香港賽馬會
The Hong Kong Jockey Club

Practical Turf Management – 5th Seminar Renovation of the Hong Kong Stadium Pitch

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Executive Manager, Tracks

The Hong Kong Jockey Club

6 June 2015

Contents

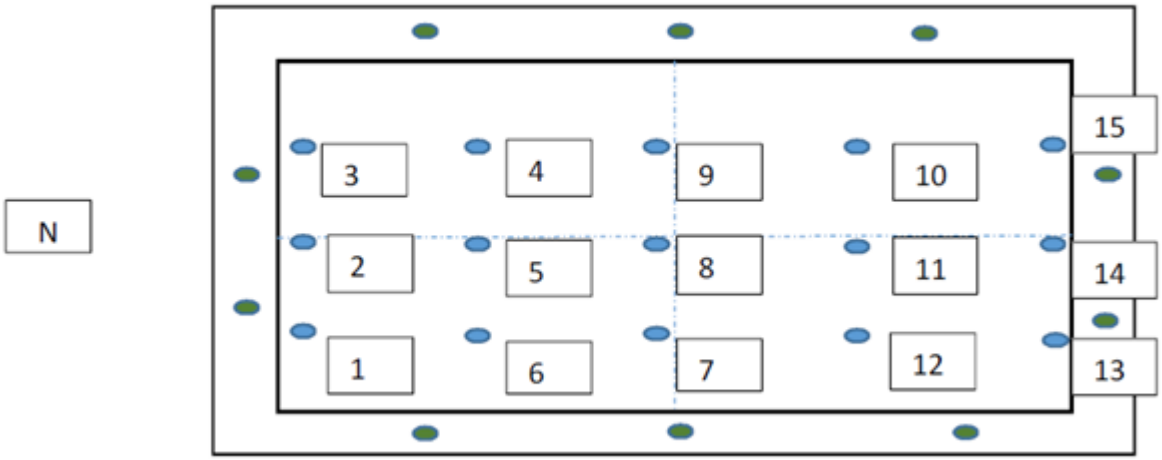
- Review of profile performance before renovation
- Site investigation & irrigation audit
- Perched water construction design: terrain, drainage
- Gravel, sand, reinforcing agent, organic amendment selection
- Irrigation system design
- Quality Management Program: Turf Nursery, Quarry
- Construction technology
- Current Progress

HVRC Tunnel Construction July 2014

2. Sampling and tests Oct 2013

- 15 sampling sites around the pitch
  - especially high wear areas

- To view roots and profile



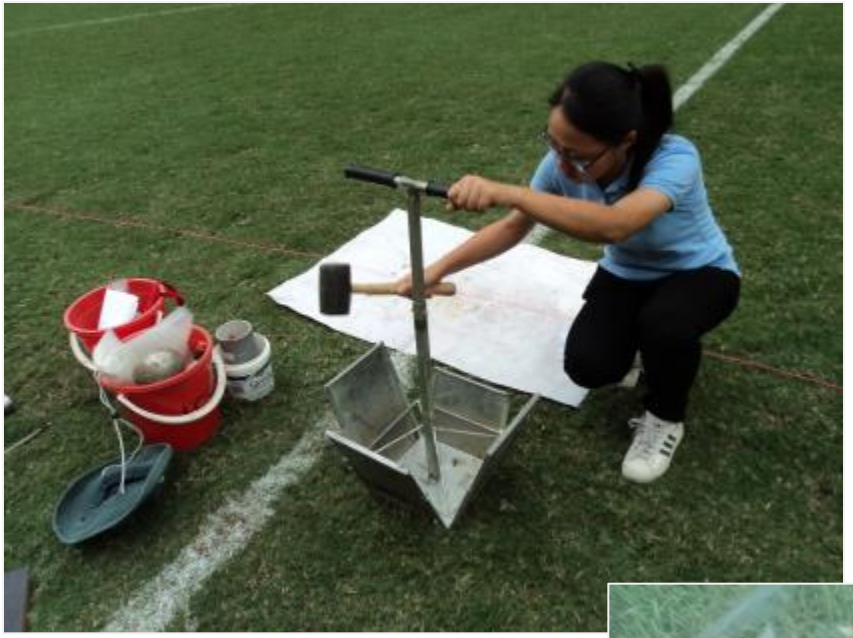
2. Sampling and tests

- A list of tests were commenced to draw the conclusion

- Testing Root Zone Material
  - Particle size & shape analysis
  - Saturated hydraulic conductivity
  - Moisture release curve & retention
  - Air filled porosity
  - Organic matter Profile

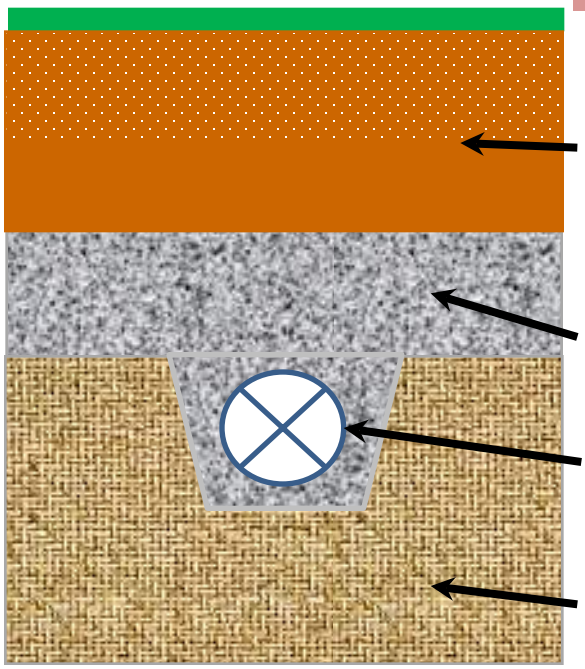
- Testing Gravel
  - Particle size analysis
  - Hydraulic conductivity
  - Gravel suction influence on the sands moisture retention
  - Migration compatibility


H12



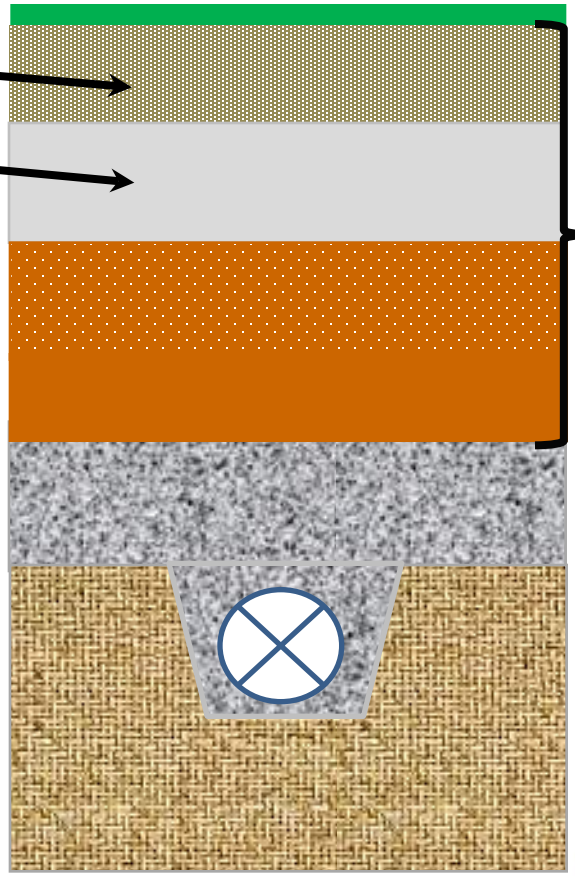
3. Profile Study

AS BUILT



- **Top Dark Layer 50mm to 130mm in thickness**
- **Grey Sand Layer 0mm to 150mm in thickness**
- Orange/ Mesh Layer from 50 to 250mm from the grass surface. This over laid a lower Orange/Lower Sand only layer. The overall thickness of these two layers ranged between 200mm to 300mm
- Crushed Granite Gravel 48mm to 125mm
- 65mm Subsoil Drainage Lateral Pipe System at 0.38% slope and 3m spacing
- Existing Subgrade - found some road base but mainly appeared a gravely clay material

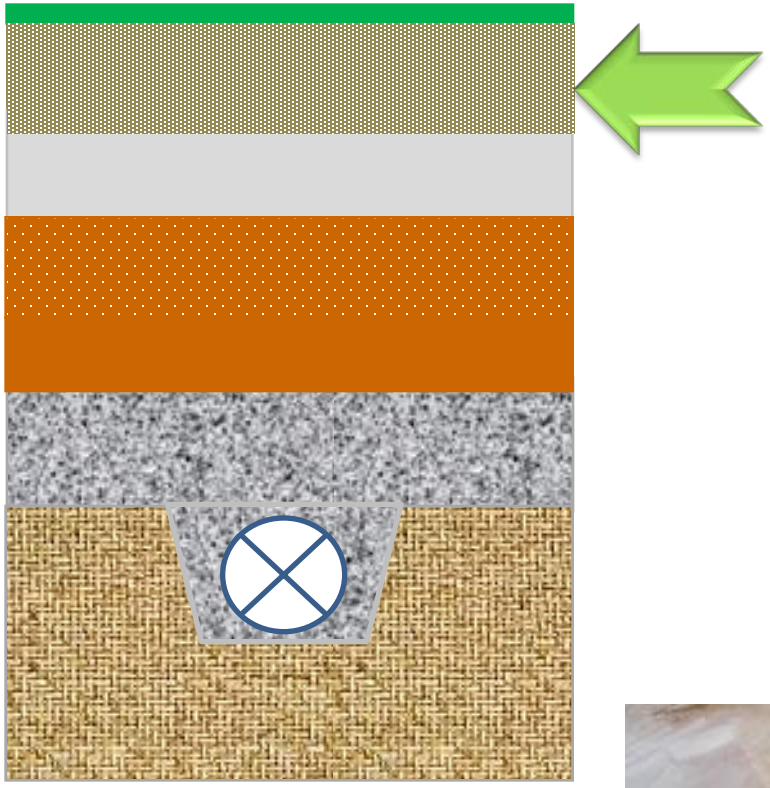
EXISTING PROFILE



Major issue: non uniform drainage

The overall thickness of the root zone above the gravel ranged from 350mm to 490mm

2. Profile Study - Top Dark Layer (Result of poor maintenance)

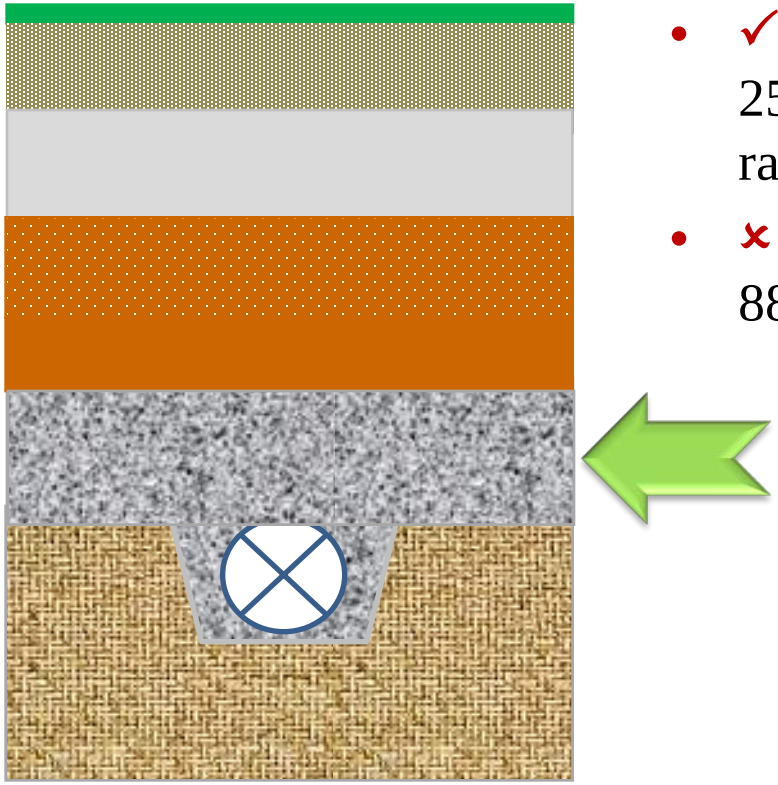


- ✗ Silty sand containing **3.0 % - 9.4 %** organic matter
- ✗ Very poor drainage **(1mm - 40mm/hr.)** & water can't infiltrate this layer
- ✗ Variable depths (50mm - 130mm in thickness, ave 99mm)
- ✗ Foul (anaerobic) smell for some samples
- ✗ Extended time to dry the profile after rain
- ✗ Cut up easily during play in wet
- ✗ Difficult to develop sustainable deep roots

- **Initial thought - this top silty sand layer material should be removed**

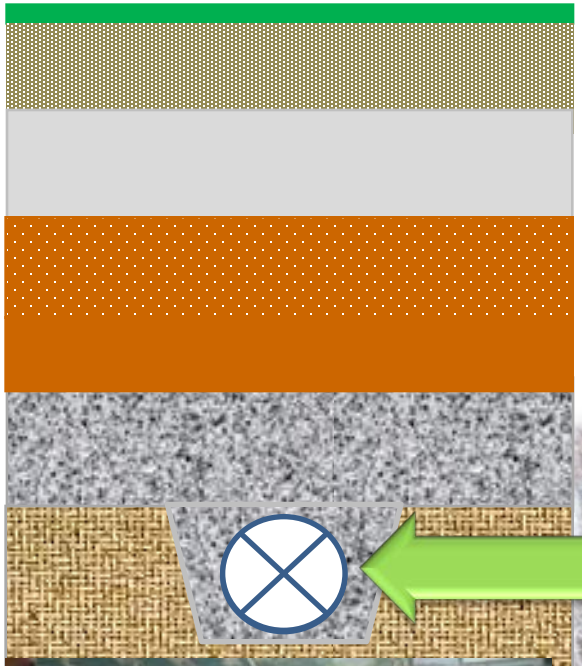

2
3
4
5
6
7
8
9
10
1
2

3. Profile Study - Gravel Drainage Layer



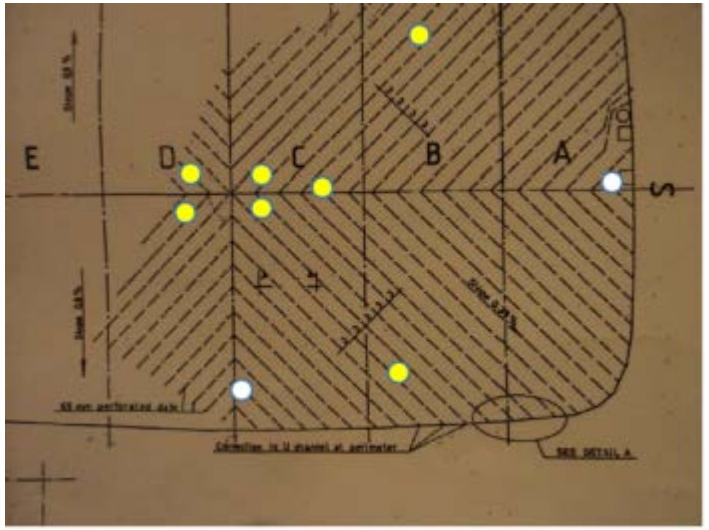
- ✓ Hydraulic conductivity of the gravel: 252,768mm/hour (low for a gravel of this size range)
- ✗ Variable thickness: 48mm -125mm, ave 88.7mm

3. Profile Study – Drainage evaluation



- ✓ each side of the field drain over 100mm/hour (white dots)
- ✗ center of the field drains at 18mm/hour (yellow dots)
- Design range should be at least 150mm/hr.

- <u>Note- Lateral drainage system is inadequate for the Hong Kong climate</u>



4. Summary and Suggestions

Prior study recommendation

Remove the top dark layer only

- Back to the surface stability and dryness problems experienced in the as built profile
- Quick fix without addressing other deflects underneath
  - Do not address poor drainage
  - Unstable surface in long dry season

- Current recommendation

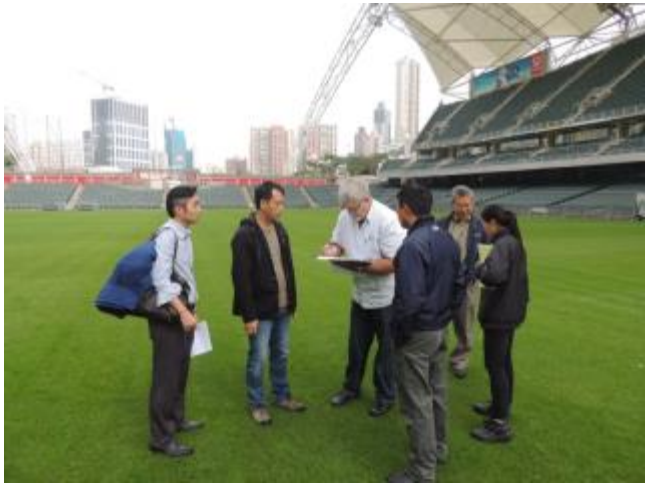
- Full reconstruction
- But – requires a package solution

- Rectify problems with proper solutions in line with international stadium standards
- Continuous and professional turf monitoring system
- Contract ready to use turf
- Grow light (to improve growth under shade)
- Fans installation (to improve ventilation)
- Skilled and qualified people

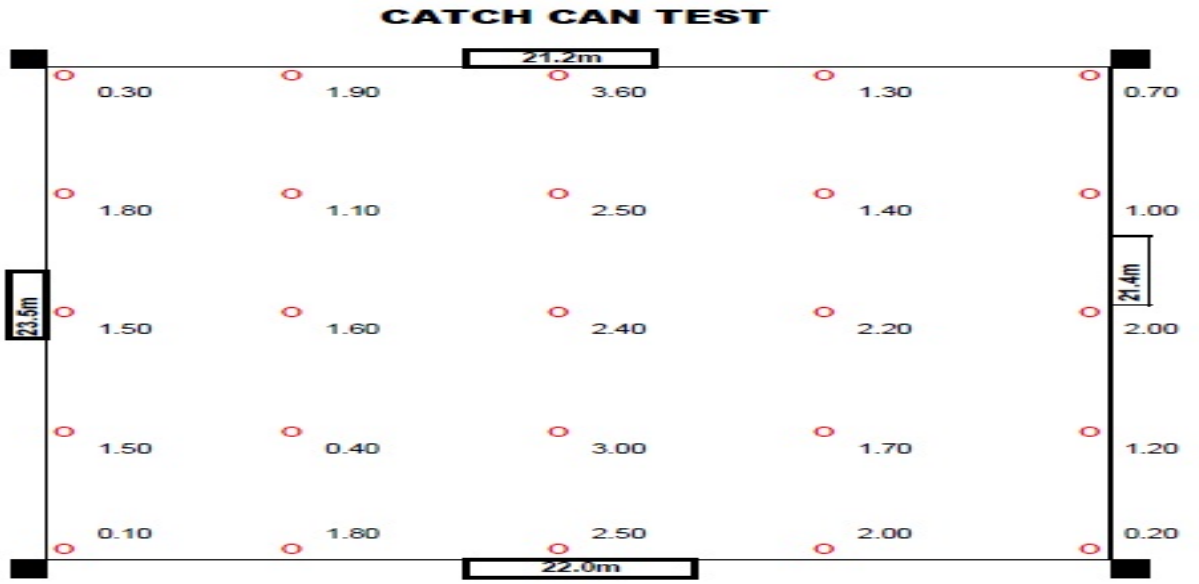
Geotechnical Investigation Nov 2014

Base Examination Dec 2014

Hong Kong Stadium Irrigation Audit
Date:6/1/2015-7/1/2015



Can Test



9.53 Precipitation rate (mm/Hr)

CU 57.9%

DU 32.5%

SC 3.1

Late Dr. V. I. Stewart

How far do we understand how it works ?

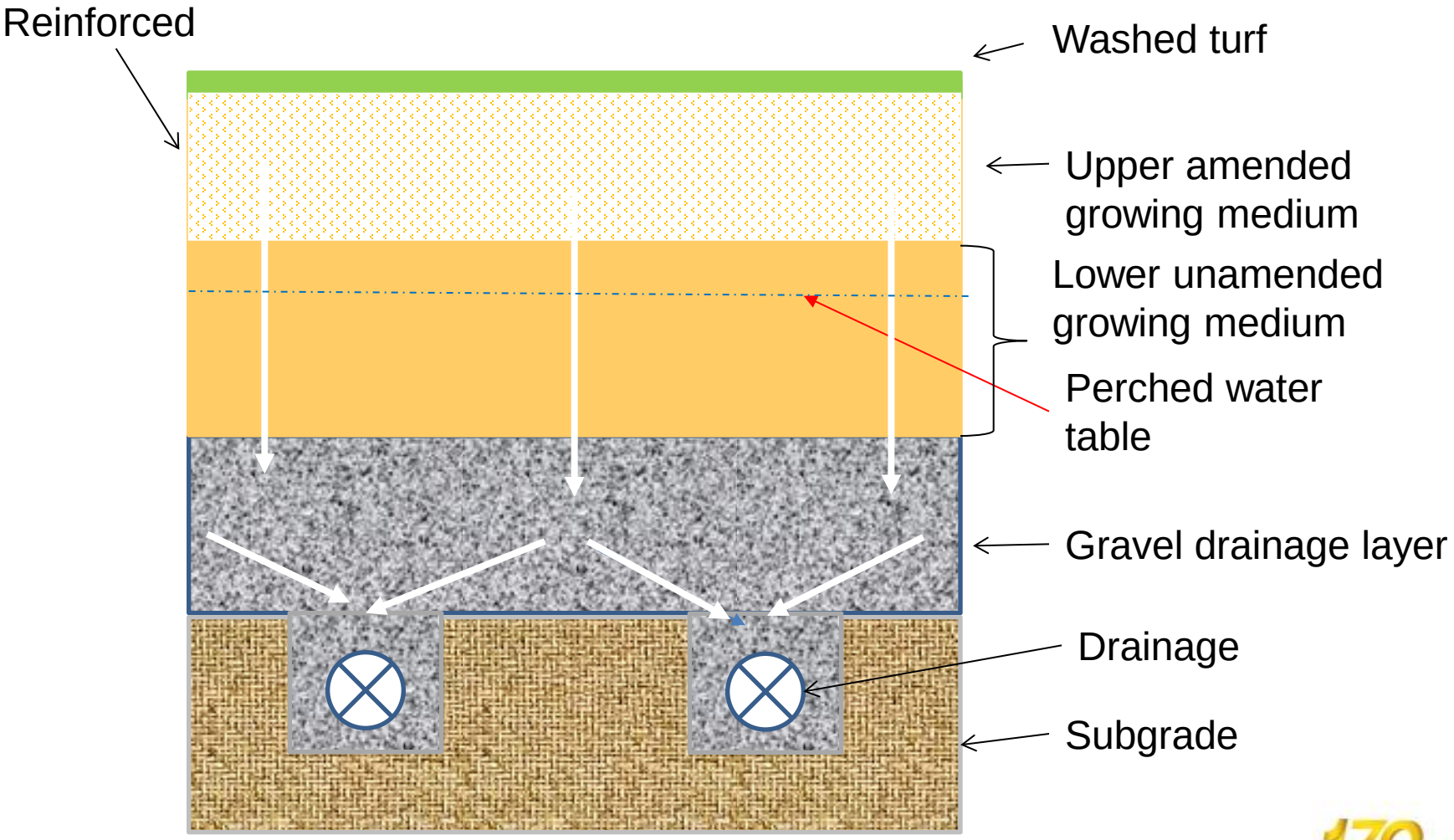
Could we not do better?

June 1970

Design Criteria

- capacity to handle 150mm/hr rain fall event.
- growing medium profile that supports deep healthy roots and healthy shoot growth
- provides the moisture retention for optimum stability and playability.
- provides for rapid recovery after usage.
- To have a grass selection that best suites the climate for the usage requirements.

Perched Water Table Reinforced Profile

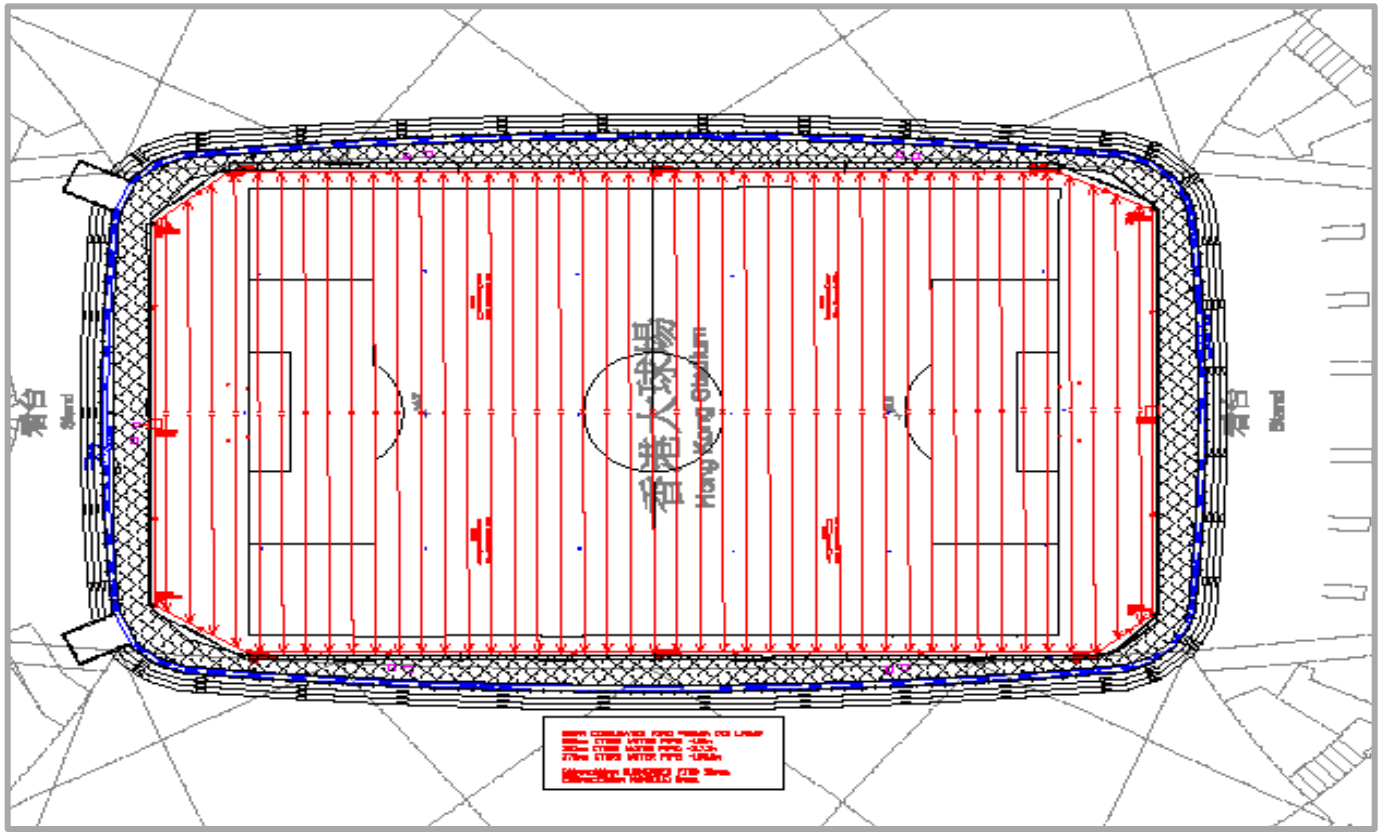


Surface Slope

Needed to fit to rubber surrounds an goal post sleeves levels while still producing sufficient grade for the drainage and some surface drainage.

Grades placed into 3D total station layout in order to laser grade all pavement layers to the pitch surface grades and to the tolerances required.

Drainage Layout



Drainage System Design Concepts

- Main drain with double lining pipe of various sizes to provide the rigidity with little resistance for water flow
- Lateral system connected to main drain pipes surrounding the edge of the pitch
- Main drain discharge at the south and north curvet
- Save cutting rubber pavers
- Design to cope with 150mm of rainfall per hour

Drainage Pipe Layout

450mm @ 2%

250mm @ 0.5%
300mm @ 0.5%
375mm @ 0.5%

Lateral connections at 4m centres

Sub soil drain pipe

New Sub soil drain pipe
Spacing: 4m apart

Old sub soil drain pipe
Spacing: 3m apart

Gravels and Sand Selected

- Gravel F - to be used for the gravel drainage layer and the lateral pipe backfill.
- Gravel 10mm - to be used as a bridging gravel over 15mm gravel.
- Gravel 15mm – to be used around all main line pipes.
- Sand F – to be used for all growing medium layers.

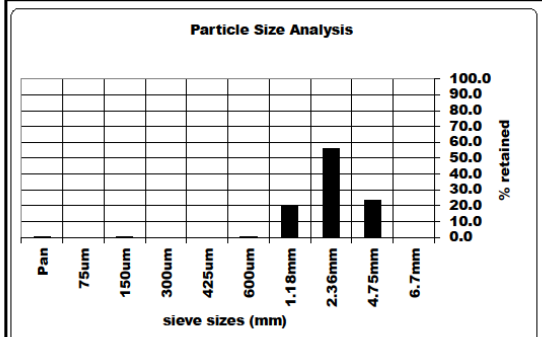
Migration test – materials preparation

Gravel F Particle Size Analysis and D90 and D15 Determinations

GroundScience
A C N 105 704 078
13 Brock Street Thomastown VIC 3074, P (03) 9464 4617 F (03) 9464 4618

Particle Size Analysis

client :	HONG KONG JOCKEY CLUB	job No:	G2793
project :	STADIUM PITCH RENOVATION	report No.	AM
location :	HONG KONG	test date:	11/03/2015
sample Id:	GRAVEL F	Sample No.	#2
material description :	gravelly SAND, fine to coarse, white, grey		



D15	1.955
D90	5.791
sieve size mm	% retained
9.5mm	0.0
6.7mm	0.0
4.75mm	23.6
2.36mm	56.1
1.18mm	19.5
600um	0.4
425um	0.0
300um	0.0
150um	0.1
75um	0.0
Pan	0.3

Natrual Moisture Content %
0.0

NATA
TECHNICAL COMPETENCE

test procedure: AS1289 3.6.1, 2.1.1

NATA Accredited Laboratory No. 15055
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements in this document are traceable to Australian/National Standards

Simon Beggs
Approved Signatory
Date 13-Mar-15

D15	1.955
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9.5mm	0.0
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600um	0.4
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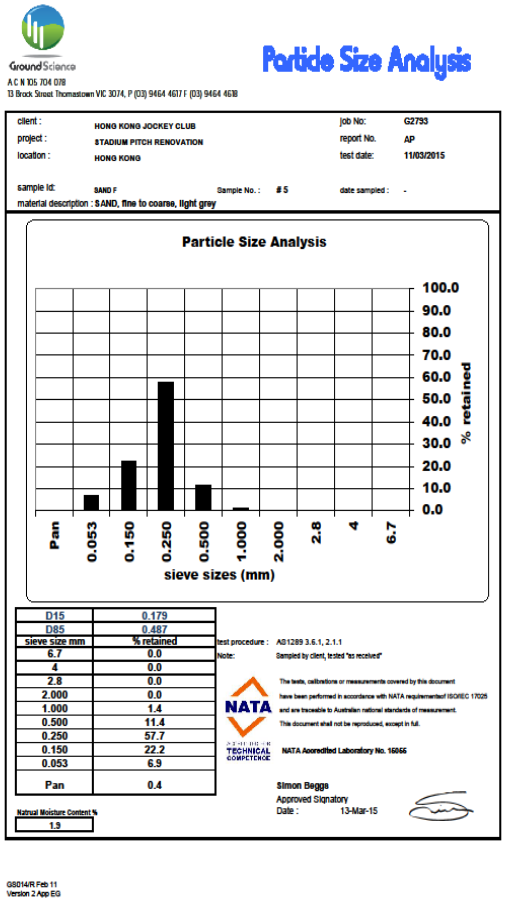
150um	0.1
75um	0.0
Pan	0.3

Further Gravel Testing

Migration testing of F gravel on 10mm gravel.
No migration occurred.

150mm lateral pipe tested for migration of gravel F if placed around pipes. Pipe covered in gravel and then vibrated and shaken with and without water applications. No migration of gravel entered into the pipe through the perforations.

Particle Size Analysis and D15 and D85 of the sand



GroundScience
A.C.N. 105 704 078
13 Brock Street Thomastown VIC 3074, P (03) 9464 4677 F (03) 9464 4678

Particle Size Analysis

client : HONG KONG JOCKEY CLUB
project : STADIUM PITCH RENOVATION
location : HONG KONG
job No: G2793
report No. AP
test date: 11/03/2015
sample Id: SAND F
Sample No. : # 5
date sampled : -
material description : SAND, fine to coarse, light grey

Particle Size Analysis

100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
% retained

Pan 0.053 0.150 0.250 0.500 1.000 2.000 2.8 4 6.7
sieve sizes (mm)

D15	0.179
D85	0.487
sieve size mm	% retained
6.7	0.0
4	0.0
2.8	0.0
2.000	0.0
1.000	1.4
0.500	11.4
0.250	57.7
0.150	22.2
0.053	6.9
Pan	0.4

test procedure : AS1289 3.6.1, 2.1.1
Note: Sampled by client, tested "as received"

NATA
PROVIDING TECHNICAL COMPETENCE

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement.
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NATA Accredited Laboratory No. 16955

Simon Begga
Approved Signatory
Date : 13-Mar-15

Natrual Moisture Content %
1.9

GS014/R Feb 11
Version 2 App EG

D15	0.179
D85	0.487
ve size mm	% retained
6.7	0.0
4	0.0
2.8	0.0
2.000	0.0
1.000	1.4
0.500	11.4
0.250	57.7
0.150	22.2
0.053	6.9
Pan	0.4

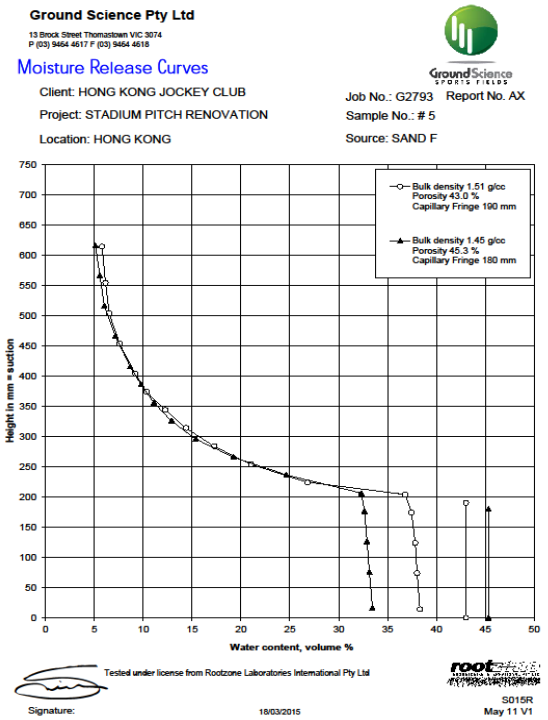
Moisture Content %

1.9

Moisture Release Curve Testing

At the proposed depth of the growing medium of 250mm plus the gravel suction (68mm), the moisture release curve indicates a moisture retention of 15 % by volume.

This is too low and needs an organic amendment to assist in lifting this to a higher level.



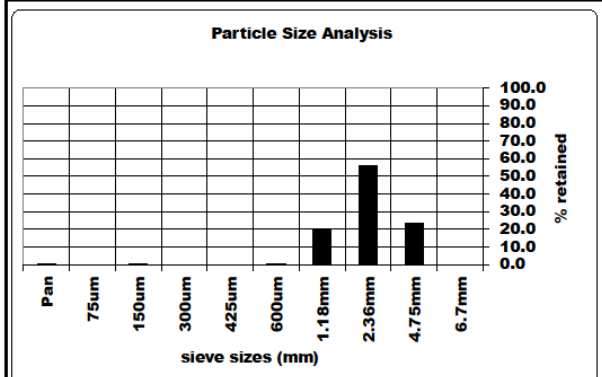
Gravel Grading and Migration compatibility

GroundScience
A C N 105 704 078
13 Brock Street Thomastown VIC 3074, P (03) 9464 4617 F (03) 9464 4618

Particle Size Analysis

client : HONG KONG JOCKEY CLUB — job No: G2793
project : STADIUM PITCH RENOVATION — report No. AM
location : HONG KONG — test date: 11/03/2015

sample Id: GRAVEL F — Sample No. #2 -
material description : gravelly SAND, fine to coarse, white, grey



D15	1.955
D90	5.791
sieve size mm	% retained
9.5mm	0.0
6.7mm	0.0
4.75mm	23.6
2.36mm	56.1
1.18mm	19.5
600um	0.4
425um	0.0
300um	0.0
150um	0.1
75um	0.0
Pan	0.3

Natrual Moisture Content %: 0.0

NATA TECHNICAL COMPETENCE

test procedure: AS1289 3.6.1, 2.1.1

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Approved Signatory
Date 13-Mar-15

SAMPLE No. #2 GRAVEL F — ROOTZONE SAND #5 SAND F

% Passing	Sieve size(mm)
100	9.5
100	6.7
76.4	4.75
20.3	2.36
0.8	1.18
0.4	0.600
0.4	0.425
0.4	0.3
0.3	0.15
0.3	0.075
90	5.791
15	1.955

Bridging Migration Factor with sand = 4.01

Uniformity Factor with sand = 2.96

Migration Compatibility

- The 15% passing diameter of the gravel must not be more than 7 times the diameter of the 85% passing diameter of the overlying growing medium.

$$D_{15\ (gravel)} < 7 \times D_{85\ (growing\ medium\ -\ bridging\ factor)}$$

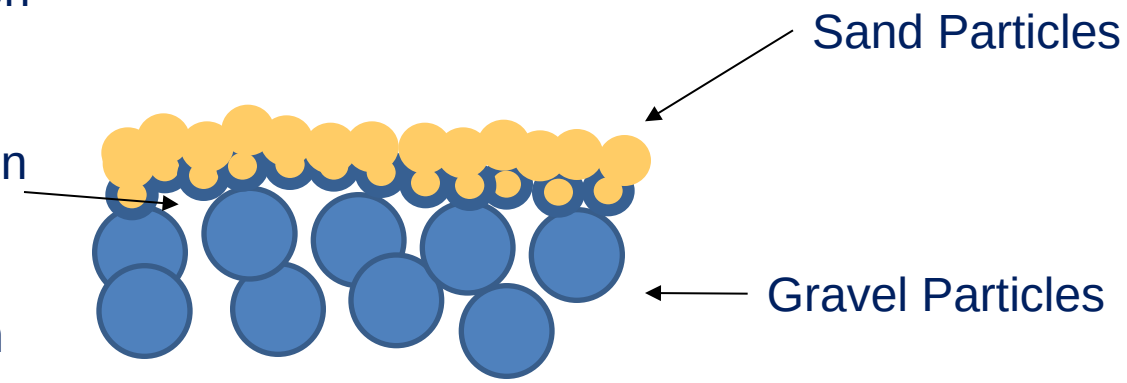
The gravel must also have a uniform particle size:

- The 90% Passing diameter of the gravel must not be more than 3 times the 15% passing diameter of the gravel.

$$D_{90\ (gravel)} < 3 \times D_{15\ (gravel\ -\ uniformity\ factor)}$$

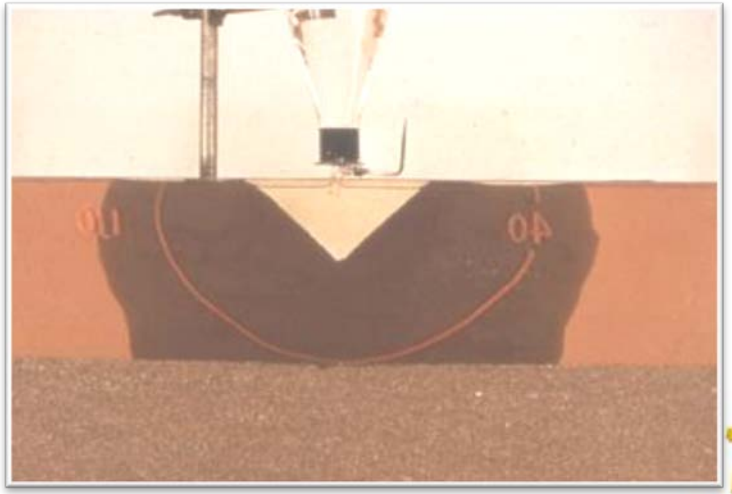
How the Perched Water Table is Formed

A meniscus is formed by the water held on the sand particles over the gravel air space that is broken by forming a head pressure of water above the gravel in the sand.

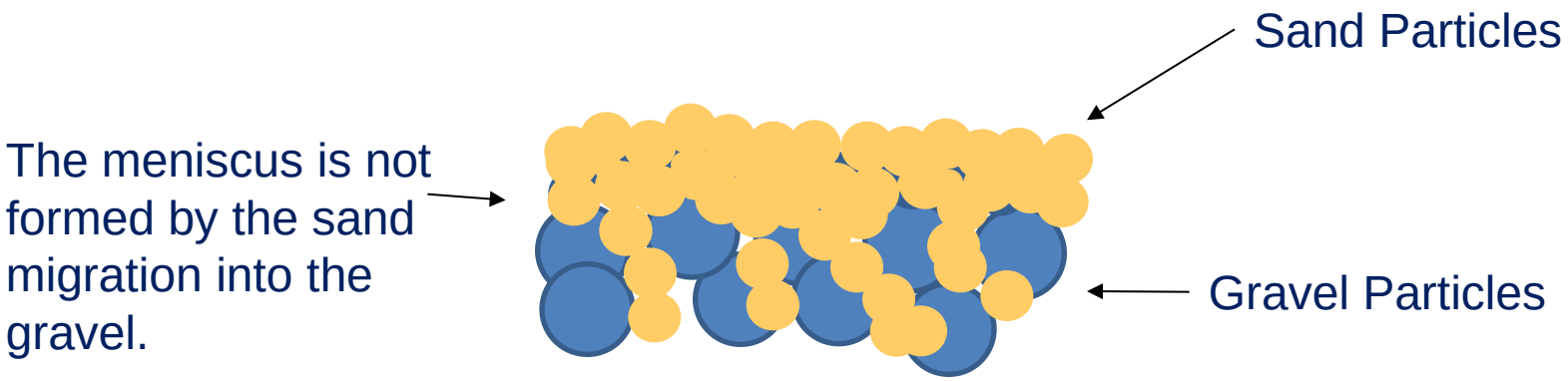


A water reserve is created by the gravel in the layer above.

This will maintain an even moisture in the above sand layer over the whole pitch.



How the Perched Water Table can be made ineffective

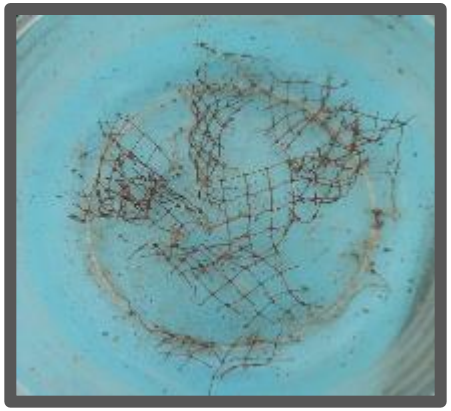


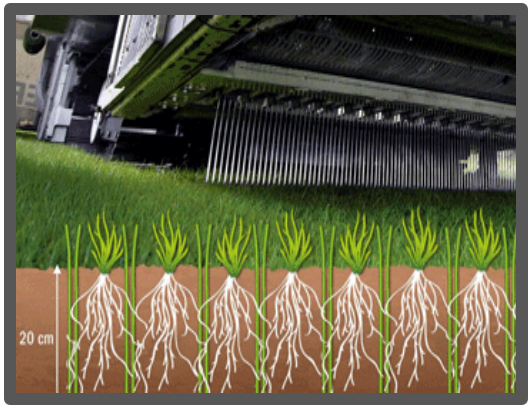
Maintaining Perched Water Table During Installation

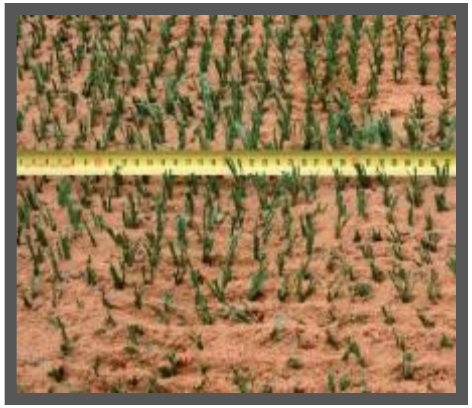
It is important to maintain a sharp interface between the gravel and the sand above and to maintain some moisture in the sand and gravel to ensure the perched water table is achieved during the installation.

Reinforcements supplied as additives in construction that are generally added by specific equipment are:

Reflex (Netlon) mesh elements







Desso Grassmaster

StaLok

Loksand

Mesh Element Reinforcement

- Product developed in 1982.
- Research undertaken by Strathclyde University and Texas A&M University.
- Used in Happy Valley Racecourse in 1988 & utilized in stadia and racecourses globally
- Assist drainage, resist compaction, provide consistent firmness, stabilize sand profile

Peat Moss Amendment

Mainly used to provide better moisture retention, root hair production and some additional stability to the sand.

Moisture Retention and Hydraulic Conductivity of the Mixture

RESULTS SUMMARY

A C N 105 704 078

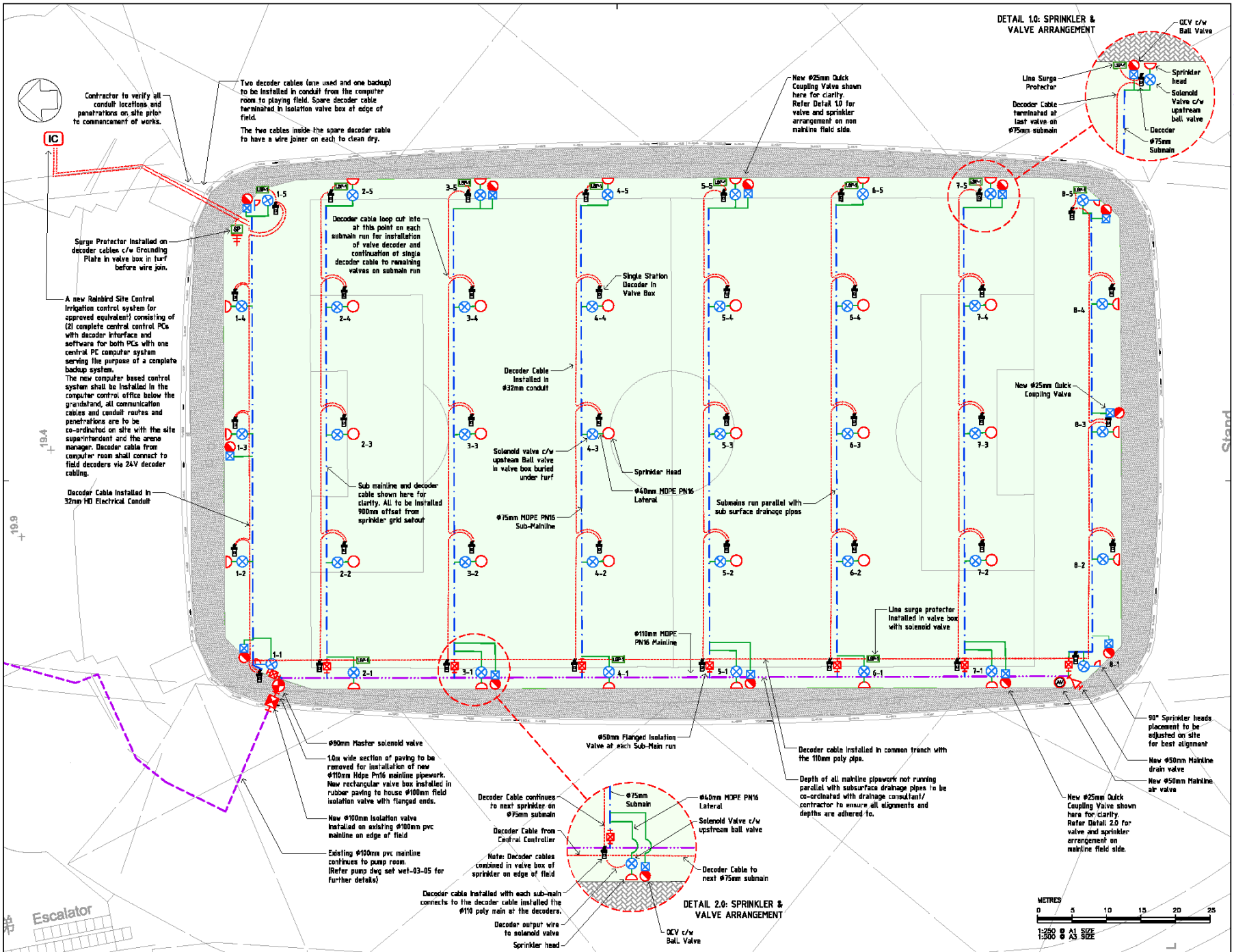
13 Brock Street Thomastown VIC 3074, P (03) 9464 4617 F (03) 9464 4618

Client:	HONG KONG JOCKEY CLUB			Job No.	G2793	
Project:	STADIUM PITCH RENOVATION			report ref	AZ	
Location:	HONG KONG			issued by:	EG	
				date	19/03/2015	
sample No.		# 9	# 9			
sample id:		SAND F 12% PEAT	SAND F 12% PEAT			
Bulk dry density of test specimen	t/m^3					
Initial Moisture content	%	22.2	22.2			
Temperature of water	C	23.5	-			
Water type		POTABLE	-			
Saturated Hydraulic conductivity @ 16 drops of 150mm	mm/hr	840	-			
compacted at bulk density	t/m^3	1.342	-			
Saturated Hydraulic conductivity @ 32 drops of 150mm	mm/hr	650	-			
compacted at bulk density	t/m^3	1.378	-			
pH 5:1 water		-	-			
Suction hieght	mm	335	315			
Specific Gravity		2.65	2.65			
volumetric water content		19.59	21.93			
Wet density	t/m^3	1.558	1.655			
Gravimetric Water content	%	14.4	15.3			
Dry Bulk Density	t/m^3	1.362	1.436			
TOTAL POROSITY	%	48.6	45.8			
Capillary Porosity	%	19.59	21.93			
Air fill porosity	%	29.0	23.9			

Hydraulic conductivity = 650mm/hr at a bulk density of 1.378t/m³

At a suction of 315mm, a specific gravity of 2.65 and at a wet bulk density of 1.655 t/m³ the mixture provides:

- A total porosity of 44.93%.
- A moisture retention of 21.93%by volume.
- An air filled porosity of 23.0%

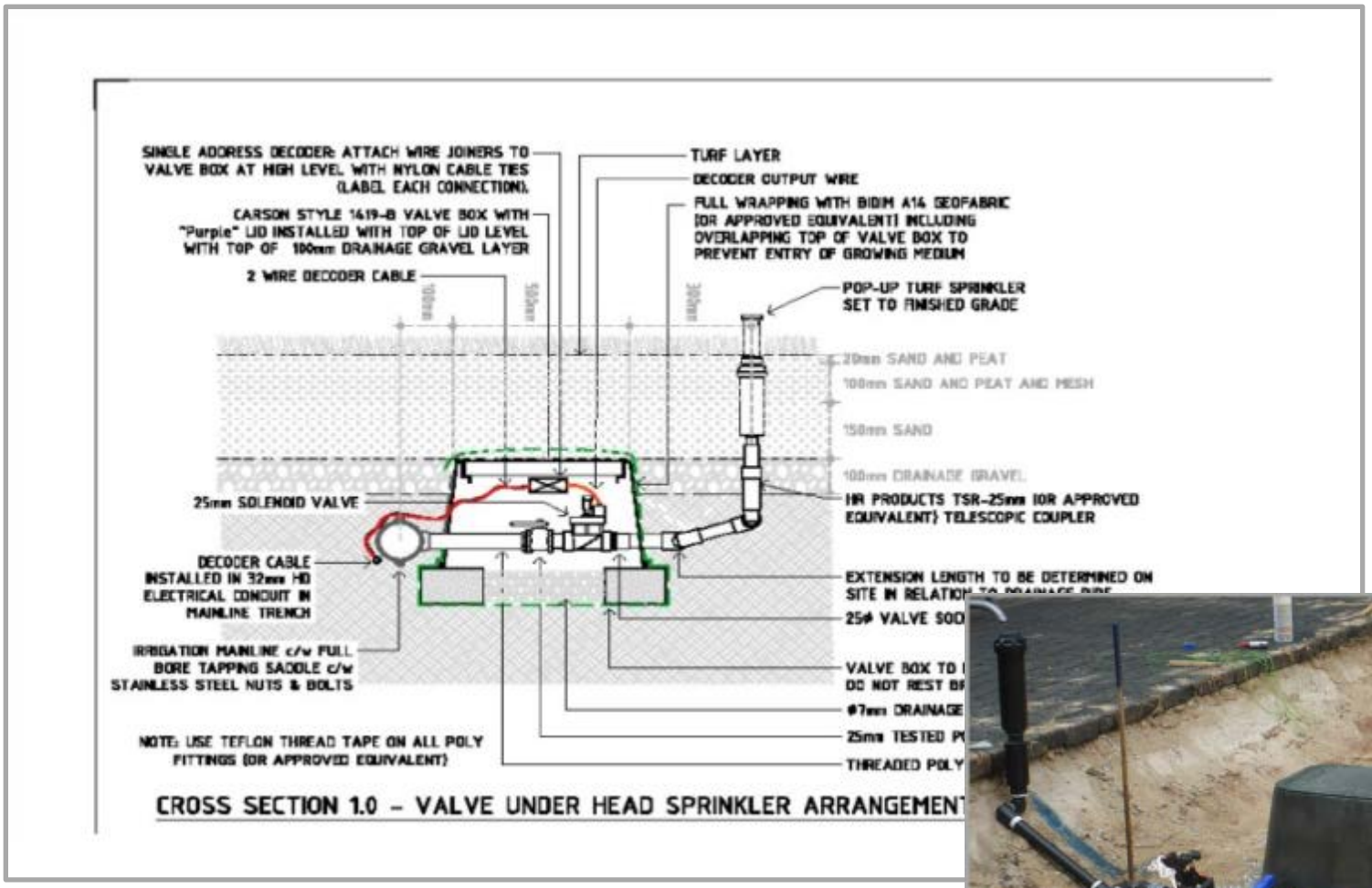

DETAIL 1.0: SPRINKLER & VALVE ARRANGEMENT
QCV c/w Ball Valve
Sprinkler head
Solenoid Valve c/w upstream ball valve
Decoder
ø75mm Submain
Line Surge Protector
Decoder Cable terminated at last valve on ø75mm submain
Contractor to verify all conduit locations and penetrations on site prior to commencement of works.
IC
Two decoder cables (one used and one backup) to be installed in conduit from the computer room to playing field. Spare decoder cable terminated in isolation valve box at edge of field.
The two cables inside the spare decoder cable to have a wire joiner on each to clean dry.
New ø25mm Quick Coupling Valve shown here for clarity. Refer Detail 1.0 for valve and sprinkler arrangement on non mainline field side.
Surge Protector installed on decoder cables c/w Grounding Plate in valve box in turf before wire join.
A new Rainbird Site Control irrigation control system (or approved equivalent) consisting of (2) complete central control PCs with decoder interface and software for both PCs with one central PC computer system serving the purpose of a complete backup system.
The new computer based control system shall be installed in the computer control office below the grandstand, all communication cables and conduit routes and penetrations are to be co-ordinated on site with the site superintendent and the arena manager. Decoder cable from computer room shall connect to field decoders via 24V decoder cabling.
Decoder Cable Installed in 32mm HDI Electrical Conduit
Decoder cable loop cut into at this point on each submain run for installation of valve decoder and continuation of single decoder cable to remaining valves on submain run
Single Station Decoder in Valve Box
Decoder Cable Installed in ø32mm conduit
Solenoid valve c/w upstream Ball valve in valve box buried under turf
Sprinkler Head
ø40mm MDPE PN16 Lateral
ø75mm MDPE PN16 Sub-Mainline
Sub mainline and decoder cable shown here for clarity. All to be installed 900mm offset from sprinkler grid setout
Submains run parallel with sub surface drainage pipes
New ø25mm Quick Coupling Valve
Line surge protector installed in valve box with solenoid valve
ø110mm MDPE PN16 Mainline
ø50mm Flanged Isolation Valve at each Sub-Main run
Decoder cable installed in common trench with the 110mm poly pipe.
Depth of all mainline pipework not running parallel with subsurface drainage pipes to be co-ordinated with drainage consultant/ contractor to ensure all alignments and depths are adhered to.
90° Sprinkler heads placement to be adjusted on site for best alignment
New ø50mm Mainline drain valve
New ø50mm Mainline air valve
New ø25mm Quick Coupling Valve shown here for clarity. Refer Detail 2.0 for valve and sprinkler arrangement on mainline field side.
ø80mm Master solenoid valve
1.0m wide section of paving to be removed for installation of new ø110mm Hdpe Pn16 mainline pipework. New rectangular valve box installed in rubber paving to house ø100mm field isolation valve with flanged ends.
New ø100mm isolation valve installed on existing ø100mm pvc mainline on edge of field
Existing ø100mm pvc mainline continues to pump room. (Refer pump dwg set wet-03-05 for further details)
Decoder Cable continues to next sprinkler on ø75mm submain
Decoder Cable from Central Controller
Note: Decoder cables combined in valve box of sprinkler on edge of field
Decoder cable installed with each sub-main connects to the decoder cable installed the ø110 poly main at the decoders.
Decoder output wire to solenoid valve
Sprinkler head
ø75mm Submain
ø40mm MDPE PN16 Lateral
Solenoid Valve c/w upstream ball valve
Decoder Cable to next ø75mm submain
QCV c/w Ball Valve
DETAIL 2.0: SPRINKLER & VALVE ARRANGEMENT
METRES
0 5 10 15 20 25
1:250 @ A1 SIZE
1:500 @ A3 SIZE
Escalator
Stand
LEGEND
NOTE:
ISSUE
CLIENT
TURF CONSU
IRRIGATION
PROJECT
DATE
19/12-1
SCALE
1:250@

Irrigation pipe

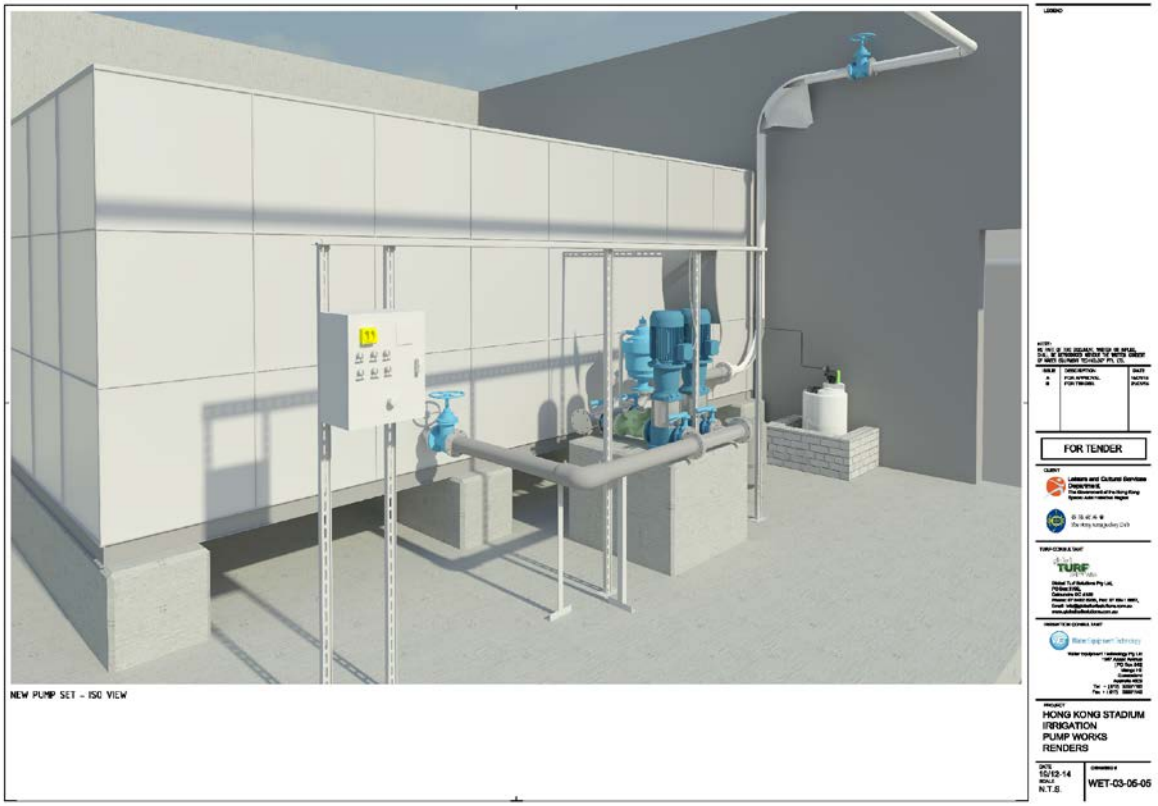
UPVC 100 (old)

PE100 [PN16] (new)

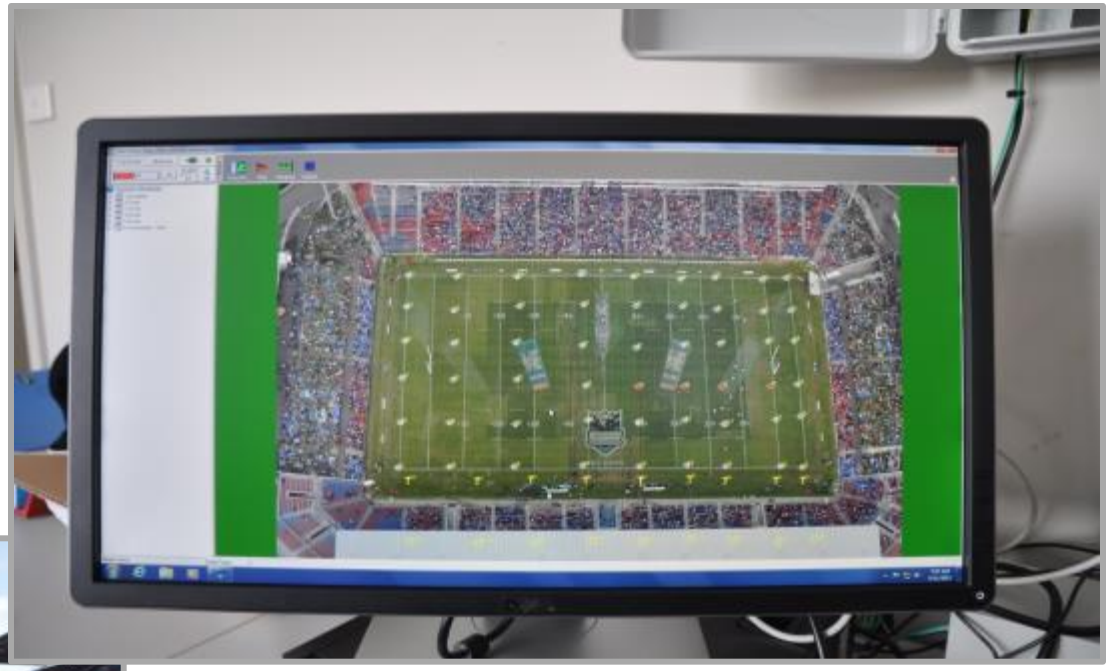
Valve Under Head Arrangement



Irrigation Pump Assembly



Computer Irrigation Controller



Profile Performance Influences

- To provide a consistent surface in all weather conditions.
- The factors that most influence surface performance are weather, usage, grass density and quality, maintenance, profile composition and its moisture retention and drainage.
- Maintaining healthy roots and low thatch will be critical to maintain the performance


Turf
Topping Sand
Sand Mesh Mix
Lower Sand
Gravel
Base

Late Dr. V. I. Stewart

What could go wrong :

unscientific design

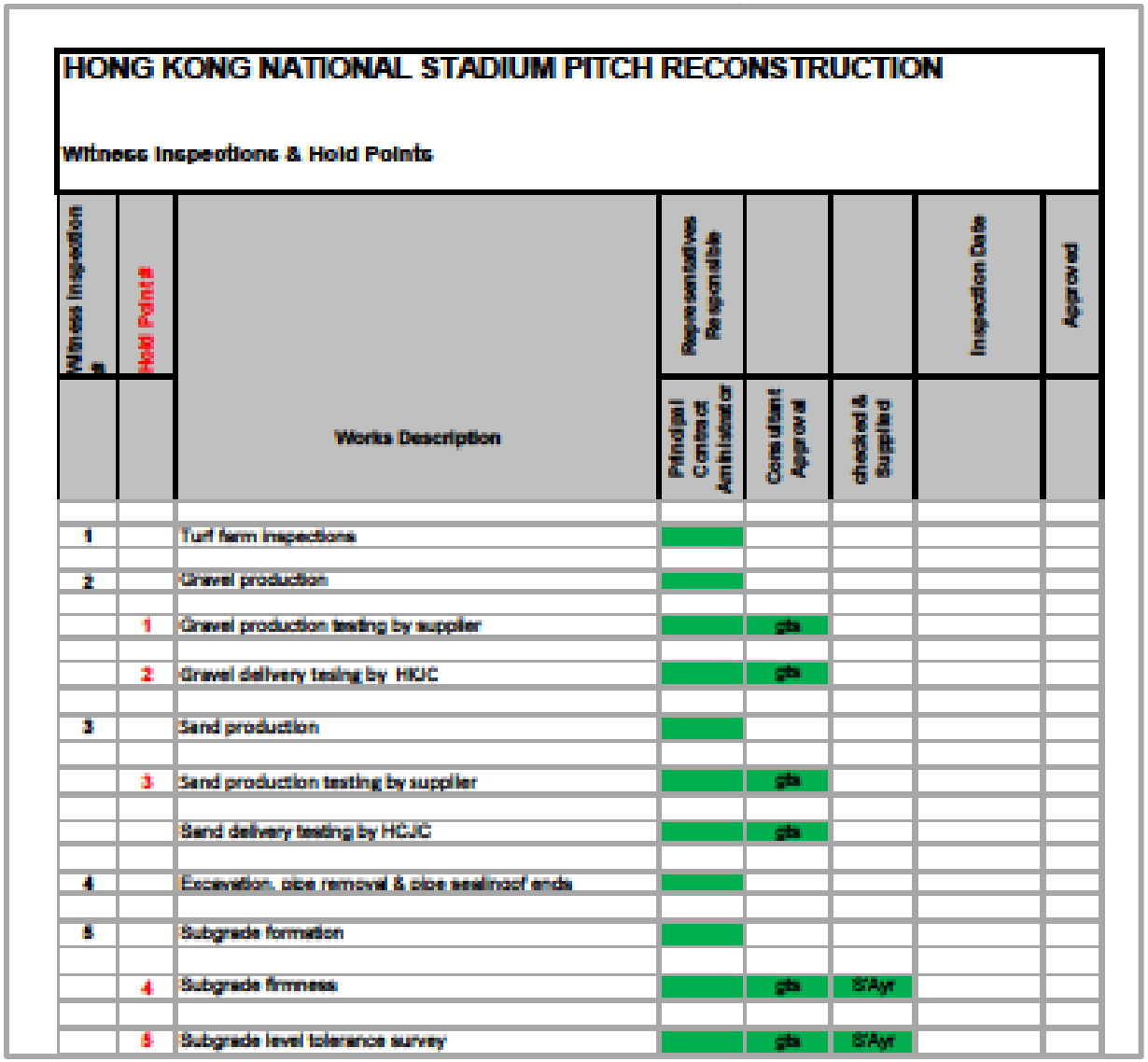
inefficient workmanship

inadequate supervision

inappropriate maintenance

1994

Quality Control Witness and Hold



HONG KONG NATIONAL STADIUM PITCH RECONSTRUCTION

Witness Inspections & Hold Points

Witness Inspection	Hold Points	Works Description	Representatives Responsible			Inspection Date	Approved
			Principal Contract Administrator	Consultant Approval	checked & Supplied		
1		Turf farm inspections					
2		Gravel production					
	1	Gravel production testing by supplier		gts			
	2	Gravel delivery testing by HKJC		gts			
3		Sand production					
	3	Sand production testing by supplier		gts			
		Sand delivery testing by HKJC		gts			
4		Excavation, obe removal & obe seal/roof ends					
5		Subgrade formation					
	4	Subgrade firmness		gts	SIAyr		
	5	Subgrade level tolerance survey		gts	SIAyr		

Quality Control : Material

- On Turf Farm
- On Quarry Plant
- On Stadium Site
- At Happy Valley Lab

ITGAP Farm (Fuzhou)

25/5/2015

ITGAP Farm (Fuzhou) information summary

- **Genetically pure foundation stock imported in 2013**
- Plant quarantine infra-structures
- Site Isolation fence
- Pre plant media fumigation
- Cleaning facility before nursery entry
- 5 m vegetation free zone
- Quality water supply and highly sandy rootzone

Sod cutting

Washing the sod by hose

Before wash: around 20-30mm root zone layer

After wash: Very good stolon, rhizome content

Reviewing turf packing & post harvest handling

Duomen Factory inspection

Gravel & Sand production

Production line inside factory

Finished product – on site PSD tests

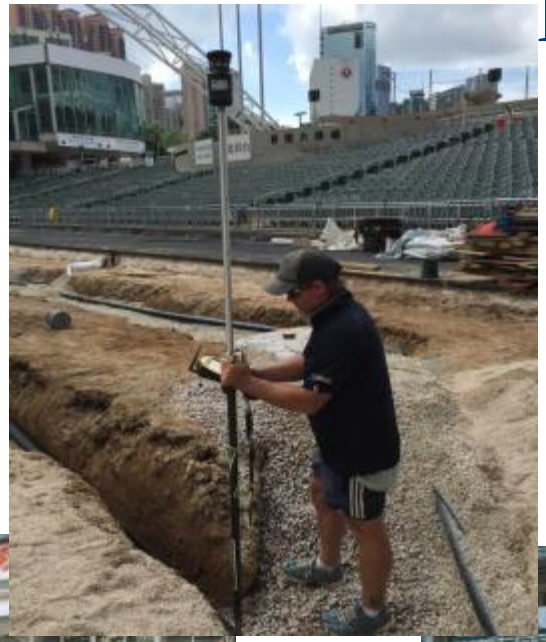
PSD tests in Happy Valley laboratory

Raw materials of 15-20 mm gravels

Final product of 15-20mm gravel

Construction Technologies & Site Progress

Laser Leveler

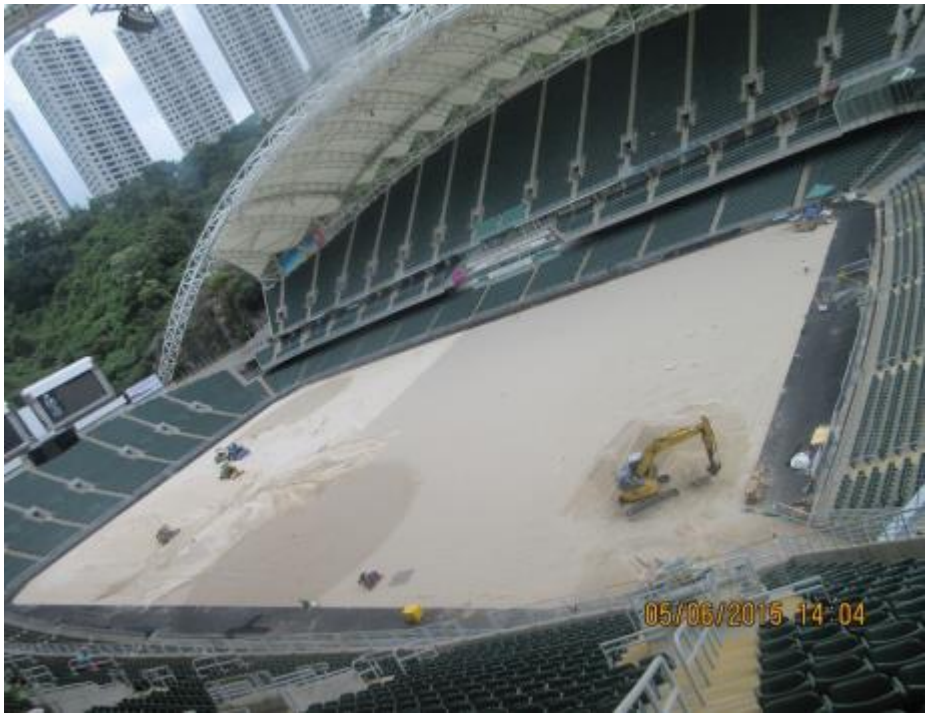


Field Top Maker

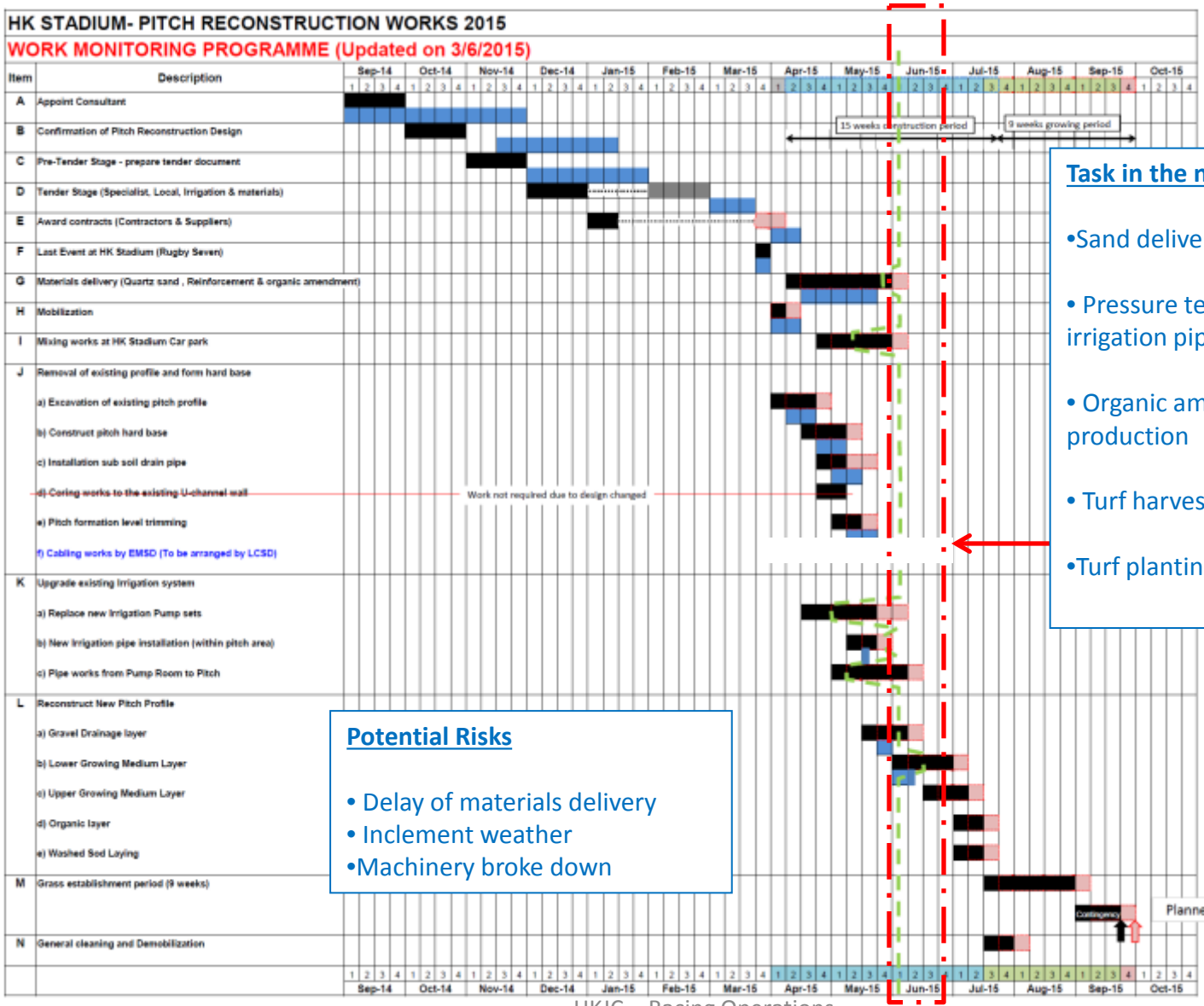
Sand mesh mix production commences

Drainage performance under the black rain storm

Latest Site Progress



Program Summary



Task in the next 3 weeks

- Sand delivery, 1800 Ton
- Pressure testing , Installation of the irrigation pipe and sprinkler system (10%)
- Organic amended sand mesh mix production
- Turf harvesting & delivery
- Turf planting

Potential Risks

- Delay of materials delivery
- Inclement weather
- Machinery broke down

Risk

Risk

"Sorry, but cannot do. Please find another supplier. "

Acknowledgement

- Mr. Peter Semos, Managing Director, Global Turf Solutions Pty Ltd
- Mr Ernie Gmehling, Managing Director, GroundScience
- Mr TY Cheung, Tracks Manager
- Mr Ray Cheng, Tracks Officer
- Ms Kiki Lau, Assistant Tracks Officer

Thank You !