Duffill Watts
Consulting Group

Tomlinson and Carruthers

Wastewater Treatment and Discharge Resource Desktop Evaluation and Site Inspection

Woodlands Road
Carterton

November 2007

Tomlinson and Carruthers
Wastewater Treatment and Discharge
Resource Desktop Evaluation and Site Inspection

Woodlands Road
Carterton

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1.0 INTRODUCTION

1.1 Background

Tomlinson and Carruthers (TC) are managing the development of a subdivision on Tiffin Hill, Woodlands Road near Carterton. The owners of the site are proposing to subdivide 48 ha of the property into 17 Lots with residential dwellings being built on 16 of the planned lots. The property is referred to as 'The Site' in this report.

Duffill Watts Consulting Group (DWG) have been engaged by TC to assist with identifying and obtaining the necessary approvals for wastewater management for the development.

In order to identify potential wastewater treatment options and assess their potential effects, system design parameters need to be established to allow effects of possible options to be determined.

1.2 Purpose

This report characterises site and local conditions found on the Woodlands Road property.

The first part of this report is a desktop study, identifying the geology, hydrology, hydrogeology, and soils in and around The Site. This information is used in the decision making processes to help select an appropriate wastewater treatment and discharge option from several that may be considered for The Site.

The second part of the report examines, in greater detail, The Site's conditions, including aspects of soil hydraulics and variations in soil properties.

The goal of this report is to provide TC with the necessary background resource information to be able to determine the effects of a wastewater treatment and discharge system at The Site.

1.3 Scope

Resource Review - All available site information is reviewed (Section 2 and 3). This includes information from the regional and district councils, NIWA and Landcare Research.

Resource Investigation – Includes field investigations with the goal of filling in any critical gaps in the knowledge uncovered by the resource review, with an emphasis on assessing soil properties. This includes gaining an understanding of soil hydraulic conductivities and textural variability across The Site.

2.0 SITE DESCRIPTION

2.1 Location

The site occupies land to the south of Woodlands Road located to the east of SH 2 (Figure 1, Appendix A). The exiting property is located 5.5 km south east of Carterton and consists of two lots. Table 1 below outlines the properties included in the Woodlands Road subdivision proposal.

Table 1: Titles Comprising the Woodlands Drive Subdivision

Section	Survey District/DPS	Area (ha)	Title	Owner
Lot 3	DP 351518	48.6	210952	Dean Richard Brian Schaef and Lesley Robyn Schaef
Pt Lot 15	DP 3680	96.352	21262	Dean Richard Brian Schaef and Lesley Robyn Schaef

For the purposes of this report the two lots are referred to as 'The Site'.

2.2 Site Use

The development area is part of a 145 ha property which is currently being used for extensive sheep and beef farming.

2.3 Topography

The Woodlands Road site is located on undulating terrain rolling hills which extend up above the relatively flat alluvial flood plain of the Wairarapa valley.

The topographic map (Figure 1, Appendix A) indicates that the site's aspect is predominantly facing a north to north west direction.

2.4 Climate

The NIWA-operated Tauherenikau and Kaitoke (NIWA Meteorological Station Numbers 2623 and 3460) climate stations are situated approximately 20 km to the southwest (#2623) and 33 km to the west (#3460) of Woodlands Road site. The stations provide monthly mean rainfall and evapotranspiration (ET) data which is presented in Table 2.

Table 2: Monthly Mean Rainfall and Evapotranspiration (ET)

Month	Average Rainfall (mm) [a b]	ET (mm) [a b]	Deficit (mm)
January	94.6	124.2	29.6
February	88.6	93.1	4.5
March	112.9	68.7	
April	112.9	31.8	
May	145.9	9.1	
June	164.8	0.4	
July	174.8	2.7	

August	163.4	17.2
September	144.5	40.5
October	158.9	73.7
November	132.8	96.2
December	126.7	115.4
Year	1620.7	673.1

a Tauherenikau- Station Number 2623, rainfall data from 1970-1994 and ET from 1985-1994
b Kaitoke- Station Number 3460, rainfall data from 1970-1998 and ET from 1967-1996

The table above shows that during the months of January and February, there is a potential for evapotranspiration to exceed rainfall. However, for a majority of the year, average monthly rainfall will exceed evapotranspiration rates. This is particularly the case in the winter months where average evapotranspiration is almost non existent.

3.0 RESOURCE REVIEW

3.1 Geology

3.1.1 Regional Context

The Wairarapa coast is approximately 65 -125 km northwest of the boundary between the Australian and Pacific Plates. The close proximity to this plate collision is reflected in the rock which underlies the Wairarapa and Wellington region. The physiography of the Wairarapa (Figure 2; Appendix A) is the result of this tectonic environment (Begg et al., 2005).

The Carterton area is located in the mid reach of the Wairarapa Valley's alluvial plain which is bordered by the Tararua Ranges to the west and the Eastern Wairarapa Hills to the east. The western boundary of the Wairarapa Valley is defined by the Wairarapa Fault. The Wairarapa Valley is also cross-cut by the three major active faults which extend off of the Wairarapa Fault; the Mokonui, Masterton, and Carterton faults (Figure 2). The Carterton region consists predominantly of Quaternary alluvial deposits comprised of gravel, sand, silt, and muds. The alluvial deposits unconformably overlie greywacke rock and largely impermeable Neogene siltstone and mud (Begg et al., 2005).

3.1.2 Local Context

The Woodlands Road site is located on Tiffen Hill, an up-faulted block which is composed of greywacke bedrock (Jones and Gyopari, 2006). No geotechnical testing has been undertaken at the Woodlands Road site as part of this investigation. However the site appears to be primarily located on basement rock since the topography of the site is higher than the surrounding flat valley (Figure 1).

3.2 Hydrology

3.2.1 Regional Context

The Wairarapa Valley consists of braided channel streams and rivers bounded by terraces which form extensive floodplains, lakes, lagoons, and beaches. The stream and river systems, which comprise the Ruamahanga River and its tributaries, the Waingawa, Waiohine, Tauherenikau, and Waiorongomai rivers, are fed by precipitation from the Tararua Range (Begg et al., 2005). The valley also contains numerous springs associated with active fault lines or topographic features. The average total discharge of the springs is estimated to be 2,500 L/s (Jones and Gyopari, 2006).

The Ruamahanga River can be regarded as the major surface water resource nearest the development site. The river is located approximately 1.3 km to the southeast of the site. The Ruamahanga River originates in the Tararua Ranges, and then flows south along the eastern boundary of the Wairarapa Valley until it reaches the Lake Onoke which drains into Palliser Bay.

The Ruamahanga River is a semi-braided river with its principal catchment consisting of smaller sub-catchments from the Tararua Ranges. The upper catchment is relatively unmodified, but the river has had some pollution issues from agricultural run-off. The water quality data was provided for an upstream (Cliffs ~7 km northeast of the site) and downstream location (Kokotau ~4.5 km south of the site) indicated that the average E. Coli levels from November 2006- March 2007 were reported at 137.1 and 234.4 cfu/100mL. This indicates an increase in *E.coli* as the river flows downstream of the area near the site.

Flow data for the Ruamahanga River from an upstream location (Gladstone Bridge) was sourced from Greater Wellington Regional Council. The data indicates that the average maximum flow of the Ruamahanga River over the last 8 years is 953.4 m^3/s (GWRC, 2007). The flow in the upper portion of the river is influenced by the fault lines (Jones and Gyopari, 2006).

3.2.2 Local Context

The topographic map (Figure 1) outlines surface water bodies located on the site. The nearest surface water body appears to be perennial ephemeral streams which originate from Tiffen Hill.

3.3 Hydrogeology

3.3.1 Regional Context

The Wairarapa groundwater system is highly influenced by the tectonic activity within the region and the structures which have formed from this activity. The combination of the sea level changes, tectonic activity, and geomorphic processes have made the hydrogeology of the Wairarapa complex (Begg et al., 2005).

Uplift of the Tararua Range during the last c.1.5 million years has enhanced rainfall from the prevailing westerly winds, much of which drains eastwards into the Wairarapa Valley. Rainfall and runoff from the range is supplemented by local rainfall, and together comprise the inflow for the Wairarapa Valley groundwater resource (Gunn et al. 1987 and Begg et al. 2005).

Rock eroded by the river systems in the ranges is the source of the gravel (rounded pebbles, cobbles and boulders) deposited where the gradients of the streams and rivers reduces, on the floodplains of the Wairarapa Valley. These alluvial gravel deposits of the floodplains contain the principal groundwater aquifers of the Wairarapa region.

Tiffen Hill is an up-faulted block of greywacke bedrock that effectively marks the edge of the regional groundwater basin. North of Tiffen Hill, raised older terrace deposits (Fernhill) provide an effective continuation of this impermeable block (Figure. 6). There are groundwater resources to east and west of Tiffen Hill. To the east there is the Ruamahanga River which has eroded a channel where aquifer depth is likely to be limited to 15 m depth. To the west of Tiffen Hill there is another groundwater basin which occupies a structure known as the ‘Taratahi Syncline’ and is called the Parkvale sub-basin.

The Parkvale sub-basin consists of Late Quaternary sediments that may extend to 200 m depth within the sub-basin, decreasing in thickness to the north and south (Butcher, 2004 and Jones and Gyopari, 2006). The Parkvale sub-basin is made up of four aquifers: a shallow unconfined aquifer (10-15 m depth) and a series of leaky-confined aquifers at depths of 20-30 m, 35-50 m, and 50-60 m. The water table is 3 to 10 m below the land surface in this part of the basin (Jones and Gyopari, 2006).

3.3.2 Local Context

Bore and bore log information for the site and the surrounding region was obtained from Greater Wellington Regional Council. The data indicated that the site did not contain any known bores. Based on the Greater Wellington Regional Council database there are a number of bores located to the east and the west of the site (See Figure 3) in the deposits described above, with the closest bore situated 300 m from the northern corner of the site. However given that groundwater flow is likely to be in a south easterly direction in these deposits similar to surface water in the area, water discharged from the site would not flow towards these bores. The closest bore in an easterly direction is over 1 km away and there are a number of surface water bodies between the site and this bore.

3.4 Soil

3.4.1 Regional Context

Information from Landcare Research Online Maps (2007) classifies the soil at the site as *Pallic Soils*. Pallic soils are pale in colour due to the low content of iron oxide. They are characterized as having weak structure and high density in the subsurface horizons. Pallic soils are low permeability soils with limited rooting depth and have medium to high bulk density. These soils are dry in the summer and wet in the winter. Pallic soils are susceptible to erosion because of the high potential for slaking and dispersion.

3.4.2 Site

Information on site-specific soil data is limited. Site specific soil information is described in Section 5 below.

4.0 SITE SOIL ASSESSMENT

4.1 Purpose

An investigation of the soils of the Woodlands Road site was undertaken to characterise the top 1 m of soil on site, and in particular describe soil properties that may be relevant for its suitability to receive wastewater. The top metre of soil is of most interest for the application of wastewater since it is the region of the soil that will have the strongest influence on the infiltration capacity and nutrient/contaminant retention capability of the soil during a discharge event. The purpose of the site soil assessment is to obtain information about the site which can be used to characterise the soil's ability to transmit water and potentially retain contaminants.

A soil survey and measurement of the soil's hydraulic properties was undertaken.

4.2 Soil Survey

4.2.1 Purpose

A soil survey of The Site was undertaken to identify features of the soil which may inhibit the transmission of treated wastewater through the soil. The purpose of the soil survey was to obtain information to determine the lateral continuity of subsurface features and identify any impeding horizons in the soil. Changes in soil morphology due to differing land use across the site can be mapped and used to identify areas of preference for irrigation of wastewater. This survey is not intended to define a range of soil properties as undertaken for traditional land use and soil classification mapping.

4.2.2 Sampling and Analysis Plan

DWG staff conducted a soil survey of The Site on 27 September 2007. The soil was surveyed by hand auguring several holes on site.

Soil profiles were assessed at 16 locations on the site. The locations of soil profiles are given in Figure 4 of Appendix A. The soil profile pits consisted of hand augured holes to a depth of 600 mm.

4.2.3 Results

There was little variation between soil profiles examined at the site. Differences in depths of horizons were likely due to the micro-topography of the site. The main difference in the soil profile was the depth of the topsoil across the site. Soil profile descriptions are given in Appendix B. The soil was found to consist of 2 main soil horizons. The horizons consisted of:

A Horizon	0-300mm	the soil of this horizon consisted of a dark brown silty loam with moderate development.
B Horizon	200-700mm	the soil of this horizons consisted of a light brown to yellow clay. The soil showed evidence of mottling

Mottling was found in the soil at varying depths ranging from 200 - 350 mm. This indicates that the maximum high water level can be within 200 mm of the soil surface during part of the year.

The limiting horizon of the soil on site is within the B horizon, as indicated by the mottling. Depending on the wastewater discharge method, this is likely to be the soil horizon that will limit the hydraulic application of wastewater.

As a result DWG classifies the soil as a 'Category 5 – light clay' (AS/NZS 1547:2000).

4.3 Soil Hydraulic Data

4.3.1 Purpose

Soil hydraulic characteristics were measured in the field across The Site to establish the suitability of the site for application of wastewater. The goal of assessing hydraulic characteristics is to determine the rate at which soil can accept water in order to minimise ponding, runoff, excessive wetness and excessive flow through the macro-pores (preferential flow).

The results from these tests will be used in conjunction with the soil analysis above to determine the appropriate loading rate to the soil on The Site.

4.3.2 Method

Hydraulic properties were assessed using a Plate Permeameter. This enables the determination of the water-transmitting and water-holding properties of the soil. The plate permeameters provide an indication of the soil's hydraulic conductivity characteristics through specific pore sizes. This is equated to the absorption and capillary forces which hold water to soil particles through the matrix potential (ψ_m) of the soil.

In theory, by supplying water to the soil under suction, not all the soil's pores will fill with water, hence only unsaturated flow can occur. By changing the degree of suction, the rate of flow through different sized soil pores can be identified. Of particular interest is the transition zone between the macro-pore and micro-pore flow, known as meso-pores. These pores have a matrix potential (ψ_m) which equates to a negative pressure head of approximately 40 mm (K_{-40}). The goal of near-saturated hydraulic conductivity tests for wastewater irrigation is to determine the rate at which the soil has the capacity to draw water into the soil matrix through matrix potential, thereby reducing the potential for ponding, runoff, excessive wetness and preferential flow (excessive flow through the macro-pores).

The intended ψ_m for this site investigation ranged from -100 mm to -20 mm. Other experiments of similar nature have proven that these ψ_m give a good indication of soil-water conductivity, particularly micro-pore, meso-pore, and macro-pore flow respectively.

Readings were recorded on a regular basis and the matrix potential (ψ_m) was adjusted once the readings indicated stability. The permeameter was initially set for 100 mm ($\psi=K_{-100}$) of negative head pressure, a value which can characterise the soil's micro porosity. The head pressure was then altered to 40 mm ($\psi=K_{-40}$); a value considered to approximate the meso-porosity of the soil. Finally the pressure head was adjusted to 20 mm ($\psi=K_{-20}$), being a rate which can be dominated by water flow through the soil's macro-pores.

4.3.3 Sampling and Analysis

DWG staff collected soil hydraulic data at the site on the 27th of September 2007. Soil was analysed at 3 locations on the site to correspond with the soil survey pit location. The location of testing is shown in Appendix A, Figure 4.

Measurement was limited to the soil surface, as it was considered unlikely that the lower soil profiles would be used for receiving any discharge due to drainage/percolation limitations as identified by the soil survey.

4.3.4 Results

Graphs of the results from the three sites are presented in Figures 5, 6 and 7, Appendix A.

Results of the Near-Saturated Hydraulic Conductivity testing were varied dependent upon the location. A $\psi = K_{-40}$ is generally regarded as the most appropriate for determining the maximum rate of movement through the soil when designing a wastewater application system. The results from the testing demonstrate the following:

Site location 1: The near saturated hydraulic conductivity for sampling location 1 has an average of 5 mm/hr. These values correspond to a daily (24 hour) near-saturated conductivity of 120 mm/day.

Site location 2: The soil near saturated hydraulic conductivity for sampling location 2 has an average of 6.5 mm/hr. These values correspond to a daily (24 hour) near-saturated conductivity of 156 mm/day.

Site location 3: The soil near saturated hydraulic conductivity for sampling location 3 has an average of 11 mm/hr. These values correspond to a daily (24 hour) near-saturated conductivity of 240 mm/day.

Despite some variability, the results suggest a high degree of consistency across the site. Based on the above, DWG believe the near-saturated conductivity for the site to be in the order of 5 mm/hr to 7.5 mm/hr or 120 mm/day to 180 mm/day.

5.0 SUMMARY

Tomlinson and Carruthers are managing the development of a subdivision on Tiffin Hill, Woodlands Road near Carterton. The owners of the site are proposing to subdivide the section into 17 Lots from the existing titles with residential dwellings being built on 16 of the planned lots.

According to geological information cited, the site appears to be primarily located on basement rock since the topography of the site is higher than the surrounding flat valley. Greywacke is the bedrock in the region

An investigation of the soils of the Woodlands Road site was undertaken to characterise the top 1m of soil on site. This investigation involved a soil survey and measurement of the soil's unsaturated hydraulic conductivity.

Based on the soil survey, DWG believes that the limiting horizon of the soil on site is the high clay B horizon. As a result DWG classifies the soil as a 'Category 5 –light clay' (AS/NZS 1547:2000).

Additionally, the soil's water retention capacity was recorded. This provides an indication of loading rate at which the soil can absorb water before ponding or mass flow occurs through larger soil pores. The testing indicated that at a matrix potential of 40 mm (k_{-40}) the soil absorption rate is 5 to 7.5 mm/hr.

6.0 REFERENCES

Begg, J.G., Brown, L.J., Gyopari, M., and Jones, A. (2005). A review of Wairarapa geology with a groundwater bias. Produced by Geological and Nuclear Sciences for the Greater Wellington Regional Council.

Cheal Consultants. (2007). Huka Falls Road, Taupo; Subdivision Stage 2 – Soils Investigation Report. 2005-184.

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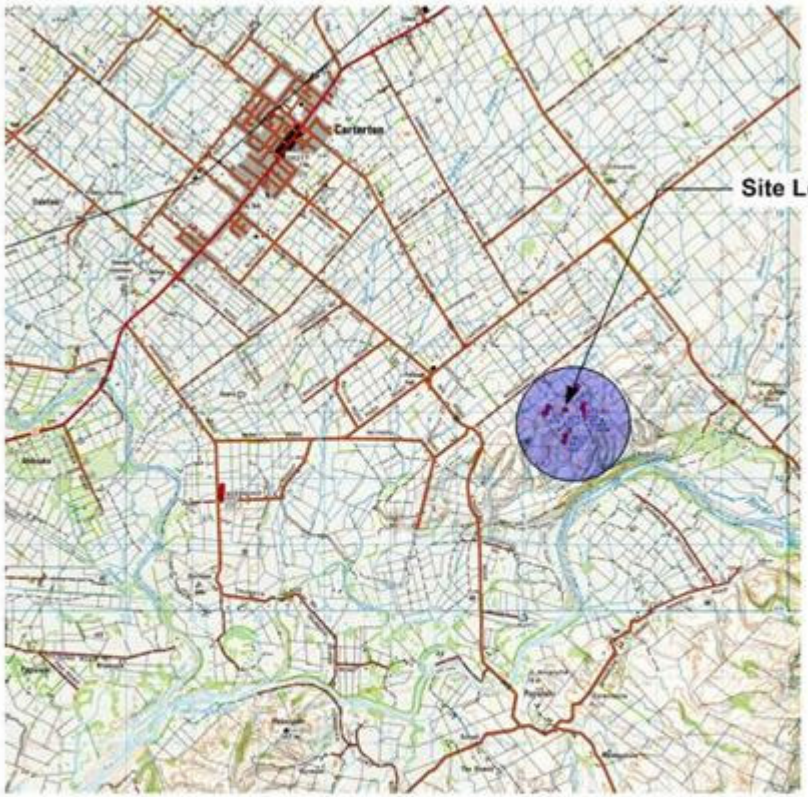
Hewitt A.E. (1992). New Zealand Soil Classification. DSIR Land Resources Scientific Report No. 19. Lower Hutt. 133p.

Jones, A. and Gyopari, M. (2006). Regional conceptual and numerical modelling of the Wairarapa groundwater basin. Greater Wellington Regional Council. GW/EMI-T-06/293.

APPENDIX A

Figures



Date: October 07

Drawing No: 303051

Sheet No. of Sheets

Figure 1: Site Location and Topography

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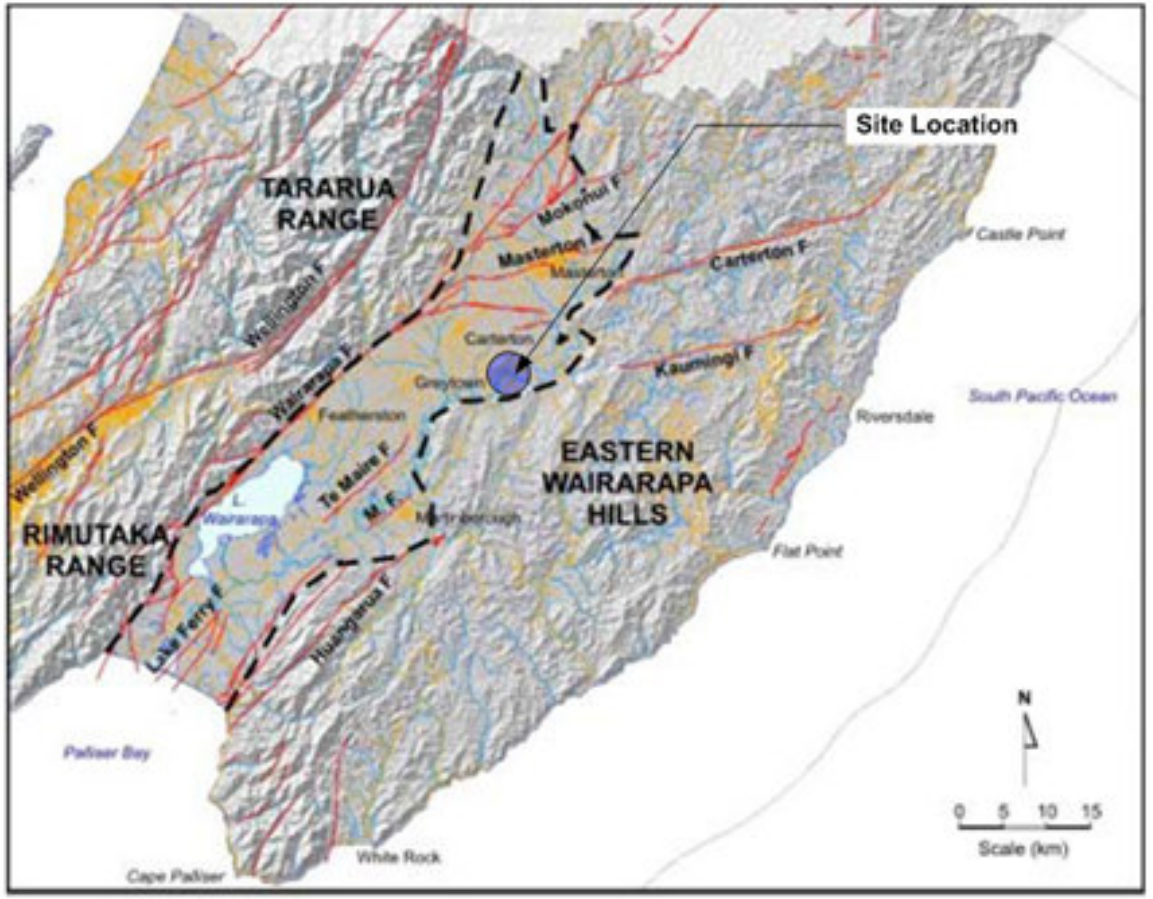

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Figure 2: Physiography of the Wairapapa Region

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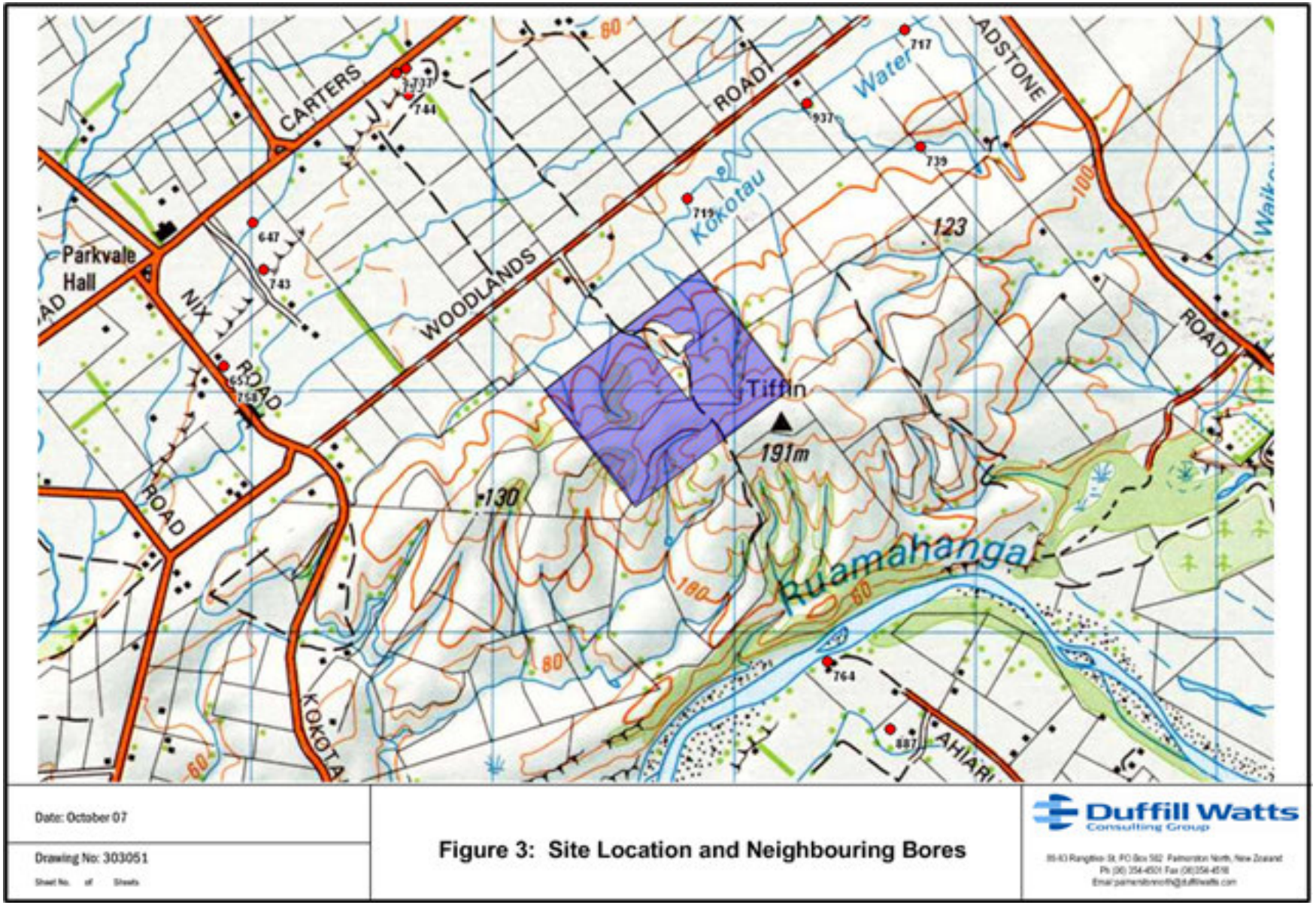

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Figure 3: Site Location and Neighbouring Bores

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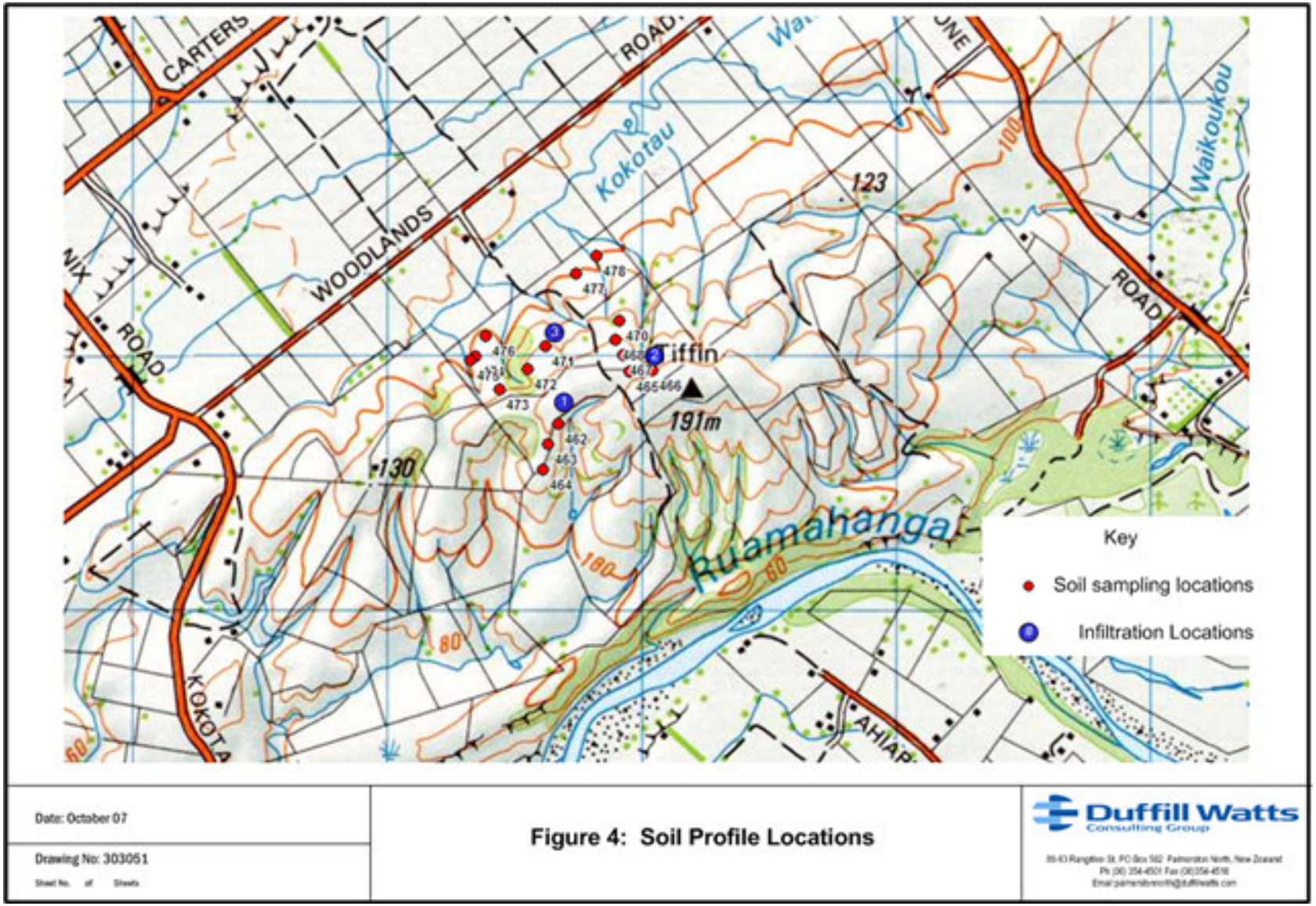

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Figure 4: Soil Profile Locations

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Figure 5: Plate Permeameters – Site 1

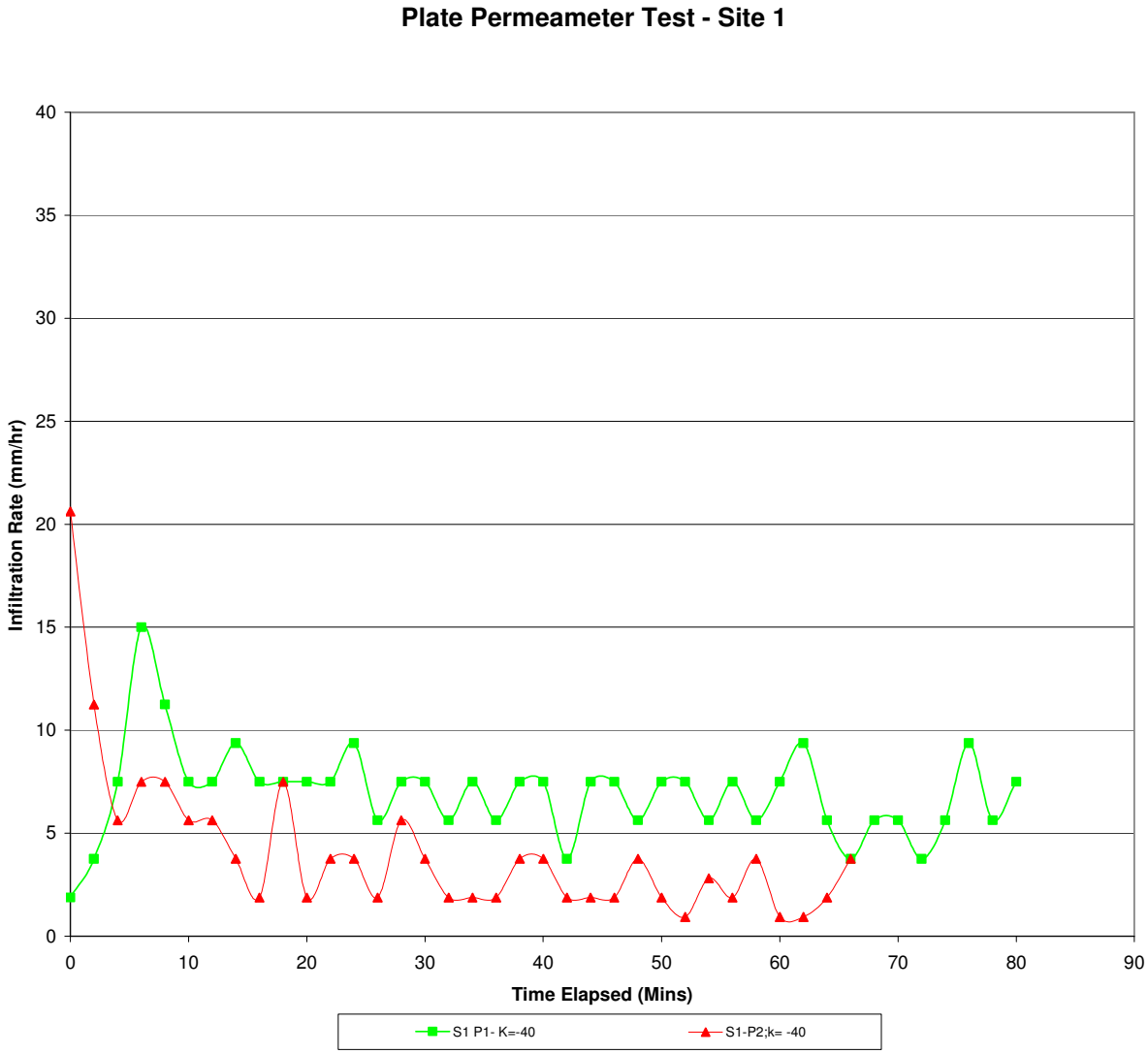

Figure 6: Plate Permeameters – Site 2

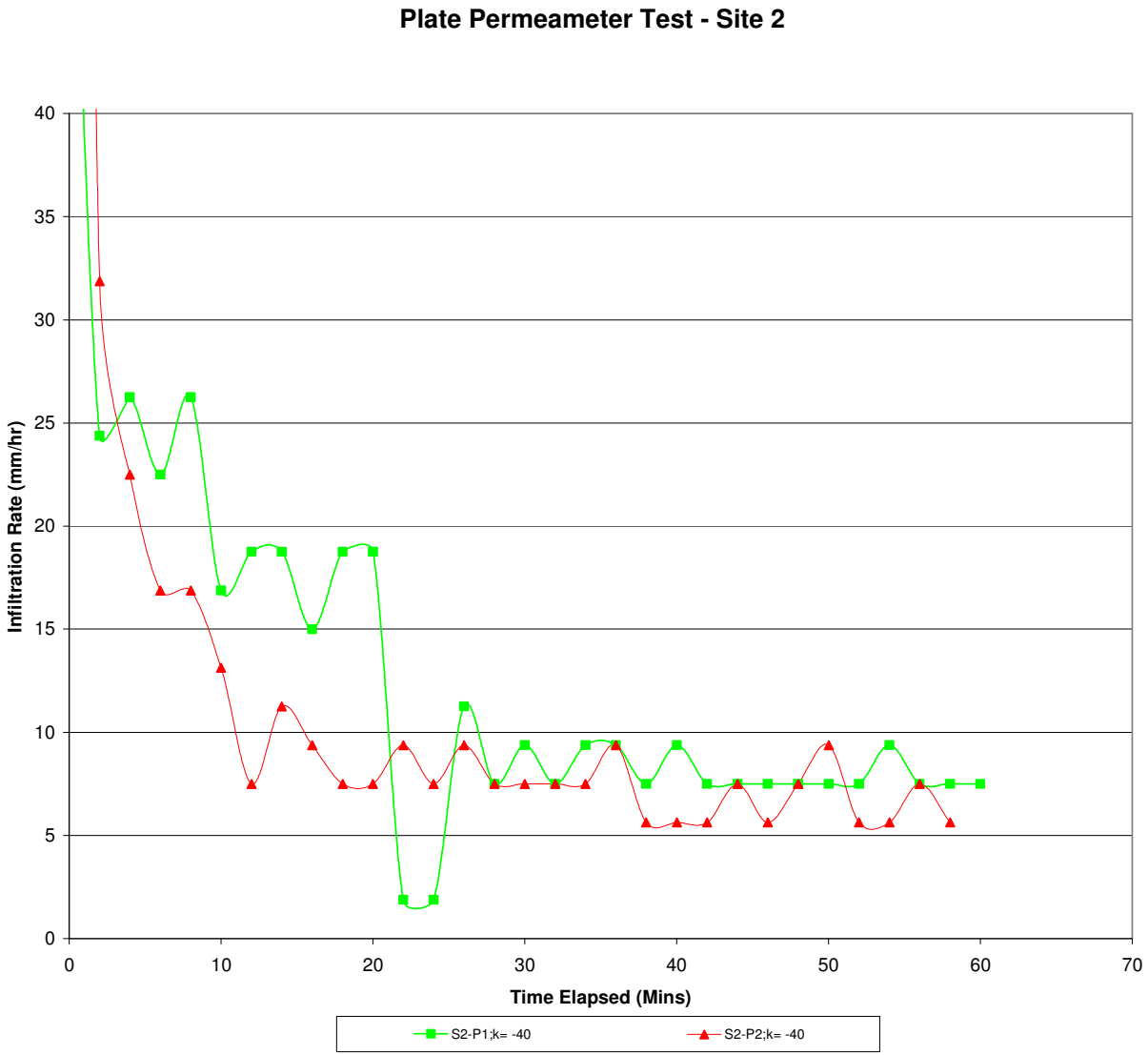

Figure 7: Plate Permeameters – Site 3

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APPENDIX B

Soil Profile Descriptions

Soil Profile

Project Soil Group: *H1* **Profile Number:** **GPS462**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J Hill / D. Richardson
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 1 (<12°)
Elevation: ~155 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

Depth (mm)	Horizon description
0-200	dark brown; silty clay; high organic matter;
200-300	light brown to yellow; compacted clay; some organic material; heavy mottling
300-600	light brown; clay; mottling

Soil Profile

Project Soil Group: *H2* **Profile Number:** **GPS463**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: Hill / D. Richardson
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 1 (<12°)
Elevation: ~150 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	dark brown; silty clay; high organic matter;
300-450	light brown to yellow; compacted clay; some organic material; heavy mottling
450-600	light brown; clay; mottling 50%

Soil Profile

Project Soil Group: *H3* **Profile Number:** **GPS464**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill / D. Richardson
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 1 (<12^{o})
Elevation: ~145 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	dark brown; silty clay; high organic matter;
300-400	light brown to yellow; compacted clay; some organic material; heavy mottling
400-450+	light brown; clay; mottling 50%

Soil Profile

Project Soil Group: *H4* **Profile Number:** **GPS465**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 1 (<12^{o})
Elevation: ~145 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	dark brown; silty clay; high organic matter;
300-400	light brown to yellow; compacted clay; some organic material; heavy mottling
400+	light brown; clay; mottling 50%

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Soil Profile

Project Soil Group: *H5* **Profile Number:** **GPS466**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 °
Elevation: ~180 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-200	dark brown; silty clay; high organic matter;
200-400	light brown to yellow; compacted clay; some organic material; heavy mottling
400-500+	light brown; clay; mottling 50%

Soil Profile

Project Soil Group: *H6* **Profile Number:** **GPS467**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: D. Richardson
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 °
Elevation: ~175 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-350	dark brown; silty clay; high organic matter;
200-500	brown with yellow mottling; silty clay; mottling mixed with organic material
500-600	light brown; clay; heavy mottling

Soil Profile

Project Soil Group: *H7* **Profile Number:** **GPS468**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 ^{o}
Elevation: ~165 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-350	dark brown; silty clay; high organic matter;
200-500	brown with yellow mottling; silty clay; mottling mixed with organic material
500-600	light brown; clay; heavy mottling

Soil Profile

Project Soil Group: *H8* **Profile Number:** **GPS469**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 ^{o}
Elevation: ~160 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-350	dark brown; silty clay; high organic matter;
200-500	brown with yellow mottling; silty clay; mottling mixed with organic material
500-600	light brown; clay; heavy mottling

Soil Profile

Project Soil Group: *H9* **Profile Number:** **GPS470**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 ^{o}
Elevation: ~145 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	dark brown; silty clay; high organic matter;
300-400	light brown to yellow; compacted clay; some organic material; heavy mottling
400-600	light brown; clay; heavy mottling

Soil Profile

Project Soil Group: *H10* **Profile Number:** **GPS471**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 ^{o}
Elevation: ~140 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	dark brown; silty clay; high organic matter;
300-600+	Light brown; clay; 20% light mottling

Soil Profile

Project Soil Group:	*H11*	**Profile Number:**	**GPS472**
Client:	Tomlinson and Carruthers	Job No.:	303051
Soil:	Silty clay	Parent Material:	Sedimentary
Survey Date:	27/09/07	Surveyed By:	J. Hill
Site Address:	Woodlands Road, Carterton		
Site Map Reference:	NZGM S26:266-131		
Survey Purpose:	wastewater design assessment		
Drainage:	Poor	Vegetation:	pasture
Topography:	relatively steep	Slope Class:	12-20 ^{o}
Elevation:	~140 mamsl	Land-use:	Cattle grazing

Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-350	dark brown; silty clay; high organic matter;
350+	light brown; clay; light mottling

Soil Profile

Project Soil Group:	*H12*	**Profile Number:**	**GPS473**
Client:	Tomlinson and Carruthers	Job No.:	303051
Soil:	Silty clay	Parent Material:	Sedimentary
Survey Date:	27/09/07	Surveyed By:	J. Hill
Site Address:	Woodlands Road, Carterton		
Site Map Reference:	NZGM S26:266-131		
Survey Purpose:	wastewater design assessment		
Drainage:	Poor	Vegetation:	pasture
Topography:	relatively steep	Slope Class:	12-20 ^{o}
Elevation:	~140 mamsl	Land-use:	Cattle grazing

Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-350	dark brown; silty clay; high organic matter;
350+	light brown; clay; 40% mottling

Soil Profile

Project Soil Group:	*H13*	**Profile Number:**	**GPS474**
Client:	Tomlinson and Carruthers	Job No.:	303051
Soil:	Silty clay	Parent Material:	Sedimentary
Survey Date:	27/09/07	Surveyed By:	J. Hill
Site Address:	Woodlands Road, Carterton		
Site Map Reference:	NZGM S26:266-131		
Survey Purpose:	wastewater design assessment		
Drainage:	Poor	Vegetation:	pasture
Topography:	relatively steep	Slope Class:	12-20 ^{o}
Elevation:	~138 mamsl	Land-use:	Cattle grazing

Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	dark brown; silt loam
300-600	light brown; clay; 40% mottling

Soil Profile

Project Soil Group:	*H14*	**Profile Number:**	**GPS475**
Client:	Tomlinson and Carruthers	Job No.:	303051
Soil:	Silty clay	Parent Material:	Sedimentary
Survey Date:	27/09/07	Surveyed By:	J. Hill
Site Address:	Woodlands Road, Carterton		
Site Map Reference:	NZGM S26:266-131		
Survey Purpose:	wastewater design assessment		
Drainage:	Poor	Vegetation:	pasture
Topography:	relatively steep	Slope Class:	12-20 ^{o}
Elevation:	~100 mamsl	Land-use:	Cattle grazing

Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-500	brown; silt loam; speckled mottling; saturated
500+	Yellow brown; clay

Soil Profile

Project Soil Group: *H15* **Profile Number:** **GPS476**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 °
Elevation: ~105 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	brown; silt loam; no mottling
300-600	light brown; clay; mottling

Soil Profile

Project Soil Group: *H16* **Profile Number:** **GPS477**
Client: Tomlinson and Carruthers Job No.: 303051
Soil: Silty clay Parent Material: Sedimentary
Survey Date: 27/09/07 Surveyed By: J. Hill
Site Address: Woodlands Road, Carterton
Site Map Reference: NZGM S26:266-131
Survey Purpose: wastewater design assessment
Drainage: Poor Vegetation: pasture
Topography: relatively steep Slope Class: 12-20 °
Elevation: ~100 mamsl Land-use: Cattle grazing
Average Annual Rainfall: 1620.7 mm (SN2623 and 3460)

	Horizon description
0-300	brown; silt loam
300-600	Yellow brown; clay

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