DESIGN STANDARDS
for
URBAN INFRASTRUCTURE
24 SPORTSGROUND DESIGN

24 SPORTSGROUND DESIGN

24.1 Introduction

These design standards form part of any project brief issued for sportsground design or for any sportsground developed by the private sector for ongoing management by Sport and Recreation Services.

Consultants are reminded of the necessity to comply with -

- Australian Standards
- Other Design Standards for Urban Infrastructure
- WSUD guidelines
- ACT Sport and Recreation Services irrigation controller requirements
- Design Acceptance Approvals
- Plumbing Approvals
- ACTEWAGL water supply and electrical supply guidelines
- Consolidation and Handover procedures of DUS QC for Gifted Assets
- Consolidation and Handover procedures of Procurement Solutions for Capital Works projects

Should a basic departure from the Design Standard for Urban Infrastructure 24 Sportsground Design be necessary, prior approval shall be sought through Sport and Recreation Services.

It should be noted that where the standards outlined within this document exceed Australian Standards, the Design Standard for Urban Infrastructure 24 Sportsground Design shall prevail.

24.2 Related codes of practice and guidelines

24.2.1 Industry Standards

AS 1141 Methods for sampling and testing aggregates, Standards Australia.

AS 1289 Methods of testing soils for engineering purposes, Standards Australia.

AS 1428 Design for access and mobility, Standards Australia.

AS/NZS 1477 PVC Pipes and Fittings for Pressure Applications, Standards Australia.

AS 2698.1 Plastics Pipes and Fittings for Irrigation and Rural Applications – Polyethylene Micro-irrigation Pipe, Standards Australia.

AS 2698.3 Plastics Pipes and Fittings for Irrigation and Rural Applications – Mechanical Joint Fittings for use with Polyethylene Micro-Irrigation Pipes, Standards Australia.

AS/NZS 2845.1 Water Supply - Backflow prevention devices - Materials, design and performance requirements, Standards Australia.

AS.NZS 3500.1.2 National Plumbing and Drainage Code, Standards Australia.

AS/NZS 4130 Polyethylene (PE) Pipes for Pressure Applications, Standards Australia.

24.2.2 Policy and standards

Standard Specification for Urban Infrastructure Works, Urban Services, Canberra, 2002.

Water Sensitive Urban Design, Guidelines for sustainable development in Canberra, Urban Services, Canberra, Draft 2005.

Overview – Plumbing and Drainage, Planning and Land Management, available online: http://www.palm.act.gov.au/bepcon/ and follow link to plumbing

Water and sewerage standards, ACTEW Corporation, Canberra, 2000.

Design Standards for Urban Infrastructure, 01 Stormwater, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 10 Parking Areas, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 11 Fences Guardrails and Barriers, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 12 Public Lighting, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 13 Pedestrian and Cycle Facilities, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 14 Urban Open Space, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 15 Playgrounds and Playground Equipment, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 18 Public Toilets, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 21 Irrigation, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 22 Landscape, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 23 Plant List, Urban Services, Canberra.

Design Standards for Urban Infrastructure, 25 Urban Park and Open Space Signage, Urban Services, Canberra.

24.3 Definitions

Definitions of terms used in this document include the following -

24.3.1 Sportsground

The term sportsground refers to the total area provided at any site or complex for organised sport. Sportsgrounds usually comprise an irrigated playing surface and surrounds that may or may not be irrigated. Their size allows multiple options for field layout.

24.3.2 Field

The term field refers to the marked out area for one sport. A field can accommodate one game of any sport including Rugby, Football, Hockey, Australian Rules or Cricket depending on the marking.

24.3.3 Neighbourhood Oval

The term neighbourhood oval refers to a sportsground that is generally located adjacent to both a suburban primary school and the local shopping centre. They are usually one basic sport unit in size. Together the three land uses generate a focus of activity for the neighbourhood. Usage is for both senior and junior match play and training as well as use by schools. Informal use by local residents is also significant. Sporting clubs have adopted neighbourhood playing fields and pressures of use have resulted in the need to provide both a toilet block and training lights to AS standard for Football.

24.3.4 Community Recreation Irrigated Park (CRIP)

In suburbs where there is no District Playing Field, District Park or School Oval, a Community Recreation Irrigated Park will be provided. Generally 0.75 to 1.0 hectare, this space will provide an irrigated low maintenance play space to support informal physical activity and recreation activities. Where possible, will be connected to a non potable water source for irrigation purposes and utilise a drought tolerant grass species (e.g. couch). The construction of the irrigated area will be same as that used for a Neighbourhood Oval or District Playing Field.

As a guide a Community Recreation Irrigated Park would generally include the provision of a toilet block, community barbeque and picnic shelter. Other facilities that could also be considered include the provision of a children's playground, basketball half court, tennis wall and cricket nets. A variety of low maintenance, drought tolerant tree species should also be provided from an aesthetic perspective and to provide shade.

It should be noted that the irrigated grass area does not need to be uniform in its shape or design, but it should be large enough to accommodate a range of informal recreation pursuits and activities. The alignment of a CRIP is not a critical factor as they involve informal sporting use and recreational pursuits.

24.3.5 District Playing Fields

The term district playing field refers to sporting facilities that serve several suburbs and comprise a number of fields with at least one pavilion. They are often associated with a high school and have a total area of at least eight hectares. District playing fields are heavily used for senior and junior competition and training and commonly they become associated with one particular sporting code, whereby several games can be played concurrently at the one venue, for ease of administration and organisation of voluntary officials.

These facilities are also heavily used for night time training under lights and appropriate lighting and other safety requirements are needed.

24.3.6 Enclosed Oval

The term, enclosed oval, refers to sporting facilities that are totally fenced to enable the collection of admission fees and to provide security. Enclosed Ovals will have larger pavilions with double changed rooms and with a grandstand above. Both covered and uncovered seating for approximately 12oo spectators will be provided. They should have floodlighting to match play standard at a minimum level of 300lux. The Enclosed ovals may be leased for 10 or more years to a sporting code. They attract a high intensity of competition use and finals and grand finals are usually staged there. Training is not permitted on enclosed ovals because of the likelihood of excessive wear on the turf surface and to ensure a quality sports turf surface that can cater for the higher levels of competition sport.

24.3.7 Turf Wicket

The term turf wicket refers to a number of wickets (usually a block of four or five) that are located on a District Playing Field or an Enclosed Oval. These wickets must be located between football fields to avoid play on them during the winter. They are constructed with a special clay wicket soil and grassed with a specified. couch grass variety.

24.3.8 Concrete Wicket

The term concrete wicket refers to a single cricket wicket constructed from concrete and in some cases covered with a synthetic grass. These wickets are located on both Neighbourhood Ovals and at some District Playing Fields-(cricket wickets are not placed on a basic unit if it is to be an AFL field). They must be located between sports fields. They should be covered with a synthetic sports turf suitable for cricket upon completion-this should not be done until the concrete has cured for at least 14 days.

24.3.9 Cricket Practice Nets

The term cricket practice nets refers to areas dedicated to structures that are usually fenced areas that have several concrete or synthetic turf practice cricket wickets within them. These facilities are associated with cricket wickets.

24.4 Performance Statement

The performance requirements for sportsgrounds will be outlined in the Brief or Deed Agreement documentation.

The primary objective is to provide an irrigated grass sports field surface within a playing field arrangement that provides acceptable levels of access, safety, amenity and convenience for all users. This is achieved by addressing the following -

- provide the type of sportsground appropriate to ACTPLA planning hierarchy,
- provide north/south orientation,
- provide appropriately sized sports fields,
- provide buffer distances to adjacent development,
- provide an adequate level of safety relative to risk assessment,
- allow for runoff and rainfall events within acceptable time limits,
- provide acceptable and durable grass cover,
- provide playing surfaces that are of acceptable hardness with the ability to be decompacted to safe user levels,
- comply with WSUD guidelines,
- provide appropriate lighting for sportsgrounds to the required Australian Design Standard,
- provide irrigation to maintain appropriate sportsground playing surface conditions,
- provide ancillary facilities appropriate to the standard of playing field,
- provide car parking appropriate to the demand generation,
- provide convenient and safe access to sportsground facilities for vehicles, cyclists, pedestrians and disabled persons,
- provide appropriate access for emergency and service vehicles,
- provide for shade, shelter and amenity landscaping that is appropriate to the use areas, and
- provide appropriate access for maintenance vehicles and legitimate users, whilst preventing (through fencing and/or bollarding) access to unauthorised people who may cause vandalism.

24.5 Standards

24.5.1 Siting

Siting of sportsgrounds shall have appropriate regard for climate, geology, topography and the environment.

The site for sportsgrounds should be relatively level in order to reduce earthworks. Multi-level configurations are to be avoided. Playing fields shall be orientated north-south along the direction of play. Cross falls are preferable to longitudinal grades.

The standard orientation is between North and 15 degrees east of North. Certain sports may, with the approval of Sport and Recreation Services, be orientated between 20 degrees west of North and 35 degrees east of North.

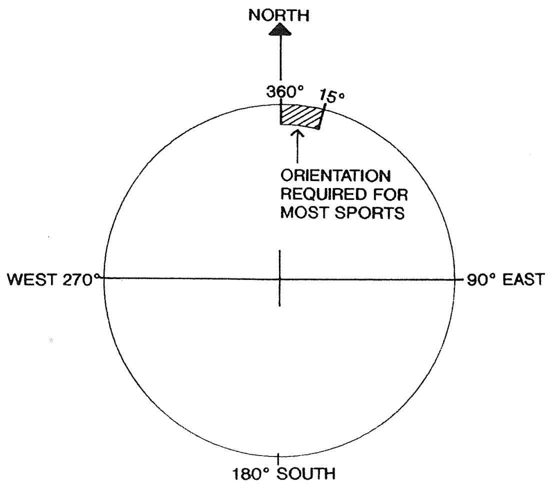


Figure 24.1 Orientation Diagram

Minimum offsets from playing fields shall be established to adjacent uses such as -

- behind goal posts, 30 metres to residential lease boundaries and 40 metres to roads,
- side boundaries, 20 metres to residential lease boundaries and 30 metres to roads.

Separation distances between adjacent fields shall be not less than 10metres. Minimum separation distance from sportsground to general obstructions (e.g. light pole, fence, manhole cover, sump) shall be 5 metres.

Goal posts should not be located directly adjacent to roads, car parks, water bodies and drainage channels etc. Tree planting at an appropriate distance behind goal posts at both ends of the playing field is desirable. Tree roots must not encroach onto the playing surface. Trees with aggressive root systems such as white poplars are unacceptable. Deciduous trees are preferable. Trees with red foliage should not be planted in line with cricket wicket ends.

As far as possible, evergreen tree canopy shadows shall not encroach upon the playing field between the hours of 9.00am and 3.00pm. Mature height listed in Design Standard for Urban Infrastructure 23 Plant List and winter solstice sun angle shall determine shadow extents.

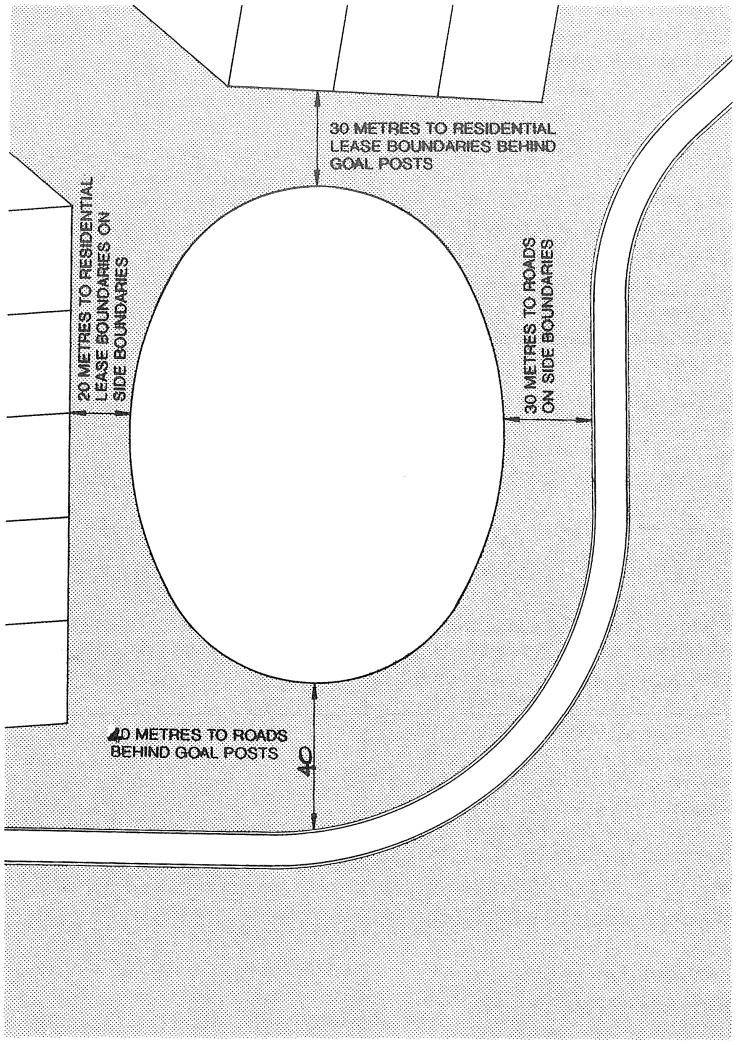


Figure 24.2 Separation Distances

Siting of playing fields within flood prone areas is allowable with approval from Sport and Recreation Services. Maximum inundation period is 1 hour. Siting of playing fields on areas of deep fill is allowable under some circumstances, only with appropriate consolidation and consultation with Sport and Recreation Services. Siting of playing fields on remediated refuse tips or garbage dumps is not recommended.

24.5.2 Dimensions

24.5.2.1 Neighbourhood Ovals

Neighbourhood ovals typically account for a total area of not less than 3.8 hectares. The sportsground area accounts for approximately 70% of the site area with the balance taken up with earthworks profiles, landscaped surrounds, setbacks from adjacent leases, roads and car parks.

There are three possible sportsground layouts, which provide design flexibility to suit almost any site. These layouts are -

1. Sports Combination Type 1A-this is the preferred layout and Sport and Recreations Services should be consulted prior to considering other options.
2. Sports Combination Type 1B

3. Sports Combination Type 2.

Common requirements of each sportsground layout for neighbourhood ovals include -

- continuation of the sportsground ground profile a minimum 5 metres beyond the marked extent of the sportsground,
- one North-South edge of the playing field shall allow for the marking of a rectangular sportsground 122 metres long.
- the extent of irrigation shall extend 6 metres beyond the sportsground marked extent,
- separation distances between adjacent sportsgrounds shall be not less than 10 metres.

Layout 1 is appropriate where a curved playing field boundary is desired. It allows for marking two Rugby or Soccer fields and an Australian Rules field. Figure 24.3

Layout 2 is appropriate where a more regular playing field boundary is desired. It allows for marking two Rugby or Soccer fields and an Australian Rules field and a cricket field. Figure 24.4

Layout 3 is appropriate where a fully rectangular layout conforms to the topography and the adjacent land uses. It allows for marking neither an Australian Rules field nor a Cricket field. Figure 24.5

NOTE: All sportsground designs must be approved in writing by Sport and Recreation Services, particularly the configuration to be used on each site.

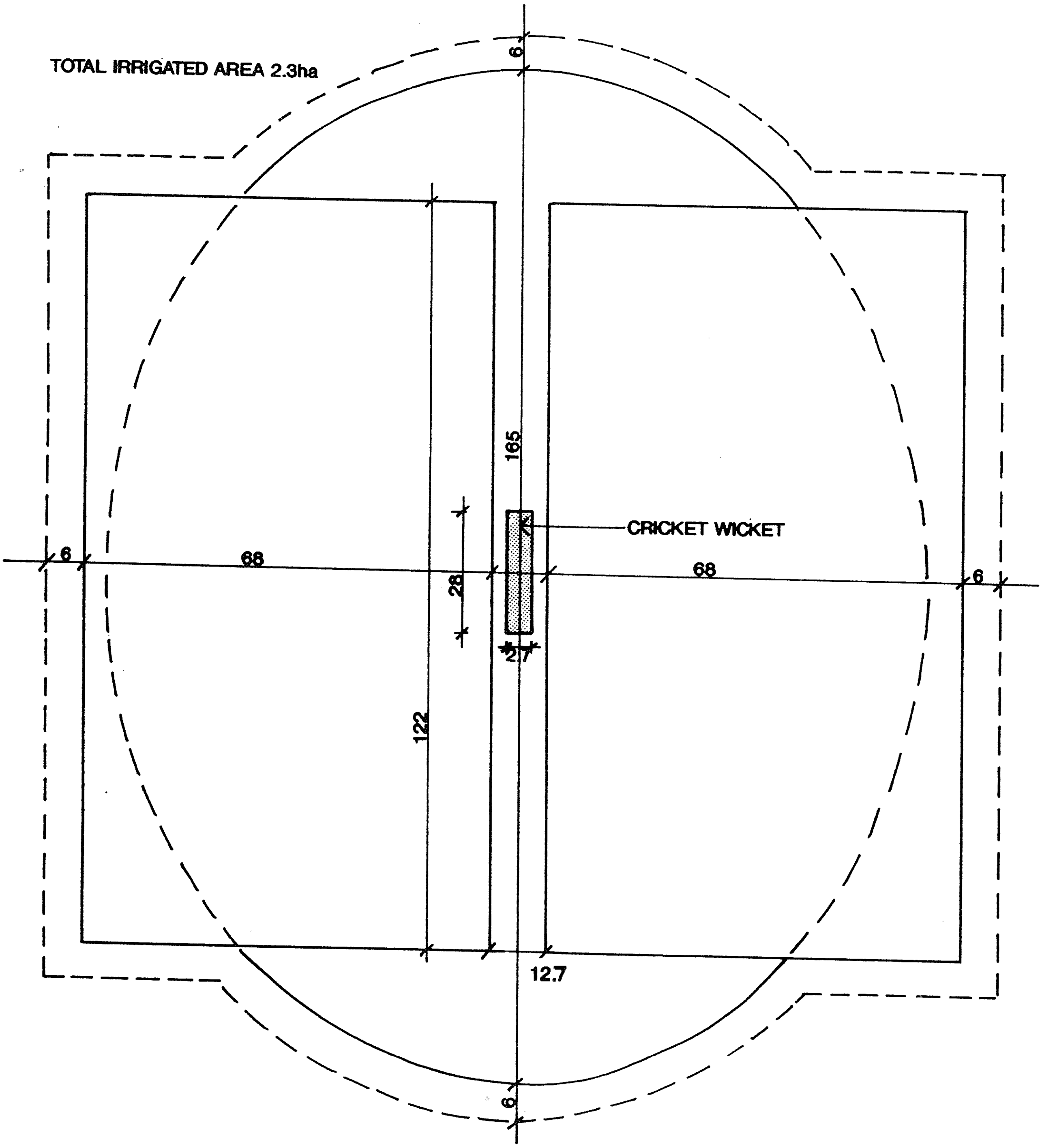
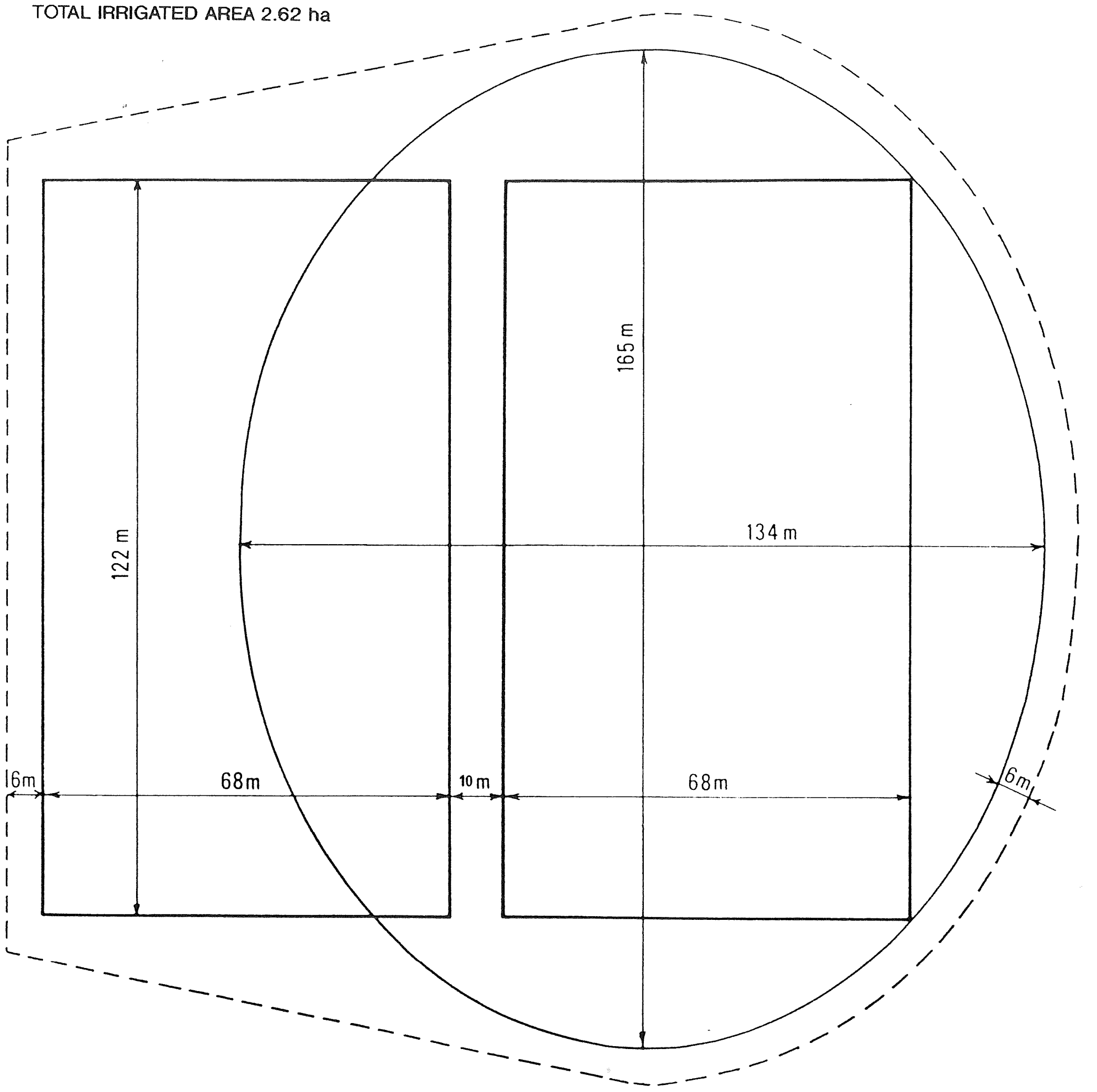
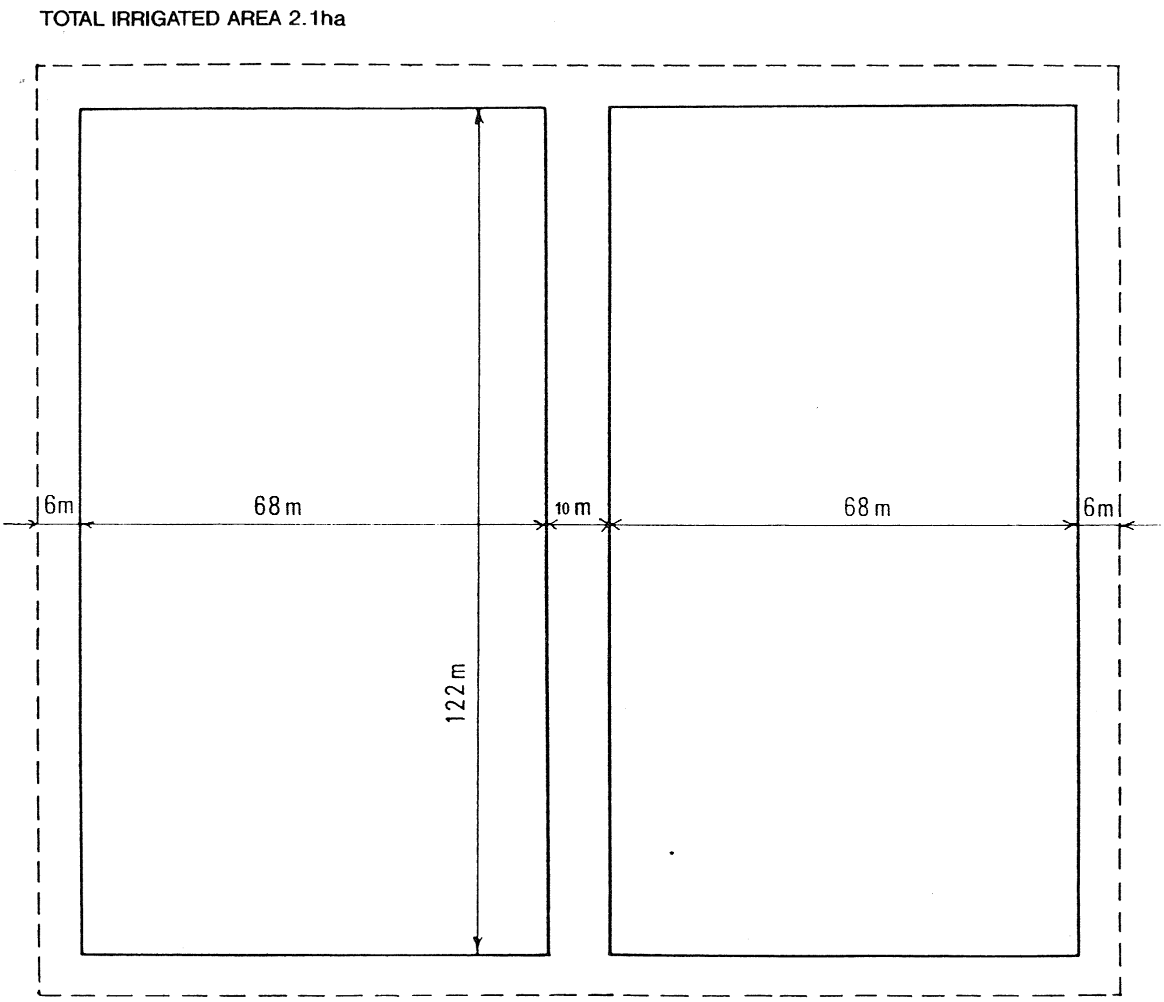


Figure 24.3 Sports Combination Type 1A



The retangular fields are combination fields which serve Soccer and the Rugby codes. By placing them to one side the combination may better suit a curved site boundary. The disadvantage is that a cricket pitch in the middle of the oval falls within a football field.

Figure 24.4 Sports Combination Type 1B



Fields are combination fields which serve Soccer and Rugby codes.

Figure 24.5 Sports Combination Type 2

24.5.2.2 District Playing Fields

District playing fields occupy large areas of land, 8 to 12 hectares is normal.

District playing fields comprise of multiples of the selected Sports Combination layout. Most district playing fields consist of 2 or more Sports Combination layouts. Sports Combination Type 1A is the basic design module. Use of any other Sports Combination Layout shall occur only with written approval of Sport and Recreation Services.

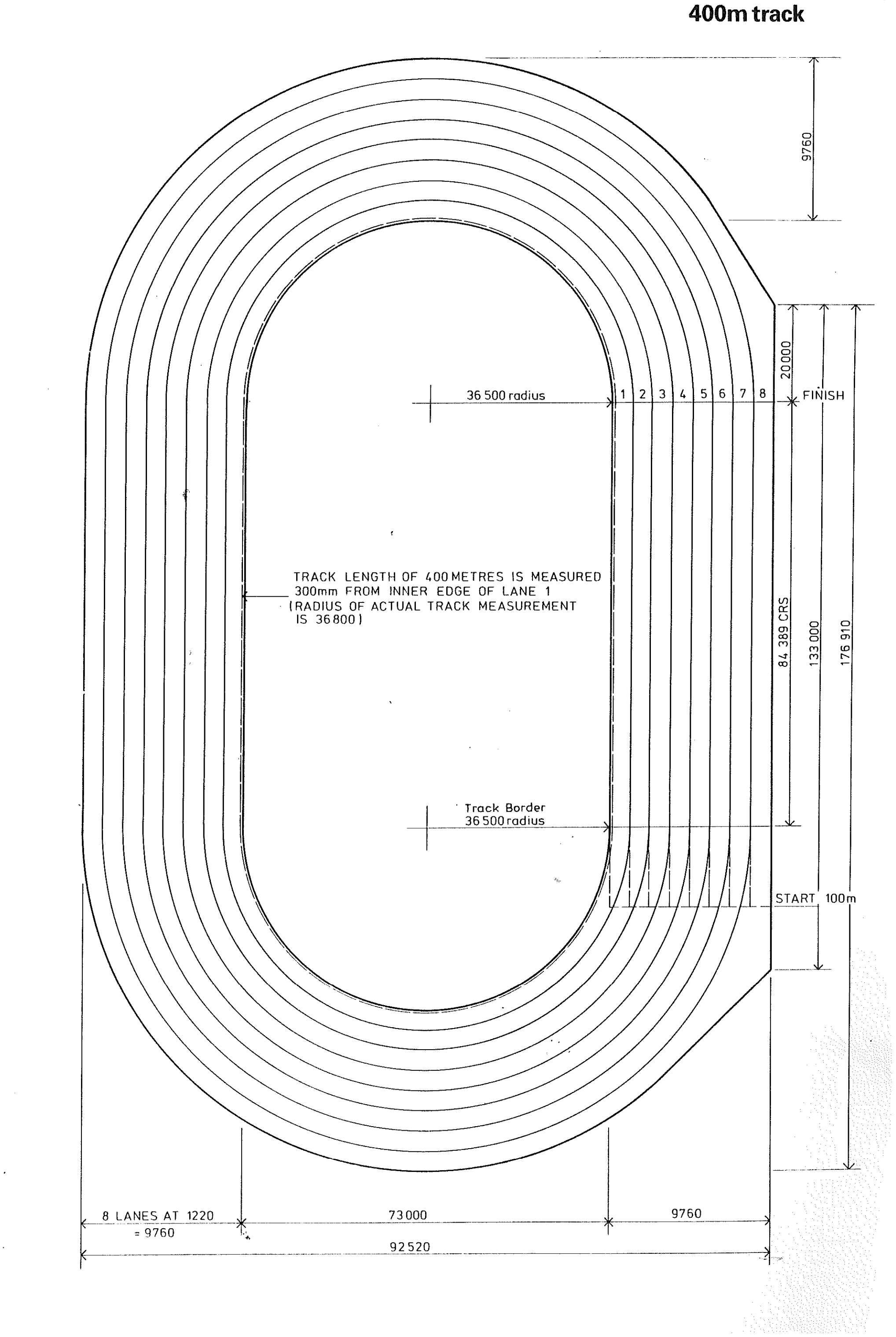


Figure 24.6 400m Athletics Track Layout

A modified District Playing Field layout shall be provided where a district playing field is required to incorporate a Little Athletics centre. A 400m Athletics Track and associated 100m sprint track shall be provided on quality irrigated grass surface with longitudinal and cross fall gradients that permit effective conduct of junior or senior athletics. Details of the design shall be approved by Sport and Recreation Services. Detailed track design data can be sourced from The International Amateur Athletic Federation Official handbook.

Space for access, car parking, pavilion, earthworks profiles, landscaped surrounds and setbacks from adjacent leases and roads is in addition to the Sports Combination layouts.

Common requirements of each sportsground layout for district playing fields include,

- continuation of the sportsground ground profile a minimum 5 metres beyond the marked extent of the sportsground,
- the area of irrigation shall extend 6 metres beyond the sportsground marked extent and further around pavilions and other areas as specified in the Brief or Deed Agreement documentation,
- separation distances between adjacent sportsgrounds shall be not less than 10 metres.

The imposition of a District Playing Field into a sites' topography may generate large changes in level and excessive cut and fill. It may be more appropriate to design the levels for individual sportsgrounds within the playing field, with consequent lesser changes in level between sports fields. In this case the overall dimensions of the playing field will increase due to the 5 metres continuation of the sportsground ground profile and the extent of earthworks at the level change.

24.5.3 Neighbourhood Ovals and District Playing Fields using Sportsground Topsoil

24.5.3.1 General

Neighbourhood ovals and district playing fields rely on surface drainage with a limited, but nonetheless very important amount of natural infiltration through the sportsground topsoil to the subsoil. Correct preparation of the subgrade and playing surface final grading is the most important design component affecting the performance of a sportsground. Less than satisfactory subgrade design is frequently attributed to long-term problems with drainage and sportsground performance. Remedial practices such as topdressing and other surface management practices are ineffectual in addressing poorly designed and constructed subgrades.

Several configurations for the subgrade are possible and each has advantages for particular sites. The sportsground may have one continuous fall or a longitudinal ridgeline or be domed.

The playing surface design concept is a fall of 1 in 70, with no slope longer than 70 metres. The maximum slope length of 70 metres is not negotiable.

This means that for the playing surface the maximum run to a water collection point is 70 metres. Depending on site conditions, the slope may be varied to a maximum of 1 in 50 once it is off the sportsground. Slopes of greater than 1 in 70 may be used to speed up the removal of water that has reached the edge of the sportsground provided the safety of the players and spectators is not compromised. These steeper slopes shall occur beyond the 5 metres edge of the sportsground.

24.5.3.2 Subgrade

The slope of the subgrade shall be continuous with no depressions or minor ridges. The subgrade shall be consolidated to no more than 95%MMDD and the use of rollers and heavy machinery is not encouraged. This subgrade MUST drain, therefore it MUST NOT be over compacted to achieve a stable and true bed for the subsequent addition of sportsground topsoil. Some differential settlement of the subgrade may occur and cause depressions and ponding at a later date. This is more preferable than a base that will not drain and badly affects the playing fields performance. Depressions can be top dressed out of the playing field surface.

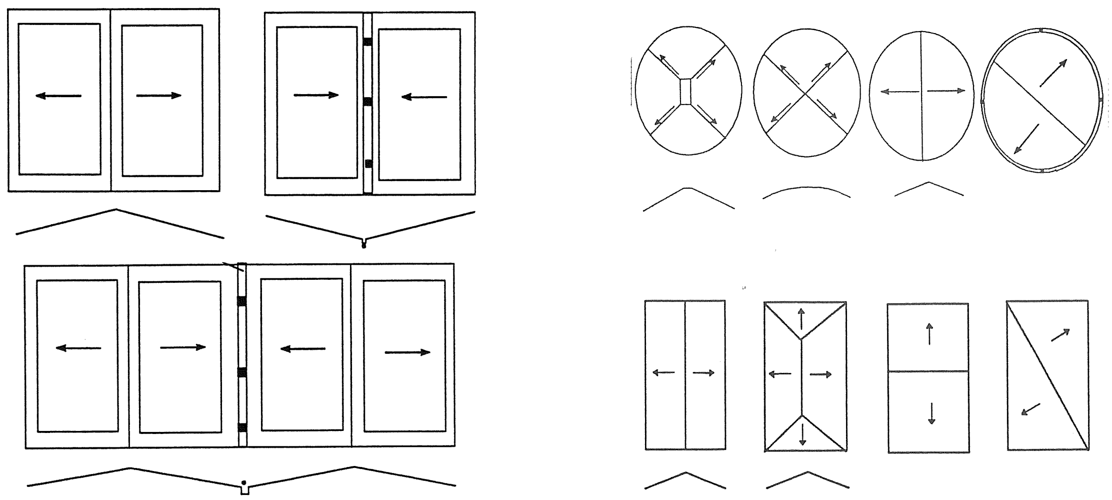


Figure 24.7 Subgrade Configuration Options

Once the subgrade levels are achieved, the subgrade shall be ripped to 350mm and lightly harrowed to break up large clods. Ripping and harrowing of the consolidated subgrade is necessary to ensure that the base will drain. If there have been areas where the base has been over compacted or glazed by the use of heavy machinery, these shall be broken up to allow drainage down through the profile to occur.

The subgrade SHALL NOT be worked when it is wet. This is of paramount importance and shall be written into the specifications and supervised to ensure compliance. Large machines such as large bulldozers and large scrapers shall not be used and this shall be included in the specification. It shall also be strictly supervised because if used it will compact the base and this has long term effects on drainage.

The limits on the size of the machines to be used shall be clearly stated in the tender documents and all tenderers should have this point drawn to their attention so the use of smaller machines can be appropriately included.

Ripping does not adversely affect the initial consolidation if done uniformly over the whole surface. Any minor inconsistencies in the resultant subgrade surface can be adjusted within the sportsground topsoil depth.

Once the subgrade has been ripped, gypsum shall be added at the rate of 500g per square metre– this applies to all subgrades.

Irrigation shall be installed after the subgrade has been ripped. The irrigation shall not be installed until the subgrade has been ripped as this seriously inhibits the proper ripping of the whole subgrade. This process may make it a little more difficult for the irrigation trenching however this sequence of works shall not be compromised.

24.5.3.3 Sportsground Topsoil

Neighbourhood ovals and district playing fields shall be finished with sportsground topsoil as defined below. Sportsground topsoil depth on neighbourhood ovals and district playing fields shall be **250mm**.

Testing procedures shall be those outlined in Section 24.5.3.4A and should comply with laboratory Testing Procedures at Appendix 1 (page 46-56).

24.5.3.4 Sportsground Topsoil Specification

The sportsground topsoil for the playing fields shall be a sandy loam and the following procedures shall be followed to procure the correct soil.

Use the following Particle Size Distribution as a starting point. Once a soil meets this specification, or comes close to it, it shall be tested to meet the remaining criteria.

Fraction Size Name	**Sportsground Guidelines specification**		
	Diameter of Sieve (mm)	**Allowable Range % Retained on Sieve**	
Gravel	2.00	≤ 3%	No more than 10% including 3% fine gravel
Very Coarse	1.00	≤ 7% to 10%	
Coarse	0.50	At least 60% particles in this range	A Minimum of >60% in these combined sand fractions
Medium	0.25		
Fine	0.15	20% Maximum	
Very Fine	0.05	5% Maximum	Combined Fractions No More than 10%
Silt	0.002	5% Maximum Allowable	
Clay	<0.002	3% Maximum Allowable	

*** Gravel plus Very Coarse should not exceed 10% total.**

The analysis shall be carried out using USA Department of Agriculture (USDA) sieves using the wet sieve analysis method.

Compacted Hydraulic Conductivity

The sportsground soil **shall** conform to the following hydraulic conductivity specifications:

Use the drop method outlined in McIntyre and Jakobsen (1998). The compacted hydraulic conductivity of the soil shall exceed:

150mm per hour at 16 drops; and

5mm per hour at 32 drops.

Bulk Density

The bulk density of the soil, before the addition of any sphagnum peatmoss or cocoa fibre shall not exceed 1.58g/cm^2 at 16 drops. This test is carried out as part of the drop test for hydraulic conductivity.

Water Holding Capacity

The water holding capacity of the soil, measured at 1 metre suction, as described in McIntyre and Jakobsen (1998), **shall** be equal to or exceed 14% by weight, when Cool Season grass is being used, and 12% by weight when Couch grass is being used.

Note. Most soils that meet the compacted hydraulic conductivity criteria will not have a water holding capacity, at 1 metre suction, of 14%.

Addition of Sphagnum Peatmoss or Cocoa Fibre

If a soil is presented that meets all of the above criteria, but has a water holding capacity below the prescribed level (12% or 14%) this soil is acceptable if the prescribed water holding capacity is reached by the addition of either Sphagnum peatmoss or cocoa fibre. The amount of sphagnum peat or cocoa fibre needed to increase the water holding capacity shall not exceed 2.5% by volume.

Note. Under no circumstances should the water holding capacity be achieved by adding more silt and clay.

Total Dissolved Salts

Total dissolved salts shall not exceed 100ppm. in a 1:5 soil: distilled water suspension

pH

The pH range shall be between 6.0 and 7.0 (in 1:5) soil to deionised water, and if outside this range it should be amended before delivery to site.

Other selection Criteria (Blake GR 1980)

Parameter	Recommended Value
Gradation Index	Ideally 4-5; acceptable range 3-6. Lower levels indicate a higher potential for surface instability
Fineness of Modulus (Fm)	1.7 to 2.5
Uniformity Coefficient (CU)	$CU=D_{60}/D_{10}$, where are an acceptable value is 2 to 4. A higher value indicates less particle uniformity. Optimum value is 2 to 3. A value < 2 is less likely to pack tightly but may indicate an unstable surface. Conversely a value >4 will have a tendency to pack tightly.

Silt:Clay ratio	Silt contents>2.5 times that of the clay fraction are rejected entirely if alternative soil sources can be found. Aim for silt/clay ratio of 2.0 or lower gives an even greater safety factor.

The Fineness of Modulus (Fm) and Uniformity Coefficient (Cu) are determined from a graph of the concentration of particles versus size. The grain size graph is a useful tool in comparing sands and also determining the Fm and Cu. Grain size graphs are used to design and select materials for drain systems. The Cu is a numeric estimate of how a sand is graded. The term graded relates to where the concentrations of sand particles are located.

Sand with all the particles in two size ranges would be termed narrowly graded and would have a low Cu value. Sand with near equal proportions in all the fractions would be termed widely graded sand and would have a high Cu value. The cu is a dimensionless number or in other words it has no units. For turf applications, the Cu values we are looking for range from 1.8 to 4.0.

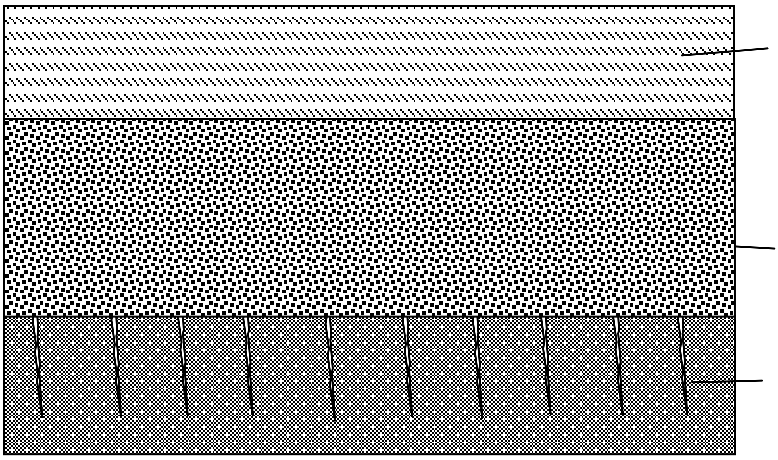
Widely graded materials usually offer firm turf surfaces and will be less prone to developing divots and ruts. Football pitches are firmer with higher Cu materials. The goal is to balance physical stability with the desired drainage characteristics. The materials with higher Cu values also have a more tortuous path for water to move through and will have lower infiltration rates or permeability. Usually the water retention is greater with sands that have a higher Cu.

Addition of Chicken Manure to the top 100mm of Topsoil

Once a suitable topsoil has been selected, and any addition of sphagnum peatmoss or cocoa fibre have been included to increase the water holding capacity to the approved level, composted chicken manure should be added to the topsoil to be used in the top 100mm of the profile. The chicken manure should be incorporated into the topsoil prior to placement and under no circumstances should in be incorporated using rotary hoeing. The preferred method is to lay the 150mm of topsoil and then apply the second layer of 100mm with the chicken manure pre-blended.

This material should be composted so there is no residual ammonia present. The total added material should not exceed 5% by volume.   A suitable material is “Broiler Chicken Manure” which is a mixture of wood shavings and chicken manure from under caged birds.

This material should be well composted and dry.   It should have no pieces greater than 6mm in size.   It should be totally blended by drop mixing at the soil yard and approved before delivery to the site.



Cross section of the final profile

24. 5.3.4A COLLECTION OF SANDY LOAM SAMPLES FOR LABORATORY TESTING

Samples being collected to be sent for laboratory testing should be done in the following way:

- Take samples from the stockpile following AS 1289.1.1. 2-3kg is needed to carry out all of the appropriate tests.
- Double bag the samples in strong plastic bags and, attach clear labels to the samples. It is also good practice to place a label inside the bag as well.

24. 5.3.4B LABORATORY PROCEDURES FOR TESTING SPORTSGROUND SOIL

There are many different methods used for the measurement of hydraulic conductivity in soils, and these different methods can give different answers.

The test required for the testing of Sportsground Soils is the *Drop Test* as developed by Dr Bent Jakobsen for the ACT Government. This test determines the Compacted Hydraulic Conductivity and Bulk Density at several different compaction levels. The determination of the Water Holding Capacity at one metre suction (approximates field capacity) is also done in conjunction with this test.

These tests developed by Dr Jakobsen are simple and effective. The results of these tests can be used in the meaningful assessment of soils and sands for sports turf. This method requires no expensive laboratory equipment, and has proved to be highly repeatable.

Note

It is very important to ensure that the sample is at field capacity when the soil is placed in the tubes prior to the test. Failure to ensure this will result in the wrong result. It is also very important to ensure that the tube is dropped from the correct height every time and that it falls vertically. If the tube falls on an angle rather than flat on the bottom of the tube, it can de-compact the sample.

Treatment of Topsoil Samples on Arrival at the Laboratory.

It is **imperative** that soil samples are prepared properly when they arrive at the laboratory prior to testing. Because of the small sample size used in the following tests, it is crucial that the soil is homogeneous and uniformly moist when prepared for testing. Thus the special procedure for preparation of the soil sample before testing, as described below must be strictly followed.

2-3 kilos of soil usually arrives in (sometimes more) in a bag or container. Weigh the bag and its contents and record the weight. Pass the contents of the bag through a 6mm sieve and collect on a sheet of plastic. If there are any large pebbles that do not pass through the sieve, collect and weigh them. If they represent less than 0.5% of the total sample, they may be disregarded, even though 0% is specified. However if they represent more than 0.5% this must be reflected in the mechanical analysis figures.

If there are any lumps of soil, these should be broken up by hand and passed through the sieve – do not use force that would create dust in this process.

Mix the whole sample on the plastic sheet by lifting the sides and rolling the sample until there is a uniform mix. This is necessary because the moisture content can vary within the sample when it is taken from different parts of the stockpile. It is imperative to obtain a sample with a uniform moisture content. Do not just take a sample out of a bag and use this for the test.

Take about a 1Kg sample of this mixed material and place it into a 2 litre (approx) plastic container with a tight fitting lid. Take two samples from the plastic container to determine the moisture content of the soil in the container, and one to place on the Suction Plate. (Sections 1 and 2, Laboratory Procedures for Testing Sportsground Soil), and replace the lid immediately

Once the water content of soil in the container and the water content of the soil from the suction plate (field capacity) are determined, it is calculated how much water must be added to bring the remaining soil in the container up to field capacity. This amount is measured out in a measuring cylinder and spread carefully and slowly over the soil surface in the container. Leave the soil in the closed container to stand overnight, then gently mix it by rolling the closed container in all directions. The soil in the container is then ready to be used for the Saturated Hydraulic Conductivity and Bulk Density test (Sections 3, Laboratory Procedures for Testing Sportsground Soil).

These Laboratory procedures are extremely important and must only be carried out by Laboratories approved by the ACT Government.

Approved Laboratories

Ground Science Pty. Ltd.

Factory 11, 820 Brock Street

Thomas Town Vic 3074

Phone 03 9464 4617 Fax 03 9464 4618

Email ernie.gmehling@optusnet.com.au Website www.groundscience.com.au

Sydney Environmental & Soil Laboratory Pty. Ltd.

16 Chilvers Road

Thornleigh NSW 2120

PO Box 357 Pennant Hills NSW 1715

Phone 02 9980 6554 Fax 02 9484 2427

Email info@sesl.com.au Website www.sesl.com.au

24.5.3.5 Procuring the Sportsground Topsoil

The situation where Contractors tendering for the construction are required to source the topsoil has proved to be a major problem over the past twenty years. Typically when Contractors are tendering they approach soil yards with the soil specifications and are assured that they can supply for a particular price. Once the contract is awarded, often to the contractor with the cheapest soil, it is discovered that the soil supplier cannot supply the soil that meets the specification.

To avoid this occurring two possible approaches are;

A Separate Contract is Let for the Sportsground Topsoil

Let a separate contract to procure the sportsground topsoil, guaranteeing its quality and availability.

or,

Sportsground Soil Suppliers Nominated

The following procedures shall be used for selection of nominated suppliers:

- Call for Expressions of Interest for the supply of the sportsground topsoil using the specifications outlined above.
- The sportsground soil suppliers shall submit samples of the proposed sportsground soil to one of the two following specified laboratories (Ground Science, 56 Mercedes Drive Thomas Town Vic, Phone 03 9464 4617 Sydney Environmental and Soil Laboratory Pty Ltd. PO Box 357 Pennant Hills NSW 1715. Phone 02 9980 6554). Other laboratories may be used with written approval of Sport and Recreation Services.
- These laboratory procedures are complex and these two laboratories are the only two accredited to do the tests. This will ensure that the laboratory procedures are comparable when assessing the sportsground soil.
- The sportsground soil suppliers shall demonstrate that the sportsground topsoil offered for use in any mixture is from a large reliable deposit and there shall be at least ten samples from different parts of this deposit supplied and tested.
- Any manufactured soil shall meet all of the specifications outlined above.

If there is more than one sportsground soil supplier with sufficient sportsground soil that meets the specification, both may be nominated as potential suppliers.

Relationship Between Sportsground Soil Supplier and the Contractor.

There are two options for the supply of the sportsground topsoil to the Contractor for the facility.

Option 1 - The ACT Government Purchase the Sportsground Topsoil

To ensure that the sportsground topsoil is sourced at a value for money price the sportsground topsoil shall be purchased by the ACT Government (either Sport and Recreation Services directly or another agency on Sport and Recreation Services behalf), who will become the supplier to the Contractor at the purchase price of the sportsground topsoil (or some such arrangement that complies with the procurement rules).

Option 2 - Sportsground Topsoil is Tested and Suppliers are Nominated

The second option is for the soil supplier(s) to be nominated by Sport and Recreation Services as the only source of the sportsground topsoil and the Contractor must use the nominated supplier(s). This leaves the Contractor to negotiate a price for the sportsground topsoil with the supplier(s).

24.5.3.6 Supply of the Sportsground Topsoil to the Job

The supply of sportsground topsoil to the construction site shall be strictly monitored. These procedures shall be followed:

- The soil supplier must prepare the sportsground topsoil in $500m^3$ stockpiles;
- Each stockpile must be tested using the Australian Standard AS 1289.1.2.1 for testing a stockpile. Samples shall be taken by the Superintendent (someone other than the Contractor or the soil supplier);
- The samples shall be tested by the nominated laboratory to ensure that the sportsground topsoil conforms to the specification;
- The sportsground topsoil from that stockpile may then be delivered to the site. **Soil that has not passed the tests shall not be delivered onto the site under any circumstances;**
- Sampling of the sportsground topsoil in-situ shall also be carried out to ensure that it has met the specifications.

The process of testing and approving every $500m^3$ stockpile is essential to ensure adequate quality control. In the past this has not always been adhered to and has led to problems in the future with parts of a sportsground under performing. The Superintendent shall employ a “Clerk of Works” to supervise the delivery of sportsground topsoil to the site and its compliance with the specifications.

24.5.3.7 Playing Surface Construction

After the addition of a uniform depth of sportsground topsoil, a final grading of 1 in 70, with maximum runs of 70 metres, shall be achieved. This facilitates the speedy collection and removal of surface water during and after rain.

Design grades, off the playing surface, as steep as 1 in 50 may, with approval, be acceptable where site conditions dictate.

Surface slope shall be parallel to the subsoil slope. The sportsground topsoil layer shall be of uniform depth.

PLACING TOPSOIL

The Consultant shall specify the following elements in the construction specification which shall be in the form of Technical Exception Clauses to the Standard Specification for Urban infrastructure Works (the "Specification").

The topsoil shall be placed over a subgrade prepared as follows:

- An initially prepared surface parallel to the proposed finished surface compacted to 90% of the Modified Maximum Dry Density and free of weeds.
- Following acceptance of the compliant tolerance survey (specify grid interval and level and straightness tolerance as Technical Exception Clauses of the Specification if other than specified in Section 3 of the Specification) by the Superintendent, the surface to be ripped to a depth of between 150 to 200 mm normal to the direction of the slope and lightly harrowed to break up large clods and Gypsum (specify rate) applied.
- The irrigation to be installed in the prepared surface.

The supplied topsoil must be spread over the prepared subgrade in a manner which meets the following criteria:

- The topsoil must be of a constant depth and have an even slope meeting the tolerances nominated in the construction Technical Exception Clauses of the Specification. The Consultant shall specify the tolerances in terms of design level, thickness and straightness.
- The topsoil must meet the characteristics of the supplied topsoil at all times during placing and at the completion of placing.
- The topsoil shall be placed in two layers, the unamended soil forming the initial layer and the amended soil forming the top layer.
- The soil must be placed in a manner which avoids repetitive passing over, and thus over-compacting, soil already placed.
- The dry bulk density of the placed topsoil must be in the range of 1.45 to 1.55 t/m^3 at all times during the placing process. The topsoil MUST NOT be over-compacted at any stage during the placement process as this has the potential to alter the characteristics of the blended soil and any amendments. ALL REWORKING OF OVER-COMPACTED PLACED MATERIAL IS STRICLY PROHIBITED AND WILL NOT, UNDER ANY CIRCUMSTANCES, BE ACCEPTED BY THE SUPERINTENDENT OR TaMS SPORT AND RECREATION SERVICES. The density of the placed soils must be continually checked using a nuclear surface moisture-density gauge calibrated for the moisture content of the topsoil material being placed.
  The Consultant must specify in the construction Technical Exception Clauses of the Specification that any soils placed in compacted state exceeding the specified density tolerances will be rejected and required to be removed and replaced with a conforming soil and any incorporated amendments supplied by the Soil Supplier. The cost of removal, supply of new materials and their placement shall be specified as all being at the construction Contractor's expense.

- The construction Technical Exception Clauses must also specify the following contractual requirements to be met by the Contractor:

- Nomination of the equipment proposed to be used by the Contractor to install the topsoil to achieve the requirements of the construction Technical Exception Clauses of the Specification.
- The provision of a Method of Work statement outlining the processes to be adopted by the Contractor to achieve the required quality of the installation using the nominated equipment.
  - Quality Assurance measures to be implemented contained within a Project Management Plan (PMP).
- HOLD and WITNESS points to be used to control the quality of the placement.
- The provision of a test strip measuring 10m x 100m demonstrating in the presence of the Superintendent the use of the nominated Method of Work procedures achieves all the requirements of the Technical Exception Clauses to the Specification. The installation and Quality Assurance testing of the materials in the test strip will constitute a HOLD POINT. A satisfactory disposition of the Hold Point will be: conformance to the Technical Exception Clauses of the Specification and acceptance by the Superintendent and TaMS Sports and Recreational Services. Should the test strip meet the specification requirements it may be incorporated into the final surface, however the test strip must be identified with stakes and recorded in x and y coordinates.
- The supplied topsoil shall not be placed if the moisture content exceeds the Water Holding Capacity of the material. The Contractor must supply details within its Method of Work statement of how it plans to achieve the required density and other tolerances of the material in place with a varying range of moisture content within the material.
- The Contractor must allow adequate time in its construction program to achieve a conforming product.
- Extensions of time due to non conforming product and time to achieve a conforming product will not be granted.
- Materials contaminated by spillage of petroleum products for construction equipment will be rejected and must be replaced at the contractor’s expense
- The Principal will only supply and deliver to the site adequate material to achieve a density in place of 1.45 to 1.55 t/m^3 plus an 8% allowance (measured by volume) for construction tolerances. It will be the Contractor’s responsibility to check and verify the volume/tonnage of material supplied and advise the Superintendent of the adequacy of the material to meet its contractual obligations. The Contractor shall, as part of its PQP, nominate the methods to be used to monitor the volume/tonnage of material as it is placed.
- Insitu bulk density by nuclear surface-moisture density gauge, hydraulic conductivity and the rate of testing of the installed material are to be specified as part of the specification requirements.

Notwithstanding the requirements of the Technical Exception Clauses of the Specification, the Consultant shall assist ACT Procurement Solutions and TaMS Sports and Recreational Services in the preparation of a Procurement Plan for the project.

The Procurement Plan must include as part of the Tender Assessment Criteria the following:

- There must be a pre-tender meeting to inform the Tenderers of the specification requirements for the placing of the topsoil, the information to be supplied with the Tender to assist in the assessment of the Tender.

- The Tenderer in its Tender must be able to adequately demonstration that the requirements of the construction specification can be met.
- The Tenderer shall provide examples where the proposed construction equipment and methodologies proposed for this project have been successfully used in past projects to achieve similar results to those specified in the construction specification using similar topsoils and the nominated amendments.
- The Tenderer shall provide referees to the nominated past projects and their contact details.
- The program for the procurement of the project must consider the optimum time for the planting of the turf stolons or other turf forms.

24.5.4 "Premier" playing fields with subsurface drainage and sportsground sand

24.5.4.1 General

This construction design is to be used only when specifically requested by Sport and Recreation Services.
At all other times the specification for topsoil at 24.5.3.4 is to be used.

This method of construction uses the technology of high draining, non compacting sand growing medium over a gravel layer with sub-soil drains. This structure, although expensive to construct, allows the surface to drain at a rate in excess of 100mm per hour, whilst still allowing excellent grass growth.

The construction of these types of playing fields shall be carried out to a very high degree of engineering expertise, as each layer shall have a tolerance of about 5mm. These very high standards of design, sportsground sand and gravel selection and construction precision shall be followed. Deviation from the prescribed standard will not achieve the desired sportsground surface. Under no circumstances shall there be compromises made on the quality of the sportsground sand. If the sportsground sand is too fine the drainage rate is drastically reduced and if it is too coarse, the top loses traction and becomes droughty in the summer. There is no compromise between this design and a conventional soil profile – it is either one or the other.

"Premier" playing fields with subsurface drainage and sportsground sand can be used when other grounds with conventional soil profiles would be unplayable in wet conditions.

24.5.4.2 Subgrade

Premier grounds are designed on a shaped impervious subgrade into which a system of subsoil drains is located. Examples of the range of impervious subgrade patterns include -

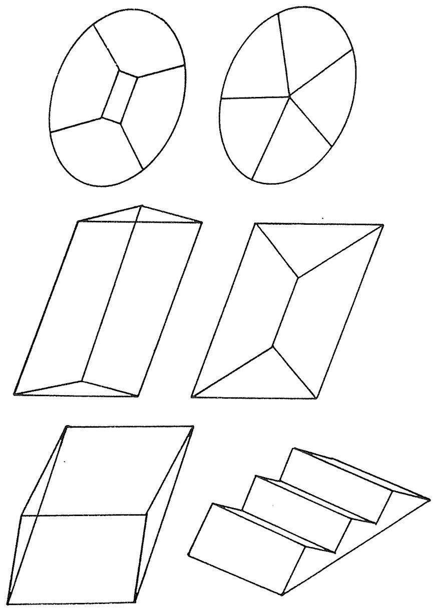


Figure 24.8 Impervious Subgrade Patterns

The subgrade shall be compacted to form an impermeable base, with subsoil drains located in trenches cut a minimum of 200mmm deep and 200-300mmm wide, depending on the pipe size in the trench. The pipes shall be surrounded on all sides by a minimum of 50mm of 3-5mm gravel. The overall slope of the subgrade shall be 1 in 100. There shall be a minimum slope on all pipes of 1:100.

The figure below illustrates in section the relationship between subgrade, subsoil drains, gravel drainage layer and the sportsground sand.

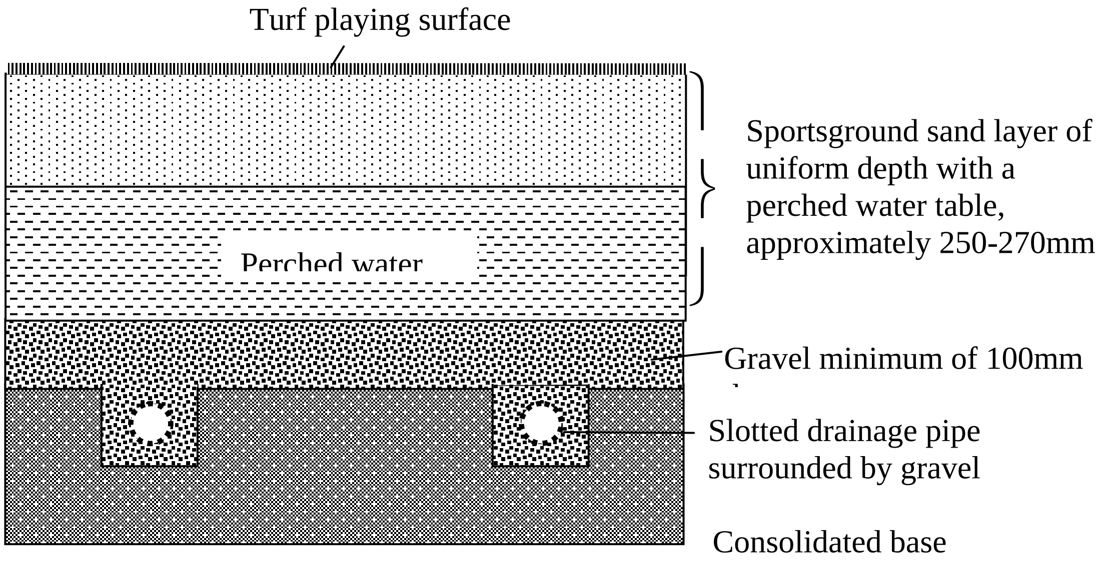


Figure 24.9 "Premier" Playing Field Section

24.5.4.3 Subsoil Drainage

Positive subsoil drainage is achieved through highly permeable sportsground sand with water being delivered to subsoil drainage pipes via a gravel drainage layer laid on an impermeable subgrade. The water is moved from the field by a system of lateral subsoil drainage pipes located at a maximum 7 metre spacing to stormwater sumps located at least 5 metres beyond the sportsground.

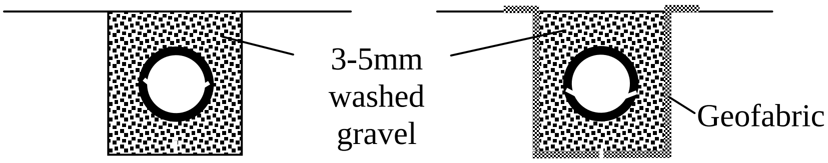
The subsoil drainage pipe shall be 100mm diameter corrugated high-density polythene tubing as specified in Clause 3.06.1 of the Standard Specification for Urban Infrastructure Works, 2002. The subsoil drainage pipe shall be laid on minimum 50mm of washed 3-5mm gravel.

The configuration of the subsoil drainage pipes is usually best served by a herringbone design, with laterals spaced no further apart than 7metres. The lateral subsoil drainage pipes shall be minimum 100mm diameter corrugated drainage pipe, (smooth slotted drainage pipe can be used, but this is more expensive). To accommodate a rainfall event of 100mm/hour, no 100mm corrugated drainage pipe lateral shall be longer than 37 metres.

The collector pipes into which the laterals feed shall be solvent welded uPVC stormwater drainage pipe. Cross-sectional diameter sizes of these collector pipes shall be designed to accept water at the rate of 100mm per hour, down stream pipe diameter shall increase as more laterals feed into them. It should be noted that one hectare of surface generates 1,000,000 litres (10,000m^2 x 100mm) of water per hour.

There shall be no socks on the drainage pipes, and no geofabric covering the pipes.

Geofabric can be used on the bottom and the sides of the trench.



A drainage layer of 3-5mm diameter sharp, washed gravel shall be placed between the subgrade and the sportsground sand. The depth of the gravel can vary, but shall have a minimum depth of 100mm. The top of the gravel layer shall be parallel to the finished surface.

24.5.4.4 Sportsground Sand

The "Premier" playing field growing medium shall be highly permeable uniform sand with only small amounts of fines (sportsground sand).

The top layer shall be a uniform depth of sportsground sand. The actual depth must be calculated from the moisture release curve of the sportsground sand and the suction of the gravel. Experience has shown that this will be between 250-270mm. It is therefore essential to determine which sportsground sand and gravel are to be used for the project before final levels are determined for the top of the profile. This depth will determine the volume of sportsground sand to be used.

Peat moss or coco peat shall be added to the top 100mm of the sportsground sand to increase the water holding capacity to approximately 15% at the surface as determined by the moisture release curve. The amount of peat moss or coco peat shall be determined by the laboratory test results.

The peat moss or coco peat amendment must be thoroughly mixed through the sportsground sand off site, and added as a separate layer to the top of the profile.

24.5.4.5 Sportsground Sand Selection Criteria

It should be noted that these specifications follow the USGA specifications, but are much tighter in what they allow. The depth of the sportsground sand layer shall be determined by first selecting the sand, matching it with an appropriate gravel (as per the USGA), then testing its suction.

Sportsground Sand Specification and Supply

The sportsground sand used shall be selected using the following specifications:

Mechanical analysis

The following wet sieve mechanical analysis shall be used to select the sportsground sand but this is the least important of all the selection criteria. If the material supplied is slightly outside these very tight parameters but meet all of the other criteria, there may be a case to accept the material based on cost and availability, dependent on expert advice.

Accepting a material outside this specification shall not be done lightly.

USDA Sieves	% Retained by weight	
> 2.00mm	0	
1.0-2.0mm	0-10	
0.5-1.0mm	0-20	
0.25-0.5	55-90 *	
0.1-0.25mm	< 20	Maximum combined proportion of these fractions shall not exceed 25%
< 0.1mm	0-10	
<0.002mm (clay)	0-4	

* If sportsground sand has more than 90% in this range it shall have proven stability.

Compacted hydraulic conductivity

Compacted hydraulic conductivity at 16 drops shall exceed 700mm per hr

Bulk density

Bulk density at 16 drops shall not exceed 1.58

Acid soluble material

There shall be less than 5% of any material that will be dissolved in hydrochloric acid.

24.5.4.6 Moisture Release Curve of the Sportsground Sand

A Moisture Release Curve shall be made for the selected sportsground sand using the method developed by Dr Bent Jakobsen Chapter 19 McIntyre and Jakobsen (1998). This curve shall indicate the air entry point, the depth of the perched water table and the air filled porosity of the sand as well as the moisture content at the top of the profile.

24.5.4.7 Contract Specification for the Sportsground Sand

Once the sportsground sand has been selected based on the above selection criteria, the actual mechanical analysis, hydraulic conductivity and bulk density of this sportsground sand shall then become the contract specification with the following allowances:

- The sportsground sand shall not differ from the selected and approved sample by more than 5% in the 0.25-0.5mm range; the value for the 0.105-0.25 range shall always be equal to, or lower than, the selected sample and the value for the 0.5-1mm range shall not rise by more than 3%, but may fall below that of the sportsground sand selected.
- The compacted hydraulic conductivity of the sportsground sand at 16 drops shall always exceed 700mm/hr.
- The bulk density of the sportsground sand shall not exceed 1.58 at 16 drops.

Stockpiling and testing of the stockpiles before delivery

The sportsground sand shall be stockpiled before delivery in stockpiles of 500 cubic metres. Each of these stockpiles shall be tested by an independent laboratory, using the sampling techniques set out in AS 1289.1.2.1, 1998.

All mechanical analyses shall be carried out using wet sieve analysis and all other tests shall use the methodology set out in the Chapter 19 McIntyre and Jakobsen (1998).

The sportsground sand shall meet the contract specification as outlined above.

24.5.4.8 Gravel

The gravel used for the drainage layer and to surround the sub-soil drainage pipes shall be a sharp washed crushed rock.

24.5.4.9 Gravel Selection Criteria

USGA Bridging and Uniformity Factors

The gravel shall be selected **after** the sportsground sand has been selected, as it shall have a relationship to this sportsground sand. The gravel shall meet the USGA Bridging and Uniformity Factors, which are:

Bridging Factor $D_{15\ (gravel)} \leq 5 \times D_{85\ (sand)}$

Uniformity Factor $D_{90\ (gravel)} / D_{15\ (gravel)} \leq 2.5$

Mechanical Analysis

The following specification shall be used as a guide to select gravel that could meet the above criteria

Recommended gravel specification

Aust Standard Sieve Sizes in mm	% Passing by weight
9.5	100
6.7	75-100
4.75	20-55
2.36	0-15
1.18	0-5
0.6	0-2
0.3	0-2
0.15	0-2
0.075	0-2

The gravel must be washed.

Stockpiling and testing of the stockpiles before delivery

The gravel shall be stockpiled before delivery in stockpiles of 500 cubic metres. Each of these stockpiles shall be tested by an independent laboratory using the sampling techniques set out in AS 1141.3.1, 1996.

24.5.4.10 Determination of the Capillary Suction of the Gravel

Once suitable compatible gravel has been selected, its capillary suction shall be determined. The methodology to be used is that developed by Dr Bent Jakobsen in Chapter 19 McIntyre and Jakobsen (1998). This data is to be used in conjunction with the moisture release curve of the sand, and shall determine the depth of the profile.

24.5.4.11 Determination of the Depth of the Profile

The depth of the profile shall be determined by using the data from the sportsground sand moisture release curve, together with the capillary suction of the gravel. The value for the suction of the gravel (in mm) shall be subtracted from the depth of the perched water table and there shall be approximately 100mm of root zone available above the top of this new, perched water table. The soil moisture content at the top of the sportsground sand profile shall be close to 15% and if this does not occur there shall be a need to add peat moss or some other approved organic amendment to the top 100mm of the sportsground sand profile to ensure a manageable soil moisture content for the root zone in the first year.

These calculations shall determine the depth of the sportsground sand layer.

Organic amendments

As stated above, there is usually a need to add an organic amendment to the top 100mm of the profile for most sportsground sands to increase the water holding capacity in the top of the profile to about 15% at equilibrium, to make the top of the profile manageable. This amendment does not impede drainage.

The amount of peat moss or other approved organic amendment required shall be determined by the shape of the moisture release curve and by the moisture content of the sportsground sand at the top of the profile.

The total amount of peat moss used shall not exceed 1.5% organic matter by weight, and shall only be incorporated into the top 100mm of the profile.

Type of organic amendment

A high-grade sphagnum peatmoss or coco peat shall be used. Chicken manure is not an acceptable equivalent. This material shall have dissolved salts less than 10ppm.

The total organic matter content, determined by loss following ignition at 700^0C for four hours, shall exceed 95%.

pH Adjustment

When the sphagnum peatmoss or other organic amendment is added to the top 100mm of the profile the pH of this mixture shall be adjusted by the use of agricultural lime so as to achieve a pH for the mixture in the range of 6.3-6.8.

24.5.5 Stormwater Drainage adjacent to the Sportsground

The minimum slope required to remove water from the sportsground is 1 in 70 with a maximum run of 70 metres. Beyond the 5-metre edge to the sportsground, the slope may increase to 1 in 50 and the distance to a floodway or sump shall not exceed 50 metres.

In many situations, and particularly where the sportsground abuts a cut batter, a piped stormwater system that utilises grated sumps would normally be required in order to achieve the 1 in 50 / 50 metre run criteria.

The top of the sump shall be set to ensure that with settlement of the topsoil, fall to the sump is maintained.

A typical longitudinal section through a swale is illustrated below.

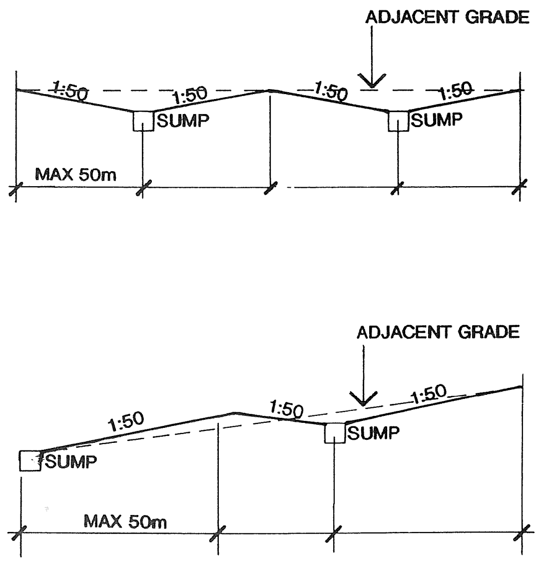


Figure 24.10 Swale Sections

24.5.5.1 Mowable Drains

When water is to be collected around the perimeter of a field or in other cut-off situations, and this water is collected in grated sumps the cross section of the drains must be such that they are easily mown with large mowing machinery.

24.5.5.2 Mowable Drains and Swales.

Mowable drains or swales are cheap, effective and easy to maintain. They are essentially surface drains that collect water and transfer it to underground pipes, usually through grated sumps, then to other stormwater systems, dams or creeks.

The grass cover in the bottom of the mowable drain is usually the same as the surrounding surface and is mown with the same mowing equipment. A swale shall be constructed so that it can be mown by the large mowers that mow the adjacent surface. Changes of grade shall be designed to the requirements of specified mowing equipment. Mowing scalping shall be rectified by regrading and regrassing. Short run or steeper swales or swales that require a different mowing regime, technique or machinery shall be avoided.

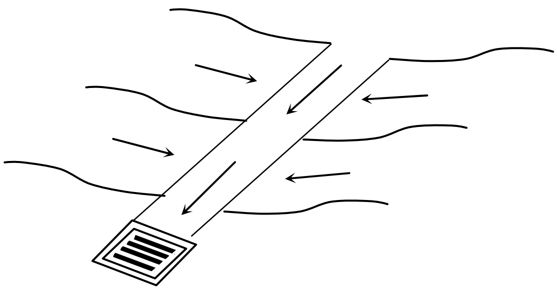


Figure 24.11 A typical mowable swale with water running into a grated sump.

Typical locations for mowable drains and swales for playing fields are around the perimeter of and in between sportsgrounds. These drains should be placed on the edges of playing fields, at changes of levels, and other locations to prevent surface water from flowing onto areas where it is not wanted.

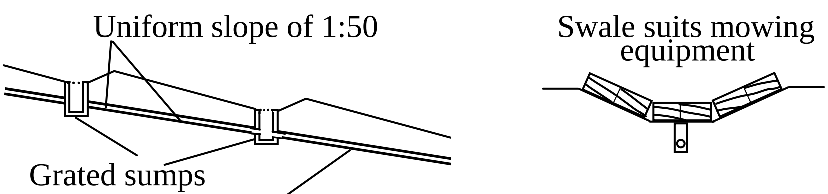


Figure. 24.12 Longitudinal section through a mowable drain, and a cross section showing how the swale should suit the mowing equipment.

The base of the mowable drains and swales **shall** have a uniform slope that ideally should be a minimum of 1:50. This is essential to allow the rapid removal of surface water. If there are even small depressions in the bottom of the swale water will lie there, machines will bog or cause indentations, grass will grow long, rubbish will accumulate and it will become un-maintainable and unserviceable. The length of the slopes running into the grated sumps shall not be more than 20m, otherwise the tops of the sumps will become too far below the surrounding area. Sumps may be spaced about 40m apart if the slope goes towards them in both directions.

An open concrete invert, about 400-600mm wide placed in the middle of a mowable drain works well and ensures an even slope on the bottom of the drain which in turn ensures the rapid delivery of water to sumps. It also gives those constructing it a reference line from which to grade the sides of the swale evenly.

A concrete drain does not suit all locations but where it can be used it is preferable to a grassed swale.

The water collected in these mowable drains (swales) shall be disposed of through sumps to solid stormwater pipes to an existing stormwater outlet.

24.5.6 Stormwater Approvals

For the purposes of Design Acceptance approvals, playing field stormwater drainage shall be treated in the same way as stormwater systems within private leases. Sport and Recreation Services shall be responsible for the ongoing maintenance of the system both above and below ground. Maintenance may be undertaken either by ACTEWAGL or a private contractor.

Department of Urban Services Asset Acceptance will accept Design Acceptance submissions for approval.

Design Standard for Urban Infrastructure 01 Stormwater shall apply to stormwater design.

Grated Sumps shall be used as the inlet structure for playing fields. Refer Design Standard for Urban Infrastructure 01 Stormwater Standard Drawing ST-0013 for details.

The stormwater system shall be designed to accommodate a discharge rate of 50mm/hr over the sportsground.

The stormwater system shall protect adjoining leases from overland flow from playing fields. Playing field designs shall incorporate overland flow paths that provide 1 in 100 AEP protection to adjoining leases in the event of a blockage to the grated sumps or stormwater system pipes.

24.5.7 Irrigation

All new playing fields in Canberra shall include fully automatic irrigation systems. The requirements for design and operation of irrigation systems shall comply with Design Standard for Urban Infrastructure 21 Irrigation.

The following points shall be addressed in the irrigation design,

- No irrigation mains shall cross a sportsground.
- Sportsground irrigation stations shall run from perimeter ring mains.
- Sprinkler stations shall be aligned with the direction of play.
- A sprinkler station shall be configured for the heaviest wear area at the centre of the sportsground.
- All valves shall be located not less than 5m from the marked extent of sportsgrounds.
- A Computer Irrigation Management System (COMTROL) shall be installed.

Where a turf wicket occurs on a playing field, the wicket table shall be free of sprinkler heads and other underground service lines. The wicket table shall be watered on a separate station controlled by a separate irrigation controller to allow the curator of the wicket to water separately to the remainder of the sports field. Quick coupling valves shall be provided to allow hand watering in addition to the automatic sprinklers.

24.5.8 Turf –Grass Species

Turf Species-grass mixtures to be used.

The grass mixture species and ratios for all enclosed ovals and district playing fields turf shall be as follows.

Grass Species	Percentage by weight
Kentucky Blue Grass	24%
(approved cultivar)	
Fine Leaf Perennial Ryegrass	76%
(approved cultivar)	

The grass mixture species and ratios for neighbourhood oval turf shall be as follows.

Grass Species	Percentage by weight
Kentucky Blue Grass	24%
(approved cultivar)	
Tall Fescue	76%
(approved cultivar)	

* The above tables are to demonstrate the required turf types. Seeding is not to be used for establishment of all new sportgrounds (including CRIP’s) with turfing using maxi-rolls to be the method of establishment.

Couch grass may be specified with Legend and Conquest cultivars being the preferred varieties. Other varieties need to be approved by Sport and Recreation Services.

No variation from these turf blends shall be permitted without written approval from Sport and Recreation Services. Sport and Recreation Services shall provide details of the approved cultivars in the Brief or Deed Agreement documentation.

Mowing during Consolidation shall maintain the grass height at 38 to 40mm for cools season turf blends and 25mm or shorter for couch cultivars. Grass shall be mown to reflect a “field in full usage”. Mowing frequency shall be twice a week during the October to March growing season and once a week at other times of the year.

24.5.9 Landscaping

Tree planting shall be arranged to provide shelter and shade. Tree planting between the car park area and the sports field shall be designed to allow an uninterrupted view of the sports field from the car park. Tree planting shall provide summer shade for cars.

Limited bench seats shall be provided for spectators on the exterior of pavilions at district playing fields. Consideration shall be given to a limited number of bench seats strategically located around the playing fields. Seating provision details shall be determined with Sport and Recreation Services during the design development. At neighbourhood ovals the provision of some limited seating for spectators shall be determined in conjunction with Sport and Recreation Services. The incorporation of playground equipment and barbecue facilities with appropriate seating near the pavilion site shall be considered for district playing fields. Provision shall be as specified in Brief or Deed Agreement documentation.

Pavilions and viewing areas shall be sited on the western side of the playing field to avoid spectators looking into the afternoon sun.

No evergreen tree shall be planted within 20 metres of the northern edge of the sports field. This is to prevent the potential problems of winter shading effects and moisture retention after rain on the performance of the grass within the sports field. Trees that sucker or have aggressive rooting habits shall not be planted closer than 40 metres from the sports field.

Trees, seating and other landscape elements shall be located no closer than 5m to allow for unimpeded access for maintenance and mowing equipment. Landscape elements that require spatial layout of less than 5m (e.g. bins, BBQ, tables etc) shall be connected with non-mowable ground surfacing (e.g. granite gravel or hard paving).

24.5.10 Cricket Wickets

The provision of cricket facilities shall be determined by Sport and Recreation Services and outlined in the Brief or Deed Agreement documentation for each playing field.

24.5.10.1 Concrete Wickets

The standard concrete cricket wicket detail is illustrated at Figure 24.13

24.5.10.2 Turf Wickets

The design for turf cricket wickets shall conform to the methodology and standards outlined in *Cricket Wickets – Science v Fiction,* McIntyre and McIntyre (2001).

Number of Wickets

The wicket table to be installed into most sportsgrounds shall be for four or five wickets, or as agreed with Sport and Recreation Services and shall be included in the Brief or Deed Documents.

Location of Wicket Table

The wicket table shall be located as close to the centre of the playing field in relation to the east/west and north/south axies of the field as possible.

Concrete cricket wicket

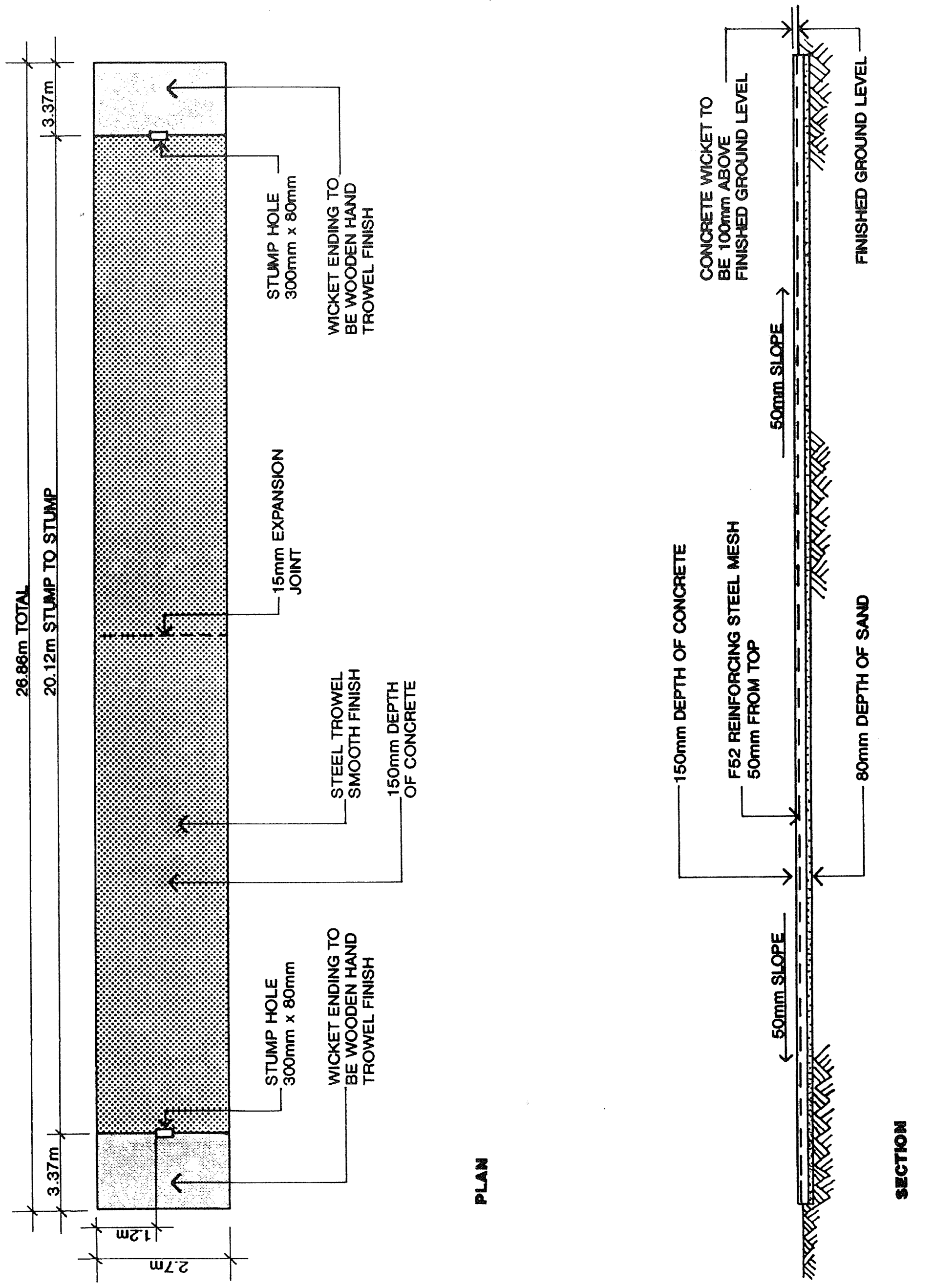


Figure 24.13 Standard Concrete Cricket Wicket Detail

Dimensions and Surface Slopes of Wicket Table

The wicket table shall be of the following dimensions,

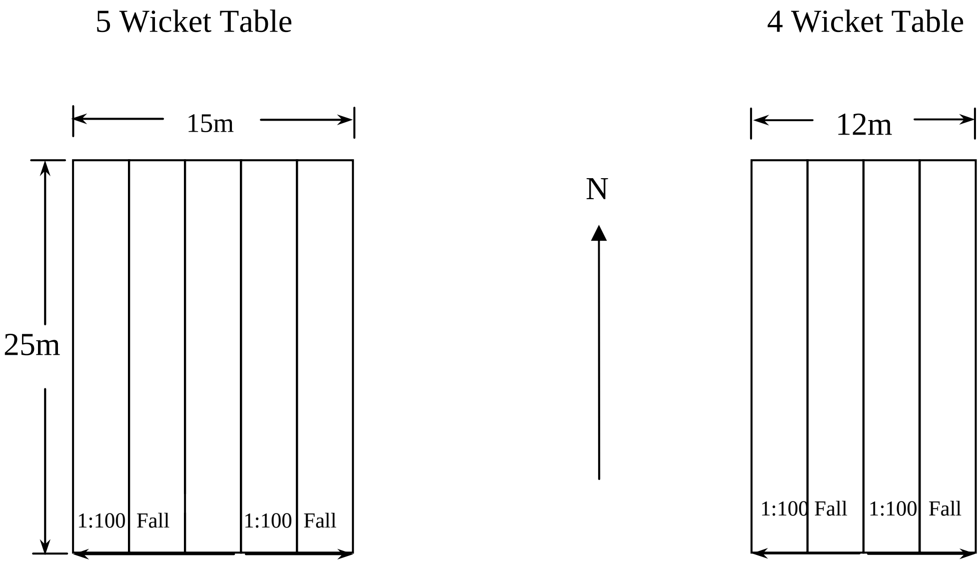


Figure 24.14 The wicket table will consist of either four or five x 3m wide wickets running in a north/south direction.

There shall be a fall from the centre to the outside of the table of 1:100. There shall be a fall across the wicket table from the centre to the outside of 1:100 on the four wicket table and from across three and two wickets respectively on the five wicket table. There is no fall on the wickets in a north/south direction.

Drain to link with swale drain or stormwater pipe

Install a 150mm solvent welded uPVC stormwater drainage pipe from the middle of the of the wicket table to be linked into a swale or stormwater drainage pipe on the edge of the playing field.

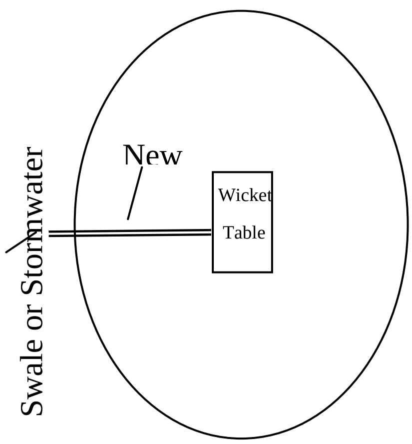


Figure 24.15 Shows a drain that shall run from the centre of the wicket table, connecting into a swale or stormwater pipe

The drain shall be in a straight line from the wicket to the perimeter of the playing field. The trench shall have the following profile:

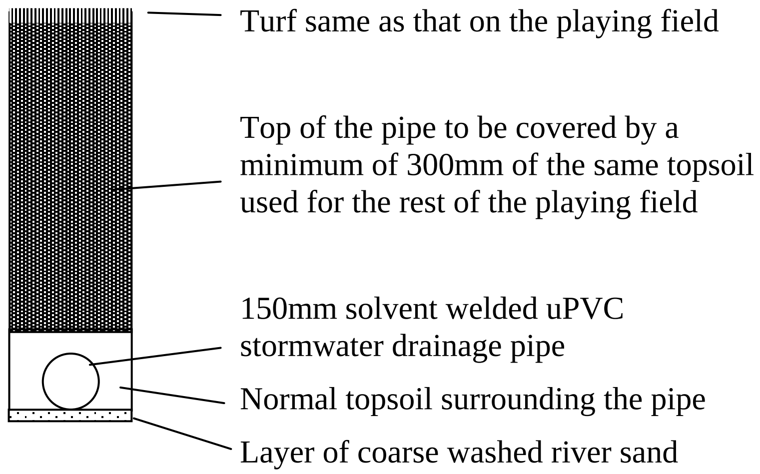


Figure 24.16 Cross section of the drain that runs from the wicket table to the swale or stormwater pipe on the edge of the playing field.

The drain shall be a minimum of 450mm deep and shall have a layer of coarse washed river sand in the base to ensure that the bottom of the trench is smooth and with an even grade. A 150mm smooth stormwater drainage pipe shall be used and this shall be covered with topsoil the same as that used on the rest of the playing field. The pipe should have a uniform minimum fall of 1:100 from the wicket.

The completed trench shall be turfed with a turf of the same grass mixture to the rest of the playing field, or sown with the same grass mixture.

Sump at Eastern/Western Side of the Wicket Table

A sump with an artificial turf cover shall be constructed about one metre to the east of the centre of the eastern side of the wicket table so the wicket manager can discharge excess water from the covers into this sump.

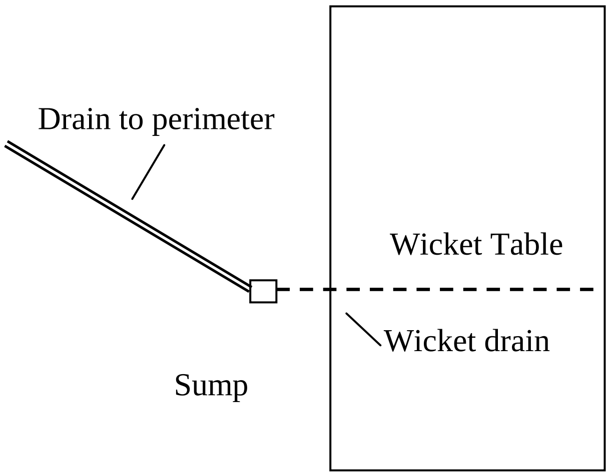


Figure 24.17 Sump to be located on the side of the wicket table to connect the wicket drainage to the stormwater pipe.

The sump will collect all of the water from under the wicket and discharge it into the drainage pipe that runs to the perimeter of the oval.

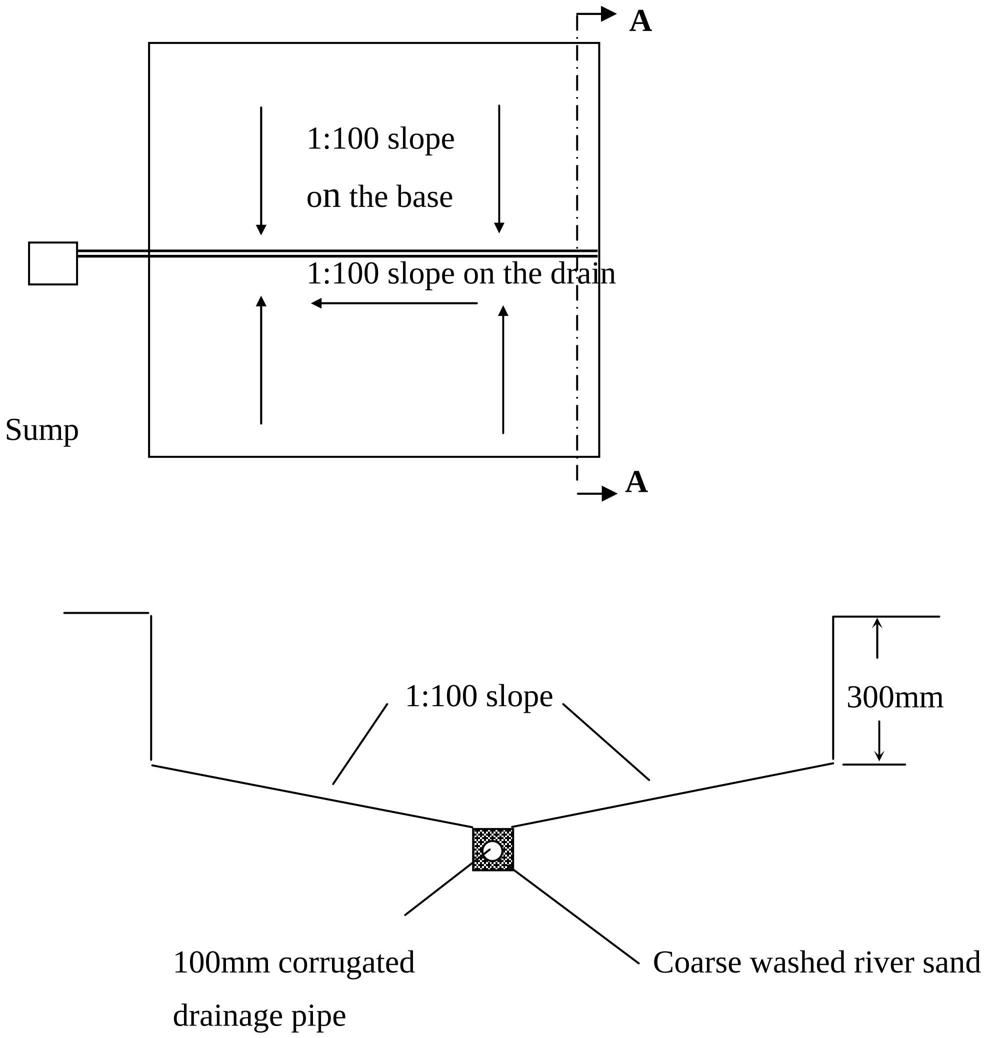
The sump lid will be covered by 150mm of topsoil. This is to prevent damage to turf maintenance equipment in the future.

Base and Sub-surface Drain

The base shall slope from the northern and southern ends of the wicket table to the centre where a 100mm diameter sub-soil drain shall be cut into the base. The base shall be consolidated to ensure a firm base for the wicket and there shall be no wet spots. If a wet spot occurs it shall be dug out, dry material placed in the hole, re-compacted and covered with geofabric before the sand layer is placed.

Great care must be taken during the excavation of the wicket hole to ensure that no sub-soil is spread over the existing ground surface. If the wicket is being built after the oval has been completed and grassed then boards from the perimeter to the wicket shall be used for any trucks and machines to drive on. Only small trucks shall be used to take soil off the site and to bring the sand and wicket soil onto the field. No materials shall be stockpiled on the playing surface. Great care shall be taken not to contaminate the drainage sand or the wicket soil with other materials.

A sub-soil drain is to be cut into the centre of the base in an east west direction. The drainpipe shall be a 100mm corrugated pipe with a fall of 1:100. The pipe shall be surrounded by a minimum of 50mm of clean coarse washed river sand.



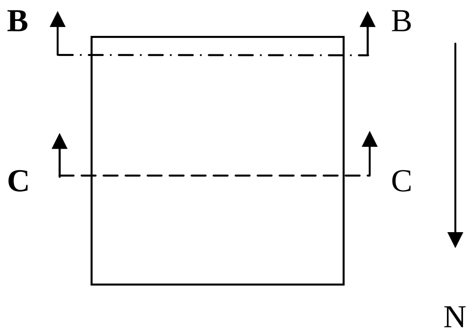
Section AA

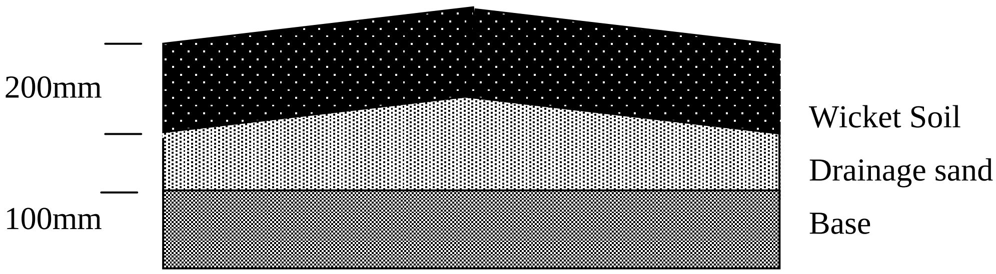
Figure 24.18 Shows the location of the central drain, and the slope on the base of 1:100 to the centre. Section AA shows the depth of the excavation and the base.

The coarse washed river sand that surrounds the corrugated drainage pipe shall meet the following specifications.

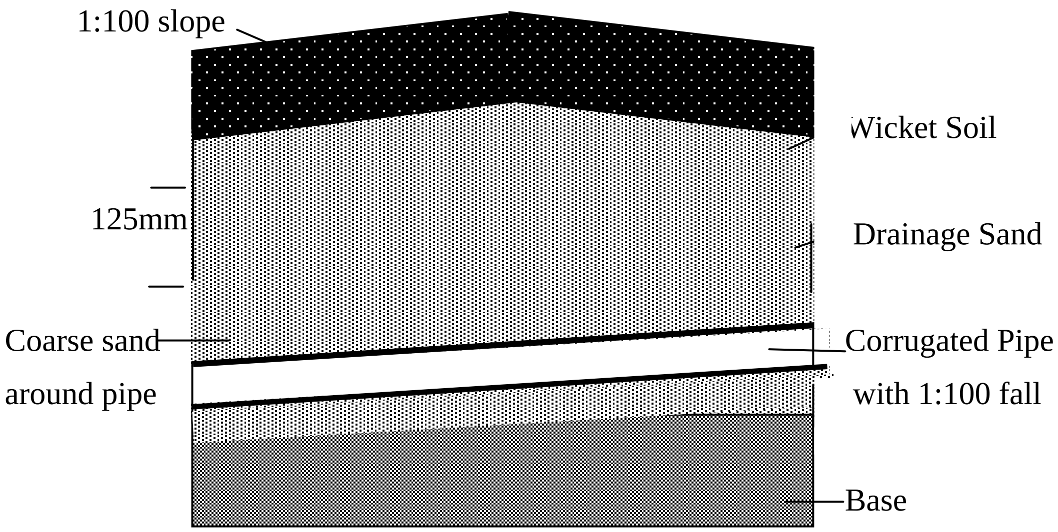
USDA Sieves	% Retained by weight
2.8-4.0mm	0-20
2.0-2.8mm	0-20
0.5-2.0mm	55-100
0.1-0.5mm	0-10
<0.1mm	0

Wicket Profile





Section BB



Section CC

Figure 24.19 Shows the cross sections through the profile at the southern end of the table and through the centre drain.

Sand Drainage Layer

There shall be a sand drainage layer of a minimum of 100mm in depth placed over the base. The surface of the sand shall be parallel to the finished surface of the wicket.

The sand in the drainage layer shall meet the following specifications:

USDA Sieves	% Retained by weight
> 2.00mm	0
1.0-2.0mm	0-10
0.25-1.0mm	70-90
0.1-0.25mm	< 20
< 0.1mm	0-10
<0.002mm(clay)	0-4

The sand shall be clean and have only very low amounts of silt and clay. It should have a significant majority of its particles between 0.25 and 1.0mm, preferably with most in the 0.25-0.5mm range.

Cricket Wicket Soil

There shall be a uniform 200mm layer of wicket soil placed above the sand drainage layer in at least two layers.

There shall be a 1:100 slope on the surface of the wicket soil sloping from the centre to the outside of the table as shown in Figure 24.19.

The wicket soil shall have the following characteristics. The clay content shall be between 50% and 70% to provide a sufficiently hard pitch. A higher clay content may cause excessive cracking or cracks that are too wide. There shall be less than 10% of coarse sand as it can cause ball damage if present in excess.

The crushing strength of the soil should be between 0.8 and 1.6MPa, and the clay must have enough cohesion to withstand ball impact hundreds of times. A clay with a low crushing strength may turn into dust after lengthy periods of continued impact.

Organic matter improves structural stability and hydraulic conductivity however any more than 5% will produce a soft pitch and poor ball bounce.

Cracking is essential for good grass growth, however if cracks become too wide ball bounce becomes erratic and if cracks are too far apart grass growth will be poor or uneven. The cracking is measured on 100mm diameter petri dishes. Upon drying the soil should break into pieces, two to five pieces per dish is preferable. Excessive cracking will produce a crumbly wicket.

Shrinkage from field capacity to air dry measured on small prepared cores shall be no more than 15% (0.15), preferably 10% (0.10). If the shrinkage is within this range the soil will crack properly and will also have good strength and cohesion.

Wicket Soil Specifications

The wicket soil shall meet the following specifications when tested in the laboratory using the testing methodology outlined in Chapter 14 of McIntyre and McIntyre (2001).

Mechanical Analysis

Mechanical analysis shall be carried out using wet sieve analysis and the clay content measured using a hydrometer.

Specification for particle size distribution for a cracking clay soil suitable for cricket wickets.

Fraction	Particle sizes	% by Weight
Clay	< 0.002mm	50-70
Silt	0.002-0.02mm	5-20
Fine Sand	0.02-0.25mm	10-30
Medium Sand	0.25-1.0mm	0-10
Coarse Sand	1.0-2.0mm	1-2

Shrinkage	0.08 - 0.15
Crushing Strength	0.8 - 1.6 MPa
Cracking	2 - 14 pieces
pH	6.0 - 7.5 in H_2O or 5.0 - 6.5 in $CaCl_2$
Total Dissolved Salts	<200ppm
Organic Matter	<5%

The above specifications shall be met by having the soil tested in either of the following laboratories that have the appropriate equipment and proven ability to carry out these tests. Other laboratories may be considered for the conduct of these tests with the written approval of Sport and Recreation Services.

Ground Science, 56 Mercedes Drive Thomas Town Vic, Phone 03 9464 4617

Sydney Environmental and Soil Laboratory Pty Ltd. PO Box 357 Pennant Hills NSW 1715. Phone 02 9980 6554

Cricket Wicket Order of Construction

Construction of Sump

The construction of the sump on the side of the wicket and the installation of the drain to the perimeter sump shall be completed first.

Excavation for the wicket

The hole shall be excavated and the sub-soil drain installed and connected to the sump as quickly as possible to guard against the possibility of damage by rain.

Sand Drainage Layer

The sand drainage layer shall be installed as quickly as possible to ensure that the hole does not fill up with water if there is rain. Care shall be taken that the final levels of the sand layer are parallel to the proposed final surface levels.

Placement of the Wicket Soil

The wicket soil shall be placed carefully so as to ensure the integrity of the sand layer. The wicket soil shall be placed in at least two layers using dry soil that has been crushed to 10-15mm diameter pieces. Each layer shall be lightly compacted. The use of a small tracked machine such as a Bobcat shall be used for this purpose.

Completion of Wicket Surface

The final levels shall be obtained using a laser level and the soil lightly compacted as dry material using the tracks of the Bobcat. The final levels of the finished surface shall be between 30-40mm above the final levels, to allow for levels to settle once rolling commences

Under no circumstances shall the wicket be rolled at this stage.

Consolidation and Turfing

The finished wicket shall be thoroughly watered and allowed to stand for about one month to allow for natural consolidation.

The wicket shall be allowed to dry out then final levels checked and any depressions top dressed out with wicket soil.

The surface shall be lightly watered prior to the laying of the turf. Washed Legend (or other approved cultivar) Couch turf shall then be carefully laid making sure that there are no footmarks left on the surface. Once the turf is laid, the whole wicket shall be thoroughly watered using the irrigation system

The surface of the turf shall be kept moist to ensure that it does not dry out. As the turf produces roots, the frequency of watering shall be reduced to allow for deep rooting to occur.

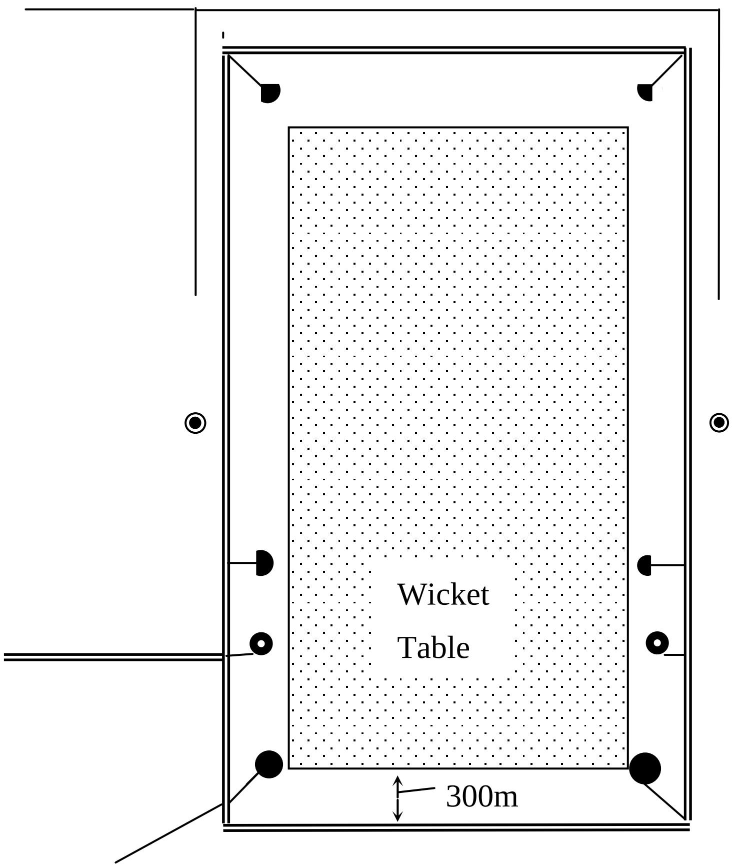
Once the roots have developed to at least 150mm depth, **and only then**, shall the wicket be rolled. The first rolling shall be with a light roller so as to allow mowing equipment to be used without causing depressions in the surface of the wicket.

A heavy roller shall not be used until the wicket is being prepared for use. At this point it shall be necessary to top dress out small depressions with fine wicket soil.

Installation of Wicket Irrigation

After the wicket is complete the perimeter irrigation shall be installed. Care shall be taken for the wicket ring-main to be installed far enough away from the edge of the wicket so as not to jeopardise the integrity of the edge of the wicket table. This trench shall be 300-400mm out from the finished wicket table.

Irrigation Layout



50mm ring main

Legend

Quarter circle gear driven sprinkler

Half circle gear driven sprinkler

Sprinklers shall have a 15m throw for a five wicket table, and a 13metre throw for a four wicket table

QCV with valve under head

QCV on a live line

Figure 24.20 Wicket Irrigation Layout

The layout is basically the same for a four or five wicket table, the only difference being the nozzle size.

Ring Main

The wicket shall be watered from a 50mm ring main that is connected to the playing field irrigation system. This main shall be about 300mm from the edge of the wicket table to ensure that the trench for the pipe does not affect the edge of the wicket.

Care shall be taken, with the installation of this main, not to interfere with the drainage of the wicket.

Sprinklers

The sprinklers shall be gear driven with stainless steel turrets and rubber caps. These sprinklers shall throw 13m at 344kpa on a four-wicket table and 15m on a five-wicket table.

The contractor shall supply a full circle Hunter I21 sprinkler on an stand to a design approved by Sport and Recreation Services which shall be attached to a 25mm hose with a bayonet fitting to connect to a quick coupling valve.

Quick Coupling Valves (QCVs) with Valves under the Head

There shall be two QCVs installed with valves under head, one on either side of the wicket table. These QCVs shall be capable of taking a bayonet to supply a 25mm hose and shall operate at 344kpa.

QCVs on a Live Line

There shall be two QCVs (similar to above) without valves under the head, one on either side of the wicket table. These QCVs shall be 'live' and served by a dedicated line from a point in the metre pit before the master valve to enable the wicket to be watered if the rest of the irrigation for the field has been turned off.

Wiring

Each sprinkler and QCV with valve under head shall be separately wired back to a dedicated 12-station controller. Each sprinkler and QCV shall be able to be operated independently.

Controller and Location of Controller

The controller shall be a 12 station electronic controller and the type is to be approved by Sport and Recreation Services.

The locked controller box shall be located in a position where the cricket wicket users can have access without being able to have access to the irrigation for the rest of the field. Sport and Recreation Services shall determine the location of this controller.

24.5.11 Pavilions

Where pavilions are required by the Brief or Deed Agreement documentation the following points shall be addressed in the design,

- The siting of the pavilion shall consider shelter from the wind and sun and shall be co-located with the car park. Pavilions shall have a good address to the sportsgrounds, preferably mid way along the sideline and perpendicular to the centre line of the sportsground. The front of the pavilion shall be not less than 20 metres from the sportsground edge.
- A 4 metre wide paved vehicle access strip shall be provided around the perimeter of the pavilion and shall link to the car park.
- Provision shall be made for the storage of goal posts and other large equipment during non-use periods. Equipment storage in a fenced compound or in lockable racks adjacent to the pavilion shall be considered.

- Where space allows, it is preferable to use excess fill to construct viewing banks rather than elevate the sportsground. Slopes of viewing banks shall be no steeper than 1 in 6 and the bank shall tie in with the existing landform to create a unified and pleasing landscape effect. Long straight lengths of mounding that are out of scale with the surrounding landscape are not acceptable. The effect of mounding on the views of adjacent leases shall be considered.
- The inclusion of a canteen shall be considered. Canteen location shall provide a good view of sportsgrounds.

24.5.12 Car parks

Where car parks are required by the Brief or Deed Agreement documentation the following points shall be addressed in the design,

- The layout and physical geometry of a car park shall be designed in accordance with AS 2890.
- The number of car park spaces provided shall be in accordance with the ACT Parking and Vehicular Access Guidelines unless stipulated otherwise.
- The car park layout shall be designed to be sympathetic to the landform and surrounding landscape.
- Off street car parking shall be provided at the rate of not less than 20 car parks for neighbourhood playing fields and not less than 60 car parks for each 2 BSU equivalent for district playing fields.
- Off street car parking for Enclosed Ovals shall be provided in accordance with the ACT Parking and Vehicular Access Guidelines.
- The provision for car parking shall allow for the use of shared facilities (e.g. schools) in close proximity to the playing field.
- Car parking facilities shall be elevated above the sportsground. This provides the opportunity to view the sportsground from within the car.
- Bollards shall be used around car parks and vehicular access to prevent unauthorised vehicle access. Bollards shall be designed with non-maintainable surfaces adjacent (e.g. granite gravel, concrete, asphalt).
- Fencing, bollards and gates provision shall be determined by Sport and Recreation Services and included in Brief or Deed Agreement documentation.
- Ambulance access to playing fields shall be provided through a dedicated entry point from the car park through locked ranger gates. Ambulance access routes shall provide smooth travel from sportsground to adjacent urban road system. Ambulance access routes shall not jump kerbs, follow steep inclines and declines or cross open concrete inverts or mowable swales.

24.5.13 Lighting

Where lighting is required by the Brief or Deed Agreement documentation the following points shall be addressed in the design,

- compliance with appropriate Australian Standards
- compliance with Design Standard for Urban Infrastructure 12 Public Lighting
- siting of light standards to comply with separation distances from sportsgrounds

- siting of light standards to enable free movement of specified mowing equipment

24.5.14 Water sensitive urban design

Sportsground design projects shall incorporate the principles of WSUD. Design Acceptance approvals shall be subject to the satisfactory inclusion of appropriate WSUD measures. The measures to be incorporated will depend on both the nature and the location of the works involved and Brief or Deed Agreement documentation. Options for water supply shall be specified in the Brief or Deed Agreement documentation. Collected and reused water may be an approved water supply for sportsground irrigation. Sport and Recreation Services shall approve details of the collection and reuse water system for sportsground irrigation. Systems that rely on pumps shall be avoided.

Design Acceptance approval submissions for sportsgrounds shall include details of water sensitive urban design measures, including:

- targets and criteria applicable to the proposed development,
- WSUD measures proposed for the development, including location and design details
- description of assessments – the details of the tools used to assess the performance of the selected WSUD measures, including a summary of inputs and adopted parameters, and
- a statement confirming that the applicable targets and criteria will be met by the proposed measures.

24.5.15 Signage

Where signage is required by the Brief or Deed Agreement documentation the signage shall comply with Design Standards for Urban Infrastructure, 25 Urban Park and Open Space Signage, Urban Services, Canberra.

APPENDIX I

LABORATORY PROCEDURES FOR TESTING SPORTSGROUND SOIL

METHODOLOGY FOR DETERMINING SOIL HYDRAULIC CONDUCTIVITY

*If the soil testing does not follow these procedures it should be deemed to be invalid.

Introduction

In this document the *Drop Test* has been referred to several situations as a measure of saturated hydraulic conductivity. There are many different methods used for the measurement of hydraulic conductivity in soils, and these different methods can give different answer.

Dr Jakobsen has developed a very simple and effective test for saturated hydraulic conductivity which can be used in the meaningful assessment of soils and sands for sports turf and horticulture. This method requires no expensive laboratory equipment, and has proved to be highly repeatable.

Many of the traditional methods for determining hydraulic conductivity involve dropping a hammer or some sort of weight onto the soil sample, which is held in a steel container. There is one major problem with this method of applying compaction, and that is the friction loss of the impact with the soil which is very close to the edge of the container.

This causes a deceleration of the energy being applied close to the edge. This means that the soil close to the edge of the container is not compacted to the same density as that soil near the centre of the container. When water flows down this column, it passes through the less dense edges of the soil in the container more quickly than the adjacent soil.

There is also a variation in the compaction, or bulk density of the sample, from the top to the bottom. It also means that the compaction needed by the hammer or dropping weight method has to be high to achieve good compaction of the whole sample.

If the whole container, including the soil inside it, (Handreck and Black, 1984) is dropped onto a flat hard surface, then much less energy has to be applied to achieve the same compaction of the sample. The soil and the edge of the container decelerate at the same rate, so there is a minimum of edge effect in this method, and the soil compacts more uniformly through the whole sample than the drop hammer method.

The apparatus used for this procedure is ordinary laboratory equipment, including a drying oven, suction plate, vernier callipers, distilled water, and a balance. There is no complex machine required to apply compaction, and there is no special apparatus required to keep a constant head of water for special stainless steel tubes.

A four-litre ice-cream container, or large beaker, is ideal to place the tubes of soil in for wetting up from the bottom.

25mm diameter PVC water pipe can be used for the tubes. Cut into 150mm lengths, ensuring that the ends are cut off exactly at right angles and the edges smoothed so they are even. Each tube has a piece of gauze glued to the bottom to prevent soil from falling out, while still allowing water to freely flow through it.

Note

It is critically important to ensure that the sample is at field capacity when the soil is placed in the tubes prior to the test. Failure to ensure this will result in the wrong result. It is also very important also to ensure that the tube is dropped from the correct height every time and that it falls vertically. If the tube falls on an angle rather than flat on the bottom of the tube, it can de-compact the sample.

With practice and care, the method is very reliable and staff can be trained to carry it out with a high degree of reputability.

The methods have been written in the format of an Australian Standard and are as follows:

1. METHOD FOR DETERMINING SOIL WATER CONTENT

General

Before any soil is used for testing, the whole sample received must be made homogeneous.

Pre treatment of soil samples before physical testing can affect the results, in particular for hydraulic conductivity, but also to a lesser degree for compaction and water holding capacity. Thus, the screening and mixing of samples, as needed to obtain representative sub samples for different tests, must be carried out with a minimum impact on the soil. Otherwise the pre treatment may easily incur effects on the soil that will not occur in the field operations.

Many soils are destabilised and slake easily after being worked while wet, and after drying the soil may regain its former stability. If such a soil is stored moist in a stockpile to be used for an irrigated turf area then drying of the soil is unlikely to occur in the field, and it should be avoided in the laboratory prior to testing.

Dry and lumpy clay soil should be moistened first, so it crumbles easily and can be passed through the screen with a minimum of effort. Crushing dry lumps with a hammer will produce a lot of dust, which is not characteristic of the soil in nature.

Dry soil or gravel is difficult to sample representatively, because fine particles fall to the bottom between larger ones. Moistening the sample to a water content just below its field capacity will make all dust cling to larger particles. Such a sample can be mixed well and representative sub samples taken out. If the water content is below the lower plastic limit, mixing will not destabilise the soil and cause it to slake.

If the soil is dry then add water to what is judged to be near field capacity, e.g. for a gravel 1-1.5%, a sand ~5-8%, a pug soil ~20-30%. Give clay soil time to absorb the water so no muddy lumps are formed during screening and mixing.

Scope

This standard follows the procedures outlined in Australian Standard 1289.1 and 1289.2.1.1

Apparatus

a. A drying oven

b. A heat-resistant and corrosion-resistant container

c. Analytical balance

d. 12mm screen

e. Desiccator containing anhydrous silica gel

Procedure

Crush any big lumps by hand so that the soil can be passed through a 12mm screen.

Mix the sample well and store in a plastic storage container(a) with an airtight lid.

1. Weigh a clean and dry container(b) in grams, to 2 decimal places, **T**.
2. Take a representative sub-sample of soil from the storage container(a) and place in the drying container(b).

   Weigh container(b) with wet soil, **TSW**.
3. Place sample in drying oven at 105^{o}C for at least 12 hours, or until its weight becomes constant.
4. Allow sample to cool in a desiccator for 10-20 minutes and weigh again, **TS**.

Calculations

Calculate the gravimetric water content from:

$$W\% = \frac{TSW - TS}{TS - T} \qquad (1)$$

The relation between the gravimetric water content and the volumetric water content of a soil at a given bulk density is:

$$\text{water vol.\%} = w\% \times \text{bulk density } (g/cm^3) \qquad (2)$$

For tests made on wet soil, but where the amount of dry soil must be known, e.g. hydraulic conductivity, a conversion factor, **C**, may be useful:

$$C = \frac{TS - T}{TSW - T} \qquad (3)$$

Now use:

$$\text{Dry soil, g} = C \times \text{Wet soil, g} \qquad (4)$$

If the moist soil is kept in a closed plastic container, then the measured water content and the value of C may be valid for a week or more.

2. PROCEDURE FOR PREPARING SAMPLES TO BE AT FIELD CAPACITY FOR TESTING (Canberra Landscape Guidelines 1993)

Scope

This standard sets out a method for the laboratory determination of the field capacity of a soil.

Apparatus

a. Ceramic suction plate, adjusted to 1m suction (–10kPa).*

b. Plastic rings, approximately 30mm high and 50mm in diameter.

c. Heat-resistant and corrosion resistant containers.

d. Vernier callipers.

e. Analytical balance.

f. Drying oven complying with AS 1289.0.

g. Wash bottle.

Procedure

1. Wet the suction plate and make sure there are no air bubbles in the drain tubes.
2. Place the empty plastic rings on the suction plate and fill the rings with soil. Pack the soil samples to ensure good contact with the suction plate.

Wet the samples thoroughly using a wash bottle.

Cover the suction plate and leave the samples to drain for at least 16 hours.

3. Weigh the empty drying containers, **T**g.

   Using vernier callipers measure the depth of soil, **H**mm.

   Transfer the samples from the rings to the heat-resistant containers and record the wet weight, **TSW**g.

   Record the dry weight, **TS**g after drying at 105°C for at least 12 hours.

Calculations

Soil bulk density (Db):

$$Db = \frac{TS - T}{\text{volume}} \quad g/cm^3 \qquad (1)$$

Gravimetric water content (w):

$$W = \frac{TSW - TS \times 100}{TS - T} \quad \% \qquad (2)$$

***Notes**: **1.** Flexible tubing is used to join the suction plate to a water reservoir. The porous plate is saturated with water, and air removed from the cavity behind the plate and from the flexible tubing. By adjusting the free water surface in the reservoir to 1m below the upper plate surface, 1m suction is achieved. This system is usually referred to as a hanging water column.

This description is taken from Loveday, (1974):

2. For sand materials the suction is set at 30cm

3. PROCEDURE FOR THE DETERMINATION OF SATURATED HYDRAULIC CONDUCTIVITY IN SOILS AND SANDS

General

The saturated hydraulic conductivity, **K**, of a soil refers to the movement of water through the soil profile when it is saturated (completely filled with water). It is the coefficient, **K**, in Darcy's equation:

$$\text{Rate of Flow} = K \frac{dh}{dx} \quad mm/hr \qquad (1)$$

where (**dh**/**dx**) is the driving force, i.e. change in water pressure with distance.

In the following test **K** (saturated) is measured under conditions of a falling head of water, **H**. At the time when the surface of the ponded water reaches the soil surface, it falls at a rate equal to **K**.

The samples used for testing are compacted to a range of soil densities, which are expected to cover the range occurring in the field after several years of use. A very light level of compaction is applied as well, because some soils will slump during wetting and then become very slow draining.

Scope

This standard sets out a method for laboratory determination of the hydraulic conductivity of a soil.

Apparatus

The following apparatus is required:

a. A drying oven
b. 6 Plastic tubes, 150mm long, 30mm diameter, with nylon gauze fitted on one end. The gauze should allow free drainage of water, but not of soil.
c. Plunger, comprised of a plastic tube with a rubber stopper on one end and fitting neatly inside the plastic tubes.
d. Analytical balance.
e. Vernier callipers.
f. Large plastic container, deeper than 150mm to fit the 6 plastic tubes.
g. Free draining surface.
h. Heat resistant container.
i. Hard flat surface eg. steel base of retort stand.
j. Stop watch.
k. Wash bottle.

Procedure

Sample preparation

1. The soil should have a water content near to Field Capacity prior to testing, i.e. the water content held against a suction of 10kPa or 1m hanging water column or 0.3m for sands
2. Mix the moist soil sample well to make sure that the moisture content is uniform and no wet lumps exist. Keep the soil in a closed container to avoid water loss during the test. Take out a sample for determination of the exact water content (See method 1).
3. Prior to filling each tube with the moist soil, place the tube on the balance and tare the balance.
4. Fill the tube with soil. Whilst filling stand the tube on a flat surface to ensure that the soil does not bulge out at the bottom.

   Compact the soil in the first tube by dropping it once from a height of 150mm onto a hard, flat surface. Ensure the tube is kept upright and is not allowed to fall over.

   Lightly firm the soil surface down to the same level of compaction as the rest of the soil in the tube using a plunger. Do not use excessive force.
5. Weigh the tube immediately after filling and compaction to prevent weight loss due to evaporation. Record the weight of wet soil in the tube, **SW**.

   Using vernier callipers, measure and record the distance from the rim of the tube to the compacted soil surface, **h**.
6. Repeat steps 4 to 6 on the remaining tubes, applying increasing levels of soil compaction for each tube by doubling the number of times, **N**, the tubes are dropped, i.e. 2, 4, 8, 16 and 32.

   Record the values of **SW**, **h** and **N** for each sample.
7. Place the tubes in the plastic container, and slowly fill this container with water until the level approaches the outside rim of the tubes. Allow the water to rise up through the soil to displace most of the soil air.

   Only fill the tubes from the top after the water surface inside them is close to the rim, or at least the soil surface is under water. This should be done carefully with a wash bottle so as to minimise disturbance of the soil surface.

Testing procedure

1. Lift the tubes out of the plastic container and place them on a free draining surface.

   For fast draining sands lift one tube at a time and use a stopwatch to record the time, **t**, for the water to fall from the rim of the tube to the soil surface. For a coarse sand this time may be as little as 5 seconds.

   For slow draining samples, when **t** is likely to exceed 10-20 minutes, it becomes difficult and too time consuming to get the exact time when water disappears from the soil surface. In these instances lift all the samples out and record their starting time. Measure the distance from the rim to the water surface at intervals (eg. 10, 20 and 30 minutes; these intervals should be varied according to the rate of drainage): **h1**, **t1**; **h2**, **t2**; **h3**, **t3**; etc.

   Take three readings or more of each sample.

2. When each sample is fully drained, measure with vernier callipers the distance from the rim to the soil surface, **h**, again as the soil may have slumped after wetting.

Calculations

The conductivity, **K**, and the bulk density, **Db**, for the soil of each tube is calculated by use of equations (2), (3) and (4).

The measurements were made under a decreasing head of water, **H1**=150 - **h1**, **H2**=150 - **h2**, **H3**=150 - **h3**, where **h1**, **h3** is the distance from the rim to the water surface and 150 is the tube height, all in mm.

The decreasing head causes a decreasing rate of flow, which is compensated for in the equation for calculation of the hydraulic conductivity (**K**):

$$K = \frac{l}{t} \times \ln [H_1/H_2] \qquad \text{mm/hr} \qquad (2)$$

where **l** = 150 - **h,** height of soil column in mm; and **t** is the time in hours between the measurements, **H1** and **H2**. Repeat the calculation with **H2** and **H3** and the corresponding value of **t**.

The weight of dry soil, **S**, in a tube is calculated by :

$$S = SW \div \frac{1.0 + W\%}{100} \quad \text{g.} \qquad (3)$$

The bulk density is:

$$Db = \frac{S}{0.1 \times l \times A} \qquad (4)$$

where **l** is the height of soil in mm (150 - **h**), and **A** is the cross sectional area of the tube (7.07cm^2 for a 30mm diameter tube).

If no additional compaction test is made, then the sample compacted by 16 drops of 150mm is used as a standard level of compaction for irrigated turf, and 8 drops for shrub beds and non-traffic areas. Generally 32 drops is adopted for sand profiles in sportsgrounds.

All values of **K** for tubes of compaction by 16 drops and less, should be more than 5mm/hr.

PARTICLE SIZE DISTRIBUTION HYDROMETER AND WET SIEVE ANALYSIS

1.0 GENERAL

The particle size distribution is measured by a wet sieve analysis for particles larger than 0.053mm, and by hydrometer measurements for particles smaller than 0.053mm diameter.

Oven dried soil is used for the analysis. The soil should be allowed to cool for 10-20 minutes before weighing out a sample. If the soil is allowed to stand for longer it may absorb moisture from the air. This is especially true for clay soils, and the amount of dry soil weighed out could, in such cases, be too small.

A sample size of about 60-70g dry matter is used for clay soils.

Soils with a high content of fine sand and silt may clog the finer sieves and only pass through these very slowly, which can cause erroneous results. For such soils the amount of particles up to 0.106mm can be more reliably measured with the hydrometer.

The sample used for the hydrometer test is then used for the sieve analysis to get the distribution of larger particles.

2.0 SCOPE

This standard sets out a method for the laboratory determination of the particle size analysis of a soil. For most areas tap water contains too much calcium and distilled water must be for use in the hydrometer test.

3.0 REFERENCED DOCUMENTS

The following document is referred to in this standard:

AS1289 Methods of testing soil for engineering purposes.

4.0 APPARATUS

The following apparatus is required:

(a) Hydrometer

(b) Set of sieves - with hole diameters of 2.8mm, 2.0mm, 1.0mm, 0.5mm, 0.25mm, 0.106mm and 0.053mm (these sieves are those used by the USDA).

(c) Drying oven complying with AS 1289.0

(d) Plastic container with a nominal capacity of 2 litres

(e) Desiccator containing anhydrous silica gel

(f) Calgon (water softener), 5% solution

(g) Piston

(h) Mechanical stirrer

(i) Two 1 litre glass measuring cylinders

(j) Spray bottle

(k) Thermometer

(l) Plunger

(m) Stop watch

(n) Analytical balance with accuracy as per Table 1 AS1289 2.1.1

(o) Heat-resistant and corrosion-resistant container

(p) Distilled water

5.0 CALIBRATION

(a) Refer to AS 1289 3.6.3 for calibration of the hydrometer.

6.0 PROCEDURE

6.1 SAMPLE PREPARATION

(a) Take a sample of soil that is estimated to give the amount of dry matter needed in the test and place in a drying container. Oven dry the soil for at least 12 hours.

(b) Cool the sample for 10-20 minutes in a desiccator with silica gel. Weigh all of the dried sample in a plastic container (**S**), in grams to 2 decimal places. All the soil from the drying container should be used.

(c) Add 100ml of Calgon (5% solution), stir well to wet the sample thoroughly and allow the soil to soak overnight. Pounding with a piston for dispersion of aggregates may be also required.

(e) Disperse the sample, using a mechanical stirrer, for at least 30 minutes

(d) Add water to make the sample up to 600ml.

6.2 TESTING PROCEDURE

6.3 HYDROMETER MEASUREMENTS

(a) Transfer the sample to a large glass cylinder by using a spray bottle to get all the soil into the cylinder. Fill the cylinder up to 1000ml. Be careful not to use more than 400mls of water to wash the soil into the cylinder.

(b) Add 100ml of Calgon solution into another 1000ml glass cylinder and add water to make up to 1000ml. This is used for a **blank** reading, to make a correction for the effect of the Calgon on the hydrometer reading.

(c) Stir the sample thoroughly with a plunger for at least 30 seconds.

Start stopwatch when the stirring finishes.

After 30 seconds lower the hydrometer into the suspension and take a reading **R**, at 1mminute.

(d) Stir the sample again and take a hydrometer reading after 30 seconds; knowing that the reading will be somewhat higher than the first makes it easier to place the hydrometer at the right depth.

(e) Take a hydrometer reading after 1, 2 and 10 minutes standing; one after 2 to 5 hours; and a reading next day, after 12 to 16 hours standing.

Note the exact time of standing since last stirring, **T**, when each hydrometer reading is taken.

Take a blank reading in the Calgon/water solutions, **B**, at the same time as readings of the soil sample.

6.4 SIEVE ANALYSIS

(a) Place the nest of sieves in the sink with the finest sieves at the bottom.

(b) Transfer the soil sample to the nest of sieves by using a spray bottle or a fine jet on a hose from the water tap to ensure all the soil is transferred.

Turn on tap water and wash soil through sieves.

(c) Watch that the outflow from the bottom sieve is running freely. If it is blocked, turn the water off and shake sieves, to make the soil move on the bottom sieve.

(d) When the sample has been washed through, pull the sieves apart, washing the soil on each sieve to make sure all the smaller particles have passed through on to the finer sieve below.

(e) Stack the sieves with the finest in the bottom, wipe off excessive water and dry in an oven for 2 to 3 hours.

(f) When the sample is dry remove the sieves from the oven and allow to cool. Shake the stack of sieves thoroughly. Record the mass of material retained on each sieve ($m_{2.8}$, $m_{2.0}$, $m_{1.0}$,…….. $m_{0.053}$).

7.0 CALCULATIONS

7.1 SIEVE ANALYSIS

(a) Add the weights from all sieves together:

$$m = m_{2.8} + m_{2} + m_{1} + m_{0.5} + m_{0.25} + m_{0.106} + m_{0.053}\text{, g}$$

(b) Calculate the weight of particles smaller than 0.053mm, lost in the drain:

$$m_{<0.053} = S - m\text{, g}$$

(c) Calculate the different size fractions as a percentage of the total sample:

Example: Percentage retained on a 2.8mm sieve

$$= \frac{m_{2.8}}{S} \times 100\text{, \%}$$

7.2 HYDROMETER MEASUREMENTS

(a) Use a computer programme to find the maximum particle diameter included in each hydrometer reading, as depending on the reading value, R, the time elapsed, T(minutes), and the temperature.

(b) Find concentration of soil in suspension, **C**, at each reading, by subtraction of the blank reading:

C = R - B, g/litre

As the amount of soil used is not exactly 100.0g in a one litre suspension, then convert the values of concentrations to percentage of soil sample by dividing the concentration by grams of soil, S, and multiplying by 100.

Use computer programme for interpolation of the percentages of the soil sample smaller than 53μm, 20μm and 2μm.

(c) When taking a hydrometer reading the resulting particle diameter is found by calculation. To get the percentage values for 2, 20, 53 and 106μm, interpolations are needed.

The cumulative percentage, P, smaller than a given particle diameter, D, can be described by the function:

$$P\% = 100 \times \left(1 - \exp\left(-K \times D^{N}\right)\right),$$

Where the parameters K and N are determined from two pairs of percentage – diameter values. Extrapolations outside the range of measured values are best avoided.

Using the values, $P_1 = \frac{P_1\%}{100}$ smaller than the diameter D_1 and $P_2 = \frac{P_2\%}{100}$ smaller than the diameter D_2,

we get: $$N = \frac{\left[\ln\left(-\ln\left(1-P_1\right)\right) - \ln\left(-\ln\left(1-P_2\right)\right)\right]}{\left[\ln\left(D_1\right) - \ln\left(D_2\right)\right]}$$

and, $$K = \exp\left[\ln\left(-\ln\left(1-P_1\right)\right) - N \times \ln\left(D_1\right)\right]$$

*****

Hole diameter, (mm)	**Soil fraction retained**	**Maximum to be retained on sieve, (g)**
2.80	gravel	150
2.00	fine gravel	150
1.00	very coarse sand	100
0.50	coarse sand	70
0.25	medium sand	45
0.106	fine sand	20
0.053	very fine sand	10
Material passing through	silt and clay	

Table 19.1. The diameter of the pores of the sieves used, and the soil fraction retained; as well as the recommended maximum mass of material to be retained on each sieve at the completion of sieving:

References:

Handreck, K. and Black, N. 1994. ***Growing Media for Ornamental Plants and Turf.*** New South Wales University Press Kensington Aust.

Department Urban Services, ACT Government 1993. ***Canberra Landscape Guidelines, Soil Testing Procedure LG B22***. *Canberra.*

Standards Australia 1999; ***Methods of Testing Soils for Engineering Purposes, Australian Standard 1289***.

24.6 Further reading

Belconnen's Urban Parks, Sportsgrounds and Lake Ginninderra Plan of Management, Canberra Urban Sport and Recreation Services, Canberra, 1990.

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Irrigation Policy, Department of Territory and Municipal Services-Sport and Recreation Services, available online

http://www.tams.act.gov.au/__data/assets/pdf_file/0012/40035/21_Irrigation_Edition_1_Revision_1.pdf

"Drainage for Sportsturf and Horticulture". Horticultural Engineering Consultancy Canberra 162pp McIntyre, Keith., and Jakobsen, Bent. 1998.

"Problem Solving in Golf courses, Sportsgrounds, the Landscape, and racecourses" Horticultural Engineering Consultancy Canberra 429pp McIntyre, Keith. 2004

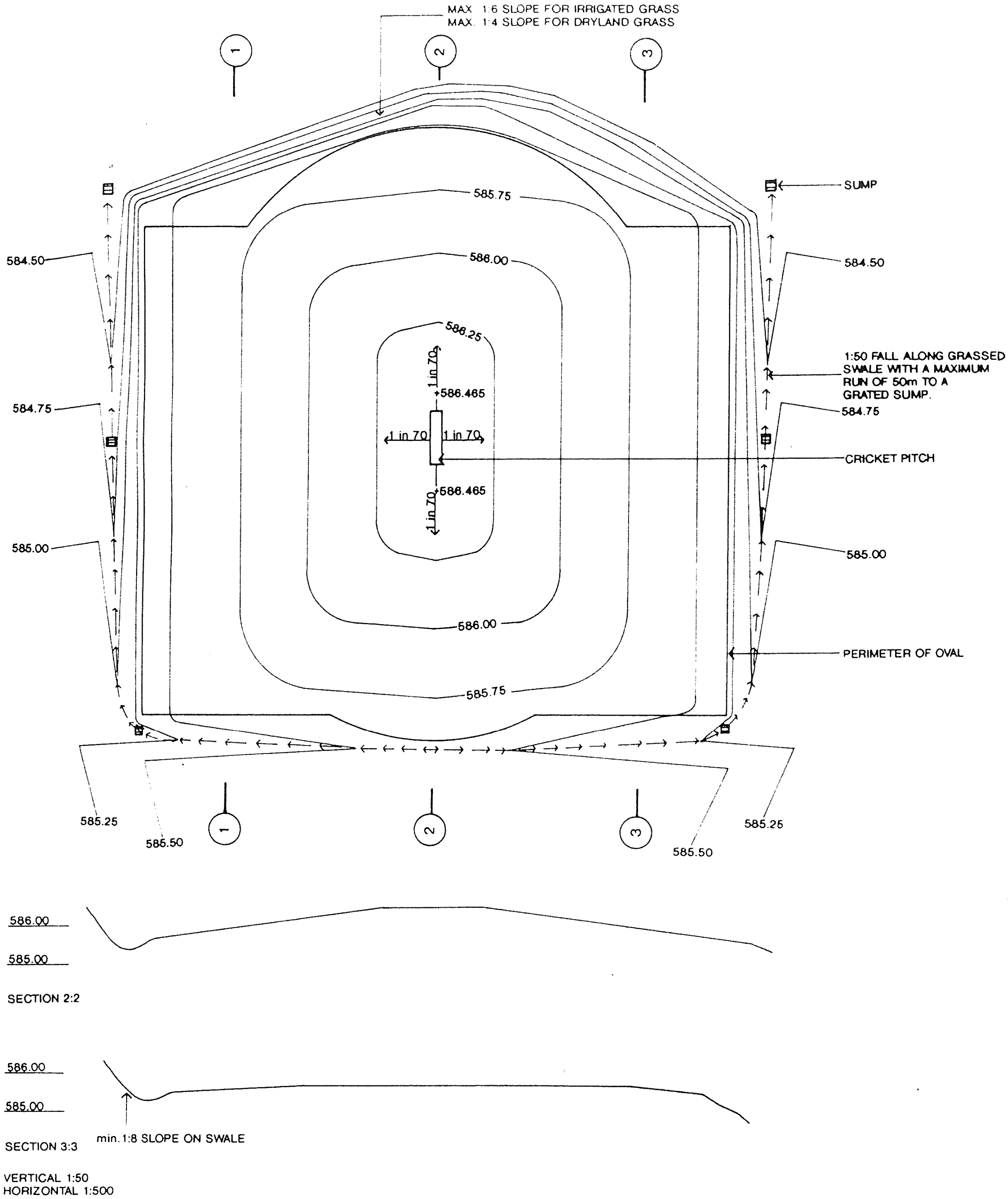
"Cricket Wickets - science v fiction". Horticultural Engineering Consultancy Canberra 282pp McIntyre, Keith, and McIntyre, Don 2001.

Tuggeranong's Urban Parks and Sportsgrounds Plan of Management, Canberra Urban Sport and Recreation Services, Canberra, 2000.

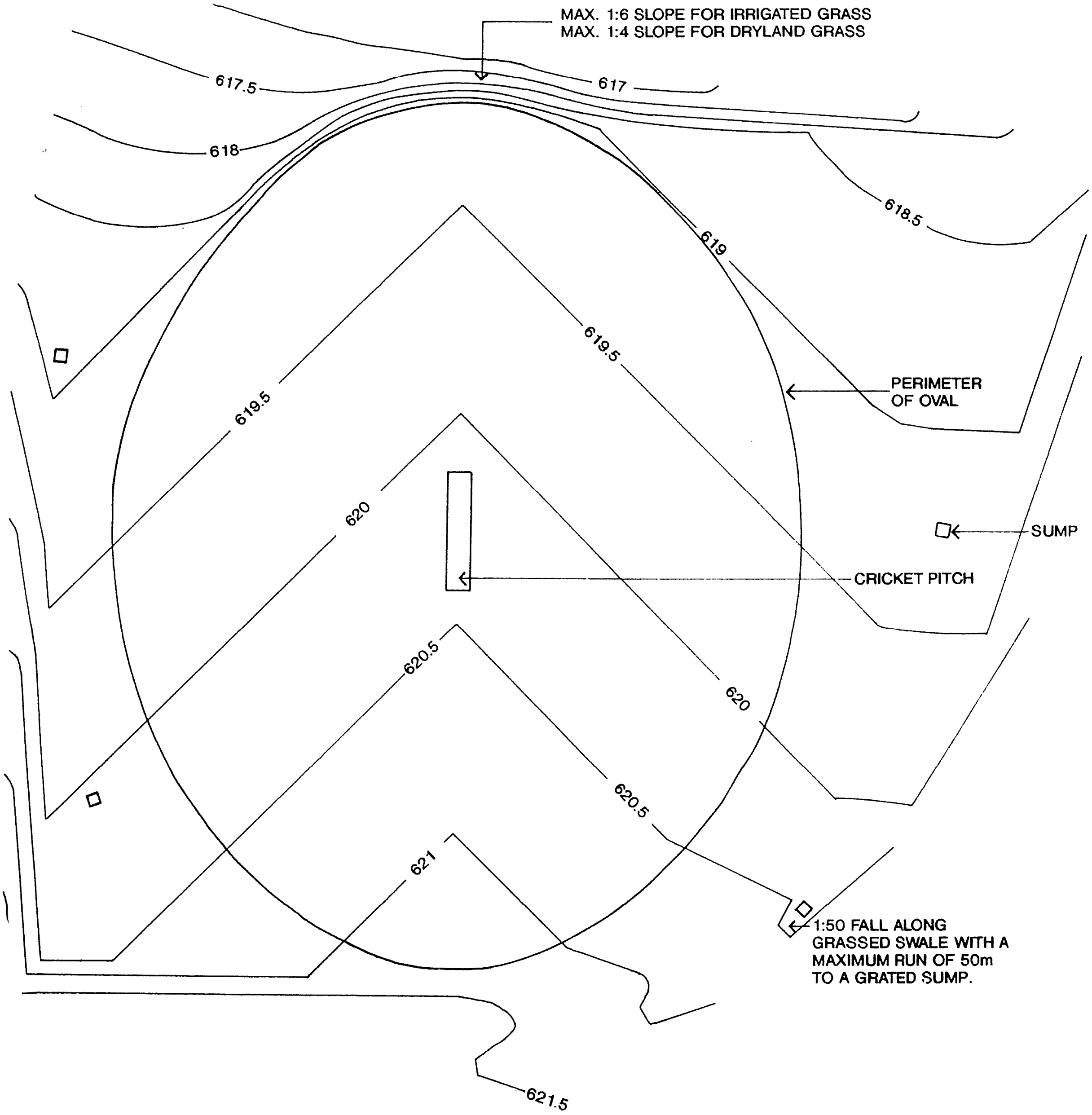
Woden and Weston Creek's Urban Parks and Sportsgrounds Plan of Management, Canberra Urban Sport and Recreation Services, Canberra, 1998.

Standard drawings

Indicative grading plan - domed formation



Indicative grading plan - two way crossfall



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