SOIL AND SOIL LANDSCAPE INVESTIGATIONS

PART LOT 22 PACIFIC HIGHWAY
SANDY BEACH NORTH

AUGUST 2013
(REF: 3065/3)

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1. INTRODUCTION

This Report has been prepared to provide additional site specific information in relation to soil types and soil landscape units for two areas at Hearns Lake, north of the existing residential area. The study area is shown in Figure 1.

The purpose of this additional investigation is to determine:

i. The soil types present within this area from field and laboratory investigations;

ii. Whether the soil landscape mapping (Millford 1999) at 1:100,000 scale is accurate for the site level;

iii. Whether the vegetation growing on these soil types constitutes one of the various coastal floodplain endangered ecological communities as described by the NSW Scientific Committee;

iv. Whether the vegetation present can be classified as a sandplain vegetation community (which is different from a floodplain vegetation community).

The following sections of this Report provide details on the Coastal Floodplain Endangered Ecological Communities (EEC), soil landscapes, soil characteristics and vegetation types in relation to coastal floodplain EEC.

Previous assessments of the vegetation of the site have been undertaken by *Conacher Environmental Group* which have identified the presence of sandplain vegetation communities within the eastern part of the site (CEG 2008, 2011).

2. DETERMINATION AND CLASSIFICATION OF COASTAL FLOOPLAIN ENDANGERED ECOLOGICAL COMMUNITIES

The classification of a vegetation community as an EEC is dependent on the descriptive details provided by the NSW Scientific Committee in their publications on the Final Determinations issued under Schedule 3 of the TSC Act.

The Land and Environmental Court (LEC) may clarify or interpret these final determinations for a specific case or site. These interpretations generally establish the background for determining whether a particular vegetation type would be classified as an endangered ecological community where this differentiation is not clear cut according to the details provided in the respective final determinations of an EEC by the NSW Scientific Committee.

In the specific matters relating to the determination of several types of Coastal Floodplain vegetation communities being classified as an EEC the LEC (LEC 2004, 2005) has provided direction to the clarification of coastal floodplain EEC's and other vegetation communities eg. coastal sandplain communities not being classified as an EEC.

These two LEC cases support and enhance the Scientific Committee Final Determinations that for an EEC to be present other factors, other than vegetation type/species composition along, need to be considered before determining that a vegetation community is to be classified as an EEC.

The classification of a vegetation community as an EEC, particularly in regard to Coastal Floodplain EEC requires the following factors to be present within the vegetation community under assessment as identified in the judgement of Motorplex v's Port Stephens Council:

i. The location of the site within a bioregion or local government area identified in the final determination;
ii. The physiographic (landform) location of the community;
iii. The edaphic (soil type) factors identified in the final determination;
iv. Whether the site or vegetation community is associated with Coastal Floodplains.

In relation to the subject site clarification is required in regards to the presence of the particular Coastal Floodplain EEC, as identified in Table 1.

TABLE 1 COASTAL FLOODPLAIN ENDANGERED ECOLOGICAL COMMUNITIES	
RFEF	Riverflat Eucalypt Forest on Coastal Floodplains
SOF	Swamp Oak Floodplain Forest
SSF	Swamp Sclerophyll Forest on Coastal Floodplains
SCFF	Subtropical Coastal Floodplain Forest

A separate final determination has been made by the NSW Scientific Committee for each of the EEC identified in Table 1. These determinations identify specific soil parameters and landform/topographical elements particular to each EEC as identified in Table 2.

TABLE 2 SOIL LANDFORM ELEMENTS OF VARIOUS ENDANGERED ECOLOGICAL COMMUNITIES (from Smith 2009)		
EEC	**SOIL**	**LANDFORM**
RFEF	Silts, clay-loams and sandy loams	On periodically inundated alluvial flats, drainage lines and river terraces associated with coastal flooplains up to 250m elevation.
SOF	Grey black clay loams and sandy loams whre ground water is saline or subsaline	On waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains up to 20m elevation.
SSF	Humic clay loams and sandy loams	On waterloggedor periodically inundated alluvial flats and drainage lines associated with coastal flooplains up to 50m elevation. Or where larger floodplains adjoin lithic substrates or coastal sand plains.
SCFF	Clay loams and sandy loams	On periodically inundated alluvial flats, drainage lines and river terraces associated with coastal flooplains up to 250m elevation.

The Coastal Floodplain EEC's are not the same as vegetation communities which occur on coastal sandplains. The distinct differences in these two vegetation types are detailed by Keith and Scott (2005) and Griffith *et al* (2004) which identify that the soil substrates of these vegetation communities are significantly different.

As identified in Keith and Scott (2004), Smith (2009) and the LEC decisions previously referenced the presence of sandplain soils (sandy podzol soils) and sandplain topographies, which include sandplains, beach ridges and sand dunes are factors which separate coastal floodplain EEC from coastal sandplain vegetation communities which are not an EEC.

For the Gales Holdings v's Tween Shire Council case (LEC 2008) Chief Justice Preston supported the findings that vegetation communities formed a sandplain soils (ie sandy podzol soils) are not the same as the coastal floodplain EEC Communities described by the NSW Scientific Committee in their final determinations. Chief Justice Preston also found that

the soils and topographical features and their corresponding vegetation communities on the Gales Holdings site were not formed as a product or in association with fluvial processes and therefore the vegetation communities growing on these soils were not an EEC.

3. SOIL LANDSCAPE DETAILS

The association of soil types with specific topographic, landforms and geology is integrated for mapping and descriptive purposes into a soil landscape unit. Soil landscapes of the locality have been mapped and described (Millford 1999) at a scale of 1:100,000 and form a basis for analysing the determination of vegetation EEC. Soil landscapes can be grouped according to their similarities of landform/topographical elements, soil material and soil parent material features.

The groupings of soil landscapes in the Coffs Harbour area (Millford 1999) are:

- Residual
- Colluvial
- Erosional
- Transferral
- Alluvial
- Estuarine
- Beach
- Aeolian/barrier
- Swamp.

In relation to the subject site the description of soil landscape units from Millford (1999) are of relevance to this discussion. These are described below (from Millford 1999 pg 9, 10):

1) ***Beach Soil Landscapes*** *have ground surfaces and soil parent materials that have been deposited by wave action. Beach soil landscapes typically occur on sandy coastlines and lake edges. Typical landform elements include beaches, berms, beach ridges, plains and associated foredunes.*

2) ***Aeolian/Barrier Soil Landscapes*** *have accumulated by deposition of sand-sized particles by wind action. Aeolian/barrier soil landscapes include dunefields, dunes, blowouts, sand sheets and lunettes.*

3) ***Swamp Soil Landscapes*** *are dominated by ground surfaces and soils which are at least seasonally waterlogged. Soil parent material includes large amounts of accumulated, decayed organic matter. Watertables are frequently close to the surface. Landform elements may include swamp, relict oxbows, abandoned channels and some lagoons and swales.*

4) ***Alluvial Soil Landscapes*** *are formed by deposition along rivers and streams. Soil parent material is alluvium. Alluvial soil landscapes include floodplains and alluvial deposits. Typical landform elements include those found on meander plains including bars, backplains, scrolls, scroll plains, flood-outs, oxbows, levees, terraces and prior and current stream channels.*

5) ***Estuarine Soil Landscapes*** *occur where rivers and streams enter large bodies of water such as the sea or inland lakes. Channel flow is dissipated and modified by wave and/or tidal action. Soil materials may be influenced by saline conditions. Landform elements may include estuaries, tidal creeks and tidal flats.*

The soil landscape units present within the subject site are as outlined in Table 3.

TABLE 3 KEY CHARACTERISTICS OF RELEVANT SOIL LANDSCAPE UNITS	
Goolawah (Beach Soil Landscape Group)	**Landscape** – mainland and barrier beaches plus associated barrier foredune and incipient foredune on Quaternary (late Holocene)sands. Beach plains with relief and elevation <6m; foredunes with slopes up to 45%; relief 2-15m. Mixed herland/grassland to closed-woodland on foredunes. **Soils** – deep well-drained Siliceous Sands.
Coffs Harbour (Aeolian/Barrier Soil Landscape Group)	**Landscape** –low, flat to very gently undulating sandplain on Pleistocene beach and dune sand. Elevation <5m; relief <2m; slopes<3%. Extensively cleared, wet heathland. **Soils** – deep, moderately to poorly drained Podzols with sandy Acid Peats and Peaty Podzols in swamps .
Newports Creek (Swamp Soil Landscape Unit)	**Landscape** – low, level to gently undulating coastal back-barrier floodplains on Pleistocene estuarine sediments. Local relief <5m; slopes <2%; elevation <10m. Extensively cleared closed-forest (swamp sclerophyll forest). **Soils** – deep poorly-drained Yellow Podzolic Soils and Humic Gleys.

The presence of the Coffs Harbour and Newports Creek Soil Landscape units within the site is also identified in the following documents/reports:

1. Millford (1999);
2. Connell Wagner (2007);
3. WBM Oceanics (2006);
4. Coffs Harbour City Council (2005).

However the boundaries between the various soil landscape units within the site vary slightly in the various reports.

Additionally, the type photograph for the Newports Creek Soil Landscape (Millford 1999, pg 158) identifies a site location as "*east of the Pacific Highway, 300 metres south-west of Hearns Lake*". It would appear from this description that the type photograph is from the subject site to the west of the dune and sandplain vegetation.

The Coffs Harbour Soil Landscape Unit is located in the eastern part of the site while the Newports Creek Soil Landscape Unit is located within the north-west parts of the site and is mapped as extending into the south-east part of the site adjoining the Goolawah Soil Landscape (Figure 2). The boundary between these two soil landscape units would be located in the south-east part of the site but has not been specifically determined at this stage. Millford (1999) identifies that the Newports Creek Soil Landscape……"*grades eastwards into the podsolised Pliestoscene sands of the Coffs Harbour Soil Landscape across a boundary that is difficult to accurately locate in the field or on aerial photographs"*

The soil types identified within the subject site during field investigations match the descriptions for the respective soil landscape units identified in Table 3.

However field inspections has also confirmed that the boundary between the Newports Creek Soil Landscape and the Coffs Harbour Soil Landscape is located further to the south and west than is illustrated on the Soil Landscape Maps at 1:100,000 scale.

4. FIELD INVESTIGATIONS AND SOIL SAMPLING

To determine the soil types present within the site sub-soils were sampled at 11 locations by using a tractor mounted post-hole auger to sample to a depth of 1500-1700mm below the ground surface. Details of the test hole and soil characteristics were recorded. Soil samples from four of the test holes were collected from visually different soil horizons and sent to a soil laboratory for analysis (particle size distribution, texture classification).

The purpose of this soil sampling was to determine the occurrence of sand podzol soils (sandplain soils from the Coffs Harbour Soil Landscape) or clay loams from the Newports Creek Soil landscape.

The results of the soil texture determinations based on particle size analysis is provided in Table 4 with test results provided in Appendix 1.

TABLE 4
SOIL ANALYSIS – SOILTEXTURE GROUPING

Sample Name.	Sample No.	Texture Class*	Comments
A1/1	1	Sand	Coffs Harbour Soil Landscape
A1/2	2	Sand	Coffs Harbour Soil Landscape
A1/3	3	Sand	Coffs Harbour Soil Landscape
A1/4	4	Sand	Coffs Harbour Soil Landscape
B1/1	5	Sand	Coffs Harbour Soil Landscape
B1/2	6	Sand	Coffs Harbour Soil Landscape
C1/1	7	Sand	Coffs Harbour Soil Landscape
C1/2	8	Sand	Coffs Harbour Soil Landscape
C1/3	9	Sand	Coffs Harbour Soil Landscape
D1/1	15	Silt	Newports Creek Soil Landscape
D1/2	16	Silty Clay Loam	Newports Creek Soil Landscape
D1/3	17	Silty Clay	Newports Creek Soil Landscape
D1/4	18	Silty Clay	Newports Creek Soil Landscape

** Refer to soil analysis results in Appendix 1 for detailed Particle Size Analysis % for each sample.*

The soil test results support the field observation that:

i. The soils from the south-east part of the site are predominantly medium sand with insignificant percentages of silt and clay sized particles. These soils are characteristics of sand podzols of the Coffs Harbour Soil Landscapes Units;

ii. The sandplain associated with the Coffs Harbour Soil Landscape Unit extends into the flat land further to the west than the mapped boundary for this soil landscape unit;

iii. The soils from the north-west parts of the site are silty-clays or silty loams characteristics of the Newports Creek Soil Landscape;

Although no mineralogy tests were completed for the sampled soils the results of the field observations and laboratory tests indicate that the soils present are of a type that would be expected to occur in each of the respective soil landscape units (ie Coffs Harbour or Newports Creek Soil Landscape Units). However the boundary between these two soil landscape units is located further to the south and west than depicted in the soil landscape maps.

5. SANDPLAIN OR COASTAL FLOODPLAIN VEGETATION COMMUNITIES

Based on the results of the soil investigations, topographical/landscape units and vegetation community present the vegetation present in the south-east part of the site would be grouped as Dune Forest (Group 23) or Swamp Sclerophyll Forest on Coastal Sandplains (Group 10) as described by Keith and Scott (2005). These vegetation communities present on sand dunes and sandplains are not the same as coastal floodplain vegetation communities.

6. CONCLUDING COMMENTS

i. The results of the soil testing (both field observations and laboratory soil texture results) confirm that the soils in the south-east part of the site comprise sandy podzol soils which occur within the aeolian soil landscape unit of Coffs Harbour. These soils, and the associated vegetation growing on them are part of the sandplain vegetation communities and are not classified within any of the coastal floodplain EEC.

ii. The results of the soil testing (both field observations and laboratory soil texture results) confirm that the soils in the north-west part of the site comprise yellow podzollic soils with a silty clay texture which occur within the swamp landscape of Newports Creek.

iii. The extent of the Coffs Harbour Soil Landscape unit within the site includes areas in the south east part of the site which are shown as being within the Newports Creek Soil Landscape Unit.

On the basis of the detailed information obtained from subsoil investigations it is concluded that:

- The Coffs Harbour Soil Landscape Unit is more extensive in the south-east part of the site than is illustrated on the 1:100,000 Soil Landscape Mapping (Millford 1999);

- The vegetation growing on the sandy podzol soils within the south-east part of the site are sandplain vegetation communities and are not vegetation communities classified within the coastal floodplain endangered ecological communities.

Investigation prepared by:

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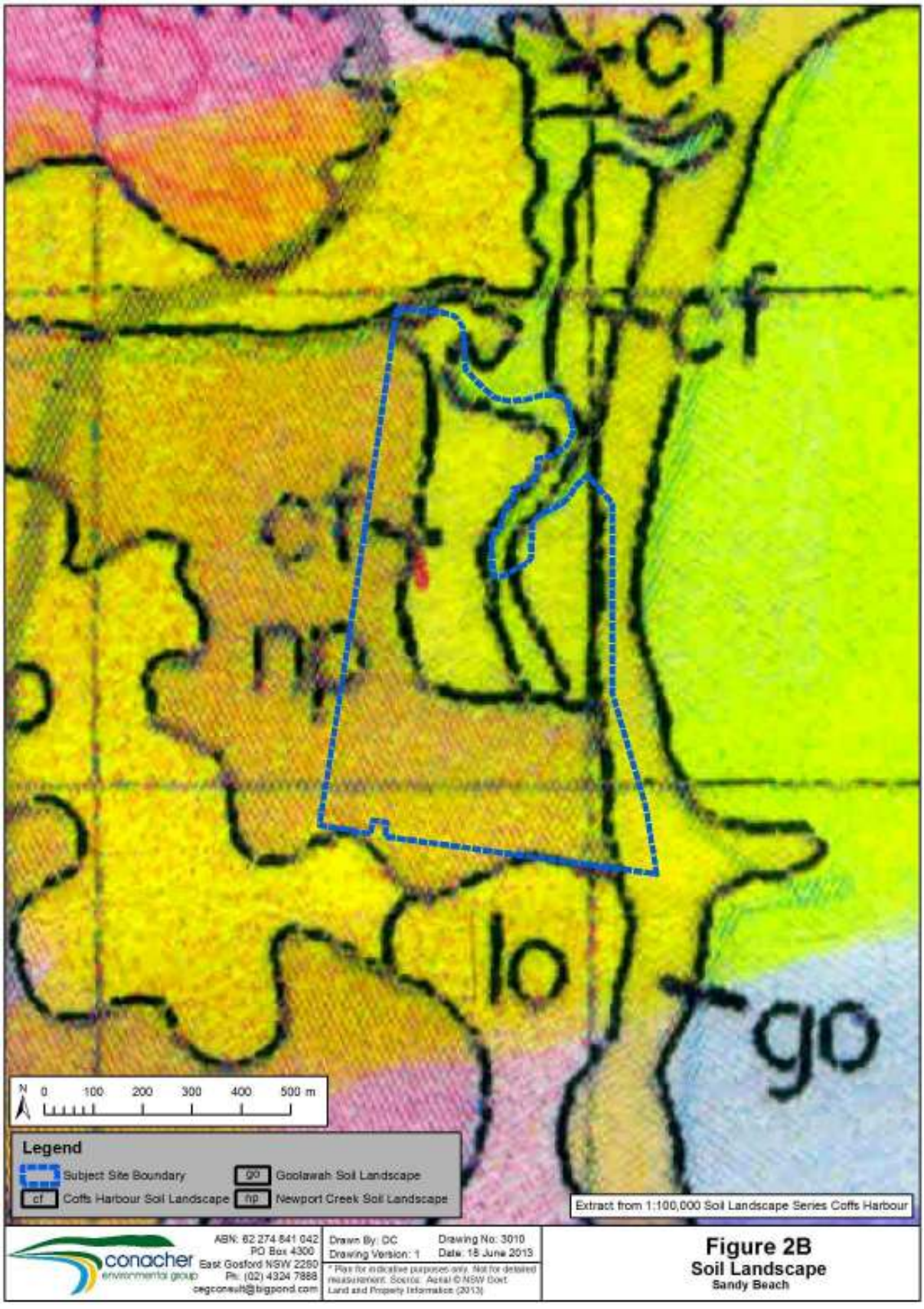
Director
Conacher Environmental Group

Dated: 12 August 2013


cf
cf
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N
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100
200
300
400
500 m
Legend
Subject Site Boundary
go Goolawah Soil Landscape
cf Coffs Harbour Soil Landscape
np Newport Creek Soil Landscape
Extract from 1:100,000 Soil Landscape Series Coffs Harbour
conacher environmental group
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Ph: (02) 4324 7888
cegconsult@bigpond.com
Drawn By: CC
Drawing No: 3010
Drawing Version: 1
Date: 18 June 2013
* Plan for indicative purposes only. Not for detailed measurement. Source: Aerial © NSW Govt Land and Property Information (2013)
Figure 2B
Soil Landscape
Sandy Beach


D1
B2
B1
A4
C1
A3
A1
C2
A2
Legend
Soil Sample Locations
Subject Site Boundary
N
0
50
100
150
200 m
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Date: 18 June 2013
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Figure 1
Soil Sample Locations
Pacific Highway, Sandy Beach


cf
me
su
me
cf
cf
np
ul
go
lo
N 0 50 100 150 200 m
Legend
Subject Site Boundary
Goolawah Soil Landscape
Coffs Harbour Soil Landscape
Newport Creek Soil Landscape
Extract from Soil Landscapes Coffs Harbour OEH Data Catalog Online
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Drawn By: DC
Drawing No: 3065
Drawing Version: 1
Date: 13/08/13
* Plan for indicative purposes only. Not for detailed measurement. Source: Aerial © NSW Dept Land and Property Information (2013)
Figure 2A
Soil Landscape
Sandy Beach

APPENDIX 1

SOIL TEST RESULTS

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
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Batch N°: 26835	Sample N°: 1	Date Received: 5/7/13	Report Status: ○ Draft ◉ Final

Client Name:	**Conacher Environmental Group**	Project Name:	**Particle Size Analysis - Coffs Hbr**
Client Contact:	**Phil Conacher**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**13/004**	Sample Name:	**A1/1**
Address:	**PO Box 4300** **EAST GOSFORD NSW 2250**	Description:	**Soil**
		Test Type:	**PSA_AS, Texture_SESL**

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	99.90	0.10
0.6	Medium Sand	99.60	0.30
0.425	Medium Sand	97.80	1.80
0.3	Medium Sand	81.50	16.30
0.15	Fine Sand	9.60	71.90
0.075	Fine Sand	5.00	4.60
0.02	V. Fine Sand	4.1	0.9
0.002	Silt	.9	3.2
<0.002	Clay	0%	1

D VALUES	
D_{100}:	2.36
D_{95}:	0.40
D_{90}:	0.37
D_{85}:	0.33
D_{80}:	0.26
D_{50}:	0.23
D_{30}:	0.20
D_{20}:	0.19
D_{25}:	0.18
D_{15}:	0.16
D_{10}:	0.15
D_5:	0.08

Coefficient of Uniformity (Cu): 1.69 - Uniform particle grading, potential surface instability.

Coefficient of Curvature (Cc): 0.96

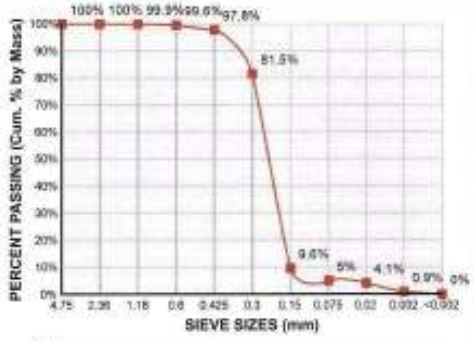
Gradation Index (GI): 2.42 - Uniform particle grading, potential surface instability.

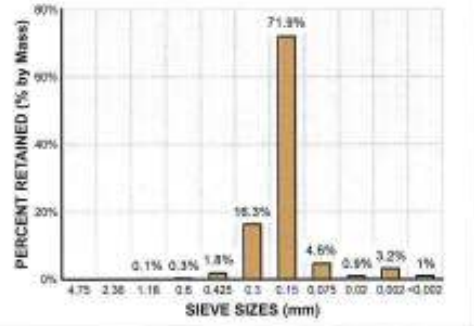
Fineness Modulus (Fm): 1.1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Uniformly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

sesl AUSTRALIA

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
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Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 1 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>3 0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 1
Silt (%)*: 4.1
Sand (%): 94.9
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1.1	
Effective particle diameter - D_{eff} (mm):	0.203	
Median particle diameter - Dmed (mm):	0.23	Fine sand
Saturation (cm³ water/cm³):	0.26	
Field capacity (cm³ water/cm³):	0.09	
Permanent wilting point (cm³ water/cm³):	0.03	
Available water capacity (cm³ water/cm³):	0.06	(6% v/v)
Total porosity* (%v/v):	28	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	9	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	17	(Typically 10 – 28%v/v)
Critical Tension (mm):	351.7	

* at Field Capacity

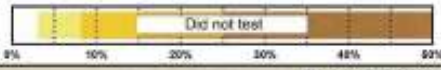
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.86
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 521
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test

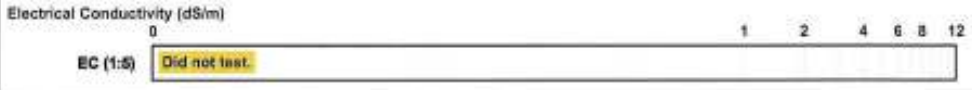


Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY



Electrical Conductivity by Saturated Extract (EC$_e$ dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chanway & Roper 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Landscape Guidelines, Soil Testing Procedure LG-S02.
pH and Electrical Conductivity: Bradley et al (1992)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1994) Sports Turf Science, construction, and maintenance.

Tests are performed under a quality system certified as complying with ISO 9001: 2008. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.

Turf Root Zone Assessment (AS Sieves)

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Batch N°: 26835 **Sample N°:** 2 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	A1/2
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

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<0.002	Clay	0%	0.4

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D_{50}:	0.28
D_{30}:	0.24
D_{20}:	0.21
D_{10}:	0.20
D_{05}:	0.19
D_{03}:	0.17
D_{02}:	0.15
D_0:	0.09

Coefficient of Uniformity (Cu): 1.67 - Uniform particle grading, potential surface instability.

Coefficient of Curvature (Cc): 0.96

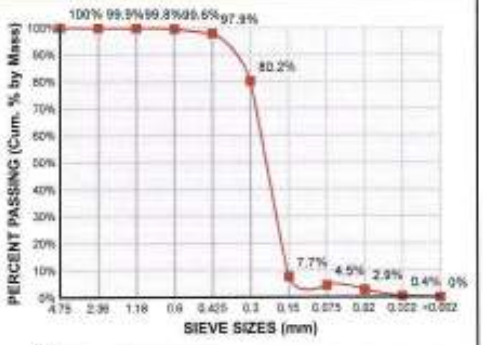
Gradation Index (GI): 2.39 - Uniform particle grading, potential surface instability.

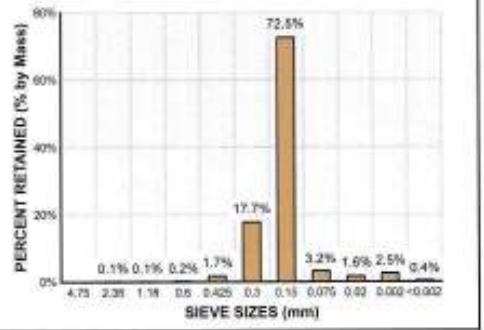
Fineness Modulus (Fm): 1.1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Uniformly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





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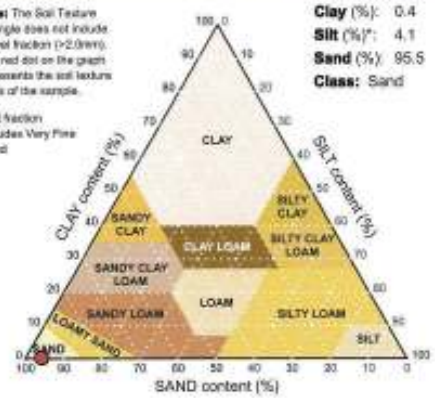
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 2 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand



Clay (%): 0.4
Silt (%)*: 4.1
Sand (%): 95.5
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1.1	
Effective particle diameter - D_{eff} (mm):	0.206	
Median particle diameter - Dmed (mm):	0.24	Fine sand
Saturation (cm³ water/cm³):	0.21	
Field capacity (cm³ water/cm³):	0.09	
Permanent wilting point (cm³ water/cm³):	0.03	
Available water capacity (cm³ water/cm³):	0.06	(6% v/v)
Total porosity* (%v/v):	21	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	9	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	12	(Typically 10 – 28%v/v)
Critical Tension (mm):	346.6	

* at Field Capacity

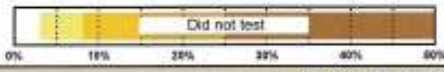
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 2.09
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 535
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test



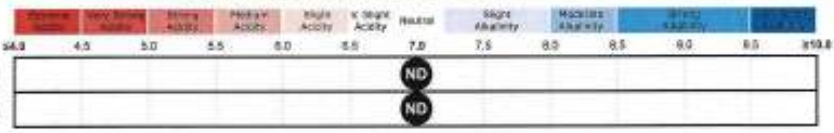
Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

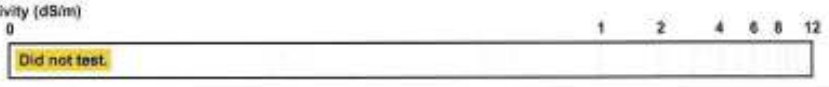
Repacked core method:	Point:	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY

pH Analysis



Electrical Conductivity (dS/m)



Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee **Authorised Signatory:** Ryan Jacka **Date of Report:** 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Charman & Roper 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Contams Landscape Guidelines, Soil Testing Procedure LG-822.
pH and Electrical Conductivity: Bradley et al (1992)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1994) Sports Turf: Science, construction and maintenance.

Tests are performed under a quality system certified as complying with ISO 9001: 2008. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554 **Fax:** 02 9484 2427
Em: info@sesl.com.au **Web:** www.sesl.com.au

Batch N°: 26835 **Sample N°: 3** **Date Received: 5/7/13** **Report Status:** ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	A1/3
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	100.00	0.00
0.6	Medium Sand	99.80	0.20
0.425	Medium Sand	98.30	1.50
0.3	Medium Sand	83.60	14.70
0.15	Fine Sand	12.90	70.70
0.075	Fine Sand	9.30	3.60
0.02	V. Fine Sand	6.5	2.8
0.002	Silt	1.9	4.6
<0.002	Clay	0%	1.8

D VALUES	
D_{100}:	1.18
D_{90}:	0.40
D_{80}:	0.35
D_{60}:	0.31
D_{50}:	0.25
D_{30}:	0.23
D_{25}:	0.20
D_{15}:	0.19
D_{10}:	0.18
D_{5}:	0.15
D_{3}:	0.09
D_{0}:	0.01

Coefficient of Uniformity (Cu): 2.79 - Optimal range for sportsfield applications.

Coefficient of Curvature (Cc): 1.55

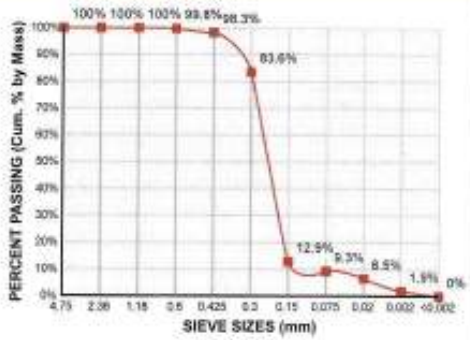
Gradation Index (GI): 3.96 - Optimal range for sportsfield applications.

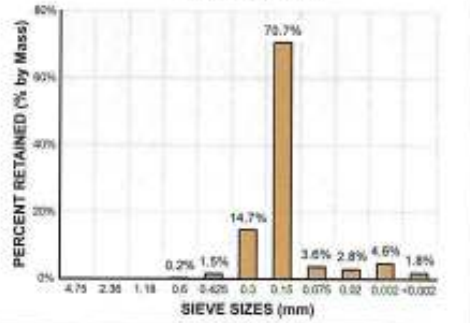
Fineness Modulus (Fm): 1.1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

sesl AUSTRALIA

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
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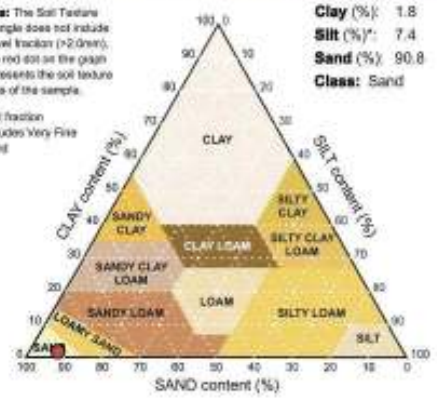
Web: www.sesl.com.au

Batch N°: 26835 | Sample N°: 3 | Date Received: 5/7/13 | Report Status: ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand



Clay (%): 1.8
Silt (%)*: 7.4
Sand (%): 90.8
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1.1	
Effective particle diameter - D_{eff} (mm):	0.176	
Median particle diameter - Dmed (mm):	0.23	Fine sand
Saturation (cm³ water/cm³):	0.3	
Field capacity (cm³ water/cm³):	0.11	
Permanent wilting point (cm³ water/cm³):	0.04	
Available water capacity (cm³ water/cm³):	0.07	(7% v/v)
Total porosity* (%v/v):	30	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	11	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	19	(Typically 10 – 28%v/v)
Critical Tension (mm):	405.7	

* at Field Capacity

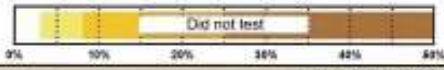
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.86
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 407
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test

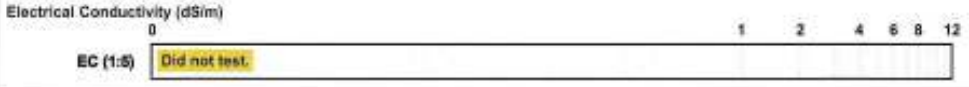


Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY



Electrical Conductivity by Saturated Extract (EC$_e$, dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Charman & Roper 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Lawnseed Guidelines, Soil Testing Procedure LG 822.
pH and Electrical Conductivity: Radley et al. (1963)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Dexter, V.I. (1994) Sports Turf: Science, construction, and maintenance.

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Page 2 of 2

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
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Web: www.sesl.com.au

Batch N°: 26835	Sample N°: 4	Date Received: 5/7/13	Report Status: ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	A1/4
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	99.90	0.10
0.6	Medium Sand	99.70	0.20
0.425	Medium Sand	98.10	1.60
0.3	Medium Sand	81.70	16.40
0.15	Fine Sand	14.00	67.70
0.075	Fine Sand	8.50	5.50
0.02	V. Fine Sand	6.4	2.1
0.002	Silt	9	5.5
<0.002	Clay	0%	0.8

D VALUES	
D_{100}:	2.36
D_{90}:	0.40
D_{80}:	0.36
D_{60}:	0.33
D_{50}:	0.25
D_{40}:	0.23
D_{30}:	0.20
D_{20}:	0.19
D_{25}:	0.17
D_{15}:	0.15
D_{10}:	0.10
D_5:	0.02

Coefficient of Uniformity (Cu): 2.64 - Optimal range for sportsfield applications.

Coefficient of Curvature (Cc): 1.43

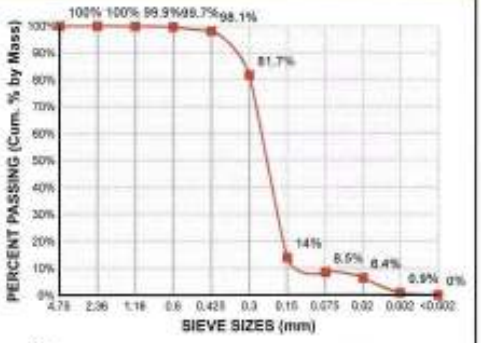
Gradation Index (GI): 3.81 - Optimal range for sportsfield applications.

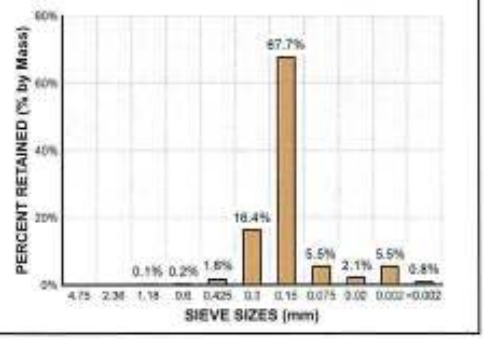
Fineness Modulus (Fm): 1.1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
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Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835	Sample N°: 4	Date Received: 5/7/13	Report Status: ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 0.8
Silt (%)*: 7.6
Sand (%): 91.6
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1.1	
Effective particle diameter - D_{eff} (mm):	0.174	
Median particle diameter - Dmed (mm):	0.23	Fine sand
Saturation (cm³ water/cm³):	0.25	
Field capacity (cm³ water/cm³):	0.1	
Permanent wilting point (cm³ water/cm³):	0.03	
Available water capacity (cm³ water/cm³):	0.07	(7% v/v)
Total porosity* (%v/v):	25	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	10	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	15	(Typically 10 – 28%v/v)
Critical Tension (mm):	410.3	

* at Field Capacity

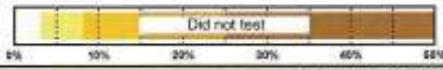
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.99
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 399
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test



Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY

Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee
Authorised Signatory: Ryan Jacka
Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chapman & Pratt 1982
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1992, Canberra Landscape Guidelines, Soil Testing Procedure LG 9.02
pH and Electrical Conductivity: Bradley et al (1982)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1994) Sports Turf: Science, construction, and maintenance.

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Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 | Sample N°: 5 | Date Received: 5/7/13 | Report Status: ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	B1/1
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	99.90	0.10
0.6	Medium Sand	99.70	0.20
0.425	Medium Sand	99.30	0.40
0.3	Medium Sand	96.30	3.00
0.15	Fine Sand	14.10	82.20
0.075	Fine Sand	1.50	12.60
0.02	V. Fine Sand	1.9	-0.4
0.002	Silt	.1	1.8
<0.002	Clay	0%	0

D VALUES	
D_{100}:	2.36
D_{95}:	0.30
D_{90}:	0.29
D_{85}:	0.28
D_{80}:	0.23
D_{50}:	0.22
D_{30}:	0.19
D_{25}:	0.18
D_{20}:	0.17
D_{15}:	0.15
D_{10}:	0.13
D_5:	0.10

Coefficient of Uniformity (Cu): 1.86 - Uniform particle grading, potential surface instability.

Coefficient of Curvature (Cc): 1.09

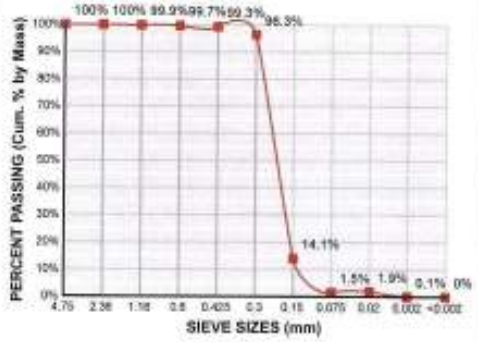
Gradation Index (GI): 2.3 - Uniform particle grading, potential surface instability.

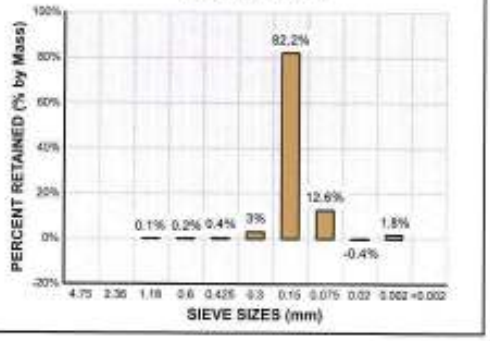
Fineness Modulus (Fm): .9 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
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Web: www.sesl.com.au

Batch N°: 26836 | Sample N°: 5 | Date Received: 5/7/13 | Report Status: ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 0
Silt (%)*: 1.4
Sand (%): 98.6
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	9	
Effective particle diameter - D_{10} (mm):	0.188	
Median particle diameter - Dmed (mm):	0.22	Fine sand
Saturation (cm³ water/cm³):	?	
Field capacity (cm³ water/cm³):	0.08	
Permanent wilting point (cm³ water/cm³):	0.02	
Available water capacity (cm³ water/cm³):	0.06	(6% v/v)
Total porosity* (%v/v):	?	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	8	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	?	(Typically 10 – 28%v/v)
Critical Tension (mm):	379.8	

* at Field Capacity

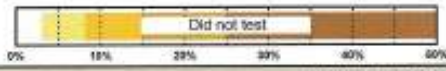
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): ?
Saturated Hydraulic Conductivity using D_{10} (mm/hr): 456
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test

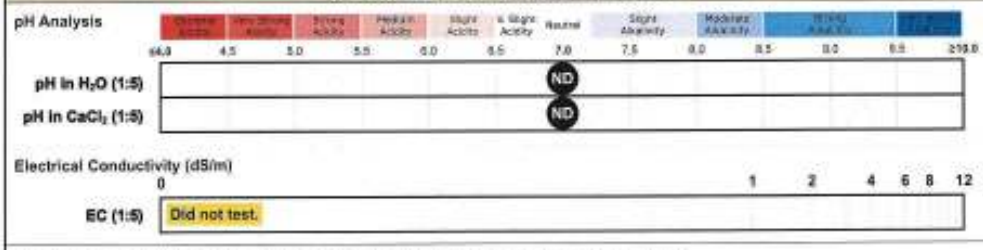


Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY



Electrical Conductivity (dS/m)

Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chapman & Roper 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1998. Canberra Landscape Guidelines, Soil Testing Procedure LG 822.
pH and Electrical Conductivity: Bradley et al (1997)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1984) Sports Turf: Science, construction, and maintenance.

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Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
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Web: www.sesl.com.au

Batch N°: 26835 | **Sample N°: 6** | **Date Received: 5/7/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Conacher Environmental Group**	Project Name:	**Particle Size Analysis - Coffs Hbr**
Client Contact:	**Phil Conacher**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**13/004**	Sample Name:	**B1/2**
Address:	**PO Box 4300** **EAST GOSFORD NSW 2250**	Description:	**Soil**
		Test Type:	**PSA_AS, Texture_SESL**

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	100.00	0.00
0.6	Medium Sand	100.00	0.00
0.425	Medium Sand	99.80	0.20
0.3	Medium Sand	97.30	2.50
0.15	Fine Sand	20.70	76.60
0.075	Fine Sand	1.10	19.60
0.02	V. Fine Sand	1.9	-0.8
0.002	Silt	.5	1.4
<0.002	Clay	0%	0.4

D VALUES	
D_{100}:	0.60
D_{95}:	0.30
D_{90}:	0.29
D_{85}:	0.28
D_{80}:	0.23
D_{50}:	0.21
D_{30}:	0.18
D_{20}:	0.17
D_{25}:	0.16
D_{15}:	0.13
D_{10}:	0.11
D_5:	0.09

Coefficient of Uniformity (Cu): 2.08 - Optimal range for sportsfield applications.

Coefficient of Curvature (Cc): 1.14

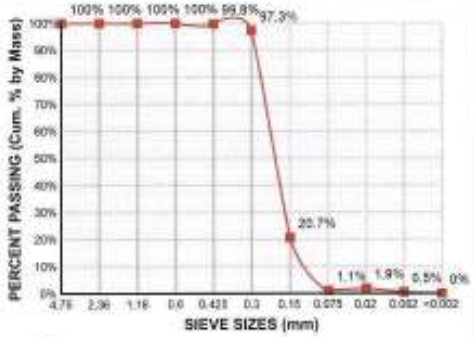
Gradation Index (GI): 2.62 - Uniform particle grading, potential surface instability.

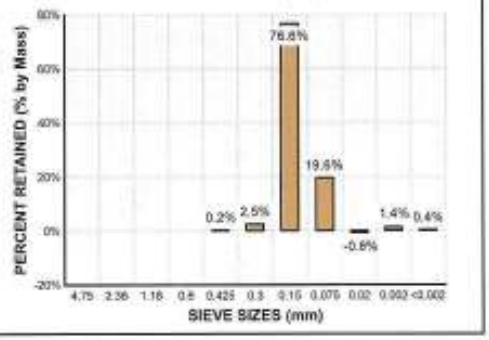
Fineness Modulus (Fm): .8 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

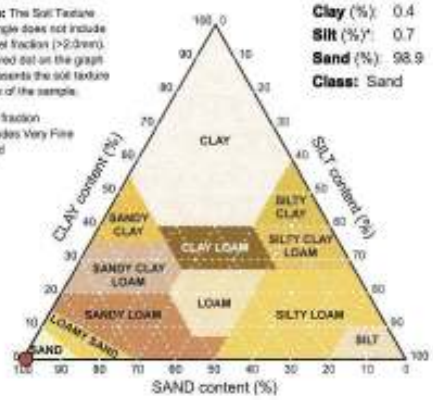
Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 6 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand



Clay (%): 0.4
Silt (%)*: 0.7
Sand (%): 98.9
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	.8	
Effective particle diameter - D_{e0} (mm):	0.178	
Median particle diameter - Dmed (mm):	0.21	Fine sand
Saturation (cm³ water/cm³):	0.21	
Field capacity (cm³ water/cm³):	0.08	
Permanent wilting point (cm³ water/cm³):	0.03	
Available water capacity (cm³ water/cm³):	0.05	(5% v/v)
Total porosity* (%v/v):	21	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	8	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	13	(Typically 10 – 28%v/v)
Critical Tension (mm):	401.1	

* at Field Capacity

Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 2.09
Saturated Hydraulic Conductivity using D_{e0} (mm/hr): 415
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

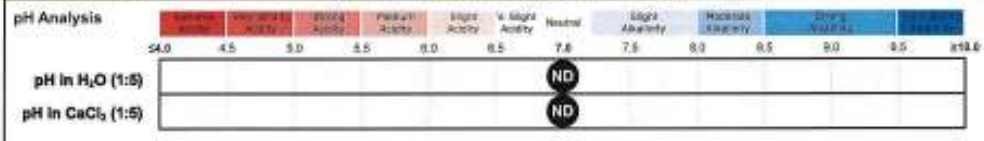
Organic Matter (%w/v): -
Did not test

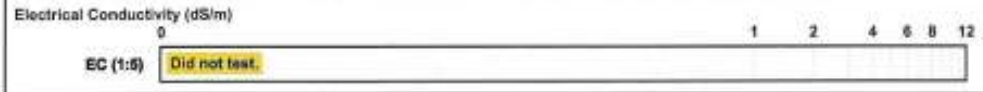
Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY





Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee **Authorised Signatory:** Ryan Jacka **Date of Report:** 18/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chapman & Pratt 1982
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Landscape Guidelines, Soil Testing Procedure LG 822.
pH and Electrical Conductivity: Bradley et al (1983)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Rosetti, V.I. (1984) Sports Turf: Science, construction, and maintenance.

Tests are performed under a quality system certified as complying with ISO 9001:2008. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 | **Sample N°: 7** | **Date Received: 5/7/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Conacher Environmental Group**	Project Name:	**Particle Size Analysis - Coffs Hbr**
Client Contact:	**Phil Conacher**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**13/004**	Sample Name:	**C1/1**
Address:	**PO Box 4300** **EAST GOSFORD NSW 2250**	Description:	**Soil**
		Test Type:	**PSA_AS, Texture_SESL**

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	99.90	0.10
0.6	Medium Sand	99.60	0.30
0.425	Medium Sand	98.10	1.50
0.3	Medium Sand	85.10	13.00
0.15	Fine Sand	13.10	72.00
0.075	Fine Sand	8.00	5.10
0.02	V. Fine Sand	5.2	2.8
0.002	Silt	1	4.2
<0.002	Clay	0%	1

D VALUES	
D_{100}:	2.36
D_{90}:	0.40
D_{80}:	0.35
D_{60}:	0.30
D_{50}:	0.25
D_{30}:	0.23
D_{15}:	0.20
D_{10}:	0.19
D_{05}:	0.17
D_{02}:	0.15
D_{10}:	0.10
D_5:	0.02

Coefficient of Uniformity (Cu): 2.37 - Optimal range for sportsfield applications.

Coefficient of Curvature (Cc): 1.33

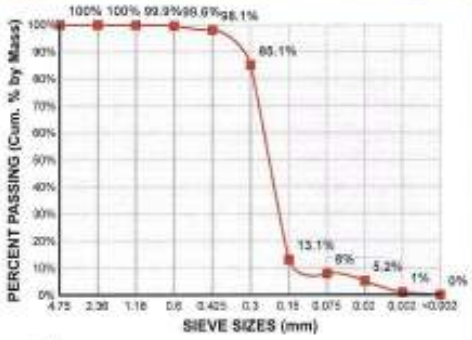
Gradation Index (GI): 3.32 - Optimal range for sportsfield applications.

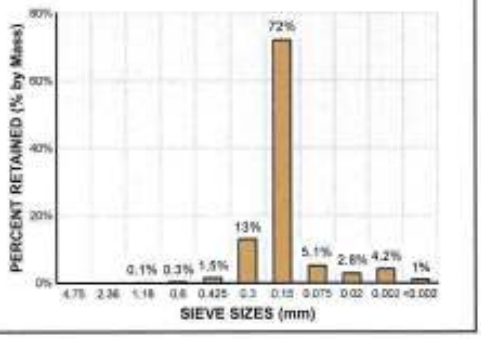
Fineness Modulus (Fm): 1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6854
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 | Sample N°: 7 | Date Received: 5/7/13 | Report Status: ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 1
Silt (%)*: 7
Sand (%): 92
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1	
Effective particle diameter - D_{eff} (mm):	0.175	
Median particle diameter - Dmed (mm):	0.23	Fine sand
Saturation (cm³ water/cm³):	0.27	
Field capacity (cm³ water/cm³):	0.1	
Permanent wilting point (cm³ water/cm³):	0.03	
Available water capacity (cm³ water/cm³):	0.07	(7% v/v)
Total porosity* (%v/v):	27	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	10	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	17	(Typically 10 – 28%v/v)
Critical Tension (mm):	408	

* at Field Capacity

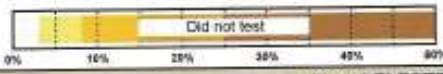
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.93
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 403
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test



Actual Ksat results (Laboratory determination)

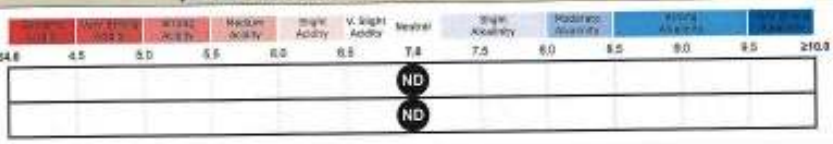
Field core method (cm/hr): Did not test.

Repacked core method:

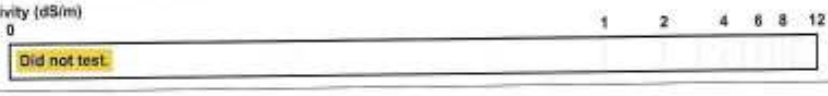
Point	Ksat (mm/hr)	Bulk Density (g/cm³)
8 drops:	D.N.T.	Tube N°?
16 drops:	D.N.T.	Tube N°?
32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY

pH Analysis



Electrical Conductivity (dS/m)



Electrical Conductivity by Saturated Extract (EC, dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chatman & Rogers 2008
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1998, Canberra Landscape Guidelines, Soil Testing Procedure LG 822.
pH and Electrical Conductivity: Bradley et al (1963)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1998) Sports Turf: Science, construction, and maintenance

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Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
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Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 8 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	C1/2
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	100.00	0.00
0.6	Medium Sand	99.90	0.10
0.425	Medium Sand	98.60	1.30
0.3	Medium Sand	84.70	13.90
0.15	Fine Sand	9.20	75.50
0.075	Fine Sand	3.20	6.00
0.02	V. Fine Sand	3	0.2
0.002	Silt	.3	2.7
<0.002	Clay	0%	0.5

D VALUES	
D_{100}:	1.18
D_{95}:	0.39
D_{90}:	0.35
D_{85}:	0.30
D_{80}:	0.25
D_{70}:	0.23
D_{60}:	0.20
D_{50}:	0.19
D_{40}:	0.18
D_{30}:	0.16
D_{20}:	0.15
D_{10}:	0.10

Coefficient of Uniformity (Cu): 1.66 - Uniform particle grading, potential surface instability.

Coefficient of Curvature (Cc): 0.96

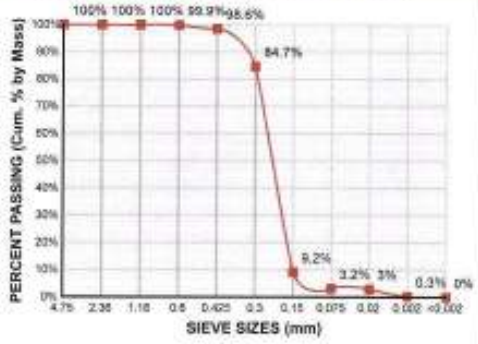
Gradation Index (GI): 2.29 - Uniform particle grading, potential surface instability.

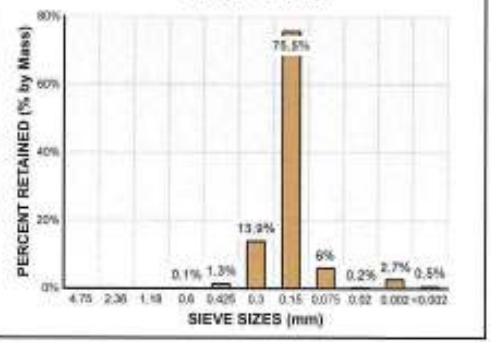
Fineness Modulus (Fm): 1.1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Uniformly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 8 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 0.5
Silt (%)*: 2.8
Sand (%): 96.7
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1.1	
Effective particle diameter - D_{eff} (mm):	0.201	
Median particle diameter - Dmed (mm):	0.23	Fine sand
Saturation (cm^3 water/cm^3):	0.22	
Field capacity (cm^3 water/cm^3):	0.09	
Permanent wilting point (cm^3 water/cm^3):	0.03	
Available water capacity (cm^3 water/cm^3):	0.06	(6% v/v)
Total porosity* (%v/v):	22	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	9	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	13	(Typically 10 – 28%v/v)
Critical Tension (mm):	355.2	

* at Field Capacity

Predicted Ksat results (based on PSA)

Bulk Density (g/cm^3): 2.07
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 513
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test

Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm^3)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY

pH in H_2O (1:5) N/D
pH in $CaCl_2$ (1:5) N/D

Electrical Conductivity (dS/m)

0 1 2 4 6 8 12

EC (1:5) Did not test.

Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee **Authorised Signatory:** Ryan Jacka **Date of Report:** 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chapman & Pratt 1961
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993 Canberra Landscape Guidelines, Soil Testing Procedure LG 822.
pH and Electrical Conductivity: Rayley et al (1993)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1994) Sports Turf Science, construction, and maintenance.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Tel: 02 9980 6554
Fax: 02 9484 2427
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 | **Sample N°: 9** | **Date Received: 5/7/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Conacher Environmental Group**	Project Name:	**Particle Size Analysis - Coffs Hbr**
Client Contact:	**Phil Conacher**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**13/004**	Sample Name:	**C1/3**
Address:	**PO Box 4300** **EAST GOSFORD NSW 2250**	Description:	**Soil**
		Test Type:	**PSA_AS, Texture_SESL**

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	99.90	0.10
1.18	V. Coarse Sand	99.70	0.20
0.6	Medium Sand	99.40	0.30
0.425	Medium Sand	98.80	0.60
0.3	Medium Sand	89.80	9.00
0.15	Fine Sand	12.80	77.00
0.075	Fine Sand	6.40	6.40
0.02	V. Fine Sand	5.3	1.1
0.002	Silt	1	4.3
<0.002	Clay	0%	1

D VALUES	
D_{100}:	4.75
D_{90}:	0.37
D_{80}:	0.30
D_{70}:	0.29
D_{60}:	0.24
D_{50}:	0.22
D_{40}:	0.19
D_{30}:	0.18
D_{25}:	0.17
D_{15}:	0.15
D_{10}:	0.12
D_0:	0.02

Coefficient of Uniformity (Cu): 2.06 - Optimal range for sportsfield applications.

Coefficient of Curvature (Cc): 1.19

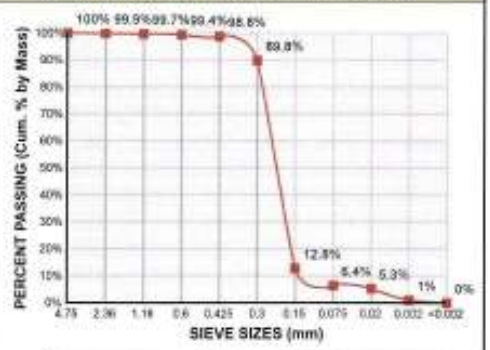
Gradation Index (GI): 2.58 - Uniform particle grading, potential surface instability.

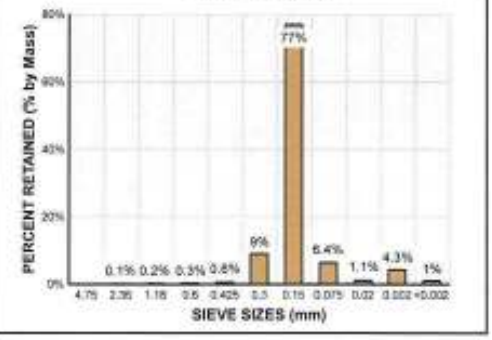
Fineness Modulus (Fm): 1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

sesl AUSTRALIA

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6854
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Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 9 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 1
Silt (%)*: 5.4
Sand (%): 93.6
Class: Sand

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	1	
Effective particle diameter - D_{eff} (mm):	0.193	
Median particle diameter - Dmed (mm):	0.22	Fine sand
Saturation (cm³ water/cm³):	0.26	
Field capacity (cm³ water/cm³):	0.1	
Permanent wilting point (cm³ water/cm³):	0.03	
Available water capacity (cm³ water/cm³):	0.07	(7% v/v)
Total porosity* (%v/v):	26	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	10	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	16	(Typically 10 – 28%v/v)
Critical Tension (mm):	369.9	

* at Field Capacity

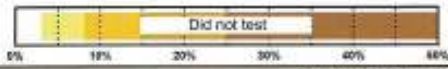
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.98
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 478
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test



Actual Ksat results (Laboratory determination)

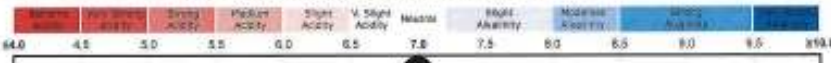
Field core method (cm/hr): Did not test.

Repacked core method:

Point	Ksat (mm/hr)	Bulk Density (g/cm³)
8 drops:	D.N.T.	Tube N°?
16 drops:	D.N.T.	Tube N°?
32 drops:	D.N.T.	Tube N°?

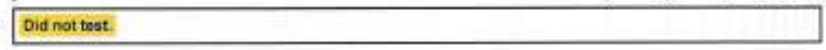
pH and ELECTRICAL CONDUCTIVITY

pH Analysis



pH in H_2O (1:5): ND
pH in $CaCl_2$ (1:5): ND

Electrical Conductivity (dS/m)



EC (1:5): Did not test.

Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee **Authorised Signatory:** Ryan Jacka **Date of Report:** 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chariton & Roper 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Landscape Guidelines, Soil Testing Procedure US 822.
pH and Electrical Conductivity: Bradley et al (1963)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1984) Sports Turf: Science, construction, and maintenance.

Tests are performed under a quality system certified as complying with ISO 9001:2008. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835	Sample N°: 15	Date Received: 5/7/13	Report Status: ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	D1/1
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	99.60	0.40
1.18	V. Coarse Sand	98.90	0.70
0.6	Medium Sand	97.50	1.40
0.425	Medium Sand	96.60	0.90
0.3	Medium Sand	95.30	1.30
0.15	Fine Sand	90.20	5.10
0.075	Fine Sand	86.90	3.30
0.02	V. Fine Sand	48.1	38.8
0.002	Silt	6.5	41.6
<0.002	Clay	0%	6.7

D VALUES	
D_{100}:	4.75
D_{90}:	0.29
D_{80}:	0.15
D_{60}:	0.07
D_{50}:	0.04
D_{40}:	0.02
D_{30}:	0.01
D_{25}:	0.01
D_{15}:	0.01
D_{10}:	0.00
D_5:	0.00

Coefficient of Uniformity (Cu): 10.49 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

Coefficient of Curvature (Cc): 1.14

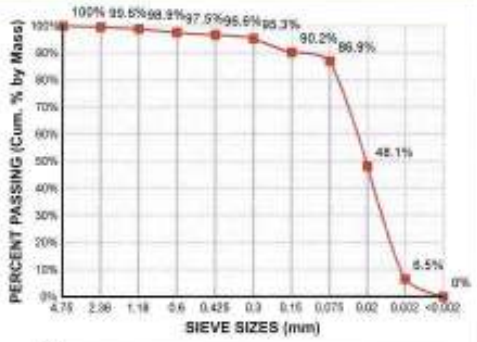
Gradation Index (GI): 41.39 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

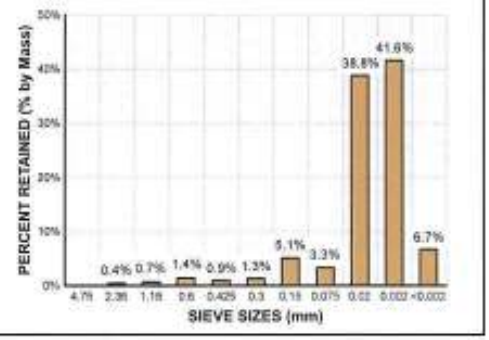
Fineness Modulus (Fm): .2 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Well graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

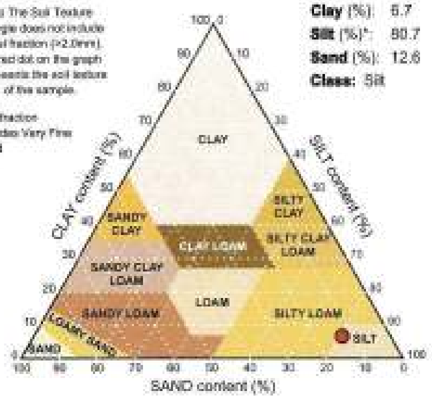
Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835	**Sample N°:** 15	**Date Received:** 5/7/13	**Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand



Clay (%): 6.7
Silt (%)*: 80.7
Sand (%): 12.6
Class: Silt

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	.2	
Effective particle diameter - D_{e} (mm):	0.006	
Median particle diameter - Dmed (mm):	0.02	Silt
Saturation (cm³ water/cm³):	0.43	
Field capacity (cm³ water/cm³):	0.3	
Permanent wilting point (cm³ water/cm³):	0.1	
Available water capacity (cm³ water/cm³):	0.2	(20% v/v)
Total porosity* (%v/v):	43	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	30	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	13	(Typically 10 – 28%v/v)
Critical Tension (mm):	11900	

* at Field Capacity

Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.51
Saturated Hydraulic Conductivity using D_{e} (mm/hr): 1
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops	D.N.T.	Tube N°?
	16 drops	D.N.T.	Tube N°?
	32 drops	D.N.T.	Tube N°?

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test

Did not test (scale: 0% 10% 20% 30% 40% 50%)

pH and ELECTRICAL CONDUCTIVITY

pH Analysis (scale: ≤4.0 Extreme Acidity, 4.5 Very Strong Acidity, 5.0 Strong Acidity, 5.5 Medium Acidity, 6.0 Slight Acidity, 6.5 V. Slight Acidity, 7.0 Neutral, 7.5 Slight Alkalinity, 8.0 Moderate Alkalinity, 8.5 Strong Alkalinity, 9.0 Very Strong Alkalinity, 9.5, ≥10.0)

pH in H_2O (1:5): ND
pH in $CaCl_2$ (1:5): ND

Electrical Conductivity (dS/m) (scale: 0, 1, 2, 4, 6, 8, 12)

EC (1:5): Did not test.

Electrical Conductivity by Saturated Extract (EC_e dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee
Authorised Signatory: Ryan Jacka
Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Dinsman & Roper 2008
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Landscape Guidelines, Soil Testing Procedure LG 9.2
pH and Electrical Conductivity: Bradley et al (1983)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1994) Sports Turf Science, construction, and maintenance.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 16 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	D1/2
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	97.90	0.50
2.36	Fine Gravel	96.60	1.30
1.18	V. Coarse Sand	95.80	0.80
0.6	Medium Sand	95.50	0.30
0.425	Medium Sand	95.40	0.10
0.3	Medium Sand	94.80	0.60
0.15	Fine Sand	90.80	4.00
0.075	Fine Sand	89.60	1.20
0.02	V. Fine Sand	76.8	12.8
0.002	Silt	29.5	47.3
<0.002	Clay	0%	29.5

D VALUES	
D_{90}:	8.61
D_{80}:	0.34
D_{60}:	0.10
D_{50}:	0.08
D_{40}:	0.01
D_{30}:	0.01
D_{15}:	0.00
D_{10}:	0.00
D_{25}:	0.00
D_{15}:	0.00
D_{10}:	0.00
D_5:	0.00

Coefficient of Uniformity (Cu): 20.07 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

Coefficient of Curvature (Cc): 0.52

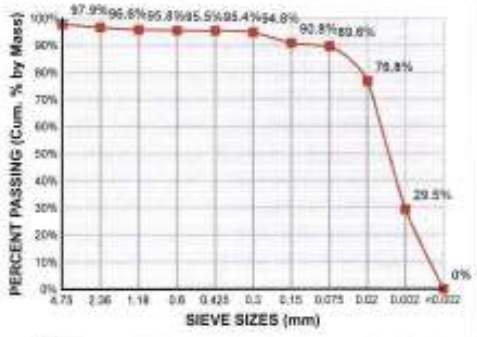
Gradation Index (GI): 147.5 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

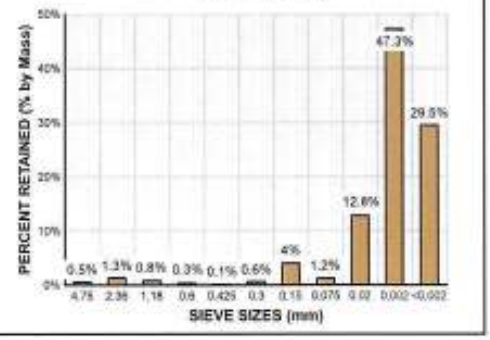
Fineness Modulus (Fm): .2 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

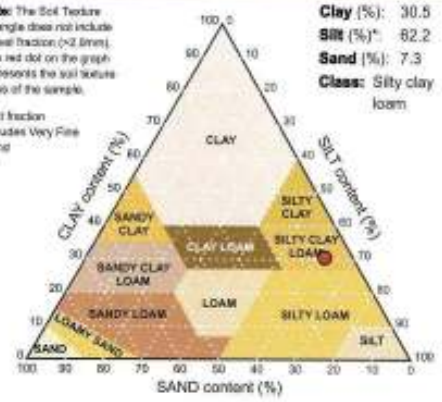
Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 | Sample N°: 16 | Date Received: 5/7/13 | Report Status: ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.8mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand



Clay (%): 30.5
Silt (%)*: 82.2
Sand (%): 7.3
Class: Silty clay loam

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	2	
Effective particle diameter - D_{eff} (mm):	0.001	
Median particle diameter - Dmed (mm):	0.01	Silt
Saturation (cm³ water/cm³):	0.52	
Field capacity (cm³ water/cm³):	0.35	
Permanent wilting point (cm³ water/cm³):	0.17	
Available water capacity (cm³ water/cm³):	0.18	(18% v/v)
Total porosity* (%v/v):	52	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	35	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	17	(Typically 10 – 28%v/v)
Critical Tension (mm):	71400	

* at Field Capacity

Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.27
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 0
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

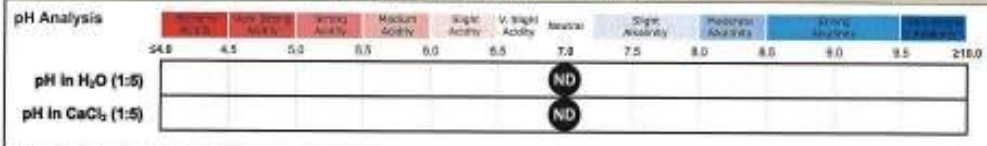
Organic Matter (%w/v): -
Did not test

Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY



Electrical Conductivity by Saturated Extract (EC$_e$, dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Charman & Roper 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Landscape Guidelines, Soil Testing Procedure LG B20.
pH and Electrical Conductivity: Rayment et al (1992)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1999). Sports Turf: Science, construction, and maintenance.

Tests are performed under a quality system certified as complying with ISO 9001:2000. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°: 17** **Date Received: 5/7/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Conacher Environmental Group**	Project Name:	**Particle Size Analysis - Coffs Hbr**
Client Contact:	**Phil Conacher**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**13/004**	Sample Name:	**D1/3**
Address:	**PO Box 4300** **EAST GOSFORD NSW 2250**	Description:	**Soil**
		Test Type:	**PSA_AS, Texture_SESL**

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	99.60	0.40
2.36	Fine Gravel	99.20	0.40
1.18	V. Coarse Sand	99.00	0.20
0.6	Medium Sand	98.70	0.30
0.425	Medium Sand	98.50	0.20
0.3	Medium Sand	98.20	0.30
0.15	Fine Sand	97.40	0.80
0.075	Fine Sand	96.70	0.70
0.02	V. Fine Sand	84.4	12.3
0.002	Silt	50	34.4
<0.002	Clay	0%	50.1

D VALUES	
D_{100}:	7.14
D_{95}:	0.07
D_{90}:	0.05
D_{85}:	0.02
D_{80}:	0.01
D_{50}:	0.00
D_{30}:	0.00
D_{20}:	0.00
D_{10}:	0.00
D_5:	0.00

Coefficient of Uniformity (Cu): 18.08 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

Coefficient of Curvature (Cc): 0.5

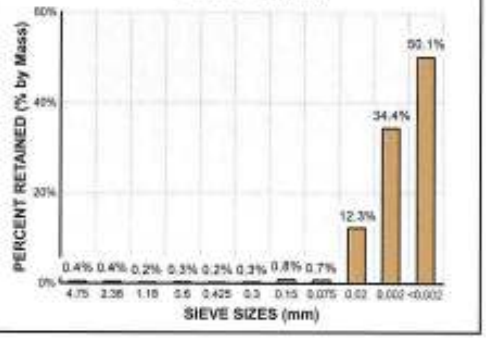
Gradation Index (GI): 112.6 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

Fineness Modulus (Fm): .1 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS



Turf Root Zone Assessment (AS Sieves)

sesl AUSTRALIA

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120 — **Tel:** 02 9980 6554, **Fax:** 02 9484 2427

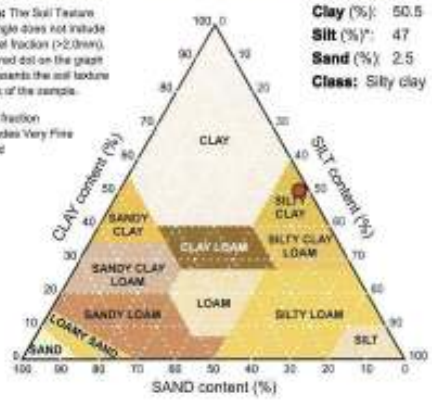
Mailing Address: PO Box 357, Pennant Hills NSW 1715 — **Em:** info@sesl.com.au, **Web:** www.sesl.com.au

Batch N°: 26835 **Sample N°:** 17 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (>2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand



Clay (%): 50.5
Silt (%)*: 47
Sand (%): 2.5
Class: Silty clay

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	.1	
Effective particle diameter - D_{eff} (mm):	0.001	
Median particle diameter - Dmed (mm):	0	Clay
Saturation (cm³ water/cm³):	0.55	
Field capacity (cm³ water/cm³):	0.46	
Permanent wilting point (cm³ water/cm³):	0.3	
Available water capacity (cm³ water/cm³):	0.16	(16% v/v)
Total porosity* (%v/v):	55	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	46	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	9	(Typically 10 – 28%v/v)
Critical Tension (mm):	71400	

* at Field Capacity

Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.19

Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 0

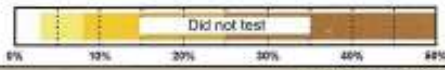
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -

Did not test



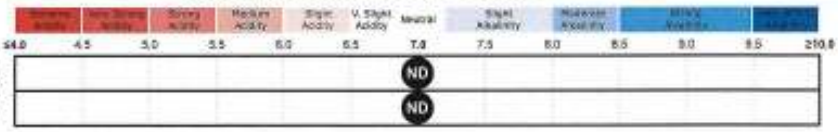
Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

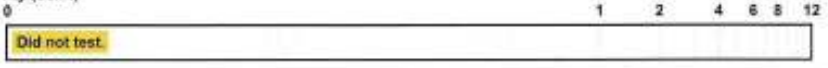
Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY

pH Analysis



Electrical Conductivity (dS/m)



Electrical Conductivity by Saturated Extract (EC$_e$, dS/m): - Requires EC and Soil Texture result.

Consultant: Kelly Lee **Authorised Signatory:** Ryan Jacka **Date of Report:** 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chapman & Roper 2008
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993. Canberra Landscape Guidelines, Soil Testing Procedure LG 823.
pH and Electrical Conductivity: Bradley et al (1993)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Minasny, V.L (1994) Sports Turf: Science, construction, and maintenance.

Turf Root Zone Assessment (AS Sieves)

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 **Sample N°:** 18 **Date Received:** 5/7/13 **Report Status:** ○ Draft ◉ Final

Client Name:	Conacher Environmental Group	Project Name:	Particle Size Analysis - Coffs Hbr
Client Contact:	Phil Conacher	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	13/004	Sample Name:	D1/4
Address:	PO Box 4300 EAST GOSFORD NSW 2250	Description:	Soil
		Test Type:	PSA_AS, Texture_SESL

DISCUSSION AND RECOMMENDATIONS

No commentary requested from SESL.

PARTICLE SIZE ANALYSIS

Size (mm)	Fraction	% Passing by mass	% Retained by mass
4.75	Fine Gravel	100.00	0.00
2.36	Fine Gravel	100.00	0.00
1.18	V. Coarse Sand	100.00	0.00
0.6	Medium Sand	100.00	0.00
0.425	Medium Sand	100.00	0.00
0.3	Medium Sand	100.00	0.00
0.15	Fine Sand	99.70	0.30
0.075	Fine Sand	99.40	0.30
0.02	V. Fine Sand	88.6	10.8
0.002	Silt	55.6	33
<0.002	Clay	0%	55.5

D VALUES	
D_{100}:	0.30
D_{95}:	0.05
D_{90}:	0.03
D_{85}:	0.02
D_{80}:	0.00
D_{50}:	0.00
D_{30}:	0.00
D_{20}:	0.00
D_{15}:	0.00
D_{10}:	0.00
D_5:	0.00

Coefficient of Uniformity (Cu): 12.23 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

Coefficient of Curvature (Cc): 0.74

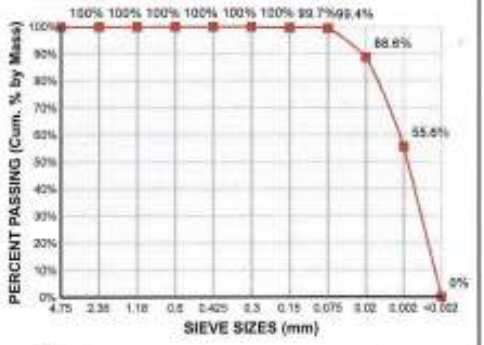
Gradation Index (GI): 75.42 - Significant risk of particle packing - generally unsuitable without specific management input (i.e. compaction relief/aeration).

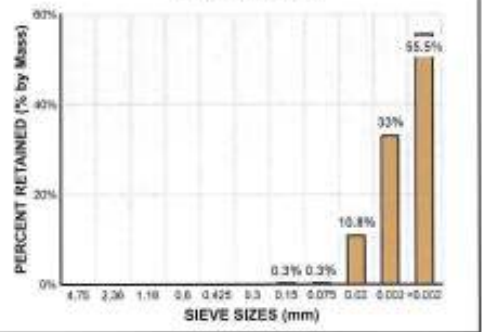
Fineness Modulus (Fm): 0 - Dominated by very fine particles (≤0.02mm). *Note: Typical range for sportsfield rootzone is 1.7 to 2.5*

Particle Distribution: Poorly graded

Note: Poorly graded soils are either uniformly graded or gap graded. Well graded soils have even distribution of particles across a wide range of particle sizes and are prone to dense packing. As a rule, well graded soils should be avoided for sportsfields and other high traffic surfaces that are subject to considerable compactive forces.

PARTICLE SIZE DISTRIBUTION GRAPHS





Turf Root Zone Assessment (AS Sieves)

sesl AUSTRALIA

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Tel: 02 9980 6554
Fax: 02 9484 2427
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 26835 | Sample N°: 18 | Date Received: 5/7/13 | Report Status: ○ Draft ◉ Final

SOIL TEXTURE TRIANGLE AND DERIVED VALUES

Note: The Soil Texture Triangle does not include gravel fraction (+2.0mm). The red dot on the graph represents the soil texture class of the sample.

*Silt fraction includes Very Fine Sand

Clay (%): 55.5
Silt (%)*: 43.8
Sand (%): .7
Class: Silty clay

Predicted soil properties calculated from PSA values

Fineness Modulus (Fm):	0	
Effective particle diameter - D_{eff} (mm):	0.001	
Median particle diameter - Dmed (mm):	0	Clay
Saturation (cm³ water/cm³):	0.55	
Field capacity (cm³ water/cm³):	0.48	
Permanent wilting point (cm³ water/cm³):	0.33	
Available water capacity (cm³ water/cm³):	0.15	(15% v/v)
Total porosity* (%v/v):	55	(Typically 25 – 35%v/v)
Water-filled porosity* (%v/v):	48	(Typically 8 – 15%v/v)
Air-filled porosity* (%v/v):	7	(Typically 10 – 28%v/v)
Critical Tension (mm):	71400	

* at Field Capacity

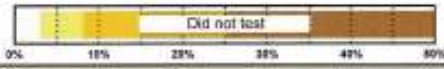
Predicted Ksat results (based on PSA)

Bulk Density (g/cm³): 1.19
Saturated Hydraulic Conductivity using D_{eff} (mm/hr): 0
USGA Saturated Hydraulic Conductivity (mm/hr):

Particle shape: Shape not tested, sphericity not tested.

ORGANIC MATTER

Organic Matter (%w/v): -
Did not test

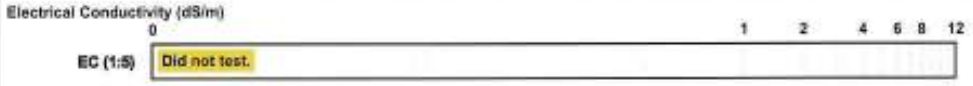


Actual Ksat results (Laboratory determination)

Field core method (cm/hr): Did not test.

Repacked core method:	Point	Ksat (mm/hr)	Bulk Density (g/cm³)
	8 drops:	D.N.T.	Tube N°?
	16 drops:	D.N.T.	Tube N°?
	32 drops:	D.N.T.	Tube N°?

pH and ELECTRICAL CONDUCTIVITY



Electrical Conductivity by Saturated Extract (EC$_e$, dS/m): - Requires EC and Soil Texture result

Consultant: Kelly Lee

Authorised Signatory: Ryan Jacka

Date of Report: 16/07/2013

METHOD REFERENCES:
Particle Size Analysis: ASTM F 1632-03
Organic Matter: Chanter & Rose 2000
Saturated Hydraulic Conductivity and Bulk Density: Department Urban Services, ACT Government 1993 Canberra Landscape Guidelines, Soil Testing Procedure LG 822
pH and Electrical Conductivity: Bradley et al (1993)
Effective Particle Diameter, Predicted Ksat, and Predicted Critical Tension: Stewart, V.I. (1994) Sports Turf: Science, construction, and maintenance.

Tests are performed under a quality system certified as complying with ISO 9001: 2008. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.