventually corrode (particularly at the joints) and allow the surrounding soil to fill the annular gap between the encasement and the carrier pipe, resulting in possible sinkholes. Therefore, steel as an encasement pipe is not considered to have a life exceeding normal carrier pipes.

Except in special circumstances, PE as an encasement pipe is not expected to be suitable to carry all imposed loads.

c) Encasement Pipe with a Fully Grouted Annulus

This arrangement shall only apply if,

- The above arrangements (a) and (b) do not apply and
- It helps to reduce the impact of open excavation such as dewatering, cost, other nearby infrastructure both during construction and while in service and it is possible for Water Corporation to install a replacement pipe crossing when necessary (e.g. failure of the initial pressure main) by open excavation or by trenchless means through the use of a temporary or permanent pressure main and/or tankering to manage flows.

For this arrangement:

- Steel and approved PVC, GRP or reinforced concrete jacking pipes listed on the Strategic Products Register are acceptable encasement pipes. PE encasement pipe may be acceptable.
- The encasement pipe shall be designed to carry all imposed loads prior to grouting of the annulus as per the requirements of AS2566.1.
- The encasement pipe shall generally provide a minimum annulus dimension between the encasement and carrier pipes of 150 mm to make allowance for the deviation in the encasement pipe and the thickenings at the joints of the carrier pipe. It also shall provide sufficient space for grouting.
- For small pipelines and/or minor crossings, a smaller annulus may be acceptable if the designer/contractor can demonstrate that the pipe can be feasibly installed and prior approval is granted by the Water Corporation.
- Grouting pressures are to be selected and controlled to avoid collapse of the carrier pipe.
- Spacers or supports shall be used to prevent flotation/displacement of the carrier pipe during grouting.

4.16.10 Discharge Arrangements

- a) Where the proposed pump rate exceeds two thirds of the capacity of the receiving sewer, the system design shall be discussed with the Corporation.
- b) The discharge access chamber at the end of a pressure main shall be constructed according to Table 4.6.
- c) No connections other than the pressure main shall be made to the discharge access chamber although provision shall be made for future duplication of the main where this is anticipated.
- d) The last section of a pressure main entering a discharge access chamber shall be constructed in a straight line with the outgoing gravity sewer for a minimum distance of ten times the pressure main diameter.
- e) A minimum length of 20 m of gravity sewer without property connections should be constructed downstream of discharge access chambers. The gravity sewer shall be constructed in accordance with the requirements of Wastewater Standard for Design and Construction Requirements for Gravity Sewers DN150 to DN600.
- f) The Corporation's preferred option is for the last section of pressure main to be constructed at a grade rising towards the discharge access chamber. The end of the pressure main prior to discharge shall be constructed of sulphide resistant materials such as PVC, PE or GRP. These materials shall be used for the pressure main until the invert of the pipe drops to a depth of more than twice the pipe diameter below the invert level of the main at its point of discharge.
- g) Where it is not practical to have the end of the pressure main continually rising, authorisation may be given by the Corporation for the last section to have a falling grade provided that:
 - The grade is at least 10% steeper than the grade of the hydraulic grade line.
 - The pressure main is constructed from sulphide resistant materials as specified in Clause f.

Where a pressure main discharges into a DN225 sewer the downhill section shall be limited to 150m.

Where a pressure main discharges into a DN300 sewer or larger, the downhill section should be limited to 300m. Under some circumstances, depending on flow rates and the diameter of the receiving sewer, the Corporation may authorise the use of downhill sections in excess of 300 m.

Downhill pressure mains shall not discharge into DN150 sewers.

Property connections are not permitted on downhill pressure mains.

4.16.11 Discharges into DN150 Sewers

- a) Discharges into DN150 sewers shall only be permitted with prior Corporation authorisation. These discharges will only be permitted where non frontal development occurs and shall always be considered as temporary.
- b) The maximum rate of discharge into a DN150 sewer shall be 4.0L/s.
- c) Where a permanent pressure main of larger diameter than DN80 is to temporarily discharge into a DN150 sewer, authorisation from the Corporation is required for a velocity of less than 0.75 m per second in the pressure main.
- d) Property connections within 150 m of a pressure main discharge into a DN150 sewer shall be provided with boundary traps. This applies to all property connections including those on branch sewers. Where a discharge will be of a short-term duration, the Corporation may consider accepting a bond in lieu of installation of boundary traps.

4.16.12 Injection Into Another Pressure Main

- a) The injection of a pressure main discharge into another WWPS pressure main shall only be permitted with prior Corporation authorisation. These discharges will only be considered where the arrangement is temporary pending future development or where the construction of a separate dedicated pressure main is impractical.
- b) Both the injecting and injected pressure mains and pumping stations shall be assessed and designed to ensure that both pumping stations can operate separately and in parallel.
- c) Interlocking of either pumping station to prevent parallel operation is not acceptable.
- d) When both the injecting and main pressure mains are smaller or equal to DN375 then isolation and non-return valves shall be installed upstream the injection point on both pressure mains; this is to prevent back flow in the event of an upstream failure of either pressure main and to allow maintenance and repair of either pressure main. Where an injecting pressure main is less than 300m in length, the non-return valve at the injection point may be deleted.
- e) When the main pressure pipeline is bigger than DN375 and the injecting pressure main is smaller or equal to DN375, isolation and non-return valves shall be installed upstream the injection point on the injecting pressure main. Valving requirements on the main and injecting pressure pipeline shall be subject to specific agreement on a project by project basis. The Design Engineer shall consult with the Engineering Business Unit for guidance and agreement, prior to designing and detailing main and injecting pressure pipe and valve arrangements.

4.16.13 Thrust Blocks

- a) Thrust blocks shall be designed for all pressure pipeline changes of direction exceeding 5°, branches and termini where the pipeline would otherwise be structurally unrestrained (e.g. flexibly jointed).
- b) Thrust block material shall be concrete, with a bearing area against firm, undisturbed ground that is sufficient to resist all pressure loads developed during field pressure testing (< ASTP) and during operation of the pressure pipeline, with an acceptable design factor (of safety) against movement.

4.16.14 Venting and Scouring of Pressure Mains.

- a) Automatic air valves or manually operated air release valves shall be provided at all peaks on pressure mains.
- b) A branch shall be provided at all low points on pressure mains to provide a scour point.
- c) When an opportunity is identified of draining a pressure main from a scour point into a gravity sewer, which does not discharge into the same catchment, the Design Engineer shall consult with the Engineering Business Unit for guidance.

4.16.15 Marker Posts

Where a pressure main traverses open areas its route shall be indicated by marker posts at each change of direction and at uniformly spaced points in between, not more than 100 m apart. Marker posts shall be as detailed on the Standard and Example Drawings.

4.16.16 Future Duplication of the Main

Where it is known that a pressure main will be duplicated in the future, suitable provision for connection of the future pressure main shall be made adjacent to the pumping station and at the discharge access chamber.

4.17 List of Tables and Figures

1. Tables

- 4.1 Wastewater Design Flows from Residential Areas South of Latitude 26° South
- 4.2 Wastewater Design Flows from Residential Areas North of Latitude 26° South
- 4.3 Wastewater Design Flows from other than Residential Areas
- 4.4 Details of Pumping Stations
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- 4.5 Example wastewater pressure main overall profile

3. Forms

- 3.1 Application for single use of Water Corporation example drawings for pumping station facility in electronic format
- 4.1 Soft Storage Implementation Requirements

TABLE 4.1 - WASTEWATER DESIGN FLOWS FROM RESIDENTIAL AREAS OF SOUTH OF LATITUDE 26° SOUTH

RESIDENTIAL PLANNING CODE	NUMBER OF PERSONS PER DWELLING	POP. DENSITY PERSONS/ NET ha	DRY GROUND		WET GROUND	
			FLOW L/ PERSON/DAY	*G.S.D.F. L/s/NET ha	FLOW L/ PERSON/DAY	*G.S.D.F. L/s/NET ha
R15 AND LESS	3.5	52.5	180	0.164	230	0.210
R20	3.5	70	180	0.219	220	0.267
R25	3.5	87.5	180	0.273	210	0.319
R30	3,5	105	180	0.328	205	0.374
R40	3.0	120	180	0.375	200	0.417
R50	3.0	150	180	0.469	200	0.521
R60	3.0	180	180	0.563	195	0.609
R80	2.5	200	180	0.625	195	0.677
R100	2.2	220	180	0.688	190	0.726
R160	2.0	320	180	1.000	190	1.056
R220	1.9	418	180	1.306	190	1.379
R280	1.8	504	180	1.575	190	1.663
R360	1.7	612	180	1.913	190	2.019
R480	1.6	768	180	2.400	190	2.533

*Gravity Sewer Design Flow

TABLE 4.2 - WASTEWATER DESIGN FLOWS FROM RESIDENTIAL AREAS NORTH OF LATITUDE 26° SOUTH

RESIDENTIAL PLANNING CODE	NUMBER OF PERSONS PER DWELLING	POP. DENSITY PERSONS/ NET ha	DRY GROUND		WET GROUND	
			FLOW L/ PERSON/DAY	*G.S.D.F. L/s/NET ha	FLOW L/ PERSON/DAY	*G.S.D.F. L/s/NET ha
R15 AND LESS	3.5	52.5	230	0.210	280	0.255
R20	3.5	70	230	0.280	270	0.328
R25	3.5	87.5	230	0.349	260	0.395
R30	3.5	105	230	0.419	255	0.465
R40	3.0	120	230	0.479	250	0.521
R50	3.0	150	230	0.599	250	0.651
R60	3.0	180	230	0.719	245	0.766
R80	2.5	200	230	0.799	245	0.851
R100	2.2	220	230	0.879	240	0.917
R160	2.0	320	230	1.278	240	1.333

* Gravity Sewer Design Flow

TABLE 4.3 - WASTEWATER DESIGN FLOWS FROM OTHER THAN RESIDENTIAL AREAS

SOUTH OF LATITUDE 26° SOUTH

DEVELOPMENT	FLOW LITRES/NET ha/DAY	*G.S.D.F. L/s/NET ha	FLOW LITRES/NET ha/DAY	*G.S.D.F. L/s/NET ha
	DRY GROUND		WET GROUND	
Suburban Commercial Areas, Schools, Hospitals and Public Purpose land	9 450	0.164	12 075	0.210
Hotels and Motels	21 600	0.375	24 000	0.417
Perth Central Business Area	172 800	3.000	172 800	3.000
Industrial Areas	14 976	0.260	16 992	0.295

NORTH OF LATITUDE 26° SOUTH

DEVELOPMENT	FLOW LITRES/NET ha/DAY	*G.S.D.F. L/s/NET ha	FLOW LITRES/NET ha/DAY	*G.S.D.F. L/s/NET ha
	DRY GROUND		WET GROUND	
Suburban Commercial Areas, Schools, Hospitals and Public Purpose land	12 075	0.210	14 700	0.255
Hotels and Motels	27 600	0.479	30 000	0.521
Industrial Areas	14 976	0.260	16 992	0.295

* Gravity Sewer Design Flow

TABLE 4.4 - DETAILS OF PUMPING STATIONS

TYPE DESIGNATION	PUMPING RATE LITRES/SECOND	BRIEF DESCRIPTION	APPLICATION
6	4.5 to 6	One pumpset in a circular precast access chamber	Temporary pumping stations which will be removed within one year in the metropolitan regions and 2 years in country regions. Maximum depth of inlet sewer shall be 3.5 m and maximum pumping rate shall be 6L/s
10	4.5 to 10	Two pumpsets in a 1.8 m diameter precast concrete wet well	Temporary or permanent pumping stations with a pump rate of 4.5 to 10L/s
40	4.5 to 40	Two pumpsets in a 2.25 m diameter precast concrete wet well	Temporary or permanent pumping stations with a pumping rate of 4.5 to 40L/s
90	41 to 90	Two pumpsets in a 3.0 m diameter cast-in-situ or precast concrete wet well	Temporary or permanent pumping stations with a pumping rate of 41 to 90L/s
180	91 to 180	Two pumpsets in a 5.0 m diameter cast-in-situ or precast concrete wet well with full height dividing wall separating each pump well.	Temporary or permanent pumping stations with a pumping rate of 91 to 180L/s

* Gravity Sewer Design Flow

**TABLE 4.5 - EQUIVALENT PIPE LENGTHS FOR FRICTION HEAD CALCULATIONS
 TYPE 6 AND TYPE 10 PUMPING STATIONS**

P.S. DELIVERY PIPEWORK DIA.	100mm
EQUIVALENT LENGTH*	25

TYPE 40 PUMPING STATION

P.S. DELIVERY PIPEWORK DIA.	100 mm	150 mm	200 mm
EQUIVALENT LENGTH*	30	40	50

TYPE 90 PUMPING STATION

P.S. DELIVERY PIPEWORK DIA.	150 mm	200 mm	250 mm	300 mm
EQUIVALENT LENGTH*	50	55	60	70

* Equivalent length is for fittings and valves. Riser length in delivery pipework is to be added.

CONVERSION FACTORS

(To convert delivery pipework diameter to pressure main diameter)

DIA. OF P.S. DELIVERY PIPEWORK AS SHOWN ON STANDARD DRAWINGS (MSCL PIPE TO AS 1579)	DIA. OF PRESSURE MAIN PIPEWORK AS SHOWN ON STANDARD DRAWINGS (CLASS 12 uPVC PIPE TO AS/NZS 1477 SERIES)	CONVERSION FACTOR
100	100	3.4
100	150	24.2
150	150	1.9
150	200	8.2
150	225	12.2
200	225	2.5
200	250	5
200	300	13
250	300	3.5

Example:

Pressure Main: 700 m of PN12 uPVC DN150 pipe

Delivery pipework: Type 40 pumping station DN100 pipework

Riser Length: 6 m

Equivalent length of Pressure Main: $700 \text{ m} + (30+6) \text{ m} \times 24.2 = 1,571 \text{ m}$ of DN150 uPVC pipe

TABLE 4.6 - DISCHARGE ACCESS CHAMBERS

PRESSURE MAIN DIA (mm)	ACCESS CHAMBERS	DROP		MINIMUM SIZE RECEIVING SEWER DIA (mm)
		(A) PROTECTED	INTERNAL	
(B) 50	(B) NO	YES	YES	150
(B) 65	(B) NO	YES	YES	150
80	YES	(C) YES	YES	150
100	YES	NO	YES	225
150	YES	NO	YES	225
200	YES	NO	NO	300
250	YES	NO	NO	300
300	YES	NO	NO	380
400	YES	NO	NO	450

NOTE:

1. DN 50 to DN 100 drops in solvent cement jointed PVC fittings, Series 1 PN 18
2. DN 150 drops in DN 150 PVC sewer fittings
3. Access chambers shall be constructed as detailed in Wastewater Standard for Design and Construction Requirements for Gravity Sewers DN150 to DN600
4. (A) Protected plastic lined concrete access chambers
5. (B) Private pressure mains only. The relevant regional manager assets may require protected access chambers
6. (C) Internal drops only on temporary pressure mains with the authorisation of the Corporation
7. Where the proposed discharge rate into the discharge access chamber exceeds two thirds of the capacity of the receiving sewer the system design is to be discussed with the Corporation.

TABLE 4.7 - DELIVERY PIPEWORK AND PRESSURE MAINS – PIPE SIZES AND MATERIALS

PUMP STATION TYPE	DELIVERY PIPEWORK MATERIAL	PRESSURE MAINS MATERIAL
TYPE 6	PVC PIPE AND FITTINGS, ABS PIPE AND FITTINGS AND DI FITTINGS	PVC or PE
TYPE 10 TO TYPE 180	MSCL PIPE AND FITTINGS DI FITTINGS	PVC ≤ DN375 PE ≤ DN630 GRP ≥ DN375

NOTE:

1. The delivery pipework is the pipework from the pump delivery to the commencement of the pressure main.
2. This Table shall be read in conjunction with Clause 4.7.

TABLE 4.8 – ALARM REQUIREMENTS FOR PUMP STATIONS WITH DIFFERENT EMERGENCY STORAGE ARRANGEMENTS

ALARM	SITES WITH NO EMERGENCY STORAGE (note: all sites have system storage)	SITES WITH SELF-DRAINING EMERGENCY STORAGE	SITES WITH CAPTIVE EMERGENCY STORAGE
Flow to storage	NO	YES	YES
Emergency storage in use	NO	NO	YES
Half storage	YES	YES	YES

TABLE 4.9 - EXEMPTIONS FROM DETAILED SURGE AND FATIGUE ANALYSIS

Nominal Pressure Main Diameter	Nominal Pressure Main Rating	Maximum Allowable Operating Pressure (MAOP) (m)		Limiting Condition
		PVC-U	PVC-M	
DN 80 to 300	PN 12	80	53	Areas south of latitude 26° South
	PN 16	107	71	
DN 80 to 300	PN 12	61	40	Areas north of latitude 26° South
	PN 16	81	53	

For the purposes of exemption:

- Maximum Allowable Operating Pressure shall not exceed the values given in this table and
- The nominal pressure main rating (PN) shall be selected in accordance with this table
- Ultimate flow velocity in the pressure main shall be < 1.25 m/s; and
- The length of a DN 300 or larger pressure main, from its commencement, shall be limited to 500 m

TABLE 4.10 - TEMPERATURE DE-RATING FACTORS FOR PLASTIC PIPES

Pipe Material	De-rating factor ¹ , (t)				
	Time weighted 12 month average temperature ² , °C				
	20	25	30	35	40
PVC - U	1.0	0.94	0.87	0.79	0.7
PVC – M	1.0	0.94	0.87	0.79	0.7
PVC – O	1.0	0.94	0.87	0.79	0.7
PE 100	1.0	0.98	0.94	0.89	0.84
GRP3	1.0	1.0	1.0	1.0	1.0

NOTES:

1. Multiply the temperature de-rating factor (t) by the nominal pipe pressure rating (PN/10 in MPa for pipe at 20°C) to determine the de-rated MAOP value of the pipe
2. The design life of PVC pipe diminishes significantly as pipe wall temperature is elevated above 20°C over a significant time period. PVC pipe should be excluded from selection where routinely exposed to temperatures close to and exceeding 45°C during pipeline operating life.
3. The de-rating factors for GRP are based on a polyester pipe body resin. For continuous operation at temperatures ≥ 350C, GRP pipe made from vinylester resin is required. Temperature de-rating is not required up to 500C for GRP pipes with vinylester pipe body resins.

TABLE 4.11 - INDICATIVE PIPE WALL TEMPERATURES FOR PLASTIC PIPES

Region	Location	Pipe Wall Temperature
North West	Kununurra	39 °C
	Broome	37 °C
	Port Hedland	38 °C
	Karratha	37 °C
	Halls Creek	39 °C
Mid-West	Carnarvon	35 °C
	Geraldton	34 °C
	Meekatharra	39 °C
Goldfields	Kalgoorlie	35 °C
	Merredin	35 °C
	Pearce Raaf	34 °C
	Esperance	30 °C
	Eucla	29 °C
Perth	Perth	33 °C
	Medina	33 °C
South West	Witchcliffe	29 °C
Great Southern	Albany Airport	27 °C

NOTE:

The Water Corporation has conducted sewage temperature monitoring on simple sewage systems across Western Australia in order to estimate pipe wall temperatures for design purposes. These pipe wall temperatures are selective and indicative only in nature, because:

- They have been calculated only at selective locations in WA where ambient temperatures and soil temperatures were recorded by the Australian Bureau of Meteorology; and
- Are representative of conditions only at the time of monitoring and at specific locations in Western Australia; and
- Are limited to soil depths of 1m and to pipelines carrying ‘fresh sewage’.

Indicative temperatures have been calculated using the formula given in PIPA PVC Technical Information PV006/2.

These limitations render the available data suitable for general use as indicative guidance only but not suitable for detailed design purposes where calculations require consideration of project and site specific parameters.

Table 4.12 - WWPS DISCHARGE CONSEQUENCE ASSESSMENT *

Consequence Rating	Financial	People	Environmental	Service Interruption / Customer Impact	Reputation	Compliance	Impact Descriptor
Low Consequence	WWPS Size <ul style="list-style-type: none"> • <100 L/s Average Daily Flow 		WWPS Discharge Location <ul style="list-style-type: none"> • >200m to Wetlands, • >100m Waterways, Declared Rare Flora, Threatened Ecological Communities 		WWPS Discharge Location <ul style="list-style-type: none"> • >200m from prominent environmental features or recreational area • >200m from school, hospital, major roads 	WWPS Likely Discharge Volume <ul style="list-style-type: none"> • <10m³ wastewater discharged 	Insignificant

	<p>WWPS Size</p> <ul style="list-style-type: none"> • ≥ 100 L/s Average Daily Flow 		<p>WWPS Discharge Location</p> <ul style="list-style-type: none"> • $\leq 200\text{m}$ to Wetlands • $\leq 100\text{m}$ Waterways, Declared Rare Flora, Threatened Ecological Communities 		<p>WWPS Discharge Location</p> <ul style="list-style-type: none"> • 100-200m from prominent environmental features or recreational area • 100-200m from school, hospital, major road 	<p>WWPS Likely Discharge Volume</p> <ul style="list-style-type: none"> • $\geq 10\text{m}^3$ wastewater discharged 	Minor
High Consequence					<p>WWPS Discharge Location</p> <ul style="list-style-type: none"> • 50-100m from prominent environmental features or recreational area • 50-100m from school, hospital, major road 		Moderate

					WWPS Discharge Location <ul style="list-style-type: none"> • ≤50m from prominent environmental features or recreational area • ≤50m from school, hospital, major road 		Major
							Catastrophic

*An Asset Management Branch (AMB) GIS model is available to assist in the determination of the Discharge Consequence Assessment.

Table 4.13 - Required Emergency Storage Time (REST)

Location	Low Consequence	High Consequence
Metro or Town with manned Water Corp depot	1 hour + Travel time	2 hours + Travel time *
Town with unmanned Water Corp Depot or No Water Corp Depot	2 hours + Travel time	3 hours + Travel time

“Travel time” is the normal time taken to drive from the nearest manned depot to the WWPS plus an allowance of 15 minutes to allow for operations staff to return to the depot from other activities prior to deployment. The minimum total Travel Time for any WWPS shall not be less than 30 minutes.

* For High Consequence WWPS’s with a total GSDF < 20L/s, located in the metro area or a town with a manned depot with a Travel Time of up to 1 hour and an established emergency tankering capability, the minimum storage time provisions may be reduced to 1 hour plus twice the calculated Travel Time.

Table 4.14 - Dedicated On-site Generator Provisions

Design Daily Flow (DDF) (L/s)	Low Consequence	High Consequence
< 30L/s	Not Required	Required only if located in a cyclone risk area
30 to 45L/s	Not Required	Required if: *Prob. (P/O>EST) > 10/DDF or located in a cyclone risk area
46 to 100L/s	Required if: *Prob. (P/O>EST) > 25/DDF	Required if: *Prob. (P/O>EST) > 10/DDF or located in a cyclone risk area
> 100L/s	Mandatory	Mandatory

* Medium WWPS's ($10\text{L/s} \leq \text{DDF} \leq 100\text{L/s}$) require a gen-set if the annual probability of power outage duration longer than the minimum Emergency Storage Time (EST), as determined in Table 4.13 of this standard, is greater than 10/DDF (L/s) or 25/DDF (L/s) depending upon hazard rating.

For this calculation, in the absence of suitable data, the probability of power outage shall be calculated using the formula:

$$\text{Prob. (P/O > EST)} = 2.05 \times (1 + \text{min Emergency Storage Time})^{-1.509}$$

Design Standard No. DS 51
The Design and Construction of Wastewater Pumping Stations
and Pressure Mains 4.5 to 180 Litres Per Second Capacity

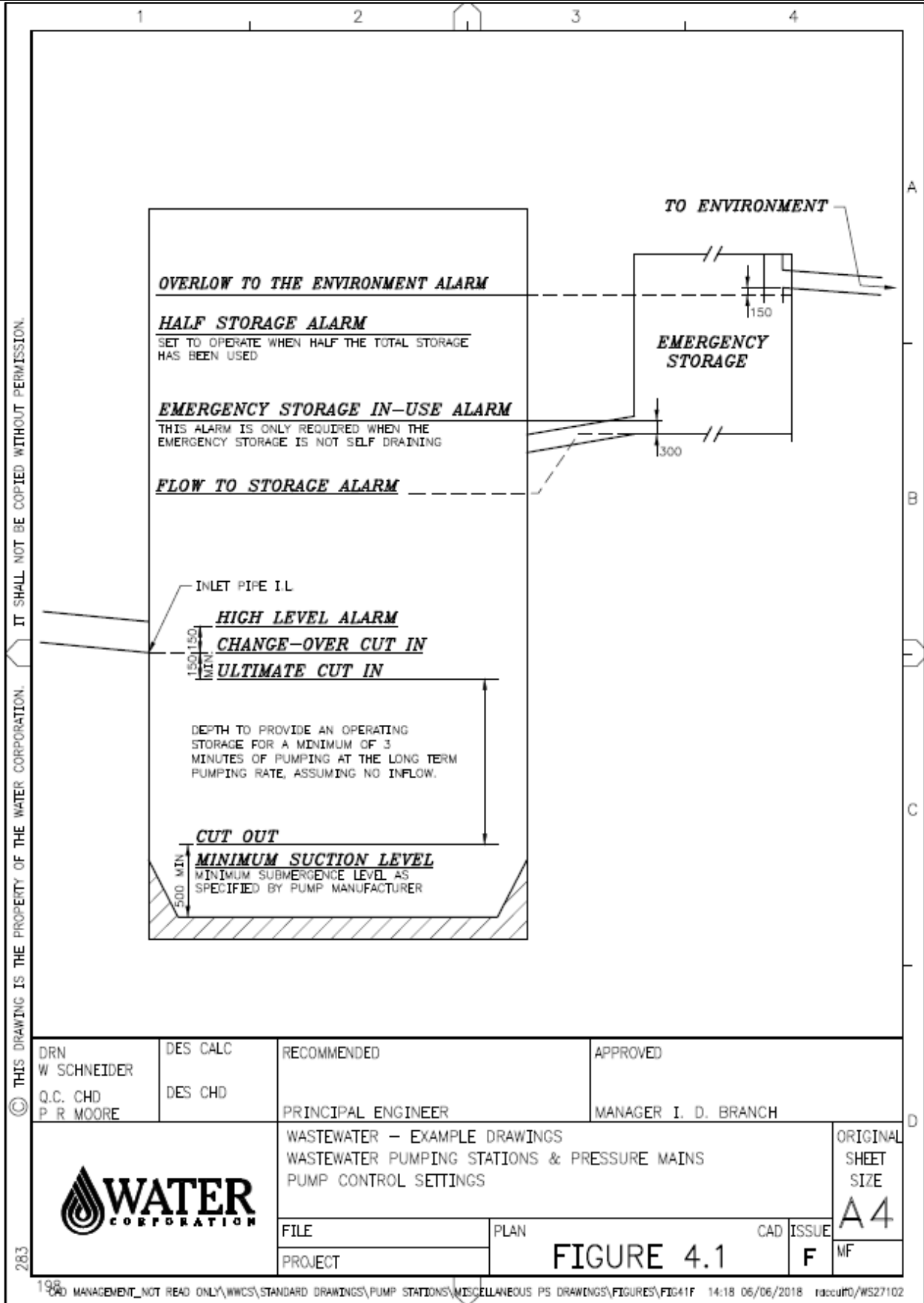
Table 4.15 - Minimum Trenchless Installation Requirements

In addition to any road or rail owner requirements, the following minimum requirements shall apply to trenchless pipeline installation applications. All alternative trenchless installation proposals shall require prior written project specific acceptance.

Input Conditions						
Select the furthest right of any input conditions.						
Level of Risk	Low consequence of settlement			High Consequence of settlement		
Surface Environment	Landscaping or Trees	Under rivers or lakes where settlement is not a problem		Environmentally sensitive or difficult to access areas		
Road Hierarchy Classification	Access roads (A)		Local Distributor (LD)	District Distributor B (DB) and Regional Distributor (RD)	District Distributor A (DA)	Primary Distributor (PD)
Rail classification						Railway
Encasement Pipe diameter	up to and incl DN250	up to and incl DN630	up to and incl DN250	DN300 to 600	DN600 or larger	DN600 or larger
Geotechnical Conditions				Undetermined or unfavourable conditions including dry running sand, variable rock/sand, high ground water table.		
Minimum Requirements						
Allowable Trenchless Technique	Earth Pressure Balance Machine Boring					
	Pipe Jacking					Not Allowed
	Horizontal Directional Drilling			Not Allowed		
Maximum Diameter of bore/cutter/reamer	1.2*Carrier OD	1.2*Carrier OD	1.1*Carrier OD	Encasement pipe OD + 20mm	Encasement pipe OD + 20mm	Encasement pipe OD + 20mm
No encasement pipe	Allowed	Allowed	Allowed	Not Allowed	Not Allowed	Not Allowed
Quality Requirements	Geotechnical Investigation					
	Topographical Survey					
	Existing Services and Utilities Survey					
	Risk Assessment					
	Safety Management Plan					
	Environmental Impact Assessment					
	Methodology plan					

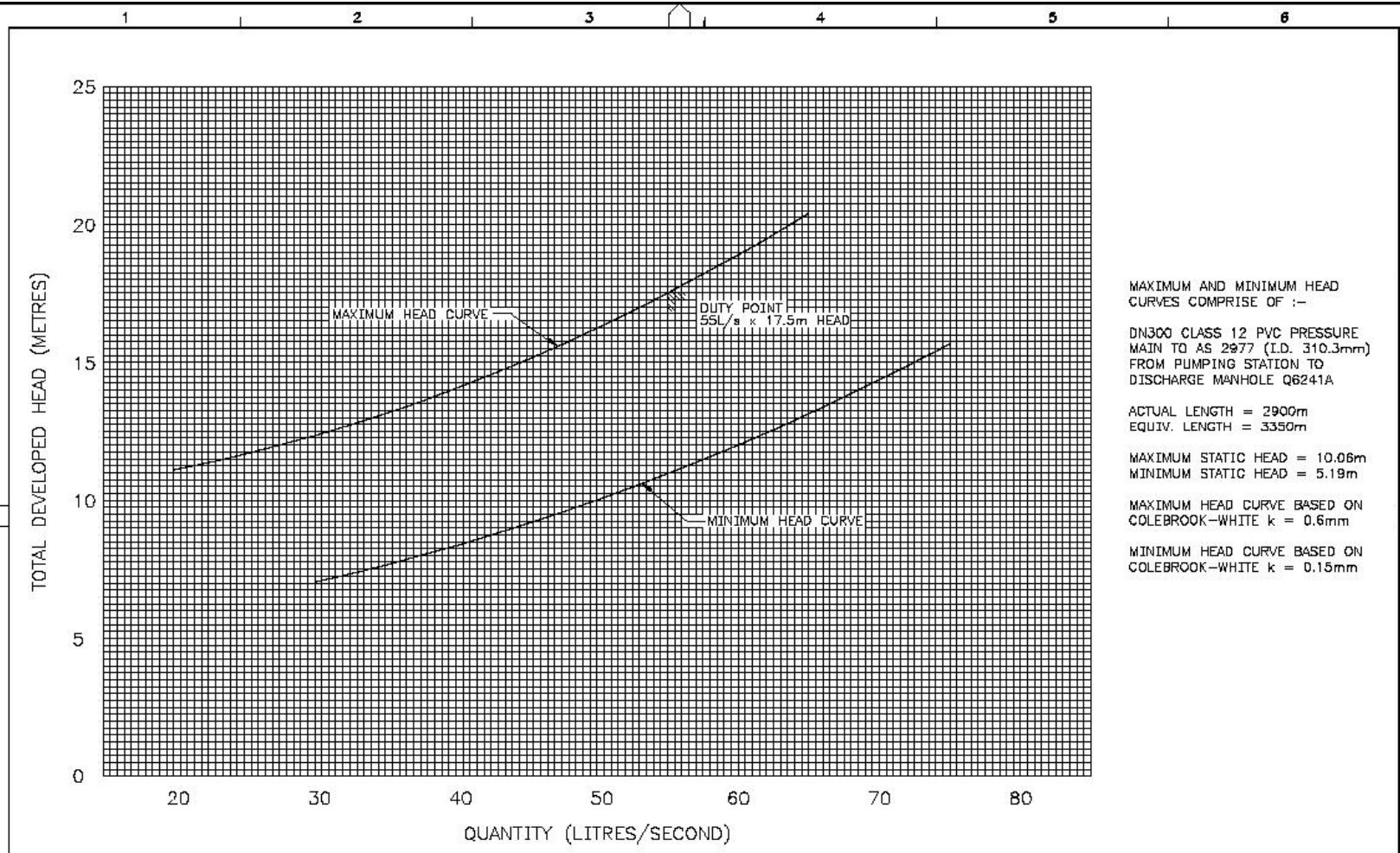
Design Standard No. DS 51
The Design and Construction of Wastewater Pumping Stations
and Pressure Mains 4.5 to 180 Litres Per Second Capacity

	Design Calculation	
	Installation Plan and Records	
		Onsite Drilling Engineer Required
		Settlement Monitoring
		Measurement of Soil Removal
		Emergency Response Plan
		Provision for grouting of outside of encasement pipes which have safe man
		Infrastructure Pre- and Post- Construction Conditions Report



DRN W SCHNEIDER Q.C. CHD P R MOORE	DES CALC DES CHD	RECOMMENDED PRINCIPAL ENGINEER	APPROVED MANAGER I. D. BRANCH
		WASTEWATER – EXAMPLE DRAWINGS WASTEWATER PUMPING STATIONS & PRESSURE MAINS PUMP CONTROL SETTINGS	
		ORIGINAL SHEET SIZE A4	
FILE PROJECT	PLAN FIGURE 4.1	CAD F	ISSUE MF

198 CAD MANAGEMENT_NOT READ ONLY\WWCS\STANDARD DRAWINGS\PUMP STATIONS\MISCELLANEOUS PS DRAWINGS\FIGURES\FIG41F 14:18 06/06/2018 rascu/PD/WS27102



MAXIMUM AND MINIMUM HEAD CURVES COMPRISE OF :-

DN300 CLASS 12 PVC PRESSURE MAIN TO AS 2977 (I.D. 310.3mm) FROM PUMPING STATION TO DISCHARGE MANHOLE Q6241A

ACTUAL LENGTH = 2900m
 EQUIV. LENGTH = 3350m

MAXIMUM STATIC HEAD = 10.06m
 MINIMUM STATIC HEAD = 5.19m

MAXIMUM HEAD CURVE BASED ON COLEBROOK-WHITE $k = 0.6\text{mm}$

MINIMUM HEAD CURVE BASED ON COLEBROOK-WHITE $k = 0.15\text{mm}$

DES CALC N/A	RECOMMENDED N/A		SEWERAGE GREENBOROUGH PUMPING STATION No.2 COBALT WAY PRESSURE MAIN CHARACTERISTIC CURVE		ORIGINAL SHEET SIZE A3
DES CHD	SUPERVISING ENGINEER		FILE N/A	PLAN	CAD ISSUE
DRN K.E.L.	APPROVED				
Q.C. CHD N/A	MANAGER I.D. BRANCH				
				FIGURE 4.2	MF

394 © THIS DRAWING IS THE PROPERTY OF THE WATER CORPORATION. IT SHALL NOT BE COPIED WITHOUT PERMISSION. G:\MANAGEMENT_HUT_READ_ONLY\DWGS\STANDARD DRAWINGS\PUMP STATIONS\MISCELLANEOUS PS DRAWINGS\FIGURE 4.2 18/08/2013

FIGURE 4.3 - EMERGENCY STORAGE FACTORS

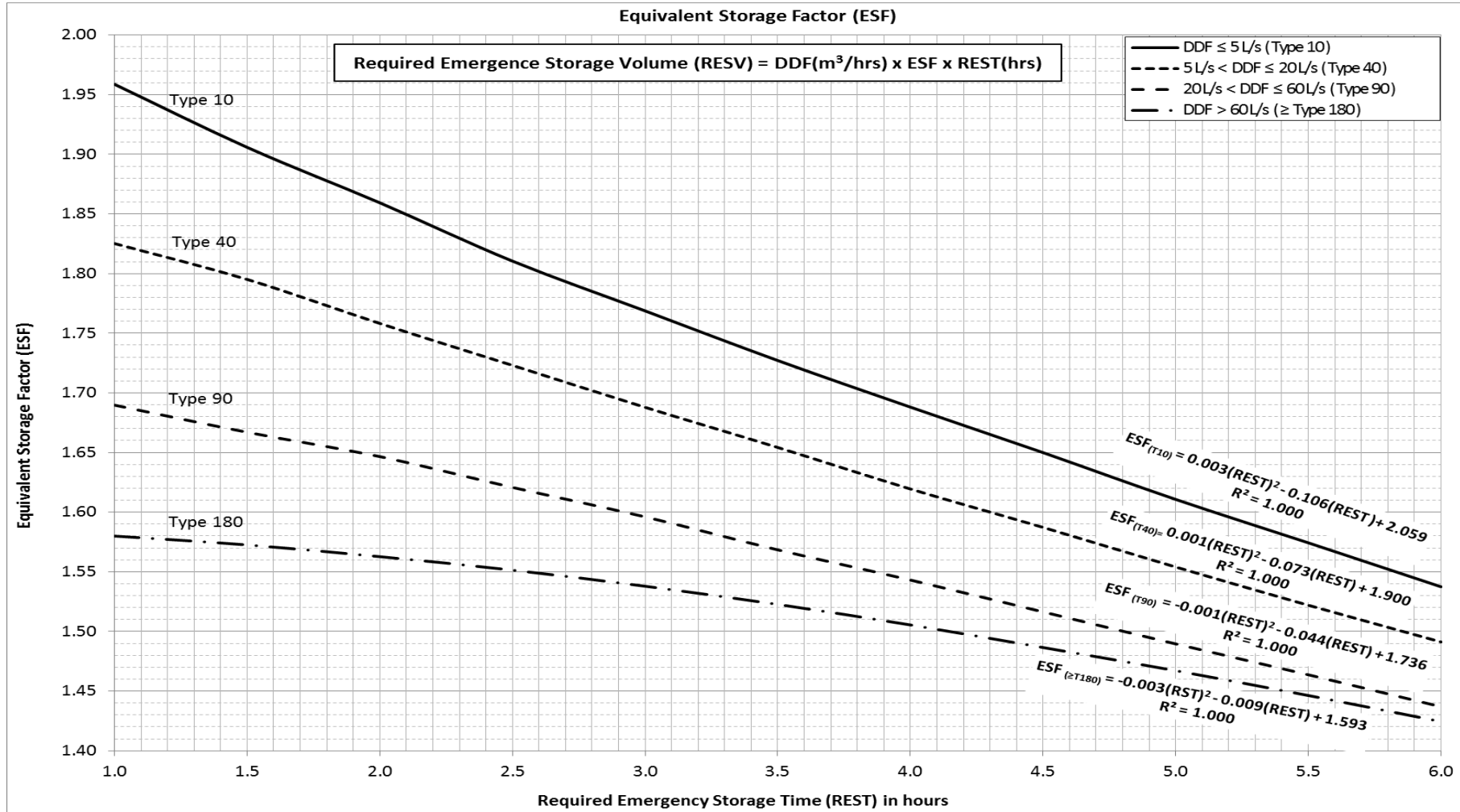
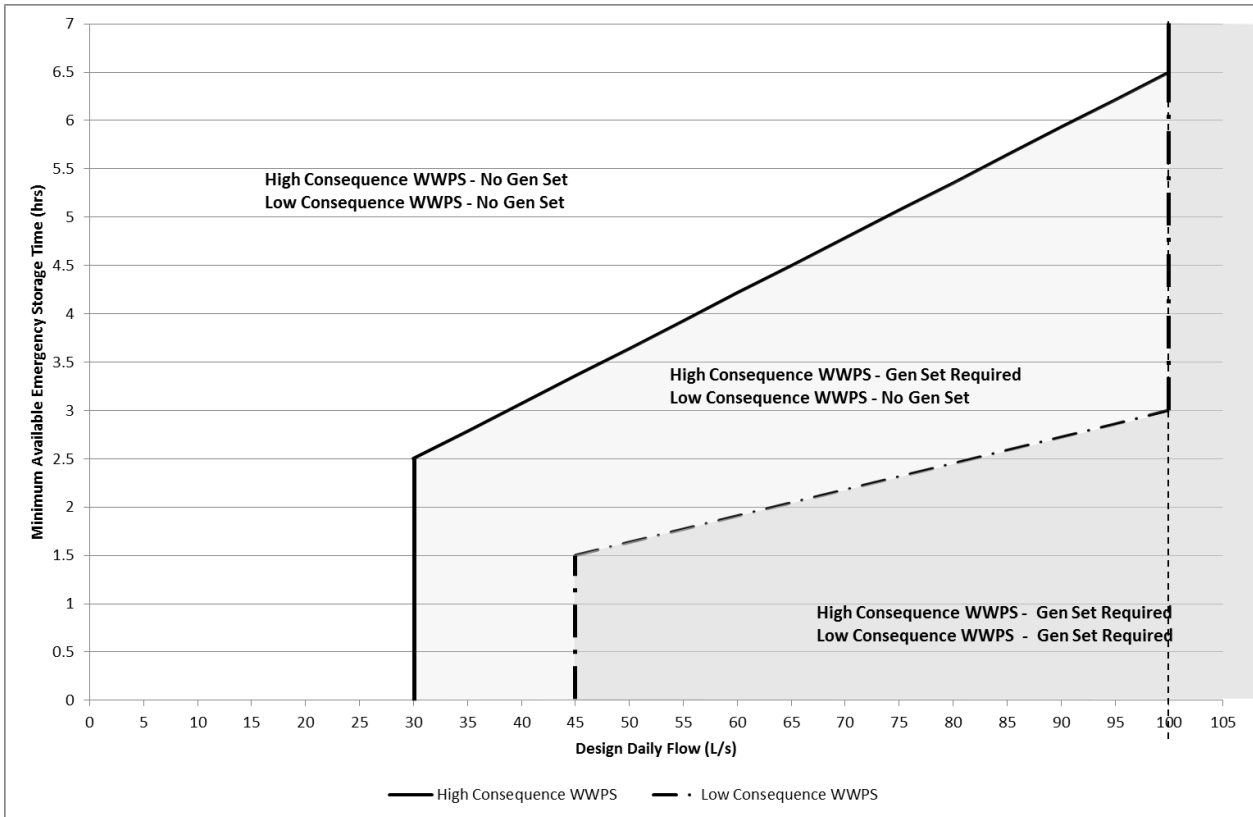


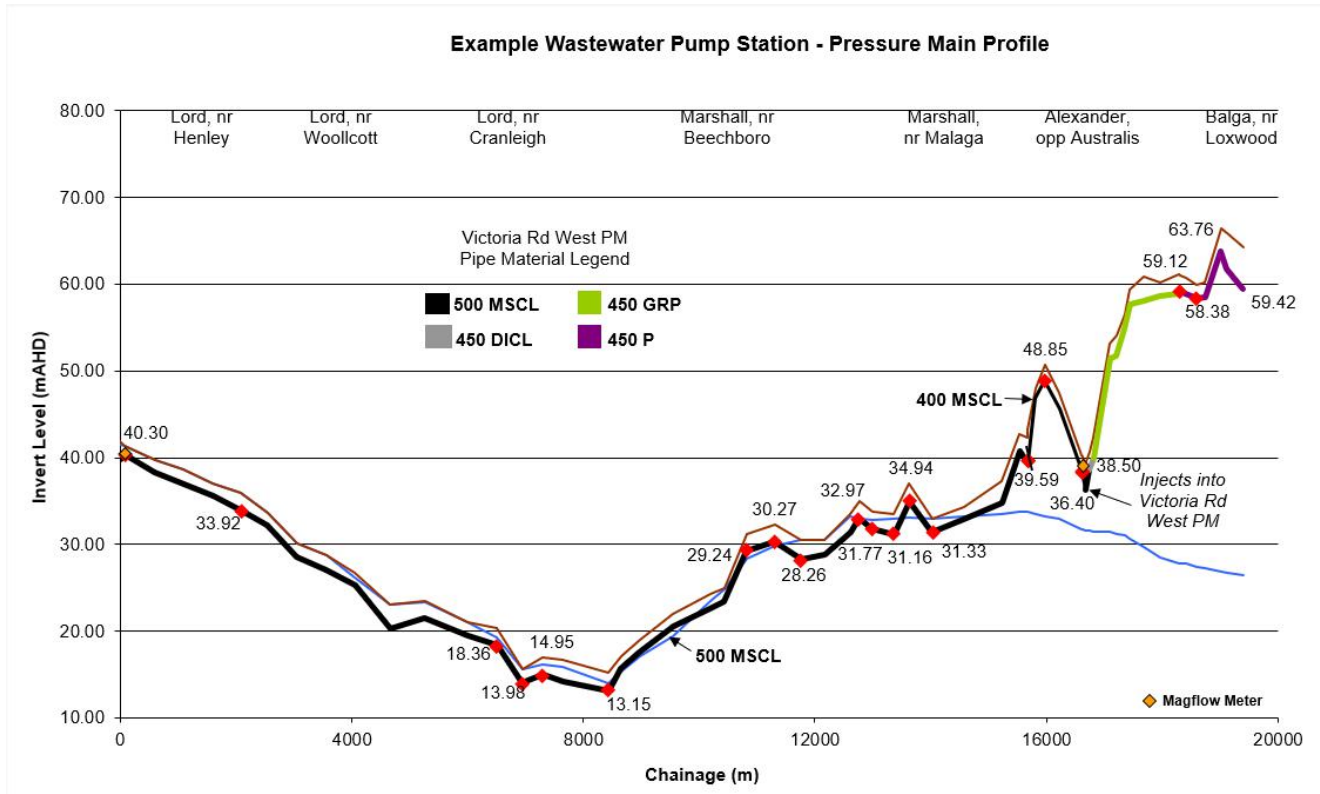
FIGURE 4.4 - DEDICATED ON-SITE GENERATOR PROVISIONS – (SIMPLIFIED APPROACH)



Notes:

- A dedicated on-site generator shall be provided for **any** High Consequence pumping stations located within a cyclone risk area regardless of Design Daily Flow.
- The cyclone risk area is defined as the zone that is within 200km of the WA coast between Coral Bay and the WA/NT border.

FIGURE 4.5 – EXAMPLE WASTEWATER PRESSURE MAIN OVERALL PROFILE



**FORM 3.1 - APPLICATION FOR SINGLE USE OF WATER CORPORATION EXAMPLE DRAWINGS
 FOR PUMPING STATION FACILITY IN ELECTRONIC FORMAT**

Pumping Station Requirements

- PS Type (10, 10D, 40, 40D or 90):
- Estimated kW's (Decontactor Model Only):
- PS Title/Name:
- PS Peak Design Flow (Estimated):
- PS Catchment Pumped Outflow (Estimated):
- Nominated Discharge Sewer Size & Access Chamber:
- Pressure Main Size & Length:
- PS Pipework Size:
- Emergency Overflow Discharge Location (Brief Description):
- Level of lowest sewer lot in PS Catchment:
- Maximum HGL of Emergency Overflow:
- Storage Volume in Sewerage System below emergency overflow IL:

Funding Arrangements – Not Applicable for INFILL PROJECTS

• PUMPING FACILITY	• Develo per • Funded	Developer Pre-Funded	Corporation Funded
Pumping Station Civil Works	Yes / No	Yes / No	Year: ____
PS Discharge Pipework & Valves	Yes / No	Yes / No	Year: ____
Pumping Equipment	Yes / No	Yes / No	Year: ____
Electrical Switchboards & Equipment	Yes / No	Yes / No	Year: ____
Copy of Funding Agreement Provided	Yes / No	Yes / No	N/A

Contact Person from Land Development Branch (Water Corporation) if applicable:

Applicant Details

Main Consulting Engineer:

Nominated Civil Design Engineer:

Electrical Design Engineer:

Drafting Software/Version and Release No:

Date of Application:

Contact & Postal Address:

FORM 4.1 - SOFT STORAGE IMPLEMENTATION REQUIREMENTS

ASSET NAME:

SOFT STORAGE AVAILABLE : YES/NO

VOLUME AVAILABLE: m³

DETAILS:

NECESSARY REQUIREMENTS TO UTILISE SOFT STORAGE:

5 CONSTRUCTION REQUIREMENTS

5.1 Introduction

5.1.1 General

- a) This Section of the Standard specifically refers to works being undertaken by a Developer for eventual takeover by the Corporation. Construction of works undertaken by the Corporation shall also follow the general principles of these requirements.
- b) Works shall be carried out in accordance with the requirements of this Standard and the relevant Acts and By-laws.

5.1.2 PVC Pipelaying Authorisation

PVC pipelaying personnel shall be trained in PVC pipelaying installation and handling. The training required shall be the successful completion of an acceptable PVC pipelaying and handling course conducted by the following training providers:

- South Metropolitan TAFE (SMTAFE)
- Civil Contractors Federation or
- Other equivalent training provider acceptable to the Water Corporation

Trained personnel shall be nominated at the “Start Up” meeting. The Corporation shall be notified of any change to PVC pipelaying personnel no later than one working day before any such change. No PVC pipelaying shall take place on any part of a project by an untrained PVC pipe-layer.

5.1.3 Construction Requirements

- a) The works shall be constructed in accordance with the latest Corporation specification or alternatively with a specification prepared by the Design Engineer and acceptable to the Corporation. A copy of the Corporation's specification will be made available on request.
- b) The Corporation's wastewater installations shall not be opened or entered without the acceptance of the Corporation's regional maintenance or inspection personnel.
- c) Construction shall not proceed until the boundaries of the pumping station site have been pegged by a licensed surveyor.
- d) The electrical works shall be constructed in accordance with the type specification for electrical installation DS 26.7

5.2 Acceptance Test Requirements

5.2.1 Underground Facilities

- a) For acceptance, underground structures and non-pressure pipelines shall be routinely inspected to assure structural integrity, internal watertightness and freedom from external infiltration. Where any infiltration or leakage is observed, the relevant structural and pipe surfaces shall be exposed at the location of concern and shall be repaired in accordance with a repair plan acceptable to the Corporation.
- b) Pipelines shall, for acceptance, be inspected for compliance with the specified line and level requirements and for freedom from obstruction.

5.2.2 Pressure Mains

For acceptance, each pressure pipeline shall be subjected to a witnessed pressure test to assure pipeline water tightness and thrust block capacity to safely resist movement. The field test pressure (ASTP), shall be calculated relative to the lowest point of the pipeline section under test, provided that each section of pipeline to be tested in a single test operation shall:

- be no longer than that proven to be within the safe and practicable capability and testing experience of the test service provider and of the selected testing equipment. Test pumping pressure gauge resolution shall generally be < 0.01 MPa and test water flow-metering gauge resolution shall be < 1 litre;
- not require a volume of test water in excess of that proven to be the sustainable capacity of the test water source nominated, by an acceptable margin of safety;
- not vary in elevation, from the highest to lowest point of the test section, by more than 30 metres;

International and national pipeline pressure testing standards generally recommend that pipeline sections to be tested should not exceed 1 km in length – particularly where pipe diameter is $> DN 300$ and where the testing record of the test service provider is unproven for the pipeline length and diameter involved. For pressure mains longer than 1 km, larger than DN 300 and those with significant differences of elevation, project-specific test section length constraints should accordingly be established during project scoping phase for definition in the project commissioning plan, by agreement between project Design and Commissioning Managers.

In accordance with the Australian pipeline installation and test standards, a pipeline pressure test shall comprise three distinct phases, being:

- 1 A pre-testing phase during which the pipeline is filled at an acceptable filling velocity (≤ 0.05 m/s), pipeline air is (mostly) vented, water absorption into (e.g. cementitious) linings is maximised and the different temperatures of pipe, air, filling water and surrounding soil have (mostly) been thermally equalised within the filled pipeline;
- 2 A pressure and pipeline component stabilisation phase during which the pressure in the pipeline is raised from a lower filling pressure to the nominated ASTP and a low rate of pressure decay indicates acceptable levels of hydrodynamic and mechanical stability;
- 3 The ‘official’ acceptance testing phase, commencing after phase 2 stabilisation has been achieved and test pumping has ceased, which determines pipeline pressure test performance acceptability or not.

These requirements shall not be varied nor diminished by the definition in some Australian pipeline test standards of a ‘pre-testing’ phase that combines the operations of both test phases 1 and 2.

A pressure testing point shall be as close as practicable in elevation to the lowest point of the test section and the test pressure shall be reduced by 10kPa for each metre that the test point is elevated above the lowest point of the test section.

Testing shall be undertaken by applying the Field Test Pressure ($< ASTP$) nominated by the Design Engineer on the pipeline design drawings. Field pressure testing shall be in accordance with:

- AS/NZS 2032 Clause 7.2 including the constant pressure (water loss) method as detailed in AS/NZS 2566.2 (Clause 6.3.4.1 and Appendix M, Paragraph M4), for PVC pipelines.
- AS/NZS 2033 Clause 7.2 including the general pressure test (Technical) method detailed in Sub-clause 7.2.4, for PE pipelines.
- AS/NZS 2566.2 Clause 6.3.4.1 and Appendix M, Paragraph M4 i.e. the constant pressure (water loss) method, for MS (steel), GRP and DI pipelines.

The duration of field pressure testing (including pre-testing) operations for pipelines shall be in accordance with the following Table:

TABLE 5.1 PRESSURE TESTING DURATION

Pressure Pipe Material	Phase 1 Pre-testing	Phase 2 Stabilisation	Phase 3 Acceptance Testing
MSCL and DICL	24 - 48 Hours	≥ 1 Hour	≥ 1 Hour
PVC and GRP	1 – 2 Hours	≥ 1 Hour	≥ 1 Hour
PE	3 - 5 Hours	5 - 8 Hours	

NOTES:

1. The objective of test phases 1 and 2 is the stabilisation of pipeline pressure decay rates prior to acceptance testing rather than the passage of a fixed or notional test duration. Premature commencement of acceptance testing may accordingly result in a false ‘pass’ or ‘fail’ test determination and a corresponding requirement for a complete re-test.
2. The phase 1 and 2 test durations shown in the Table are for guidance purposes and may need to be increased where pipeline test section length exceeds 1 km for pipe > DN 300, subject to the testing (track) record demonstrated by the test service provider.
3. The higher creep rates for thin-walled PVC-O and, to a lesser degree, PVC-M pipelines may need increased phase 1 and 2 test durations (in line with PE) to stabilise creep-induced volumetric expansion when subjected to test pressures.
4. Acceptance test pressure gauge readings and corresponding water loss measurements are likely to result in false ‘pass’ or ‘fail’ test determinations where full phase 1 and 2 stabilisation has not been achieved, particularly where retained air volume exceeds 4% of pipeline volume.

Where a pipeline section to be pressure tested is shorter than 200 m, smaller than DN 300 and where all pipeline joints are wholly exposed (e.g. not buried), a basic visual acceptance test may be considered by agreement with the Corporation. Visual testing shall be in accordance with AS/NZS 2033 Sub-clause 7.2.3 for PE pipelines and with AS/NZS 2566.2 Appendix M, Paragraph M8 for pipelines of other materials.

There shall be no visible leakage for the duration of pressure testing and make-up water volume shall be within the parameters specified in the nominated test standards.

Where a pressure tested section of pipeline fails, the causes of failure shall be investigated and addressed. The ‘failed’ section shall then be re-tested and its pressure performance shall, for acceptance, conform to the nominated test performance requirements.

5.2.3 Pumpsets

- a) The pumpsets shall be tested at the manufacturer's works in accordance with AS 2417 Grade 2, to the specified duty.
- b) Pumpset tests shall be conducted on-site to demonstrate the proper operation and performance of the pumping station. The following tests shall be carried out using clean water.
- c) Lifting, lowering and discharge connection sealing of the pumpsets.
- d) Operating of each pumpset singly through the pressure main and recording of total head, flow rate, shut off head and pump efficiency.

5.2.4 Reduced Pressure Zone Device

The Reduced Pressure Zone Device (part of the backflow prevention assembly) shall be tested and commissioned in accordance with the requirements of AS 2845.3 by an appropriately qualified licensed plumber.

5.2.5 Electrical

In addition to logic, wiring and circuit checks required to confirm correct installation, full functional testing of the control unit shall be carried out, including change-over initiation and telemetry. Motors shall be checked for correct phase rotation and an insulation resistance check undertaken. The tests shall be carried out in accordance with the requirements of the relevant type specifications of DS 26 and SPS 503

5.2.6 Test Certificates

- a) Test certificates shall be provided by the Contract Superintendent for:
- Pressure test of the pressure main referred to in Clause 5.2.2.
 - Certified pump tests carried out at the manufacturers works as detailed in Clause 5.2.3.1a.
 - Pump site commissioning tests in accordance with Clause 5.2.3b(ii) including a plot of each pump's performance on its certified pump head/quantity characteristic curve.
 - All electrical testing carried out under Clause 5.2.5.

5.2.7 Joint Final Inspection

- a) When the works have been completed, a joint final inspection shall be arranged in accordance with the requirements of the Developers Manual.
- b) At the time of the joint final inspection, the pumping station wet well and valve pit shall be dry and accessible.
- c) If the Corporation's Inspectors cannot complete a requested inspection, because of incomplete or poor workmanship, re-inspection costs may be charged to the Contractor.
- d) The access chambers and valve pit covers will be checked for level at the final inspection and again at the end of the defects liability period. Covers not at the correct level with respect to finished ground level, shall be adjusted by the Contractor.
- e) For the joint final inspection of the works, the Contractor shall provide the following:
- i. Personnel qualified to carry out the electrical and mechanical tests.
 - ii. All relevant tools and equipment required to carry out the tests.
 - iii. A crane for lifting and lowering the pumps.
 - iv. Access chamber safety grids for all access openings.

A final inspection clearance for the works will be issued when:

- v. All the works are satisfactorily completed in accordance with the requirements of the Developers Manual.
- vi. Lodgement with the Corporation of the following:
 - Complying Test Certificates as referred to in Clause 5.2.6
 - As Constructed requirements of all the works.
 - Manufacturers' equipment manuals associated with pumping station equipment.

6 AS CONSTRUCTED REQUIREMENTS

6.1 Introduction

- a) This Section of the Standard sets out requirements for the production and submission of as - constructed requirements for pumping stations and pressure mains.
- b) Works will not be taken over from developers until acceptable as constructed drawings have been received by the Corporation.

6.2 Responsibilities

- a) The Contractor shall be responsible for engaging a surveyor to record the as constructed information. Where the as constructed information will not be readily available after completion of the works, the information shall be recorded during construction.
- b) The Contract Superintendent shall be responsible for all information contained on the as constructed drawings.
- c) The Surveyor shall be responsible to the Contract Superintendent for the survey information provided.
- d) The as constructed drawings shall be certified "As Constructed", signed and dated by the Contract Superintendent and Surveyor.
- e) The Contract Superintendent or the Surveyor acting on his behalf shall submit one set of as constructed drawings to the Corporation.

Submission of As Constructed drawings.

- As constructed drawings of works provided by developers in the Perth Regions shall be submitted to:

The Manager
Development Services Branch
Water Corporation
John Tonkin Water Centre
629 Newcastle Street
LEEDERVILLE WA 6007

As constructed drawings of works constructed for the Corporation shall be submitted to the Project Manager for the works.

Where the works is within a country region, the as constructed drawings shall be submitted to the relevant regional Manager Assets.

Where a pressure main crosses under a freeway or controlled access road reserve, a drawing shall be submitted to Main Roads Western Australia showing the route and longitudinal section of the pressure main under the reserve. This drawing shall be forwarded at the same time as the submission of as constructed drawings to the Corporation.

6.3 Form and Content

- a) As constructed drawings shall comply with the requirements as set out in Section 14 of the WCX CAD Standard No. DS 80.
- b) It is important to note that every drawing used in the construction of the project shall be revised to "As Constructed". Including drawings which were constructed as drawn. (ie no changes)

7 PUMPSET SELECTION AND SPECIFICATION

7.1 Pumpset Duty Requirements

7.1.1 General Duty Requirements

The duty or duty range of each pumpset shall be in accordance with the flow/head duty point or points shown on the pressure main characteristic curve drawing as accepted for use on the project. Duty calculations and pressure main characteristic drawings shall comply with the requirements of the Standard.

7.1.2 Impeller Trimming Requirements

Pump impellers shall be selected and machined as necessary to operate at the required duty point for the nominated long term flow (Q) and total developed head (TDH).

Pumps that deliver flows (Q) higher than required may be considered by the Corporation (especially pumps which are required to pump at 12L/s or less) where this avoids unnecessary machining of impellers and where there is reasonable evidence that the higher discharge (Q) will not overload the downstream wastewater system.

7.1.3 Pumping Flow Staging Requirements

Pumpset duty parameters and selection criteria shall take account of a clearly defined pumping flow regime and staging which shall be subject to acceptance in writing in advance of any formal approaches to the suppliers of accepted pumping equipment and in advance of pumping station general arrangement drawing detail work.

7.1.4 Pumping Flow Regime

A pumping flow regime shall mean the range of pumping flows from initial or interim to ultimate flow which best (or economically) provides for:

- a) Realistic flow growth predictions for the pumped catchment.
- b) Minimum acceptable velocity in the pressure main system.
- c) Maximum flow capability of initial or interim pressure main system, consistent with availability of conforming pumpsets and with discharge sewer capacity constraints.
- d) Flow staging in ultimate pressure main system which is consistent with the capacity of the discharge sewer or with the respective capacities of staged components of the discharge sewerage system and with the available pump impeller options of any single pumpset selection.
- e) An electrical switchboard ultimate rating which is consistent with an acceptable long term pumping flow rate.

7.2 Pumpset Selection Requirements

7.2.1 General Selection Criteria

Pumpset selection criteria shall include but shall not necessarily be limited to:

- a) Compliance with all the requirements of this Section of the Standard.
- b) Least whole of life cost pumping equipment and flow rate staging option.
- c) Optimum pumping equipment delivery time within an acceptable overall project completion schedule.
- d) Proven performance in service of pumping equipment model(s) in similar installations, particularly in Corporation installations. The pumpset shall be one of the accepted pumpsets in the Strategic Products Register.

- e) Proven performance in pumpset selection and/or installation by pumpset supplier and/or installation Subcontractor or Contractor.
- f) Adequate clearance of pumpset from the sides of pumping station wet well pump access opening and from wet well fixtures during normal pump removal or replacement operations
- g) Demonstrated quality of pumpset replacement and wear components and of component delivery timeliness.
- h) Demonstrated quality of component repair or reconditioning services and service delivery timeliness.

7.2.2 Minimum Duty Point Requirements

Each pumpset shall be capable of operating without cavitation at the specified minimum pressure main characteristic duty point. This requirement shall be in addition to the requirement to operate efficiently at the specified maximum pressure characteristic duty point, or a specified range of duty points for the purposes of pumping flow rate staging.

7.2.3 Whole of Life Costing Requirements

Each of the various pumpsets offered for a specified single duty point or range of duty points shall be subjected to a like-with-like comparison with the other pumpset offered on the basis of the Net Present Values. The Net Present Values shall be calculated to take account of capital and energy costs using the Water Corporation's "NPV Calculation for Pumps" tool. The tool is available in Nexus doc #44813195 and may be requested for use on each specific project from the design manager. The tool contains up-to-date energy pricing for specific locations and financial data and local copies of the spreadsheet shall not be kept for use on subsequent projects.

The capital cost of pumpsets shall be quotations sourced from suppliers for the project and should be the delivered cost of a twin pumpset package in \$ excluding GST.

For the purposes of the assessment, pumpset life shall be taken as 25 years. For projects with staged upgrades, an assessment based on a shorter life may be appropriate and this should be discussed with the Design Manager.

The number of pumping hours for a typical day shall be calculated based on actual or estimated total daily sewage inflow to the pumping station. Pumping hour predictions for a future day shall be based on a realistic agreed flow growth prediction for that day.

The net kW input to a duty pumpset shall be calculated or estimated at the specified duty point and shall take account of the pump supplier's performance guarantees as validated by the printed pump characteristic data sheets and head/quantity curve. The net kW input at a given maximum duty point is usually lower than the maximum rated kW input of a given pumpset.

The pumpset combination which has the lowest Net Present Value shall be deemed to have the lowest whole of life cost, subject to any significant divergence of operating and maintenance costs identified by comparison of the range of conforming pumpsets offered.

7.2.4 Pumpset Delivery Requirements

The selection of a pumpset shall also take due account of pumping project timing constraints in the event that a shorter delivery period may significantly outweigh an assessed Net Present Value advantage.

7.2.5 Track Record

The past performance track record of an equipment supplier and the quality and timeliness of pumping equipment supplied by that supplier shall be a significant consideration in the selection of pumping equipment.

7.3 Pumpset Specification

7.3.1 Pumpset General Requirements

- a) The pumpset shall be capable of achieving the specified duty or range of duties in litres per second against the total dynamic head in metres.
- b) Pumpsets shall be in accordance with SPS 503.

7.3.2 Shredder/Grinder Pumpsets

- a) Where high head and low flow situations are encountered, the Corporation may authorise the use of submersible shredder/grinder pumps. A pumpset rotational speed of up to 3000 RPM may be preferred for this application.
- b) Shredder/grinder pumpsets shall be designed to reduce by grinding, shredding or by cutting action, the size of solid particles entering the pump. The size of incoming solids shall be reduced sufficiently to overcome:
 - Jamming of the pump due to the trapping of solids between the impeller and the casing.
 - Clogging of discharge pipework or of the pressure main. Shredder/grinder pumpsets shall be limited to use with discharge pipework on pressure mains smaller than DN 80, where a smaller pressure main has been accepted by the Corporation. Reduction of wastewater solids size shall be achieved by means of corrosion resistant and easily replaceable mechanical components.

END OF DOCUMENT