

1351 STORMWATER DRAINAGE (CONSTRUCTION)
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1 GENERAL**1.1 RESPONSIBILITIES****Objectives**

General: Provide drainage works as a complete system for collecting and carrying stormwater from roadways, open spaces and built-up areas as documented. Include Water Sensitive Urban Design (WSUD) principles as follows:

- Preparation for stormwater drainage construction.
- Temporary drainage during construction.
- Detention or re-use of stormwater.
- Vegetation filtering or water efficient landscaping.
- All work associated with erosion control.

Performance

Requirements: ~~[complete/delete]~~

Precedence: Where any document used in conjunction with this worksection includes technical requirements that conflict with this worksection, the requirements of this worksection take precedence.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0136 General requirements (Construction).
- 0152 Schedule of rates – supply projects.
- 0161 Quality (Construction).
- 0167 Integrated management.
- 0257 Landscape – Roadways and street trees.
- 0319 Minor concrete works.
- 1101 Control of traffic.
- 1102 Control of erosion and sedimentation (Construction).
- 1112 Earthworks (Roadways).
- 1121 Open drains, including kerb and channel (gutter).
- 1352 Pipe drainage.
- 1353 Precast box culverts.
- 1354 Drainage structures.

1.3 REFERENCED DOCUMENTS**Standards**

General: The following documents are incorporated into this worksection by reference:

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1-2009	Particle size distribution - Sieving method
AS 1289	Methods of testing soils for engineering purposes
AS 1289.3.2.1-2009	Soil classification tests - Determination of the plastic limit of a soil - Standard method
AS 1289.3.3.1-2009	Soil classification tests - Calculation of the plasticity index of a soil
AS 1289 4.3.1-1997	Soil chemical tests - Determination of the pH value of a soil - Electrometric method
AS 1289 4.4.1-1997	Soil chemical tests - Determination of the electrical resistivity of a soil - Method for sands and granular materials

AS 1289.5.4.1-2007	Soil compaction and density tests—Compaction control test—Dry density ratio, moisture variation and moisture ratio
AS 1289.5.7.1-2006	Soil compaction and density tests—Compaction control test—Hilf density ratio and Hilf moisture variation (Rapid method)
AS/NZS 2566	Buried flexible pipelines
AS/NZS 2566.1:1998	Structural design - Commentary
AS/NZS 2566.2:2002	Installation
AS 3600-2009	Concrete structures
AS/NZS 3725:2007	Design for installation of buried concrete pipes
AS/NZS 3725 Supp 1:2007	Loads on buried concrete pipes - Commentary (Supplement to AS/NZS 3725:2007)
AS 3735-2001	Concrete structures retaining liquids

Other publications

Institute of Public Works Engineering Australia (IPWEA)

IPWEA (NSW)-2010 Specification for the supply of recycled materials for pavements, earthworks and drainage (Greenspec)

NSW Department of Environment and Conservation – 2006

Managing urban stormwater – Harvesting and Reuse.

1.4 INTERPRETATIONS**Abbreviations**

General: For the purposes of this worksection the following abbreviations apply:

- D: External diameter of the pipe.
- NATA: National Association of Testing Authority.
- WSUD: Water Sensitive Urban Design.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Materials: In conformance with relevant worksection.
- Inadequate foundation material: Material beneath or adjacent to the proposed drainage structures which the Superintendent deems to be of insufficient strength to support the structure and loads on the structure, or material whose characteristics the Superintendent deems would adversely affect the performance or construction of the drainage structure.
- Selected fill: Backfill material with known properties and grading placed and compacted in layers.
- Water Sensitive Urban Design (WSUD): Design principles aimed at improving the sustainable management of the urban water cycle. It integrates the planning and design of urban water cycle, water supply, waste water, stormwater and groundwater management, urban design and environmental protection.

1.5 SUBMISSIONS**Approval**

Submissions: To the Superintendent's approval.

Documents

General: Submit the following for approval:

- Materials: Off-site certificates of components including certificate of the source of the materials used.
- Temporary drainage: Detailed proposals for diversion of existing flow paths.
- Calculations: Survey set out of stormwater works and quantity calculations.
- Work-as-executed drawings: Include stormwater system information sheets and works.
- Components: Pipes and fittings.
- Samples: For conformity testing to relevant standards.
- Technical data: Product information.
- Execution details: Refer to **HOLD POINTS**.
- Adverse ground conditions: NATA certificate for pH and electrical resistivity of soil tested to AS 1289.4.3.1 and AS 1289.4.4.1.

Design: ~~[complete/delete]~~Manuals: ~~[complete/delete]~~Prototypes: ~~[complete/delete]~~Evidence of type tests: ~~[complete/delete]~~Warranties: ~~[complete/delete]~~**1.6 HOLD POINTS AND WITNESS POINTS****Notice**

General: Give notice so that the documented inspection and submissions may be made to the **HOLD POINT table** and the **WITNESS POINT table**.

HOLD POINTS table

Clause title/Item	Requirement	Notice for inspection	Release by
PRE-CONSTRUCTION PLANNING			
Authority Approvals			
Temporary drainage	Submit details of procedures/devices for approval	2 weeks prior to site commencement	<i>Principal Certifying Authority</i>
MATERIALS			
Bedding, support and backfill material			
Durability - Geotechnical NATA test	Submit tests for pH and resistivity	1 week prior to proceeding	<i>Principal Certifying Authority</i>
Durability - Test for concentration of impurities	Test for chloride, sulphate and aggressive CO ₂	1 week prior to proceeding	<i>Principal Certifying Authority</i>
EXECUTION			
Establishment			
Siting of Culverts - Survey set-out	Submit survey set-out of culvert inlets and outlets for approval	1 week prior to proceeding	<i>Principal Certifying Authority</i>
Siting of Culverts - Changes by Contractor	Submit proposed changes for approval	1 week prior to proceeding	<i>Principal Certifying Authority</i>
Excavation near underground services - Public utilities	Obtain approval for adjacent excavation	1 week prior to proceeding	<i>Principal Certifying Authority</i>
Excavation near underground services - Contact DIAL 1100 BEFORE YOU DIG	Contact DIAL BEFORE YOU DIG	1 week prior to proceeding	<i>Principal Certifying Authority</i>
Excavation near underground services - Marking	Submit marking for approval	1 week prior to proceeding	<i>Principal Certifying Authority</i>
Construction traffic - Protection measures	Submit certification and verification of protection measures	3 working days	<i>Principal Certifying Authority</i>
Excavation for drainage systems			
General - Confirmation	Confirm soil type with design	3 working days	<i>Principal Certifying Authority</i>

Bedding and backfilling			
Uncompacted bedding for steel pipes and pipe arches	Submit details for achieving dense bedding zone	1 week	<i>Principal Certifying Authority</i>
Water sensitive urban design			
Landscape and vegetation - Plant species selection	Submit plant selection for a particular area	1 week	<i>Principal Certifying Authority</i>

WITNESS POINTS table

Clause title/Item	Requirement	Notice for inspection
EXECUTION		
Excavation for drainage systems		
Pipelines	Trench size to AS/NS 3735	3 working days
Drainage structures other than pipes	Clear widths between structure and wall of excavation	3 working days
Inadequate foundation material - Notice	Identify unsuitable material and provide remedial measures	3 working days
Inadequate foundation material - Rock foundation	Additional excavation and backfill required if rock is encountered at foundation level	1 week
Bedding and backfilling		
Backfilling – In situ concrete structures	Do not backfill against in situ concrete structures within 14 days of concrete placement	2 working days
Backfilling - Tolerance	Check shape of culvert during backfilling	1 working day
Compaction		
Compaction adjacent to culverts or drainage structures	Rectify any damage	2 working days before proceeding
Additional requirements for compaction of pipe drainage bedding	Provide if erosion of bedding material may occur	1 week
Water sensitive urban design		
Protection – Buffer strips, swales and bioretention systems	Provide temporary protection from construction traffic	3 working days
Protection – Permanent protection	Provide permanent protection from vehicular traffic	1 week

2 PRE-CONSTRUCTION PLANNING**2.1 AUTHORITY APPROVALS****Traffic control**

Provision for traffic during construction: To *1101 Control of traffic*.

Temporary drainage

Documentation: Submit details of procedures/devices to maintain effective drainage of the works area during construction. This is a **HOLD POINT**.

Road opening permit

Application: Submit application to the relevant Council for approval to undertake works to road or footpath. This application includes but is not limited to the following information:

- Opening and compaction specifications: To *1152 Road openings and restoration (Utilities)*.

2.2 ESTABLISHMENT

Documentation

Survey control: Required for the following:

- Mapping and pegging the drainage system.
- Locating components.

2.3 SCHEDULING

Program of works

General: Program the works as follows:

- Materials: Arrange the program for compliance and handling of components and materials.
- Authorities: Conform with approvals and the local environmental requirements.
- Constraints: Incorporate **HOLD POINTS** and **WITNESS POINTS**.

3 MATERIALS

3.1 GENERAL

Certificate of conformity

Verification: Provide certificates of conformance to the specification for all pipes, culverts, precast concrete units, access covers, road grates or frames and all materials and components.

Certificate: Identify the item and record the inspection and test records that verify conformity.

Materials and components

Pipes: To *1352 Pipe drainage*.

Precast: To *1353 Precast box culverts*.

Structures: To *1354 Drainage structures*.

3.2 BEDDING, SUPPORT AND BACKFILL MATERIAL

General

Recycled material: To *Specification for supply of recycled material for pavements, earthworks and drainage*. Submit for approval any recycled material proposed.

Durability

Geotechnical NATA test: Determine the pH and resistivity of water and soil in conformance with AS 1289.4.3.1 and AS 1289.4.4.1. This is a **HOLD POINT**.

Test for concentration of impurities: Carry out groundwater or soil extract testing for chloride, sulfate and aggressive CO₂. Testing to conform to AS 1289.4.2.1. This is a **HOLD POINT**.

Materials and protective treatment for durability: Conform to *1352 Pipe drainage, 1353 Precast box culverts, 1354 Drainage structures*.

Bed and haunch zones

Material for bed and haunch zones: Select fill to conform with the following:

- Particle size distribution: Within the limits set out in AS 3725 Table 6 and tested to AS 1141.11.1.
- Plasticity index: To AS 1289.3.2.1 and AS 1289.3.3.1 with a maximum of 6.

Side and overlay zones

Fill material: Select fill material for side and overlay zones of pipes, box culverts and adjacent to other drainage structures to conform with the following:

- Maximum dimension: 50 mm.
- Plasticity index: Between 2 and 12 to AS 1289.3.2.1 and AS 1289.3.3.1.

Material adjacent to weepholes

Requirement: Conform to the following:

- Clean, graded, hard and durable stone or river gravel.
- Nominal particle sizes between 10 and 50 mm.
- Maximum particle dimension < 50 mm.
- Minimum particle dimension < 5% by mass passing the 9.5 mm AS sieve.

Flexible pipes

Embankment material: If using flexible pipes and the embankment method, provide embankment material to AS/NZS 2566.1 clause 3.3 or AS/NZS 2566.2 Appendix G.

4 EXECUTION**4.1 ESTABLISHMENT****Temporary drainage during construction**

General: For each part of the drainage system, complete the erosion and sedimentation control measures before commencing the drainage works (except those parts of the drainage system forming part of the control measures).

Control of erosion and sedimentation: Conform to *1102 Control of erosion and sedimentation*. Make adequate provision for runoff flows at drainage works under construction or at surrounding areas/structure.

Dams and diversions: Do not dam up or divert existing watercourses (either temporarily or permanently). Submit for approval if required.

Material and equipment: Locate material and equipment clear of watercourses or secure to prevent danger or damage in the event of large runoff flows.

Swales and buffer strips: Protect during construction or make use of the swale as a temporary measure. Provide geotextile with a shallow 50 mm topsoil and instant turf laid perpendicular to the flow path.

Stabilisation of topsoil areas: Immediately following earthworks where required, stabilise the topsoil with hydroseed to *0257 Landscape – roadways and street trees*,

Hydroseeding.**Siting of culverts**

Requirement: Set out the stormwater drainage systems and identify the following:

- The location, lengths and levels at outlets and inlets of pipes and box culvert structures.
- The locations and levels of gully pits, junction boxes, energy dissipators, and inlet and outlet structures.
- The location and levels of the ends of wingwalls and headwalls.
- The location and levels of open drains.

This is a **HOLD POINT**.

Site conditions: If required to suit site conditions, amend the inlet and outlet locations, designed levels or the culvert length as part of the work covered by the schedule of rates.

Changes by contractor: Submit for approval any proposed change to the culvert location, length, designed levels, culvert strength, conditions of installation or cover to suit construction procedures, and provide proposed culvert set-out in addition to the designed set-out. This is a **HOLD POINT**.

Excavation near underground services

Public utilities within the excavation for drainage systems: Obtain approval of the relevant authority for the method of excavation before commencing excavation. This is a **HOLD POINT**.

Contact: DIAL 1100 BEFORE YOU DIG is a free service, from anywhere in Australia, collecting enquiries and passing them on to affiliated utilities to assist in locating underground pipe and cables (initial response possible within two working days with responses from utilities some time later). See www.1100.com.au. This is a **HOLD POINT**.

Locations: Obtain locations of water, sewer, stormwater, gas, electricity and telephone services.

Marking: Before commencing earthworks, locate and mark existing underground services in the areas which will be affected by the earthworks operations including clearing, excavating and trenching. This is a **HOLD POINT**.

Construction traffic

Protection measures: If proposing to move heavy construction plant or vehicles over pipe or box culverts structures, provide verification and certification of protective measures. This is a **HOLD POINT**.

Existing structures

Existing redundant drainage structures: Demolish and remove existing redundant pipe culverts, head walls and pits as shown on the drawings.

4.2 OPEN DRAINS**General**

Detail: Provide open drains, associated embankments and protective linings in conformance with *1121 Open drains, including kerb and channel (gutter)*.

4.3 EXCAVATION FOR DRAINAGE SYSTEMS**General**

Topsoil: Remove topsoil in conformance with *1112 Earthworks (Roadways)* before undertaking stormwater drainage excavation.

Trench support stabilising: Provide any shoring, sheet piling or other stabilisation of the sides of trench excavations necessary to conform to statutory requirements.

Excavation level: Excavate trench or foundation for stormwater drainage works to the designed level of the bottom of the bedding or foundation. Remove all loose material.

Excavation: Level beds of swales, batter slopes and bioretention trenches shown on the drawings.

Confirmation: Confirm surrounding soil type with design. Give notice if not consistent with the design. This is a **HOLD POINT**.

Pipelines

Trench size for pipelines: Excavate the trench to AS/NZS 3725. This is a **WITNESS POINT**.

~~Installation condition: [complete/delete]~~

Side zones of pipe trenches: Density and stiffness requirements to AS/NZS 3725 clause 9.2.3.1 for Type *H2* support.

Embankment installation condition: Prior to placement of bedding and laying pipes, place and compact embankment fill to a height above the top of the bed zone of at least 0.7 times the external diameter of the pipe and for a minimum lateral distance outside each trench wall of 2.5 times the external diameter of the pipe. Place earthworks to *1112 Earthworks (Roadways)*.

Trench installation condition: Complete the embankment to the underside of the selected material zone prior to the commencement of the excavation.

Drainage structures other than pipes

Excavation: Provide clear width between the structure wall and the face of the excavation as the greater of the following:

- 300 mm.
- 1/3 of the excavation face height. This is a **WITNESS POINT**.

Inadequate foundation material

Notice: Give notice of any area of the foundation including the sides of the trenches that may contain material that is inadequate to support the proposed drainage structure. This is a **WITNESS POINT**.

Confirmation of inadequate foundation material: Remove and dispose of inadequate foundation material to *1112 Earthworks (Roadways)* and replace the material to **Bedding, support and backfill material**.

Rock foundation: If rock is encountered at the foundation level, excavate for an additional depth. Backfill and compact the additional excavation with material conforming to the requirements for **H2** pipe support. This is a **WITNESS POINT**.

4.4 BEDDING AND BACKFILLING

Pipe Bedding

Type: Provide bedding depths and compaction for concrete pipes to **Pipe installation dimensions table**.

Pipe installation dimensions table

		Pipe support type						
		U	H1	H2	H3	HS1	HS2	HS3
Dimension (minimum)	x	75 on rock and Nil on soil	100 for D ≤ 1500 150 for D > 1500		0.25 D but > 100	100 for D ≤ 1500 150 for D > 1500		
	y	—	0.1D	0.3D	0.3D	0.1D	0.3D	0.3D
	z	—	—	—	—	≥ 0.7D		

D = External diameter of pipe

Flexible pipework minimum cover and embedment geometry: To AS/NZS 2566.1 Table 3.1 and Figure 3.1.

Uncompacted bedding for steel pipes and pipe arches

Tolerance: Provide minimum 75 mm thick uncompacted bedding material between the foundation and the outer surface of corrugations.

Firm support: Submit details for achieving a dense bedding zone for uniform firm support of the corrugated structure by ramming or other methods. This is a **HOLD POINT**.

Backfilling

In situ concrete structures: Do not backfill against in situ concrete drainage structures within 14 days of concrete placement. This is a **WITNESS POINT**.

Trench backfill material: Backfill the remainder of the trench to the underside of the subgrade, or selected material zone in conformance with *1112 Earthworks (Roadways)*.

Sequence: Commence backfilling and compaction at the pipe or wall to confine future backfill material.

Dimension: Place backfill around the steel pipe or structure, equally balanced on both sides, to the minimum dimension shown on the drawings or as directed.

Tolerance: Check the shape of the culvert during backfilling to ensure that on completion of backfilling, the vertical and horizontal centreline dimensions of the pipe or structure do

not vary from the manufacturer's specified dimensions by more than $\pm 2\%$ for pipes and pipe arches. This is a **WITNESS POINT**.

4.5 COMPACTION

Foundations, bedding and backfilling

Foundations, bedding (other than for pipe drainage) and backfilling: To the **Compaction table**, tested in conformance with AS 1289.5.4.1 for standard compactive effort.

Compaction table

Zone	Relative compaction
Foundations or trench base:	
-to a depth of 150 mm below foundation levels	95%
-material replacing unsuitable material	95%
Bedding material	95%
Selected backfill and ordinary backfill material:	
-below 1.5 m of finished surface	95%
-within 1.5 m of finished surface	100%
Backfill material within the selected material zone	100%

Compaction layers thickness: Compact all material in layers not exceeding 150 mm compacted thickness and to the required relative compaction before the next layer is commenced.

Moisture content range: At the time of compaction, adjust the moisture content of the material to permit attainment of the required compaction (within the range 60% to 95% of the optimum moisture content), as determined by AS 1289.5.7.1 (standard compaction).

Compacting adjacent to culverts or drainage structures

Method: If compacting adjacent to culverts or drainage structures, adopt compaction methods which do not cause damage or misalignment.

Damage: Give notice and rectify any damage caused. This is a **WITNESS POINT**.

Additional requirements for compaction of pipe drainage bedding

Protection of the pipe from construction damage: If required, adjust the layer thickness to avoid damaging the pipe e.g. for the first placed layer above the pipe crown in the overlay zone.

Bed and haunch zones compaction: Select fill material compaction to the appropriate pipe support requirements for concrete pipes in **Bedding material compaction requirements table**.

Bedding material compaction requirements table

Bedding material		Pipe support type							
Criteria	Location	U	H1	H2	H3	HS1	HS2	HS3	
Minimum Relative Compaction %	Bed and haunch zones	—	50	60	Concrete	50	60	70	
AS1289.5.4.1 (Standard Compaction)	Side and overlay zones:	Cohesionless	—	—	—	—	50	60	70
		Cohesive	—	—	—	—	85	90	95

Material directly under the pipe support: Place and shape the top 0.1D mm of the bedding and haunch material directly under the pipe.

H2 pipe support including concrete bedding: Provide concrete grade N20 to AS 3600.

Make sure pipe is suitably reinforced in conformance with AS 3725 as standard elliptically reinforced pipe may not be adequate for **H2** pipe support.

Cementitious stabilisation in the bedding and haunch zones: Provide cementitious stabilisation, if the impermeability of the natural ground and the slope of the drainage line is such that erosion of bedding material may occur. This is a **WITNESS POINT**.

4.6 CONCRETE WORK

General

Requirement: Supply and place normal class concrete, sprayed concrete, steel reinforcement, formwork and provide tolerances, construction joints, curing and protection to *0319 Minor concrete works* and as shown on the drawings.

4.7 WATER SENSITIVE URBAN DESIGN

Protection

Buffer strips, swales and bioretention systems: Do not allow any construction traffic access to areas of WSUD or infiltration tools to ensure that the soil compaction remains unaffected and as designed. Provide fences where required to *1195 Boundary fences for road reserves*. This is a **WITNESS POINT**.

Permanent protection: Install bollards, signposting or other street furniture to protect the constructed vegetated areas from damage such as parking of cars. Conform to *1192 Signposting* and *1193 Guide posts*. This is a **WITNESS POINT**.

Vegetated swales and buffer strips

Details: Conform to the drawings and to the following requirements where appropriate.

Preventing ponding: Provide a perforated pipe beneath the swale drain.

Geometry: Trapezoidal or parabolic shapes, side slopes no steeper than 3H:1V.

Longitudinal slope: Conform to the following if longitudinal slope is not within 1 to 4 %:

- Install check dams for slopes greater than 4%.
- Install under drains for slopes less than 1%.

Maximum swale width: 2.5 m.

Bioretention systems

Depth of filter media: Between 0.3 m and 0.7m, as shown on drawings.

Saturated hydraulic conductivity: Between 200 mm/hr and 500 mm/hr.

Perforated pipe capacity: Ensure perforated pipe capacity is greater than the infiltration capacity of the filter media.

Depth of drainage layer: 150 mm to 200 mm.

Drainage layer material: Coarse sand (1 mm) or fine gravel (2 to 5 mm).

Impermeable liner: If the surrounding soil is free draining use an impermeable liner on the base and sides.

Liner type: ~~[complete/delete]~~

Transition layer: Minimum 100 mm thick layer of sand or geotextile fabric.

Gross Pollution Treatment (GPTs) as part of a treatment system

General: Provide GPTs as shown on the drawings.

Treatment objectives: To capture gross pollutants litter and vegetation larger than 5 mm and sediment particles larger than 0.125 mm.

Landscape and vegetation

Landscape and vegetation: Conform to this worksection and *0257 Landscape – Roadways and street trees*.

Minimum depths of topsoil: Conform to the following:

- 150 mm for turf species.
- 300 mm for ground covers and small shrubs.
- 450 mm for large shrubs.
- 600 mm for trees.

Plant species selection: If required, conform to the species as shown on the drawings and submit plant selection for a particular area for approval. Give attention to the plant selection requirements for constructed wetlands, sedimentation basins, ponds and lakes. This is a **HOLD POINT**.

Stormwater re-use

Requirement: Provide stormwater re-use collection, storage, treatment and distribution in conformance with the drawings and this worksection.

~~Application rate for irrigation: [complete/delete]~~

4.8 COMPLETION

Inspection

Closed circuit television (CCTV) inspections: *The contractor shall carry out closed-circuit television (CCTV) inspections of all drainage structures no more than fourteen (14) days prior to the completion of the project, to verify that the works are within the specified tolerances, the flow of water is not obstructed by surplus construction material and to check for visible signs of defects.*

The contractor is to notify the superintendent of any impending CCTV inspections no less than twenty four (24) hours prior to the CCTV inspection being carried out.

On completion of the inspections the contractor shall submit to the Superintendent CCTV video footage and report of these inspections and any nonconformity detected, including video evidence of both the invert and obvert of pipes and box culverts with small openings. CCTV video footage and report is to be provided on all joints in a curved drainage line. The inspection and reporting must be in accordance with the current edition of WSA 05.

It may be in the interests of the contractor to undertake preliminary CCTV inspections on completion of the sub-base layer but prior to the construction of the kerb and guttering, to check for visible signs of defects. Any construction faults can be rectified at this stage at much lower cost than if detected on completion of the project.

Testing

Quality: Test and submit reports for all characteristics in conformance with *0161 Quality (Construction)*.

Flushing

General: On completion of the entire system, flush all pipes clean from end to end and leave in proper working order.

5 LIMITS AND TOLERANCES

Application

Summary: The limits and tolerances applicable to this worksection are summarised in **Summary of limits and tolerances table**.

Summary of Limits and Tolerances

Activity	Limits/Tolerances	Worksection clause reference
Fill for bed and haunch zones		Bedding, support and backfill material
-Maximum size of particles	50 mm	
-Plasticity index	2-12	
Fill adjacent to weepholes		
-Particle size	10 – 50 mm	
Excavation for drainage structures other than pipes		Excavation and drainage systems
-Clear width between wall of structure and face of	The greater of 300 mm and 1/3 the face of excavation height	

Activity	Limits/Tolerances	Worksection clause reference
excavation		
Uncompacted bedding and backfill	Minimum 75 mm thick	Bedding and backfilling
Maximum permitted distortion of pipes and pipe arches	± 2% from manufacturers specified dimensions	
Minimum thickness of compacted layer	150 mm	Compaction
Maximum width of vegetated swales and buffer strips	2.5 m	Water sensitive urban design
Bioretention systems		
- Depth of filter media	0.3 – 0.7 m	
- Saturated conductivity	200 – 500 mm/hr	
- Depth of drainage layer	100 – 200 mm	
- Transition layer of sand or geotextile fabric	100 mm	
Landscape and vegetation		
- Minimum topsoil depths	- 150 mm for turf species - 300 mm for ground covers and small shrubs - 450 mm for large shrubs - 600 mm for trees	

6 MEASUREMENT AND PAYMENT

6.1 MEASUREMENT

General

Payments made to the Schedule of Rates: To *0152 Schedule of rates – supply projects*, this worksection, the drawings and **Pay items 1351.1, 1351.2 and 1351.3**.

Lump Sum prices: Not acceptable.

Unpriced items: For each unpriced item listed in the Schedule of Rates, make due allowance in the prices of other items.

Methodology

The following methodology will be applied for measurement and payment:

Erosion and sedimentation control: To *1102 Control of erosion and sedimentation*.

Topsoil removal: To *1112 Earthworks (Roadways)*.

Concrete work: To *1352 Pipe drainage, 1353 Precast box culverts or 1354 Drainage structures*.

Sprayed concrete work: To *0319 Minor concrete works*.

Rock filled wire mattresses and gabions: To *1121 Open drains, including kerb and channel (gutter)*.

Excavation and stone pitching of open drains: To *1121 Open drains, including kerb and channel (gutter)*.

Miscellaneous minor concrete work: To *0319 Minor concrete works*.

6.2 PAY ITEMS

Pay items	Unit of measurement	Schedule rate scope
1351.1 Excavation and backfilling for stormwater drainage culverts and	m ³ measured as volume excavated: Box culverts:	The Schedule rate for this Pay Item to be an average rate to cover all types of material

Pay items	Unit of measurement	Schedule rate scope
structures.	<ul style="list-style-type: none"> - Plan area calculated from base slab dimensions plus 300 mm and wingwalls as shown on the drawings. - Depth is average actual site measurement from the bottom of the specified bedding to the ground surface after stripping topsoil. <p>Other drainage structures:</p> <ul style="list-style-type: none"> - Plan area from outside dimensions as shown on the Drawings. - Depth is average actual site measurement from the bottom of the specified bedding to the ground surface after stripping topsoil. <p>Unsuitable material under culverts and drainage structures:</p> <ul style="list-style-type: none"> - Actual plan area and average depth below bedding of material removed. 	excavated including both earth and rock. All costs associated with all activities for the excavation of material and backfilling as specified including setting out and associated survey, replacement of unsuitable material, replacement of over-excavation, control of stormwater runoff, temporary drainage, erosion and sediment control, disposed of excess or unsuitable material.
1351.2 Excavation for pipe drainage, pipes, structures.	m ³ measured as volume of excavated material calculated for each component to Annexure A.	The Schedule rate for this Pay Item to be an average rate to cover all types of material excavated including both earth and rock. All costs associated with all activities for the excavation of material, traffic control, erosion control.
1351.3 Inadequate foundation material under drainage structures and open drains.	m ³ measured as of excavated material.	The Schedule rate for this Pay Item to be an average rate to cover all types of material excavated including both earth and rock. All costs associated with all activities for the excavation, removal, replacement and disposal of inadequate foundation material traffic control, erosion control.

7 ANNEXURE

Annexure ASchedule of excavation dimension for **PAY ITEM 1351.2.****Excavation for reinforced concrete and fibre reinforced cement pipes**

Positive projection (if excavation required)		
Width	Single cell	External pipe diameter +1 m.
	Multi cell	Sum of external diameters + sum of spacings between pipes measured square to the line of the culvert + 1 m.
Depth	In natural ground	Average actual depth from topsoil stripped ground surface to underside of specified bedding.
	In embankment	Average actual depth or 500 mm above top of pipe to underside of specified bedding, whichever is lesser.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.
Wide trench		
Width	Single cell:	External pipe diameter + 1 m.
	Multi cell:	Sum of external diameters + sum of spacings between pipes measured square to the line of the culvert + 1 m.
Depth	In natural ground	Average actual depth form topsoil stripped ground surface to underside of specified bedding.
	In embankment	Maximum 500 mm above top of pipe to underside of specified bedding.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.
Normal trench		
Width		1.4 x external pipe diameter or + 300 mm on each side, whichever is the greater.
Depth	In natural ground	Average actual depth form topsoil stripped ground

		surface to underside of specified bedding.
	In embankment	Maximum 500 mm above top of pipe to underside of specified bedding.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.
Steel pipes and pipe arches		
Width	Wide trench	External pipe diameter or span + 2 x external pipe diameter or span.
	Normal trench	External pipe diameter or span + 600 mm on each side.
Depth		As for RC and FRC pipes.
Flexible pipes		
Width	for pipes of:	
	Ext dia at collar	External diameter of pipe + 200 mm $\geq 75 \leq 150$.
	Ext dia at collar	External diameter of pipe + 300 mm $\geq 150 \leq 300$.
	Ext dia at collar	External diameter of pipe + 400 mm $\geq 300 \leq 450$.
Depth		Average actual depth excavated.
Length		Actual excavation length, centre to centre of pits or centre of pit to face of headwall.