

Section 3

16. BUNKER CONSTRUCTION

16.1 General Notes

Bunkers may be any shape or size and there is no standard number per hole. Bunkers are to be set out and constructed as per drawings and specifications. Bunkers should appear natural and the outline of edges should not be uniform or formal. Pacific Coast Design has the right at [any time to modify bunker shapes](#).

Pacific Coast Design require that bulk earthworks finish at a point where design levels are shaped to the degree required for that Section. Fine shaping of bunkers using a Dozer type machine will leave surrounding areas as per design levels required.

The bunkers are then excavated to subgrade levels to achieve the desired contour shape. Experience has shown that an excavator is the best machine for this task. Note that design levels given on plans are **final so excavations should be 200 mm below design levels** (Bunker Sand is an average of 200 mm deep compacted).

Greenside bunkers are to be constructed at the same time as the adjacent green and the contractor is to coordinate accordingly.

Peninsulas (which are designed moving into the bunker) or islands (within the bunker), which are to be grassed at a later date shall be crowned or convex curved in cross section, not flat or concave.

16.2 Compacted Subgrade

The subgrade is intended to be natural material. The base should be shaped in a concave or saucer shape so that generally water would move to the centre (where a drain will be placed). The subsoil drainage which is installed within the bunker will take advantage of the slope by accepting water which flows across it and then draining quickly away. Compaction should be carried out by track rolling with excavator or dozer in combination with light wetting.

The subgrade should be completely free of any debris, stones or foreign matter as this material may work its way through into the placed bunker sand above.

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17. BUNKER CONSTRUCTION / DRAINAGE

17.1 General

Once the subgrade levels have been completed and the subgrade surface is smooth, the drainage system can be installed. This will usually follow the form of a herringbone system running through the bunker from back to front as well as a drain line along the bottom of the "slope area or face" of the bunker. Note that it passes completely through the bunker and connects with the fairways drainage system. At the other end it commences near the end of the bunker in a dead end.

The drainage lines should have a minimum slope of 1 in 100. Spacing will be indicated on the plans provided.



17.2 Drainage material

Drainage material where specified is to be 6 mm to 10 mm clean (washed) gravel (free from silt & clay) for around type 1 drainage pipes. A minimum of 75% of the material is to be of the 10 mm range.

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17.3 Set out of Drainage Lines.

The contractor is responsible for the setting out of drainage lines as per the detailed plans as issued by Pacific Coast Design. The Site Superintendent shall inspect and approve of such set out prior to excavation or trenching.

17.4 Drainage Lines

Trench lines to depth specified for Pipe Type 1 (section "A") attached. A trenching machine or excavator can be used for this task. The trench bottoms shall be clean and smooth to a uniform grade and all spoil excavated from trench lines is to be removed from the bunker site. No ridges shall be left on the trench edge that would prevent water movement into the trench.

17.5 Type 1 Drainage Pipe

Drainage pipe to be used for golf greens, tees and bunkers is to be Type 1 pipe (Section 'A') and the following types of pipe are described as type 1.

General : Drainage pipe is to be perforated or slotted with the holes or slots no greater than 10 mm in diameter or width. Pipe shall be made of PVC, polyethylene or plastic derivative and preference will be given to pipes with a smooth internal bore.

Acceptable Pipes are :

- (a) UPVC slotted 90 mm diameter subsoil (6 metre lengths)
- (b) Spirally wound PVC 90 mm diameter subsoil (continuous)
- (c) Other underground drainage pipe 90mm to 100mm as approved by PCD.

17.6 Installation

All U.P.V.C joints and fittings are to be sealed and glued with appropriate materials and to manufacturers recommended standards.

The bottom of the drainage trench must be smooth and without undulation, since otherwise water will collect in the drain lines and negate their effect. [All spoil from the trench must be taken out of the bunker zone.](#)

Trench width shall be pipe diameter plus 100 mm (as a minimum). The drains will be installed as designed to suit the shape of the bunker, but the principles given above must not be compromised.

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17.6 Installation (cont.)

With the drain lines cut into the subgrade and the surface completely free of loose dirt or debris and any wheel marks removed, bring in gravel to line the base of the drainage lines as a layer with minimum depth of 30mm, this should be placed throughout the entire length of the drainage trench taking care to ensure that the levels are maintained at a constant slope.

Drainage pipes are then inserted. **Fabric covers completely around drains are not recommended.**

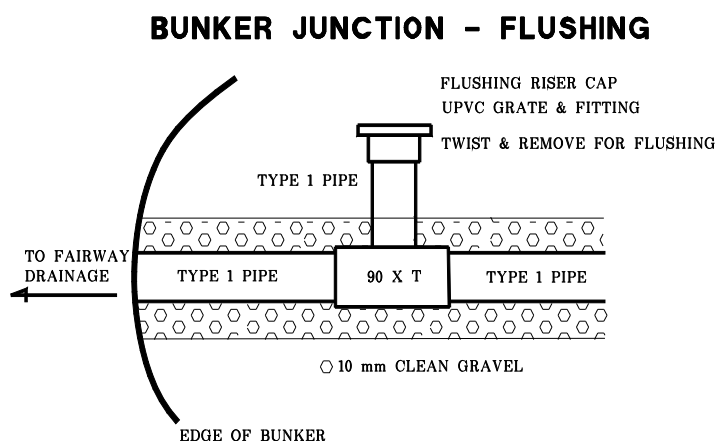
Geo-textile material placed over the floor of the bunker (and hence also the drainage) is to be slashed as per drainage specifications over the drain area so as to prevent any future sealing of material.

Pipes are to be laid in accordance with Type 1 pipe (Section A) profile as attached and encased in gravel.

The drain lines should then be filled to the surface of the subgrade over the installed drains and smoothed over. They should not be heavily compacted as this may crush the drain lines, but should be settled into place by raking or vibrating with a vibrating plate type of compactor.

17.7 Bunker Junction / Sump Pit

At the lowest point of the bunker a sump Pit must be constructed. All pipe within the bunker should flow through the pit which will be used for the flushing of drain lines within the bunker. Each bunker shall have a minimum of one such sump Pit.



Plan view of Bunker Junction / Sump

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18. BUNKER CONSTRUCTION / LINER & EDGE BOARDING

18.1 Bunker Liner

Prior to installation of the bunker liner the Contractor shall ensure that all bunker drains work properly. Drains which do not work shall be opened up, flushed out, or replaced prior to the placing of bunker liner and sand within the bunker.

The bunker subgrade “**slope area or face**” of the bunker shall be lined with SandMat 400 bunker liner, or pre-approved equal.

The bunker subgrade “**floor area or base**” of the bunker shall be lined with approved local Geo-textile material.

The bunker liner shall be a highloft nonwoven geotextile consisting of durable polyester fibers resin bonded with non water soluble polymer to form an evenly distributed, U.V. stable, three dimensional blanket matrix specifically intended for bunker sand stabilization and drainage. The bunker liner rolls shall be 3.048m wide and shall be shipped to site in opaque protective plastic bags or wrapping with the liner type clearly identified on the bags or wrap. The bunker liner shall have a permeability of no less than 6.0 cm/sec under a 50 psf load.

If the bunker liner will not be installed for more than thirty (30) days after the installation of the gravel trench perforated drain pipe, or if weather conditions are such that the pipe could clog, the Contractor shall also cover all drain lines with plastic to prevent clogging prior to the placement of the bunker liner.

The Contractor shall secure the bunker liner to the subgrade using 15.24cm long polypropylene MatStakes™ as supplied by the manufacturer, or approved equal. Stakes shall be yellow in color and shall feature serrated edges on a 'X' cross section shaft. Stakes shall be placed in accordance with the manufacturers recommendations and as shown in the Bunker Liner Cross Section drawing. If the subgrade soils are very stony, the bunker liner may need to be secured using steel staples. If steel staples are to be selected they shall be min. 15.25cm long bezinal coated 8 gauge steel. Longer staples may be required if subgrade soil conditions are very sandy. Regular 'sod staples' shall not be accepted. Adjacent bunker liner panels shall be overlapped a minimum of 10.16cm.

The bunker liner shall be terminated around the perimeter of all bunkers by securing the liner a minimum of 30cm laterally back into the surrounding soil at such an elevation that the finished bunker sand level adequately covers the bunker liner, and as shown in the Bunker Liner Edge Detail drawing. Previously placed top soil surrounding the bunkers may need to be temporarily removed such that an adequate shelf be built to accommodate lateral anchorage of the bunker liner. Care shall be taken to avoid spillage of top soil on to the bunker liner. The bunker liner will be placed such that all gravel drain lines are covered. Avoid placing liner seams above gravel drain lines.

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18. BUNKER CONSTRUCTION / LINER & EDGE BOARDING

18.1 Bunker Liner (cont.)

The bunker liner shall be covered with bunker sand within twenty (20) days following installation of the bunker liner (ideally within twenty four (24) hours). If the bunker liner is not to be covered with sand within twenty (20) days following installation, the Contractor shall cover the bunker liner with an opaque plastic liner until sand is available.

The bunker liner color shall be "Off-White" (Munsell designation in proximity of 5Y 8/1) or "Tan-Beff" (Munsell designation in proximity of 10YR 6/4) so to as closely as possible match the selected 'white' or 'tan' bunker sand. The Contractor shall advise the bunker liner manufacturer of color selection at the time of placing the order with the manufacturer.

The bunker liner manufacturer shall provide a five (5) year limited and prorated warranty to the Principal following installation per these specifications and upon receipt of full payment from the Contractor or Principal. The bunker liner manufacturer shall identify requisite check-list items enabling the issuance of the warranty to the Site Superintendent or Principal prior to construction.

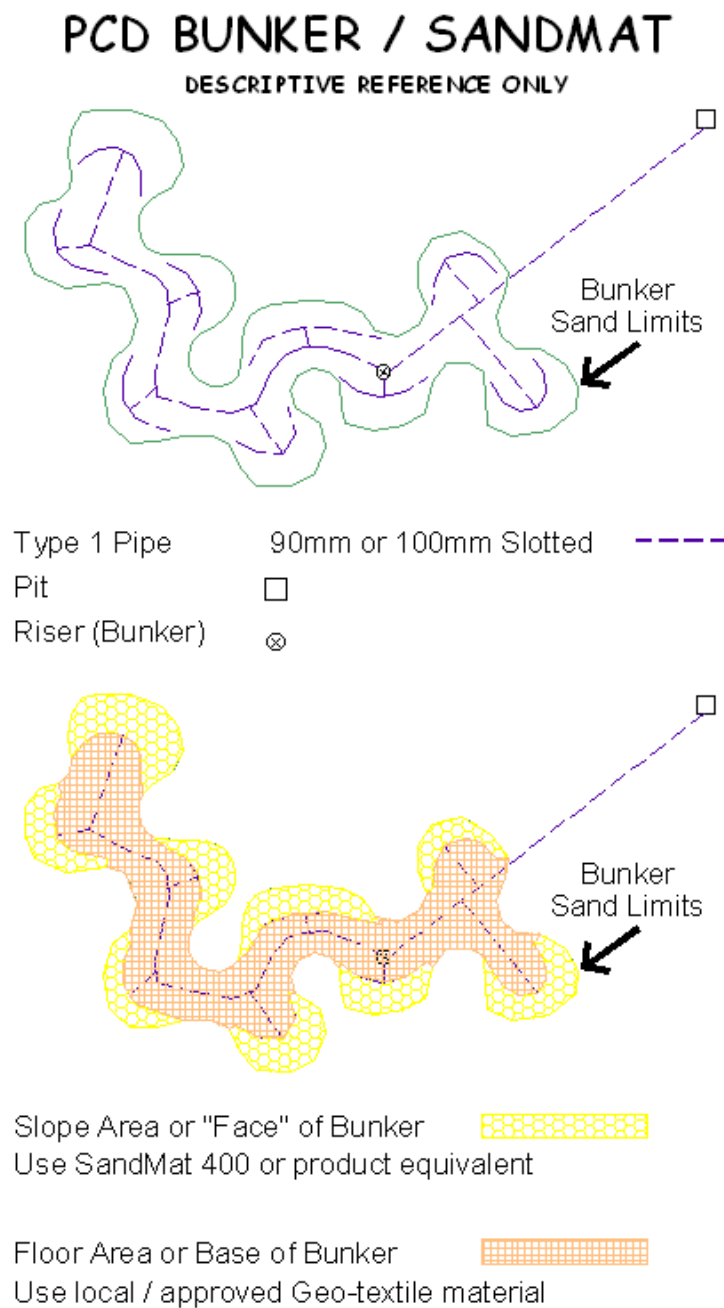


SandMat material with securing stake

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18. BUNKER CONSTRUCTION / LINER & EDGE BOARDING

18.1 Bunker Liner (cont.)



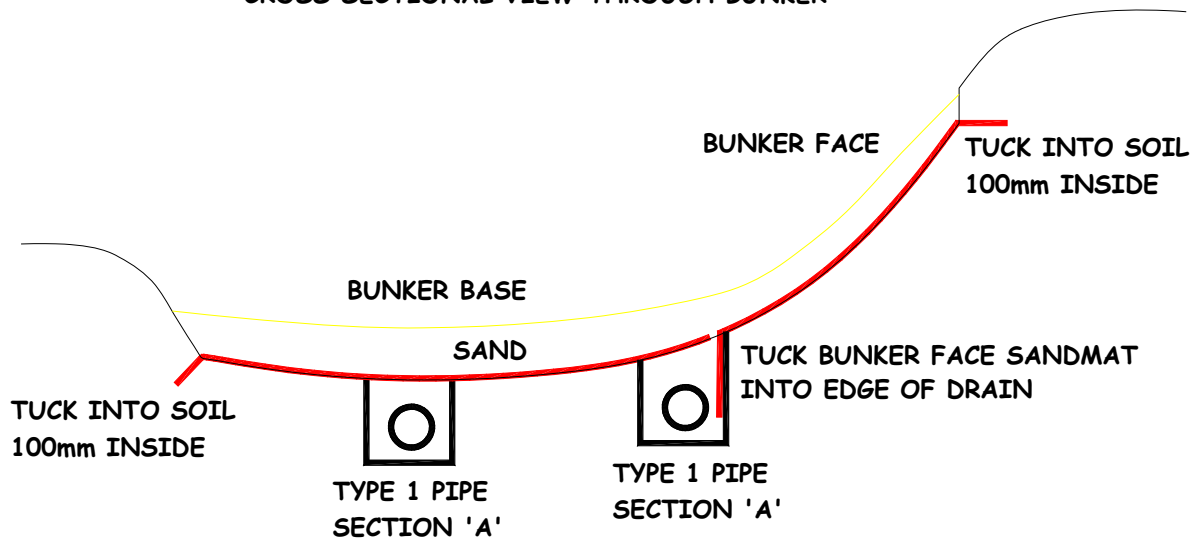
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18. BUNKER CONSTRUCTION / LINER & EDGE BOARDING

18.1 Bunker Liner (cont.)

BUNKER - SECURING SANDMAT

CROSS SECTIONAL VIEW THROUGH BUNKER



SANDMAT (OR EQUIVALENT)

SECURE SANDMAT TO BASE & FACE AS PER MANUFACTURERS RECOMMENDATIONS

SAND DEPTH ON BASE OF BUNKER 200mm

SAND DEPTH ON FACE OF BUNKER 100mm

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18. BUNKER CONSTRUCTION / LINER & EDGE BOARDING

18.1 Bunker Liner (cont.)



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18. BUNKER CONSTRUCTION / LINER & EDGE BOARDING

18.2 Boarding of Bunker

Once the Bunker has been finally shaped and drainage installed a boarding is installed around the edge of the bunker to retain the edge shape until the turf sod takes root (see attached diagrammatic specification). The boarding is usually 115 mm x 7 mm x 3000 mm and is supported by pegs (25 mm x 25 mm x 300 mm).



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19. BUNKER CONSTRUCTION / SAND

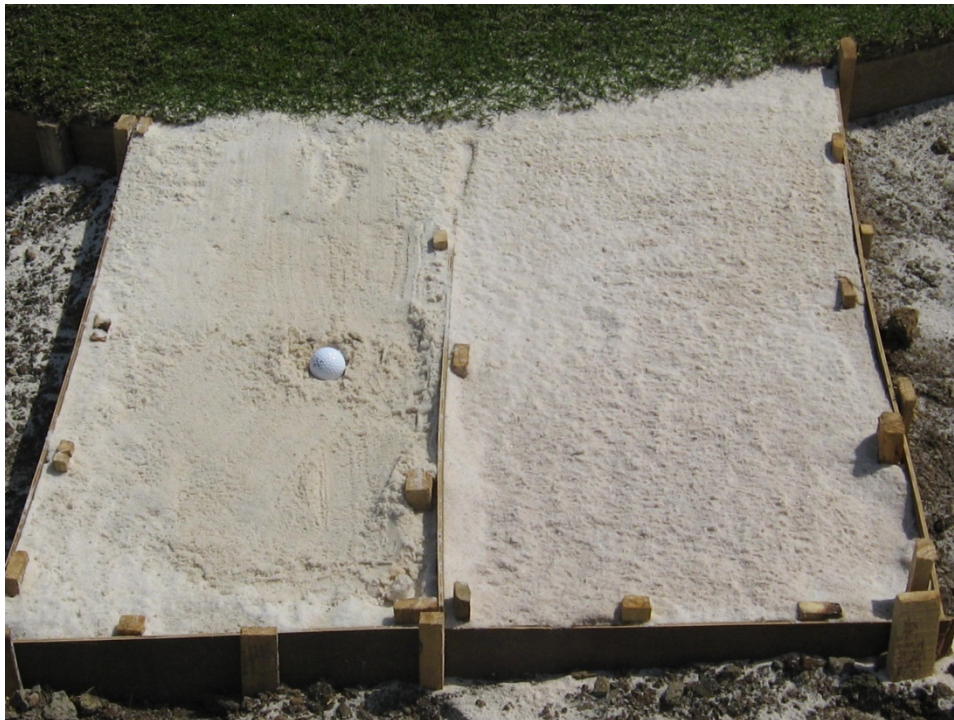
19.1 Bunker Sand

Appropriate sand for bunkers is as follows:

- (a) The sand should be free from foreign matter and impurities.
- (b) Infiltration Rate - > 700 mm per hour
- (c) Particle size for sand should be 90 - 100% in the 0.1 to 1 mm range (0% < 0.053 mm)
- (d) Sand particles to be preferably angular and naturally white.
- (e) Sand to have minimum surface crusting and allow a firmness of footing.
- (f) The ball lie in selected sand should have a penetration of > 1.8 kPa. The golf ball should not penetrate further than 45% of its diameter from a normal approach shot.

Bunker sand must be tested as outlined in "Material Testing 5.1" and approved by PCD. Samples should be clearly marked "Bunker Sand" and separated from any samples sent for analysis for suitability as growing medium sands. **"Playability"** is what bunker sands are all about and is the first criteria followed. Sand colour is preferably white but this takes second precedence over playability.

To test playability different sands should be placed in a square wooden frame of a minimum of 1m x 1m (frame/s placed on solid ground) and to a depth of 200mm. The sand should be compacted and then a golf ball thrown into the sand at reasonable velocity. The ball should not "plug" more than 45% of its diameter and then should be played by an experienced golfer to test its playability. The sand should then be thoroughly wetted and the procedure repeated.



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19. BUNKER CONSTRUCTION / SAND

19.1 (cont.)

It may be that many sands require to be field tested before a final selection is made. The prospective sands should be properly compacted, left for at least a week and subjected to the normal golf conditions that such sand could expect during normal golf play (watering & raking).

In addition to the field impact test (depth golf ball goes into sand) a reasonable golfer should also hit some shots from the sand to see the ball / sand interface reactions.

If some of the bunkers are formed then it may also be an advantage to have some of the field test boxes set up on a slope within the bunker to also evaluate golf ball / slope sand interface.



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19. BUNKER CONSTRUCTION / SAND

19.2 Sand depth & Bunker Face

Approved sand is then spread over the base of the bunker using an excavator as per attached detail. Care is to be taken to avoid damage to drainage and some of the spreading of sand is to be carried out by hand. Sand depth is 200 mm (compacted) on the base and 100 mm (compacted) on sides / faces. Once placed the sand should be raked using a motorised bunker rake, compacted using a vibrating plate and watered to firm the surface. The consolidated surface must be the design profile.

The face of the bunker is important to the overall playability of the bunker. The face should be compacted sub-base material, free of any foreign objects or stones. A golf ball hit into the face should not plug nor bury itself, instead the ball should come to a stop and then roll back onto the floor of the bunker where sand is about 200mm depth.

The ongoing maintenance of bunker faces is an important aspect of golf course presentation. In areas where heavy rains occur the bunker faces may be minimized to prevent frequent washouts however some face should be retained where possible for visual identification of bunker position.

20. BUNKER CONSTRUCTION / FINISH

20.1 Erosion

It is not intended that major flows of water enter the bunkers from the surrounding areas. During construction temporary sand bags may be required on the upper side of the bunker to prevent water run off from causing damage.

The final contouring around the bunker should be such that no major flows of water enter the bunker, these should be diverted using subtle swales around the bunkers to direct the major flow away and some of this work may be required to be hand finished.

20.2 Turf Sodding

It is intended that once the bunker construction is finished that the edges of all bunkers be sodded with turf to a minimum width of approximately 1.0 m. This sodding should ensure there are no bare earth slopes heading into the bunker, that is from the sand line to the surrounding ridge should be turfed. This is to protect the bunker and ensure no contamination of bunker sand from the surrounding topsoil.

The turf sodding is the responsibility of the grassing contractor but should be undertaken as soon as the bunker is complete and water to sustain the turf sod is available.

Any peninsulas or islands within the general bunker area should be fully turf sodded.

Contractors should note that on average for every square metre of bunker about 1m² of turf is required to turf around the bunker properly.

