# DRAINAGE STRATEGY REPORT

## FOR

# SHEPPARTON NORTH EAST GROWTH CORRIDOR PRECINCT STRUCTURE PLAN

## for

# CITY OF GREATER SHEPPARTON

**REF: 21656E**
**DATE: SEPTEMBER 2012**

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Pty Ltd

Land Surveyors
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# Contents

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# 1 INTRODUCTION

This report has been prepared to inform and assist the City of Greater Shepparton in relation to the stormwater drainage servicing issues and requirements associated with the development of the proposed Shepparton North East Growth Corridor Precinct Structure Plan.

The information contained in this report is based on investigations by Reeds Consulting Pty Ltd that have been facilitated by our inquiries with City of Greater Shepparton (CGS), Goulburn Murray Water (GMW) and the Goulburn and Broken Catchment Management Authority (GBCMA) and the information provided by these parties.

In addition to the above authority consultations, additional advice has been provided in relation to site levels and limited geotechnical investigation to assess current groundwater conditions.

Reeds Consulting have undertaken several inspections of the site and surrounding drainage infrastructure to better assess the constraints of the current conditions and the limitations that will be placed on the development of the land in its intended use of residential subdivision.

The report is based on both written and verbal advice from the abovementioned parties and our own calculations and assessments. The information has been prepared with due diligence and care however Reeds Consulting retains the right to alter this report should we become aware of a change in policy or advice that is contrary to the assumptions upon which this report has been prepared.

# 2 EXISTING CONDITIONS

## 2.1 SITE DESCRIPTION

The subject area is approximately four kilometres north east of the Shepparton town centre.

The area is bounded by Ford Road to the north, Grahamvale Road and Goulburn Murray Waters irrigation channel to the east, Verney Road to the west and Goulburn Murray Waters Drain number 3 along the southern abuttal. A plan of the subject land is shown in Figure 1 below.

The subject land has a total area of approximately 172 Ha and consists of 8 major parcels of land, several smaller landholdings and contains two existing school sites. A number of existing irrigation channels bisect the site. The retirement of these channels will be a constraint on the full development of the PSP area as the channels will need to remain until all irrigation activity ceases in the precinct.

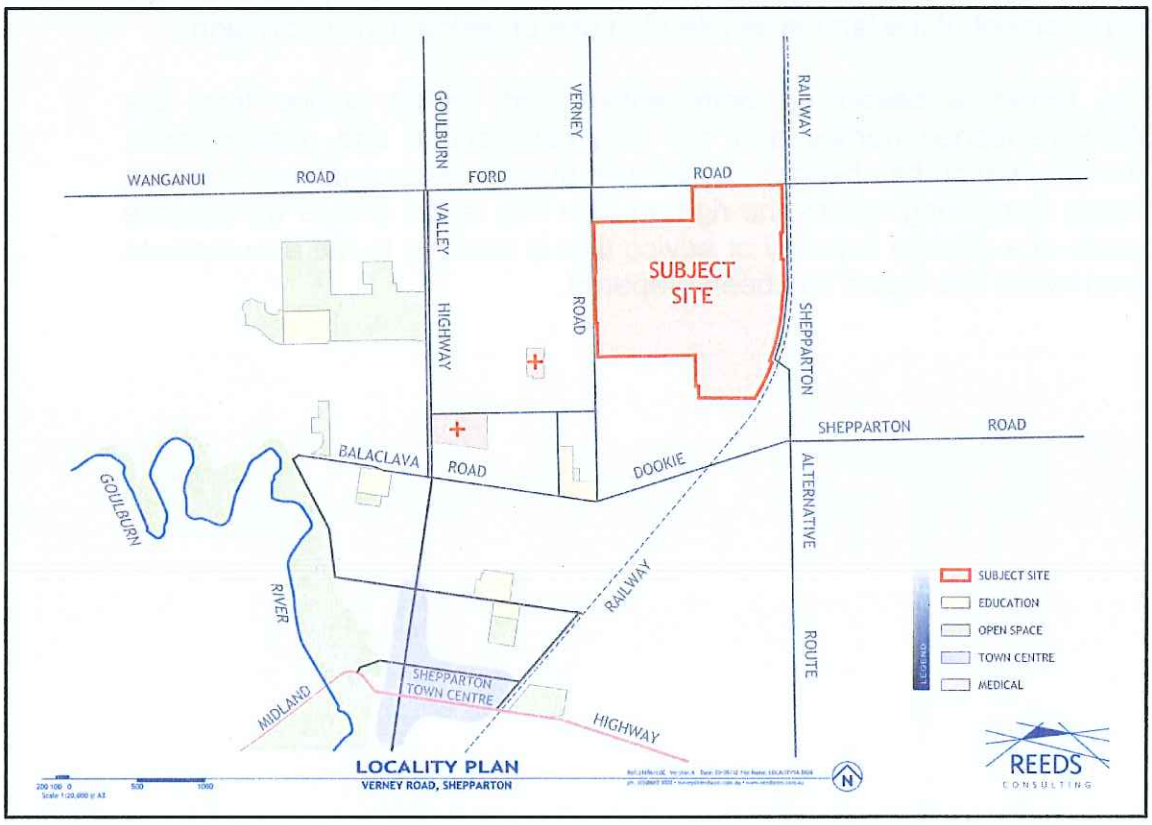


FIGURE 1: SITE LOCALITY PLAN.

## 2.2 EXISTING DRAINAGE CONDITIONS

The area has historically been used for fruit production and generally exhibits flat grades that have been artificially modified to facilitate gravity irrigation and drainage of land.

The land sheds runoff into two existing drainage catchments; these are demonstrated in figure 2 below. The southern portion of the site drains to Goulburn Murray Waters Drainage Channel No.3. The northern portion of the site drains to Goulburn Murray Waters Drainage Channel No. 4.

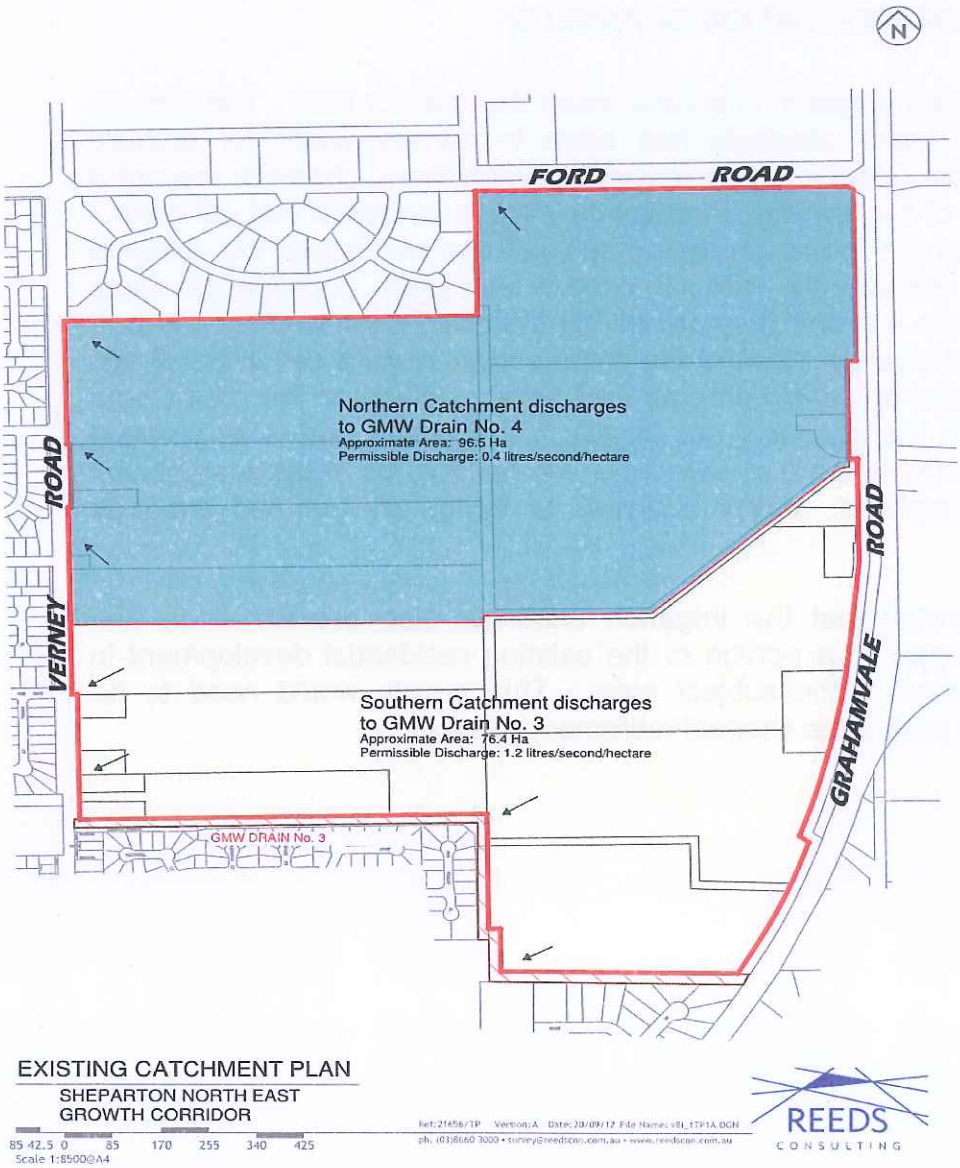


FIGURE 2: EXISTING DRAINAGE CATCHMENTS

Advice from Goulburn Murray Water indicates that the site currently has no formal drainage strategy and the current drainage outlets are limited to rural capacity and are not sufficient to provide any formal level of drainage or flood protection to the area.

The subject area is not identified as land subject to inundation in a 100Yr event on GBCMA's flood mapping of the Shepparton Area (refer Appendix A). In its current state the site is subject to localised flooding following more substantial rain events. In particular GMW has provided advice that Drain No 4 has an extremely limited capacity to receive water from the site or to accept stormwater when the drain is running partially full. This is discussed in more detail below.

## 2.3 EXISTING IRRIGATION CHANNELS

Two significant irrigation channels bisect the subject land. The primary purpose of these channels has been to convey water for orchard irrigation from GMW's supply network. Whilst these channels are not a component of the drainage strategy they are a constraint that will control the development timing, as their continued use will impact the ability to effectively remodel the site to provide adequate drainage to some portions of the site until they are retired from service and abandoned. It is noted that abandonment of the channels will require cessation of use and surrender of water rights as well as acquisition of the crown land within which the channels are located. If development is to proceed whilst the channels are in use there will need to be a bypass solution comprising siphons, gravity drainage or temporary pumped drainage lines.

It is also noted that the irrigation channels also provide stock and domestic supply to a portion of the existing residential development in the north west of the subject area. This supply would need to be replaced as part of the channel retirement process.

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# 3 PROPOSED DRAINAGE STRATEGY

The following section outlines the design constraints and logic behind the development of the drainage strategy for the site. The site has a combination of design constraints, which include physical, aesthetic and social, these have all been considered during the development of the drainage strategy. It became apparent during the process that the drainage solution for this site would have a controlling effect on the overall road and public open space network and to this end the drainage strategy has been developed in conjunction with the overall PSP layout to ensure that an integrated design solution is achieved that will permit the efficient and economic development of the site.

The constraints on the site are derived from three primary sources; these are natural topographic constraints, Goulburn Murray Water constraints in relation to outlet capacity and water quality treatment and City of Greater Shepparton constraints in relation to internal drainage requirements and a stated desire to integrate any storage / retarding basins in areas of open space. Each of these design controls is discussed below:

## 3.1 TOPOGRAPHIC CONSTRAINTS

The site is generally flat with minimal surface grades due to the historic agricultural use artificially shaping the land surface to provide efficient gravity flood irrigation of the orchards.

To develop the site for residential development it will be necessary to undertake significant site remodelling and bulk earthworks to meet required minimum grades for roads and allotments and to convey and control overland stormwater flow. Filling of the site will be constrained by abuttal to existing development in the north west of the area and to a lesser degree by the interface with existing roads and channels that surround the site.

In order to provide an economic design solution and limit the extent of earthworks it is necessary to remodel the site into a series of sub-catchments. Based on the geometry of the overall parcel the drainage strategy has proposed a series of five approximately equally sized sub-catchments. These sub-catchments are defined on the drainage strategy plan in Appendix B.

## 3.2 GOULBURN MURRAY WATER ADVICE

Goulburn Murray Water is the responsible drainage authority that manages the drainage and irrigation network in the Greater Shepparton area.

GMW defines both the treatment requirements for stormwater and the permissible discharge flows into their drainage network.

Advice from GMW in relation to drainage of the subject area has confirmed that Drainage Channel No. 4 to the north of the site has significant discharge constraints and a maximum permissible discharge rate of 0.4 litres /second /hectare.

Drainage Channel No. 3 to the south of the subject land has a permissible discharge rate of 1.2 litres /second /hectare which is still a restrictive figure when considering the size of the catchment.

In discussions with GMW there has been confirmation that alteration of the existing drainage catchment boundaries would be supported to enable the majority of the site to be conveyed to Drain No. 3 and that the maximum discharge rate is not exceeded. GVW have also advised that level monitoring of Drain No. 3 will be necessary and no outfall / discharge permitted when a pre-determined top water level is reached or exceeded. Given the extremely restrictive discharge rate permitted to Drain No 4, the drainage strategy for this precinct will be to discharge all flows, other than localised road flows in the Ford Road abuttal to Drainage Channel No 3.

During or following times of heavy rainfall GMW has advised that the drainage channel network does not have sufficient capacity to cater for any additional contributing flows. GMW have confirmed that a pump controller will be necessary to regulate discharges into Drain No. 3. As a result of this limitation it is a requirement that the drainage system within the PSP area be designed to store all discharge from a 1% AEP (100 Yr. ARI) storm for a 24 hour period. This is a significant factor in the development of the drainage strategy and requires the inclusion of significant storage basins within the site area.

In addition to the controls placed on the quantity of discharge from the site GMW have also stipulated that the quality of the discharged stormwater must meet industry benchmark practice with regard to the removal of suspended solids (80%), nitrogen (45%) and phosphorous (45%).

To achieve the water quality targets for stormwater the drainage strategy will incorporate Water Sensitive Urban Design (WSUD) elements where possible into the road and storage basin design.

## 3.3 CITY OF GREATER SHEPPARTON ADVICE

In developing the drainage strategy Council has placed a number of design constraints on the site. These are a combination of technical constraints and desired outcomes with respect of landscape interface and integration of public amenity between proposed storage basins and public open space areas.

Councils technical design criteria is based on the requirements in the Infrastructure Design Manual (IDM) and includes the provision of a major / minor drainage system with a 5Yr ARI underground system and an overland flow path with capacity to convey and control 100Yr ARI runoff.

Council have indicated a desire to move away from past municipal practices of providing isolated water storage basins. Traditionally these have been located in fenced off reserves and have been excavated depressions with steep batters to maximise storage capacity. Council have stipulated that any stormwater storage basins be integrated with public open space. Such integration offers a range of community benefits including additional opportunity for landscape embellishment of open space, increased overall size of community reserve areas, improved visual amenity and sightlines within the reserve and opportunity to integrate shared pathways with the basin to enhance passive recreation opportunities.

The inclusion of the storage basins within public reserve areas increases design constraints due to the safety and maintenance requirements of flatter batter slopes and curvilinear geometry to give a more 'natural' footprint to the basins. Both of these factors reduce the efficiency of the storage area. The design compromise is to minimise the footprint of the storage area whilst providing a natural basin shape and gentle batters that are amenable to all reserve users.

## 3.4 SUB-CATCHMENTS

The drainage strategy for this site has been dictated by the various constraints discussed above. The site has been divided into 5 sub-catchments that will each have an independent storage basin capable of storing a 1% AEP storm for a 24 hour period with no discharge to the receiving waters external to the site. The location of the storage basins is generally central within each catchment to ensure that the drainage lengths are not excessive which avoids unnecessarily deep basins.

Each storage basin will have a controlled pumped discharge as a gravity discharge will not be possible due to the site topography and relative water levels in the drainage channels.

Generally each sub-catchment will have a 5 Yr. ARI piped drainage network to convey flows to the storage basin area. Flows in excess of the 5Yr ARI event will be conveyed overland via the road network to the storage basin.

Upon entry to the basin piped drainage flows will be discharged to the surface and conveyed via a drainage swale/ bio-swale to a sump at the lowest point of the basin. In minor events and subject to the receiving water level, the stormwater will be pumped at the limited rate into Drain No. 3 via a rising main located within the road network. In the even that runoff exceeds the pump rate or in the event that the outlet is not available due to high water levels in the GVW channels, water will be stored within the basin area to be pumped once outlet conditions are suitable.

Preliminary drainage analysis of each sub-catchment has been undertaken and from this an estimated storage requirement has been determined for each basin based on the 100Yr storm. A summary of these results and preliminary basin storage volumes is presented in Fig 3 below sub-catchment identification is per Appendix 2:

| SHEPPARTON NEGC SUBCATCHMENT STORAGE REQUIREMENTS | | | |
|---|---|---|---|
| Sub-Catchment ID | Sub-catchment Approximate Area (Ha) | Storage Volume 100Yr ARI storm 24 Hour (cubic metres) | Basin Area 100Yr level (sq.m) |
| 1 | 32.2 | 31,000 | 14,720 |
| 2 | 35.5 | 38,000 | 16,850 |
| 3 | 34.5 | 33,800 | 16,200 |
| 4 | 37 | 42,800 | 19,400 |
| 5 | 25.8 | 27,500 | 14,350 |
| **TOTAL** | **165** | **173,100** | **81,520** |

FIGURE 3: BASIN STORAGE CAPACITY & INDICATIVE SIZING

Based on the required storage volumes and councils preferred batter slopes of 1 in 8 an approximate footprint area for each storage basin has been calculated. These have been located approximately central to each sub-catchment area. The road network and public open space elements have been integrated in this strategy to provide the most efficient layout for the site. The treatment of the storage basins is discussed below.

It is noted that the two school sites within the parcel have existing drainage connections. It is not proposed to alter the existing connections for the developed portion of the school sites. Where the school land may

be sold off and its use altered to residential development then these areas of altered land use would be incorporated into the estate storage design.

## 3.5 STORAGE BASINS

The storage basins vary slightly in size due to variance in the sub-catchment areas. In general these basins will be located within or directly adjacent to public open space reserves, such that the spaces become integrated community areas. Each basin is expected to be in the order of four (4) to five (5) metres deep to provide the required storage volume. In higher order rain events these basins will be sized to fill up to the level of the surrounding reserve; however the public open space areas will be above the 100 Yr. storage level and will maintain functionality.

Council has stipulated that the five year storage level in the basin must be lower than the invert level of the local drainage network to ensure that a free draining network in the 5Yr ARI event. Whilst a detailed drainage design is not within the scope of this report it is anticipated that the underground drainage network will be approximately 2.5 meters in depth hence a basin depth of 5 metres may be necessary to accommodate sufficient 5 Yr. ARI storage below the piped drainage level.

The Shepparton area has high incidence of groundwater and this was a primary consideration in assessing the viability of such significant storage bodies. To address the concern over groundwater and to confirm the feasibility of the storage basins, a geotechnical consultant was engaged to undertake field bores and assess ground water conditions.

Once preliminary assessment of likely basin location was determined the geotechnical engineer was provided co-ordinates of the proposed basin locations and drilling was undertaken at the proposed location of each basin.

The testing revealed that there was no groundwater present at depths up to five (5) metres and as such the basin footprints as proposed in the Drainage Strategy plan are considered feasible in terms of the proposed depths.

A full copy of the geotechnical report prepared by BM Consulting Engineers is included in Appendix 3.

The basin footprints proposed have been based on a council stipulated batter slope of 1 in 8. This is a reasonably conservative figure but one that provides unimpeded pedestrian access to the basins. The ultimate landscape treatment of the basins will provide opportunities to increase

this batter slope through intense localised landscape treatment or the incorporation of formal retaining walls, boardwalks and fences in other areas.

The successful integration of the basins into the public open space will rely upon the variability of the landscape treatments and the details of this concept will be fully developed during detailed design. The inclusion of areas of steeper batters has the beneficial impact of reducing the overall basin footprint, decreasing the area of land subject to regular inundation and creating or enhancing visual interest and overall aesthetics.

It is anticipated that the landscape treatments for the basins will be predominantly open grassed areas in the lower areas subjected to frequent inundation. The inclusion of open swales / dry creek beds and appropriate ephemeral plantings will be appropriate in the lower reaches of the swales.

The upper reaches of the basins can be planted with trees and species that will tolerate occasional inundation. The use of mulched garden areas should be restricted to the periphery of the basin areas to avoid transportation of the mulch and blockage of the drainage outlet systems and pumps.

Each storage basin will have a localised sump and pump station to enable discharge of collected runoff. The sump areas could be either underground chambers or incorporate small pondages.

Due to the already significant depth of the basins it is not anticipated that there will be significant opportunity for large water bodies to be incorporated into the storage basins. These would be required to be excavated below the required storage level (i.e. the top water level of any permanent water body would need to be below the 5 metre basin depth).

## 3.6 STORMWATER OUTLETS

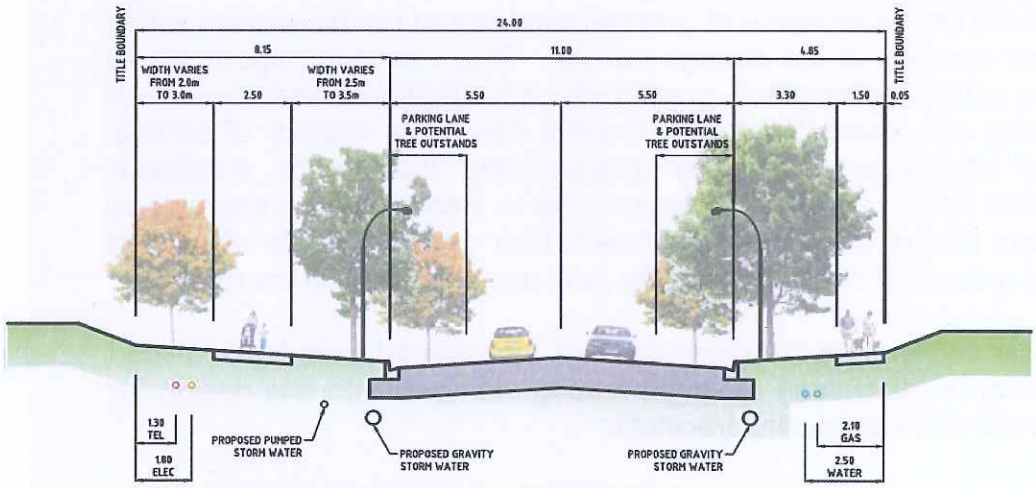
As discussed in the above report ultimate discharge of stormwater runoff is to GMW's Drain No.3. This discharge will be via a pressurised discharge from each storage basin.

After assessment of the likely development staging, landholdings, site topography and road network the most economic and flexible solution is to provide two linked pressurised systems, with two independent connection points to Drain No 3. GMW has offered in-principle support of two discharge points.

The proposed discharge system is shown in the Drainage Strategy plan provided in Appendix 2. A combined discharge system will be

constructed that links the basins in Catchments 1, 3 and 4 and discharges via Verney Road to Drain 3. Basins 2 and 5 could also combine to a localised discharge point part way long the Southern boundary of the site.

Such an arrangement will enable infrastructure costs to be rationalised and alleviate the need to install multiple pipelines within road reservations to cater for drainage discharge. A proposed street cross section is shown below which incorporates the pumped drainage outlet and demonstrates that the inclusion of this asset within a typical street is achievable.




**CROSS SECTION 3 - 24m WIDE RESERVE LINK ROAD**

## 3.7 WATER SENSITIVE URBAN DESIGN

Prior to discharge into GMW's drainage channel, stormwater flows will need to be treated to meet best practice targets for the removal of contaminants particularly suspended solids, dissolved nitrogen and phosphorous.

There are a number of treatment options available to reduce the pollutant load on receiving waters, these include;

- Household rainwater tanks connected to toilets or laundry
- Localised rain gardens adjacent to carparks, community buildings or commercial precincts.
- Inclusion of gross pollutant traps (GPT's) on local drainage networks.
- Linear treatments such as grassed swales or bio-swales
- End of line treatments such as wetlands.

Usually a combination of several treatments provides the optimal solution for a larger site.

Within the Shepparton NEGC there is opportunity to implement a number of these solutions, particularly point of capture treatments such as rain water tanks and rain gardens.

Given the depth of the storage basins required to retard stormwater flows a wetland is not considered feasible as this option would require additional excavation below the level of the basin floor and would be subject to frequent inundation due to the lack of ability to bypass 'high flow' events.

It is considered that the primary treatment feature of the drainage network will be the inclusion of grassed swales and / or bio-swales within the lower reaches of the storage basins. These provide opportunity to create a natural appearance 'creek bed' style treatment and the size of the basins will mean that swale lengths can be in excess of several hundred meters per basin by incorporating multiple or curvilinear alignments which will offer the opportunity to incorporate an appropriate landscape theme throughout the basin floor and still retain significant areas of grass that can be utilised by park users in times of low rainfall.

The basin swales can be supplemented by swales located within road medians or as discussed by incorporating elements into site design for commercial and community precincts.

Detailed design and modelling of the WSUD elements will be undertaken during the detailed design phase of the project and will need to consider not only the physical constraints of the site but also the financial impact of both initial construction and ongoing maintenance of the various treatment train elements.

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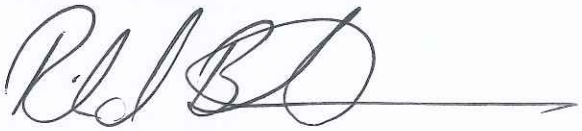
## 4 CONCLUSION

This report has sought to outline the physical and statutory constraints that impact provision of drainage facilities to the Shepparton NEGC as well as consider the desired outcomes from a public amenity perspective.

The site requires significant remodelling and the inclusion of storage basins that will be a major visual feature of the redevelopment of the site. There is significant opportunity to incorporate the required storage basins within and adjacent to public reserve areas and to incorporate appropriate landscape enhancements to reduce the visual impact of the basins while enhancing the visual amenity and of the surrounding public open space areas.

A number of opportunities exist to incorporate Water Sensitive Urban Design elements into drainage infrastructure to ensure that stormwater runoff from the development of the land meets current best practice requirements for the removal of pollutants.

Prepared by:
**REEDS CONSULTING PTY LTD**



**RICHARD BREWSTER**
Engineering Director

### Disclaimer

The information contained within this report has been obtained from various servicing Authorities either verbally or in writing however, until such time as formal applications made, conditions and the appropriate approvals obtained, it should only be used as a guide. Any party wishing to use the material contained within this report should make their own inquiries to satisfy themselves to the accuracy of the information.

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# ANNEXURE 1

## Goulburn and Broken Catchment Management Authority (GBCMA) 1% AEP Flood Inundation plan

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# ANNEXURE 2

## Shepparton North East Growth Corridor Drainage Strategy Plan

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# ANNEXURE 3

## Groundwater Investigation
## BM Consulting Engineers

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20-Apr-11

**CLIENT :** Reeds Consulting

**JOB DESCRIPTION:** Provide Site Investigation for proposed Stormwater Retardation Basins.

**PROJECT ADDRESS:** Shepparton North East Growth Area.

**OUR JOB NO:** 30170

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**REPORT BACKGROUND:**

Rezoning of farmland to residential land is proposed as part of the North East growth area of Shepparton. As part of this process up to five stormwater retardation basins may be required. John McKernan of Reeds Consulting has requested this investigation in order to determine the suitability of the nominated sites for the proposed use and also to provide the soil parameters necessary for the basin designs.

**REPORT OBJECTIVES:**

Two boreholes are to be drilled at each of the proposed retention sites. Soil profiles are to be logged and an assessment of soil type and porosity undertaken. Permeable soils or unsuitable water retaining soils such as filling, dispersive or granular soils are to be identified. The presence of groundwater or other factors that may impact on the design of basins and on the construction techniques are to be identified.

## 1.0 SITE DESCRIPTION:

**1.1** There are five (5) proposed construction sites. All sites are currently within orchards. Their locations are illustrated on figure 1 and pictured in the photos.

**1.2** Geologically the soils of the area are fine grained soils of Quaternary Pleistocene alluvium of the Shepparton Formation. These are sediments of sands, silts and clays laid down in lens like deposits. There can be variations in soil types over short distances with the discontinuity of the lenses.

## 2.0 SITE INVESTIGATION:

**2.1** Boreholes of general depth 5000mm and down to 6000mm were drilled using 100mm diameter continuous flight mechanical augering — two at each site. The

locations and logs as well as GPS co-ordinates for each test hole are shown on the attached borehole log sheets.

Photo1: Site 1 boreholes 1&2.

Photo 2: Site 2 Boreholes 3&4


Photo 3: Site 3 Boreholes 5 & 6.

Photo 4: Site 4 Boreholes 7&8.

Photo 5: Site 5 Boreholes 9&10.

Logged soils were hand and visually classified. Soil shear strength was assessed in the field using shear vane measurements. Soils were sampled and returned to the laboratory for comparison and confirmation of the classification and to indicate other soil properties typical of those in the classified group. Particle size distribution and Plasticity testing was undertaken as part of the testing process. Maximum dry densities of the pre-dominant soil type were assessed. All tests were undertaken to our NATA accredited procedures. (Laboratory Registration Number 5023)

2.2 **Borehole Descriptions**: Soils recovered were of similar texture from all test holes with minor variations in sand and clay content and colour.

**Site 1**

**Borehole 1**: There is light brown clay of sand traces to 3400mm with moist brown clay with sand traces extending to the end of the bore.

**Borehole 2**: Beneath shallow clayey fine sand, there is light brown silty clay with sand traces to 1500mm with light brown clay extending to the end of the bore at 5000mm.

**Site 2**

**Borehole 3**: There is light brown silty clay with sand extending to the end of the bore at 5000mm..

**Borehole 4**: There is light brown silty clay with sand extending to the end of the bore at 5000mm..

**Site 3**

**Borehole 5:** Beneath shallow clayey sand there is stiff brown clay to 500mm and overlying light brown silty clay with sand. The light brown silty clay of sand traces extends to the end of the bore.

**Borehole 6:** Beneath shallow clayey sand there is stiff brown clay to 500mm and overlying light brown silty clay with sand. There is a seam of clayey sand between 1800mm and 2400mm before the light brown silty clay of sand traces extends to the end of the bore.

Site 4

**Borehole 7:** Beneath shallow clayey sand there is stiff red brown clay to 800mm and overlying clayey sand of medium density to 2000mm. Beyond this, light brown silty clay with sand traces extends to the end of the bore.

**Borehole 8:** Beneath 200mm of shallow clayey sand there is stiff red/ brown clay which becomes increasingly sandy with depth to become red/brown sandy clay from 800mm to 2000mm. Beyond this, there is light brown silty clay of sand traces which extends to the end of the bore.

Site 5

**Borehole 9:** There is light brown silty clay with sand to 1500mm. Beyond this, there is very stiff light brown clay to the end of the bore at 5000mm.

**Borehole 10:** : There is light brown silty clay with sand to 1500mm. Beyond this, there is very stiff light brown clay to the end of the bore at 5000mm.

2.3 **Laboratory Testing and Classification:** The soils encountered are within the range of medium plasticity with minor variations in liquid limits yielded across the entire site. The results of site 2 (BH3 & BH4) reflect the sandier soils encountered in this area and are of lower plasticity or CL soils. There is a significant sand content in all soils analysed. The soils of the site 1 (BH1 & BH2) are of a heavier clay and this was also reflected in the higher plasticity test results for this site.

In summary, all samples analysed are classified as clays with the lesser components of silt and sand. The sand and silt will enhance the soils' workability while the clay will contribute to the impermeability properties.

These results are typical of soils gathered and tested by this company in the alluvial soils of the Shepparton area. The Plasticity testing on samples from each test hole are summarised in table 1. Particle size distribution analyses results are summarised in Table 2.

2.4 Based on the correlation of soil properties, the estimated seasonal soil surface movement is moderate. It is estimated to be between between 20mm and 40mm.

For construction of residential parameters, the site classification for the site is **M-D Moderately Reactive** in accordance with AS2870-12011.

| Borehole No. | Depth (mm) | LL | PL | PI | LS | Class |
|---|---|---|---|---|---|---|
| | % | | | | | |
| 1 | 1000-1500 | 49 | 17 | 32 | 16 | CI-CH |
| 2 | 500-1600 | 44 | 16 | 28 | 14.5 | CI |
| 4 | 200-2000 | 31 | 13 | 18 | 10 | CL-CI |
| 5 | 500-2000 | 44 | 16 | 28 | 14 | CI |
| 8 | 2000-3000 | 41 | 15 | 26 | 13.5 | CI |
| 10 | 800-1500 | 47 | 17 | 30 | 15 | CI-CH |

Table 1: Plasticity Test Results

| | | Australian Standard Sieve Sizes(mm) | | | | |
|---|---|---|---|---|---|---|
| Borehole No. | Depth (mm) | 2.36 | 0.6 | 0.3 | 0.075 | |
| | | | | % | | |
| 1 | 1000-1500 | 100 | 98 | 97 | 92 | CI-CH |
| 2 | 500-1600 | 100 | 99 | 98 | 92 | CI |
| 4 | 200-2000 | 99 | 96 | 92 | 74 | CL-CI |
| 5 | 500-2000 | 100 | 99 | 97 | 89 | CI |
| 8 | 2000-3000 | 99 | 98 | 96 | 87 | CI |
| 10 | 800-1500 | 97 | 95 | 92 | 87 | CI-CH |

Table 2: Particle Size Distribution Test Results

2.5 **Ground Water:** Bore holes were monitored over a 4 hour period . No infiltration of ground water occurred within this time in any of the test holes. It is reasonable to assume that groundwater will not be encountered in any excavations down to at least 5000mm and up to 6000mm across the site. There were no gravelly seams carrying perched water encountered in any of the bores. There were no dry gravelly seams of potential to carry water during different climatic conditions encountered in any of the bores across the site.

2.6 **Soil Moisture Content:** Soils were observed in the field to be moist (but not wet) over all of the soil profiles. Measured moistures were of the range 12.2% -18.4% . At these values the soils are pre- moistened and are within 4% of respective optimum moisture contents. Addition of moisture during construction would be nominal in magnitude and easily applied at these levels where some curing is already inherent in the soils.

2.7 **Bulk Densities:** Samples from most sites and representative of the major soil types were laboratory tested to determine the moisture density relationship. The results are tabulated in table 3.

| Report No. | Borehole No. | Depth (mm) | Moisture-Density | | |
|---|---|---|---|---|---|
| | | | Bulk Density | Max.Dry Density | OMC |
| | | | $\rho_s$ | $\rho_d$ | |
| 11721 | 1 | 1000-1500 | 1976 kg/m$^3$ | 1717 kg/m$^3$ | 18.7 |
| 11723 | 4 | 200-2000 | 2076 kg/m$^3$ | 1849 kg/m$^3$ | 14.5 |
| 11724 | 5 | 500-2000 | 1969 kg/m$^3$ | 1712 kg/m$^3$ | 19.4 |
| 11725 | 8 | 2000-3000 | 2012 kg/m$^3$ | 1760 kg/m$^3$ | 16.5 |
| 11726 | 10 | 800-1500 | 1994 kg/m$^3$ | 1684 kg/m$^3$ | 20.3 |

Table 3: Dispersion test results summary

2.8 **Bearing Capacity:** Shear vane testing was carried out at intervals within the natural soils to establish soil shear strengths. For shallow pad and strip footings bearing on natural soils below any surface silt, the estimated maximum allowable bearing capacities are as follows:

| Depth (natural soils) Below the surface. (mm) | Allowable Bearing Capacity (kPa.) |
|---|---|
| 400mm | 80 |
| 600mm | 100 |
| 900mm | 150 |
| 1200mm | 200 |

Table 4: Allowable Bearing capacities All Sites.

2.9 **Deep structures and Soil retention (manholes and pumpwells):** As a guide, typical values for cohesion and angle of shearing resistance are estimated based on the correlation of soil properties for the sandy clay soil as classified.

$c = 12kPa$
$\phi = 29°$
$\phi_g = 0.45$ max. (capacity reduction factor based on the level of investigation )

2.9 **Adhesion:** The silty clay and clay soils have estimated adhesion of at least 10kPa.

2.30 **Dispersion:** Samples were laboratory tested using the Emerson Dispersion Classification number method. The solutes of distilled water and tap water were used. Tap water is representative of the stormwater that may be retarded in the basins while distilled water is representative of the soils' behaviour under direct rainfall runoff. Dispersive behaviour of the soil during storage conditions may result in slumping and a loss of storage geometry and therefore operating capacity. It may also allow seepage of stored from the basin. Dispersive behaviour of the

soil surface slopes under the action of rainfall travelling down it will result in rutting and erosion of the banks. The eroded soils will be washed into the storage with subsequent reductions in design capacities.

Table 4 is a summary of the emerson number test results. The values indicate that the soils are non dispersive in the water storage mode. Soils form sites 1 and 4 may erode easily with rainfall possibly rutting exposed slopes.

| Report No. | Borehole No. | Depth (mm) | Emerson Class Number | |
|---|---|---|---|---|
| | | | 0 ppm | 120ppm |
| 11721 | 1 | 1000-1500 | 4 | 4 |
| 11722 | 2 | 500-1600 | 2 | 5 |
| 11723 | 4 | 200-2000 | 5 | 6 |
| 11724 | 5 | 500-2000 | 5 | 5 |
| 11725 | 8 | 2000-3000 | 2 | 4 |
| 11726 | 10 | 800-1500 | 6 | 6 |
| | | | | |

Table 5: Dispersion test results summary

**2.31 Permeability:**

Silty clay soils and clay soils of sand traces and plasticity properties of those recovered from all the sites are practically impermeable when constructed at the prescribed density and moisture content. By correlation of soil properties , the permeability of all samples tested at 95% of standard density is anticipated to be less than $1x10^{-9}$ m/s.

In their natural state , the soils are affected by the root zone and deep seasonal cracks and fissures would be prevalent. Reworking the lining of basin soils would create an homogeneous mass of compacted soil as required for impermeable conditions.

## 3.0 CONCLUSIONS, DESIGN and CONSTRUCTION:

**3.1 General:** The test bores and laboratory testing yielded similar results across the entire site. Soil profiles as encountered are typical of those of the Shepparton area on Shepparton Formation alluvial soils. Soils are generally silty clays with sand traces and of medium plasticity. These soils will be impermeable as a reworked and compacted liner in the retardation basins.

The sandy clay and clayey sand soils are of good workability properties. They are readily excavated and easy to place by conventional earth moving equipment. The soils exist at moisture contents close to optimum and nominal moisture addition will be required for compacted placement. The soils in this state are pre-cured and additional moisture will be efficiently absorbed as required. The soils' sand content facilitates the addition of moisture and the ability to be readily compacted.

There was an absence of groundwater at all of the sites tested. An awareness that water may be encountered in deeper than 6.0m excavations is important as ground water levels are subject to seasonal and climatic variations. Excavations beyond 6.0m may strike groundwater under a nominal pressure head which may lead to water rising closer to the surface. There is no evidence to suggest that this will be the case from this investigation.

There was no rock encountered in any of the test sites as would be expected in this site of deep alluvium. There are areas of surface soil which will require removal and nominal stripping to avoid vegetable matter. There is a clayey sand seam which was encountered in borehole 6 of site 4. This seam does not represent a prior stream or serious point of escape or influx of water. Such clayey sand seams if encountered during construction will need to be chase excavated, blended with the clayey soils and replaced under compaction. No other factors which may limit the selection of a particular site for the proposed new construction were encountered.

The frequency of borehole sites and the intensity of the testing program is considered reasonable and comprehensive for the requirements of this project and in the context of a subsurface investigation. It remains possible that there may be variations in the geotechnical conditions from those described in this report as no geotechnical investigation can be considered exhaustive. The results and recommendations are therefore a reasonable platform upon which to base subsequent site selection and preliminary design decisions with a flexibility to change course should there be variations in the conditions beyond a more intensive investigation within the actual construction envelope.

### 3.2 Design Recommendations:

**Beds of the Storages:** Losses and seepage form retention basins are usually through the base under the storage water pressure head. It is important that the base be impervious and constructed of appropriate materials. In the current format the natural soils are suitable at the proposed base depth. A liner of minimum layer depth 600mm is recommended . This can be constructed by reworking and compaction of the natural soils of the site with the aforementioned properties taken into account.

Reworking requires that the liner soils be conditioned to an appropriate texture and moisture content and then placed under compaction. Compaction cannot be achieved using earthmoving traffic alone — an articulated pad foot roller would be the minimum requirement for these soil types.

**The design levels of the basins:** The proposed design levels being no greater than 4.0m below existing surfaces will be satisfactory as no groundwater has been encountered within this range.

**Batter slopes:** are recommended to be 2.5 : 1 on the upstream faces of basins. These values are appropriate for the soil types. Compaction equipment should be able to negotiate slopes of this magnitude. Compaction of the batters and reinstatement of protective grasses will minimise potential erosion due to rainfall. Flatter slopes may be adopted if there is a plan to use the basins recreationally or regular grass mower traffic is planned.

### 3.3 Construction and Maintenance Recommendations:

**Stripping:** Strip the area beneath the bed and embankment construction of any topsoil and vegetable matter. Stockpile this material for spreading across the finished embankments as required. Material containing vegetable matter or humus must be avoided as structural filling.

**Compaction:** All of the recommendations given are based on the materials being compacted to engineering density standards for earthworks. This is important to counteract the potential for some site soils to be dispersive on batter slopes and it will also develop the impermeability of the soils. Re-work the bases in shallow layers of no greater than 200mm and compact using a vibrating pad foot roller.

**Moisture Content :**The filling should be placed within -2% to + 1% of its optimum moisture content. Within these limits the soils will be able to be compacted to maximum densities with impermeability and using the least compactive effort.

**Compaction Control:** In order to maintain control over density and moisture content it is recommended that a compaction testing program be undertaken during construction to establish an effective placement procedure. The earthworks code AS3798 can be used as a guide for the frequency of testing. Compaction should be such that no test is less than 95% of the maximum dry density as determined in the laboratory. With a proven test success record and therefore proven construction process, the frequency of testing may be relaxed. Obviously the most critical areas for control are within the lower embankments and the storage beds.

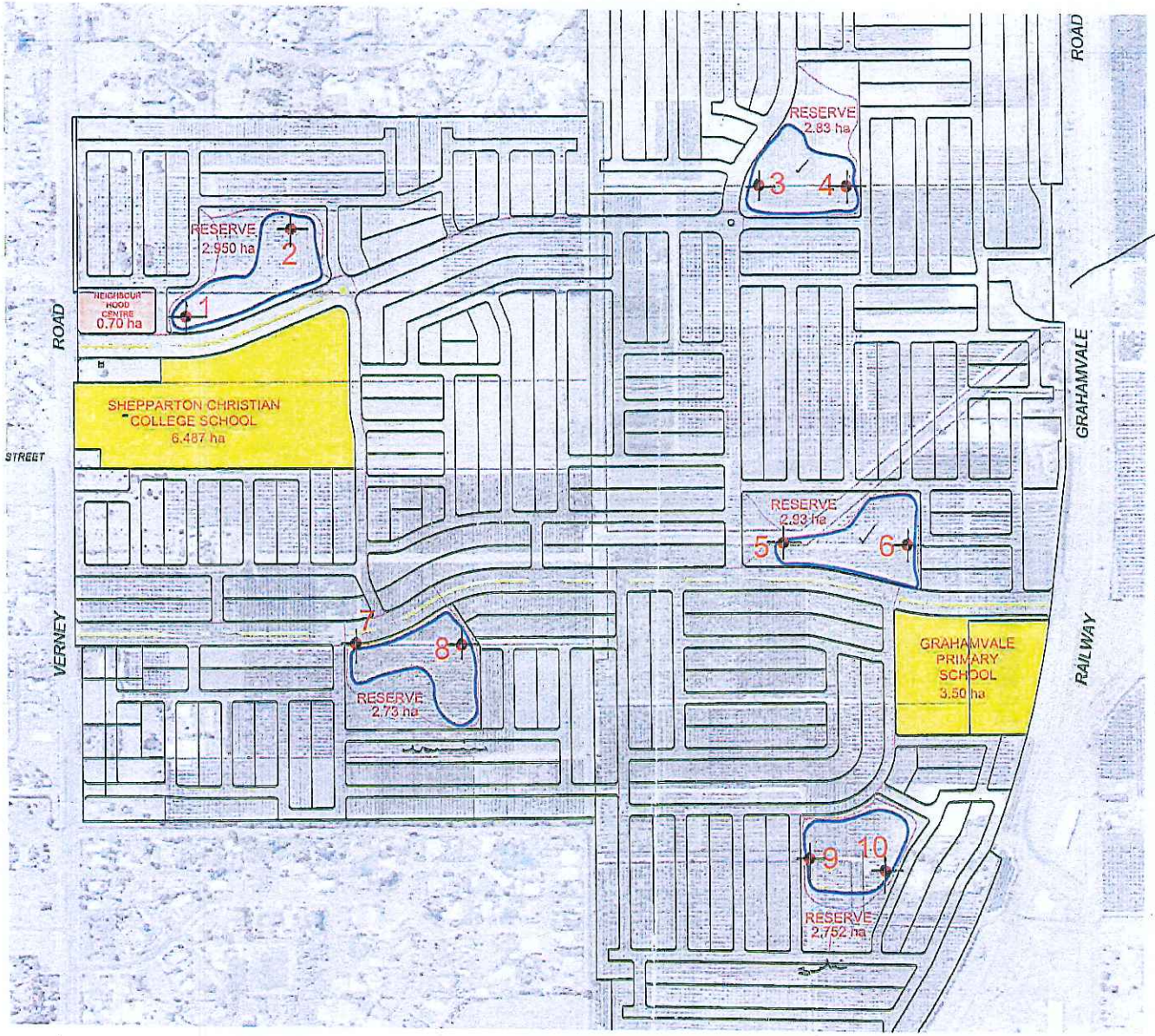
**Maintenance:** Desirably plant binding type grasses on the finished topsoiled surfaces in order to minimise erosion and the seasonal drying of storage base soils. This will assist in preventing propagation of surface cracking in the liners.

Carry out maintenance checking over the duration of the storage's operational lifetime using the techniques offered in the publication "Your Dam - an asset or a liability" (DSE-Victoria website)

Please contact the undersigned for any further enquires.

David Melrose.

BORE LOGS AND LABORATORY TEST RESULT SHEETS.




TEST BORE LOCATIONS

BORE COORDINATES

| | | |
|---|---|---|
| 1 | E 358019.639 | N 5975799.660 |
| 2 | E 358107.166 | N 5975923.281 |
| 3 | E 358827.925 | N 5975995.233 |
| 4 | E 358950.510 | N 5975995.233 |
| 5 | E 358865.708 | N 5975487.518 |
| 6 | E 359039.630 | N 5975488.397 |
| 7 | E 358265.980 | N 5975339.641 |
| 8 | E 358413.915 | N 5975339.453 |
| 9 | E 358905.418 | N 5975038.446 |
| 10 | E 359011.523 | N 5975021.267 |

# B.M CIVIL ENGINEERS

# SITE INVESTIGATION LOG

Job No.: 28565 Date: 1.4.2011

Location: NE Shepparton Growth Corridor

Client: Reeds Consulting Borehole No.: 1

Easting: E 358019

Northing: N5975799

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | | | | |
| 300 | | | | |
| 400 | | | | |
| 500 | | | | |
| 600 | Lt. Br. Clay (sand traces) | M-HP | VST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | | | | |
| 1000 | | | | |
| 1100 | | | | |
| 1200 | | | | |
| 1300 | LL=49% | | | |
| 1400 | PL=17% | | | |
| 1500 | PI=32% | | | |
| 1600 | LS=16% | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | | | | |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | Brown Clay with sand traces | MP | ST | M |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | | | | |
| 5200 | | | | |
| 5300 | | | | |
| 5400 | | | | |
| 5500 | | | | |
| 5600 | | | | |
| 5700 | | | | |
| 5800 | | | | |
| 5900 | | | | |
| 6000 | EOB | | | |

| | | |
|---|---|---|
| PLASTICITY | | LP- LOW MP- MEDIUM HP- HIGH |
| CONSISTENCY | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense |
| MOISTURE CONDITION | | D-dry M- moist W-wet SA-saturated |
| DRILLING METHOD | continuous flight auger | X hand auger |

**B.M**
**CIVIL ENGINEERS**

# SITE INVESTIGATION LOG

**Job No.:** 30170 **Date:** 1.04.2011

**Location:** NE. Shepparton Growth Corridor

**Client:** Reeds Consulting **Borehole No.:** 2

**Easting:** 358167E
**Northing:** 5975923N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | Clayey Fine Sand | | | |
| 200 | | | | |
| 300 | | | | |
| 400 | | | | |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | LL=44% | | | |
| 1000 | PL=16% | | | |
| 1100 | PI=28% | | | |
| 1200 | LS=14.5% | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | | | | |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | Lt. Br Clay | MP | VST | M |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| **PLASTICITY** | | **LP-** LOW **MP-** MEDIUM **HP-** HIGH |
| **CONSISTENCY** | COHESIVE SOILS | **VS-** very soft **S-**soft **F-**firm **ST -** stiff **VST -** very stiff **H-**hard |
| | NON COHESIVE SOILS | **VL** very loose **L-** loose **MD-**medium dense **DS-**dense **VD-**very dense |
| **MOISTURE CONDITION** | | **D-**dry **M-** moist **W-**wet **SA-**saturated |
| **DRILLING METHOD** | continuous flight auger [X] | hand auger [ ] |

# B.M CIVIL ENGINEERS

# SITE INVESTIGATION LOG

Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting Borehole No.: 3

Easting: 358827E
Northing: 5975995N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | | | | |
| 300 | | | | |
| 400 | | | | |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | LP-MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | LL=31% | | | |
| 1000 | PL=13% | | | |
| 1100 | PI=18% | | | |
| 1200 | LS=10% | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | | | | |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| PLASTICITY | | LP- LOW MP- MEDIUM HP- HIGH |
| CONSISTENCY | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense |
| MOISTURE CONDITION | | D-dry M- moist W-wet SA-saturated |
| DRILLING METHOD | continuous flight auger | X hand auger |

**B.M**
**CIVIL ENGINEERS**

# SITE INVESTIGATION LOG

Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 4

Easting: 358950E
Northing: 5975995N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | | | | |
| 300 | | | | |
| 400 | | | | |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | LP-MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | LL=31% | | | |
| 1000 | PL=13% | | | |
| 1100 | PI=18% | | | |
| 1200 | LS=10% | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | | | | |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| PLASTICITY | | LP- LOW MP- MEDIUM HP- HIGH |
| CONSISTENCY | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense |
| MOISTURE CONDITION | | D-dry M- moist W-wet SA-saturated |
| DRILLING METHOD | continuous flight auger [X] | hand auger [ ] |

# B.M CIVIL ENGINEERS

# SITE INVESTIGATION LOG

Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting Borehole No.: 5

Easting: 358865E
Northing: 5975487N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | Clayey Sand | | | |
| 300 | | | | |
| 400 | Br.. CLAY | HP | VST | M |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | LL=44% | | | |
| 1000 | PL=16% | | | |
| 1100 | PI=28% | | | |
| 1200 | LS=14% | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | LP | D | M |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | Lt. Br. Silty Clay with sand | MP | VST | M |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | M |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| PLASTICITY | | LP- LOW MP- MEDIUM HP- HIGH |
| CONSISTENCY | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense |
| MOISTURE CONDITION | | D-dry M- moist W-wet SA-saturated |
| DRILLING METHOD | continuous flight auger [X] | hand auger [ ] |

# B.M CIVIL ENGINEERS

# SITE INVESTIGATION LOG

**Job No.:** 30170 **Date:** 1.04.2011

**Location:** NE. Shepparton Growth Corridor

**Client:** Reeds Consulting **Borehole No.:** 6

**Easting:** 359039E
**Northing:** 5975486N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | Clayey Sand | | | |
| 300 | | | | |
| 400 | Br.. CLAY | HP | VST | M |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | LL=44% | | | |
| 1000 | PL=16% | | | |
| 1100 | PI=28% | | | |
| 1200 | LS=14% | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | Br. Clayey Sand | LP | D | M |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | Lt. Br. Silty Clay with sand | MP | VST | M |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | M |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | M |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| **PLASTICITY** | | LP- LOW MP- MEDIUM HP- HIGH |
| **CONSISTENCY** | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense |
| **MOISTURE CONDITION** | | D-dry M- moist W-wet SA-saturated |
| **DRILLING METHOD** | continuous flight auger | X hand auger |

# B.M CIVIL ENGINEERS

# SITE INVESTIGATION LOG

Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 7

Easting: 359039E

Northing: 5975486N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | Clayey Sand | | | |
| 300 | | | | |
| 400 | Red/Br.. CLAY | | | |
| 500 | | | | |
| 600 | Red/Brown Sandy Clay | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | | | | |
| 1000 | | | | |
| 1100 | | | | |
| 1200 | Clayey Sand | LP | ST | M |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | | | M |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | MP | ST | |
| 2800 | Lt. Br. Silty Clay with sand | | | |
| 2900 | | | | M |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | M |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | M |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| PLASTICITY | | LP- LOW MP- MEDIUM HP- HIGH |
| CONSISTENCY | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense |
| MOISTURE CONDITION | | D-dry M- moist W-wet SA-saturated |
| DRILLING METHOD | continuous flight auger [X] | hand auger [ ] |

# B.M CIVIL ENGINEERS

# SITE INVESTIGATION LOG

**Job No.:** 30170 **Date:** 1.04.2011

**Location:** NE. Shepparton Growth Corridor

**Client:** Reeds Consulting **Borehole No.:** 8

**Easting:** 358414E

**Northing:** 5975339N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | Clayey Sand | | | |
| 300 | | | | |
| 400 | Red/Br.. CLAY | | | |
| 500 | | | | |
| 600 | Red/Brown Sandy Clay | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | | | | |
| 1000 | | | | |
| 1100 | | | | |
| 1200 | Clayey Sand | LP | ST | M |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | |
| 1800 | | | | |
| 1900 | | | | M |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | |
| 2800 | Lt. Br. Silty Clay with sand | MP | VST | M |
| 2900 | | | | |
| 3000 | LL=41% | | | |
| 3100 | PL=15% | | | |
| 3200 | PI=26 | | | |
| 3300 | LS=13.5% | | | |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | M |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | |
| 4800 | | | | |
| 4900 | | | | M |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | | |
|---|---|---|---|
| **PLASTICITY** | | **LP**- LOW **MP**- MEDIUM **HP**- HIGH | |
| **CONSISTENCY** | COHESIVE SOILS | **VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard | |
| | NON COHESIVE SOILS | **VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense | |
| **MOISTURE CONDITION** | | **D**-dry **M**- moist **W**-wet **SA**-saturated | |
| **DRILLING METHOD** | continuous flight auger | X | hand auger |

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# SITE INVESTIGATION LOG

Job No.: 30170 Date: 1.04.2011

Location: NE. Shepparton Growth Corridor

Client: Reeds Consulting

Borehole No.: 9

Easting: 358905E
Northing: 5975038N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | | | | |
| 300 | | | | |
| 400 | | | | |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | | | | |
| 1000 | | | | |
| 1100 | | | | |
| 1200 | | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | M |
| 1800 | | | | |
| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | M |
| 2800 | | | | |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | Lt. Br Clay | MP | VST | M |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | M |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | | |
|---|---|---|---|
| PLASTICITY | | LP- LOW MP- MEDIUM HP- HIGH | |
| CONSISTENCY | COHESIVE SOILS | VS- very soft S-soft F-firm ST - stiff VST - very stiff H-hard | |
| | NON COHESIVE SOILS | VL very loose L- loose MD-medium dense DS-dense VD-very dense | |
| MOISTURE CONDITION | | D-dry M- moist W-wet SA-saturated | |
| DRILLING METHOD | continuous flight auger | X | hand auger |

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# SITE INVESTIGATION LOG

**Job No.:** 30170 **Date:** 1.04.2011

**Location:** NE. Shepparton Growth Corridor

**Client:** Reeds Consulting **Borehole No.:** 10

**Easting:** 359011E
**Northing:** 5975021N

| Depth | Description | Plasticity | Cohesion Density | Moisture |
|---|---|---|---|---|
| 100 | | | | |
| 200 | | | | |
| 300 | | | | |
| 400 | | | | |
| 500 | | | | |
| 600 | Lt. Br. Silty Clay with sand | MP | ST | M |
| 700 | | | | |
| 800 | | | | |
| 900 | LL=47% | | | |
| 1000 | PL=17% | | | |
| 1100 | PI=30 | | | |
| 1200 | LS=15 | | | |
| 1300 | | | | |
| 1400 | | | | |
| 1500 | | | | |
| 1600 | | | | |
| 1700 | | | | M |
| 1800 | | | | |
| 1900 | | | | |
| 2000 | | | | |
| 2100 | | | | |
| 2200 | | | | |
| 2300 | | | | |
| 2400 | | | | |
| 2500 | | | | |
| 2600 | | | | |
| 2700 | | | | M |
| 2800 | | | | |
| 2900 | | | | |
| 3000 | | | | |
| 3100 | | | | |
| 3200 | | | | |
| 3300 | Lt. Br Clay | MP | VST | M |
| 3400 | | | | |
| 3500 | | | | |
| 3600 | | | | |
| 3700 | | | | |
| 3800 | | | | |
| 3900 | | | | |
| 4000 | | | | |
| 4100 | | | | |
| 4200 | | | | |
| 4300 | | | | |
| 4400 | | | | |
| 4500 | | | | |
| 4600 | | | | |
| 4700 | | | | M |
| 4800 | | | | |
| 4900 | | | | |
| 5000 | EOB | | | |
| 5100 | | | | |

| | | |
|---|---|---|
| **PLASTICITY** | | **LP**- LOW **MP**- MEDIUM **HP**- HIGH |
| **CONSISTENCY** | COHESIVE SOILS | **VS**- very soft **S**-soft **F**-firm **ST** - stiff **VST** - very stiff **H**-hard |
| | NON COHESIVE SOILS | **VL** very loose **L**- loose **MD**-medium dense **DS**-dense **VD**-very dense |
| **MOISTURE CONDITION** | | **D**-dry **M**- moist **W**-wet **SA**-saturated |
| **DRILLING METHOD** | continuous flight auger | X hand auger |

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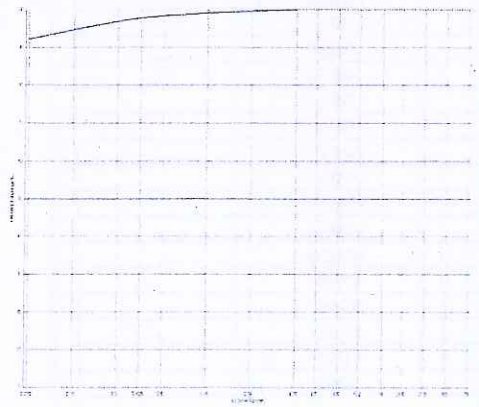
Fax: (03) 5831 3042

# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 1 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | - |
| Location | NE Shep Growth Area , Shepparton | Page 1 of 6 | |
| Lab No: | 11721 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 1 | |
| Date Tested: | 14/04/2011 | Start Depth (mm) : 1000 | |
| Sampled By: | David Melrose | End Depth (mm) : 1500 | |
| Sample Method: | AS1289.1.2.1 | Clay with trace Sand (CI-CH) | |
| Material Source: | Site | Spec Description: | - |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: AS1289.3.6.1



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | 100 | |
| 53.00 mm | | 100 | |
| 37.50 mm | | 100 | |
| 26.50 mm | | 100 | |
| 19.00 mm | | 100 | |
| 13.2 mm | | 100 | |
| 9.50 mm | | 100 | |
| 6.7 mm | | 100 | |
| 4.75 mm | | 100 | |
| 2.36 mm | | 100 | |
| 1.18 mm | | 99 | |
| 0.600 mm | | 98 | |
| 0.425 mm | | 98 | |
| 0.300 mm | | 97 | |
| 0.150 mm | | 95 | |
| 0.075 mm | | 92 | |

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | AS1289.3.1.2 | | 49 | |
| Plastic Limit (%) | AS1289.3.2.1 | | 17 | |
| Plasticity Index | AS1289.3.3.1 | | 32 | |
| Linear Shrinkage (%) | AS1289.3.4.1 | | 16.0 | |
| | | | | |
| | | | | |
| | | | | |

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Approved Signatory

David Sleep
NATA Accred No:5023

Form Number

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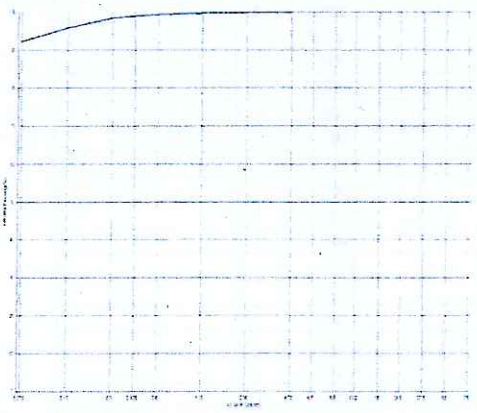
Fax: (03) 5831 3042

# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | **Reeds Consulting** | Report Number: | **30170 - 1** |
| Client Address: | **Level 6, 440 Elizabeth Street Melbourne VIC 3000** | | |
| Job Number: | **30170** | Report Date: | **18/04/2011** |
| Project: | **Geotechnical Investigation** | Order Number: | - |
| Location | **NE Shep Growth Area , Shepparton** | | **Page 2 of 6** |
| Lab No: | **11722** | Sample Location | |
| Date Sampled: | **1/04/2011** | Bore Hole : 2 | |
| Date Tested: | **14/04/2011** | Start Depth (mm) : 500 | |
| Sampled By: | **David Melrose** | End Depth (mm) : 1600 | |
| Sample Method: | **AS1289.1.2.1** | Silty Clay with trace Sand (CI) | |
| Material Source: | **Site** | Spec Description: | - |
| For Use As: | **Investigation** | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: **AS1289.3.6.1**



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | **100** | |
| 53.00 mm | | **100** | |
| 37.50 mm | | **100** | |
| 26.50 mm | | **100** | |
| 19.00 mm | | **100** | |
| 13.2 mm | | **100** | |
| 9.50 mm | | **100** | |
| 6.7 mm | | **100** | |
| 4.75 mm | | **100** | |
| 2.36 mm | | **100** | |
| 1.18 mm | | **100** | |
| 0.600 mm | | **99** | |
| 0.425 mm | | **99** | |
| 0.300 mm | | **98** | |
| 0.150 mm | | **96** | |
| 0.075 mm | | **92** | |

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | **AS1289.3.1.2** | | **44** | |
| Plastic Limit (%) | **AS1289.3.2.1** | | **16** | |
| Plasticity Index | **AS1289.3.3.1** | | **28** | |
| Linear Shrinkage (%) | **AS1289.3.4.1** | | **14.5** | |
| | | | | |
| | | | | |
| | | | | |

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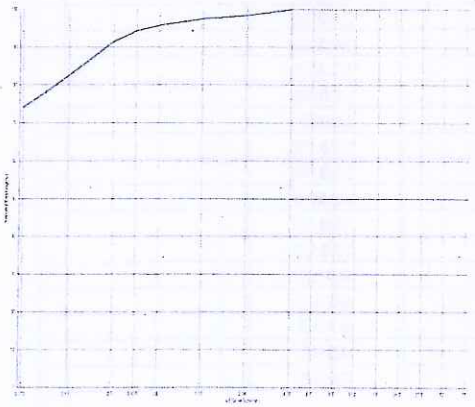
# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 1 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | - |
| Location | NE Shep Growth Area , Shepparton | Page 3 of 6 | |
| Lab No: | 11723 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 4 | |
| Date Tested: | 14/04/2011 | Start Depth (mm) : 200 | |
| Sampled By: | David Melrose | End Depth (mm) : 2000 | |
| Sample Method: | AS1289.1.2.1 | Silty Clay with Sand (CL-CI) | |
| Material Source: | Site | Spec Description: | - |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: AS1289.3.6.1



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | 100 | |
| 53.00 mm | | 100 | |
| 37.50 mm | | 100 | |
| 26.50 mm | | 100 | |
| 19.00 mm | | 100 | |
| 13.2 mm | | 100 | |
| 9.50 mm | | 100 | |
| 6.7 mm | | 100 | |
| 4.75 mm | | 100 | |
| 2.36 mm | | 99 | |
| 1.18 mm | | 98 | |
| 0.600 mm | | 96 | |
| 0.425 mm | | 94 | |
| 0.300 mm | | 92 | |
| 0.150 mm | | 83 | |
| 0.075 mm | | 74 | |

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | AS1289.3.1.2 | | 31 | |
| Plastic Limit (%) | AS1289.3.2.1 | | 13 | |
| Plasticity Index | AS1289.3.3.1 | | 18 | |
| Linear Shrinkage (%) | AS1289.3.4.1 | | 10.0 | |
| | | | | |
| | | | | |
| | | | | |

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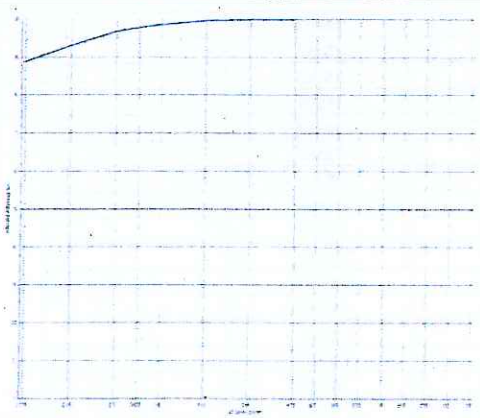
# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 1 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | - |
| Location | NE Shep Growth Area , Shepparton | | Page 4 of 6 |
| Lab No: | 11724 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 5 | |
| Date Tested: | 14/04/2011 | Start Depth (mm) : 500 | |
| Sampled By: | David Melrose | End Depth (mm) : 2000 | |
| Sample Method: | AS1289.1.2.1 | Silty Clay with trace Sand (CI) | |
| Material Source: | Site | Spec Description: | - |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: AS1289.3.6.1



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | 100 | |
| 53.00 mm | | 100 | |
| 37.50 mm | | 100 | |
| 26.50 mm | | 100 | |
| 19.00 mm | | 100 | |
| 13.2 mm | | 100 | |
| 9.50 mm | | 100 | |
| 6.7 mm | | 100 | |
| 4.75 mm | | 100 | |
| 2.36 mm | | 100 | |
| 1.18 mm | | 100 | |
| 0.600 mm | | 99 | |
| 0.425 mm | | 98 | |
| 0.300 mm | | 97 | |
| 0.150 mm | | 93 | |
| 0.075 mm | | 89 | |

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | AS1289.3.1.2 | | 44 | |
| Plastic Limit (%) | AS1289.3.2.1 | | 16 | |
| Plasticity Index | AS1289.3.3.1 | | 28 | |
| Linear Shrinkage (%) | AS1289.3.4.1 | | 14.0 | |
| | | | | |
| | | | | |
| | | | | |

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Approved Signatory

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David Earl
Peter Willmott

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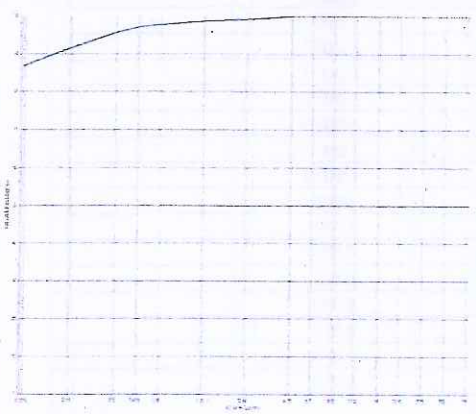
Fax: (03) 5831 3042

# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 1 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | - |
| Location | NE Shep Growth Area , Shepparton | | Page 5 of 6 |
| Lab No: | 11725 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 8 | |
| Date Tested: | 14/04/2011 | Start Depth (mm) : 2000 | |
| Sampled By: | David Melrose | End Depth (mm) : 3000 | |
| Sample Method: | AS1289.1.2.1 | Silty Clay with trace Sand (CI) | |
| Material Source: | Site | Spec Description: | - |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: AS1289.3.6.1



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | 100 | |
| 53.00 mm | | 100 | |
| 37.50 mm | | 100 | |
| 26.50 mm | | 100 | |
| 19.00 mm | | 100 | |
| 13.2 mm | | 100 | |
| 9.50 mm | | 100 | |
| 6.7 mm | | 100 | |
| 4.75 mm | | 100 | |
| 2.36 mm | | 99 | |
| 1.18 mm | | 99 | |
| 0.600 mm | | 98 | |
| 0.425 mm | | 97 | |
| 0.300 mm | | 96 | |
| 0.150 mm | | 91 | |
| 0.075 mm | | 87 | |

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | AS1289.3.1.2 | | 41 | |
| Plastic Limit (%) | AS1289.3.2.1 | | 15 | |
| Plasticity Index | AS1289.3.3.1 | | 26 | |
| Linear Shrinkage (%) | AS1289.3.4.1 | | 13.5 | |
| | | | | |
| | | | | |
| | | | | |

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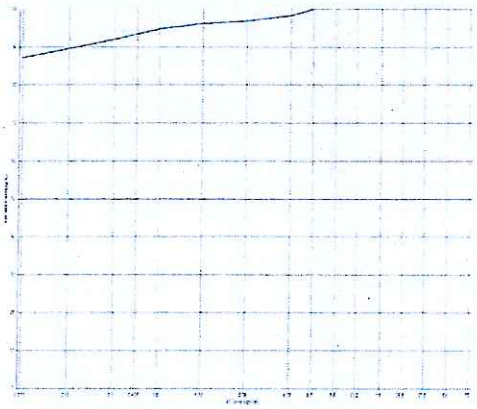
Fax: (03) 5831 3042

# Quality of Materials Report

| | | | |
|---|---|---|---|
| Client: | **Reeds Consulting** | Report Number: | **30170 - 1** |
| Client Address: | **Level 6, 440 Elizabeth Street Melbourne VIC 3000** | | |
| Job Number: | **30170** | Report Date: | **18/04/2011** |
| Project: | **Geotechnical Investigation** | Order Number: | - |
| Location | **NE Shep Growth Area , Shepparton** | | **Page 6 of 6** |
| Lab No: | **11726** | Sample Location | |
| Date Sampled: | **1/04/2011** | Bore Hole : 10 | |
| Date Tested: | **14/04/2011** | Start Depth (mm) : 800 | |
| Sampled By: | **David Melrose** | End Depth (mm) : 1500 | |
| Sample Method: | **AS1289.1.2.1** | Clay with trace Sand & Gravel (CI-CH) | |
| Material Source: | **Site** | Spec Description: | - |
| For Use As: | **Investigation** | Lot Number: | - |
| Remarks: | - | Spec Number: | - |

Test Method: **AS1289.3.6.1**



| A.S. Sieve Sizes | Specification Minimum | Percent Passing | Specification Maximum |
|---|---|---|---|
| 75.00 mm | | **100** | |
| 53.00 mm | | **100** | |
| 37.50 mm | | **100** | |
| 26.50 mm | | **100** | |
| 19.00 mm | | **100** | |
| 13.2 mm | | **100** | |
| 9.50 mm | | **100** | |
| 6.7 mm | | **100** | |
| 4.75 mm | | **98** | |
| 2.36 mm | | **97** | |
| 1.18 mm | | **96** | |
| 0.600 mm | | **95** | |
| 0.425 mm | | **94** | |
| 0.300 mm | | **92** | |
| 0.150 mm | | **90** | |
| 0.075 mm | | **87** | |

| Atterberg Tests | Test Method | Specification Minimum | Result | Specification Maximum |
|---|---|---|---|---|
| Liquid Limit (%) | **AS1289.3.1.2** | | **47** | |
| Plastic Limit (%) | **AS1289.3.2.1** | | **17** | |
| Plasticity Index | **AS1289.3.3.1** | | **30** | |
| Linear Shrinkage (%) | **AS1289.3.4.1** | | **15.0** | |
| | | | | |
| | | | | |
| | | | | |

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Approved Signatory

David Sleep
NATA Accred No:5023

Form Number

**REP ASQUAL-1-42**

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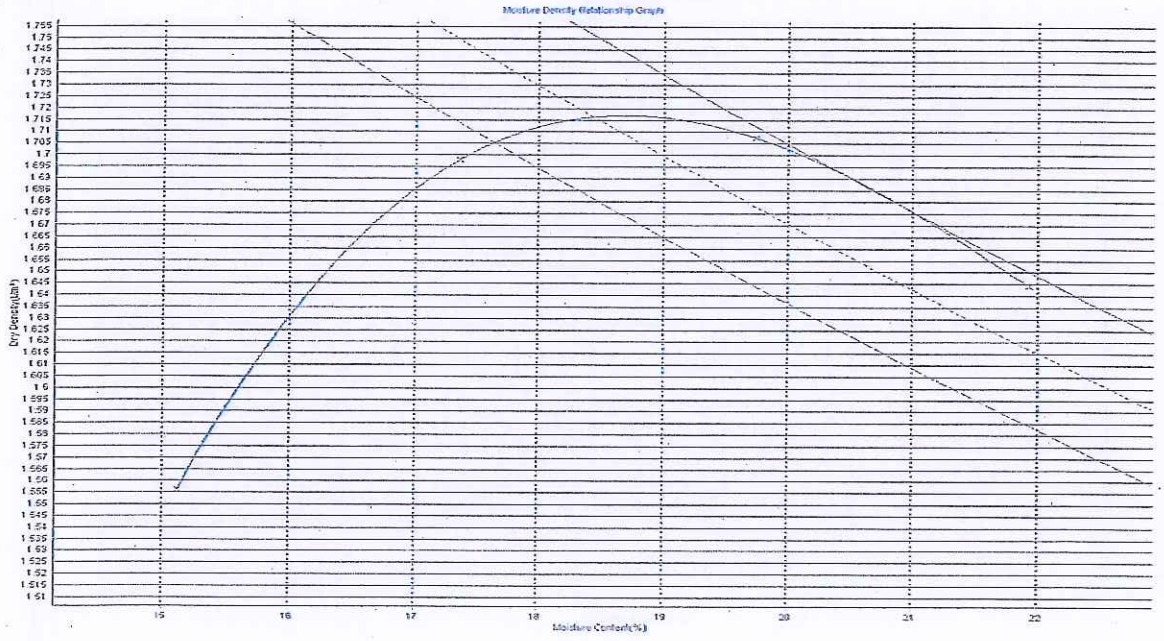
Fax: (03) 5831 3042

# Moisture Density Relationship Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 3 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | |
| Location | NE Shep Growth Area , Shepparton | Test Method : | AS1289.5.1.1 |
| Lab No: | 11721 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 1 | |
| Date Tested: | 8/04/2011 | Start Depth (mm) : 1000 | |
| Sampled By: | David Melrose | End Depth (mm) : 1500 | |
| Sample Method: | AS1289.1.2.1 | Clay with trace Sand (CI-CH) | |
| Material Source: | Site | | |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Item Number : | - |



| | | | |
|---|---|---|---|
| Maximum Size (mm) : | 19.0 | Moisture Content Test Method : | AS1289.2.1.1 |
| Oversize (%) : | - | Oversize Test Method : | - |
| **MDD (t/m³) :** | **1.717** | Oversize Density (t/m³) : | |
| **OMC(%) :** | **18.7** | | |

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Form Number

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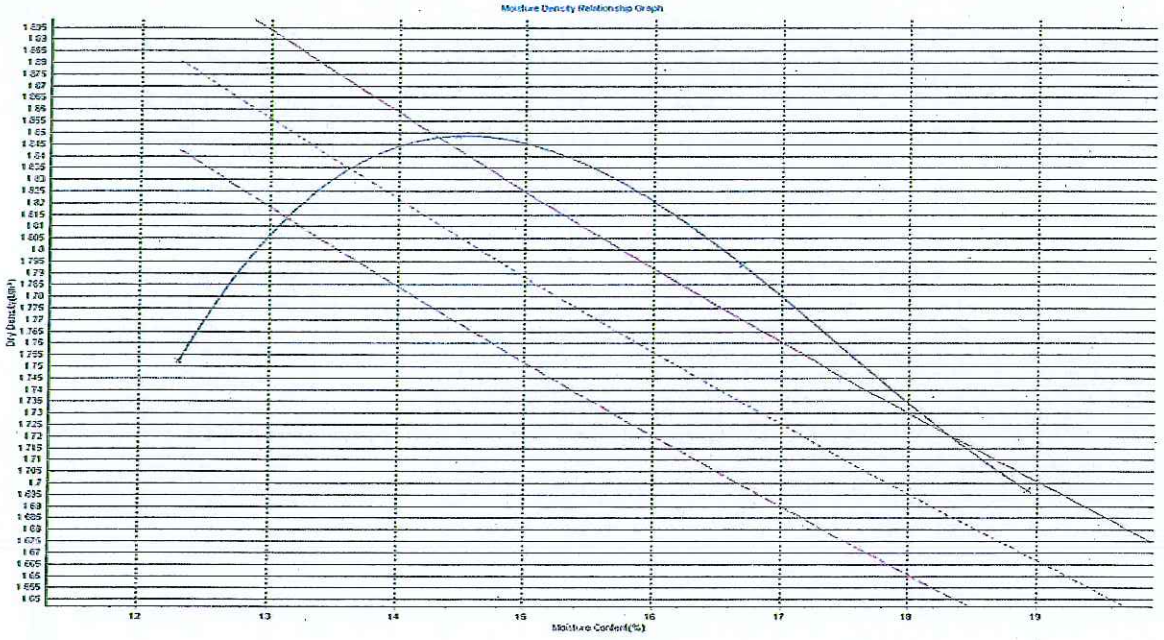
# Moisture Density Relationship Report

| | | | |
|---|---|---|---|
| Client: | **Reeds Consulting** | Report Number: | **30170 - 3** |
| Client Address: | **Level 6, 440 Elizabeth Street Melbourne VIC 3000** | | |
| Job Number: | **30170** | Report Date: | **18/04/2011** |
| Project: | **Geotechnical Investigation** | Order Number: | |
| Location | **NE Shep Growth Area , Shepparton** | Test Method : | **AS1289.5.1.1** |
| Lab No: | **11723** | Sample Location | |
| Date Sampled: | **1/04/2011** | Bore Hole : 4 | |
| Date Tested: | **8/04/2011** | Start Depth (mm) : 200 | |
| Sampled By: | **David Melrose** | End Depth (mm) : 2000 | |
| Sample Method: | **AS1289.1.2.1** | Silty Clay with Sand (CL-CI) | |
| Material Source: | **Site** | | |
| For Use As: | **Investigation** | Lot Number: | - |
| Remarks: | - | Item Number : | - |



| | | | |
|---|---|---|---|
| Maximum Size (mm) : | **19.0** | Moisture Content Test Method : | **AS1289.2.1.1** |
| Oversize (%) : | - | Oversize Test Method : | - |
| **MDD (t/m³) :** | **1.849** | Oversize Density (t/m³) : | |
| **OMC(%) :** | **14.5** | | |






| Approved Signatory | Form Number |
|---|---|
| David Sleep<br>NATA Accred No:5023 | **REP MDR-1-17** |

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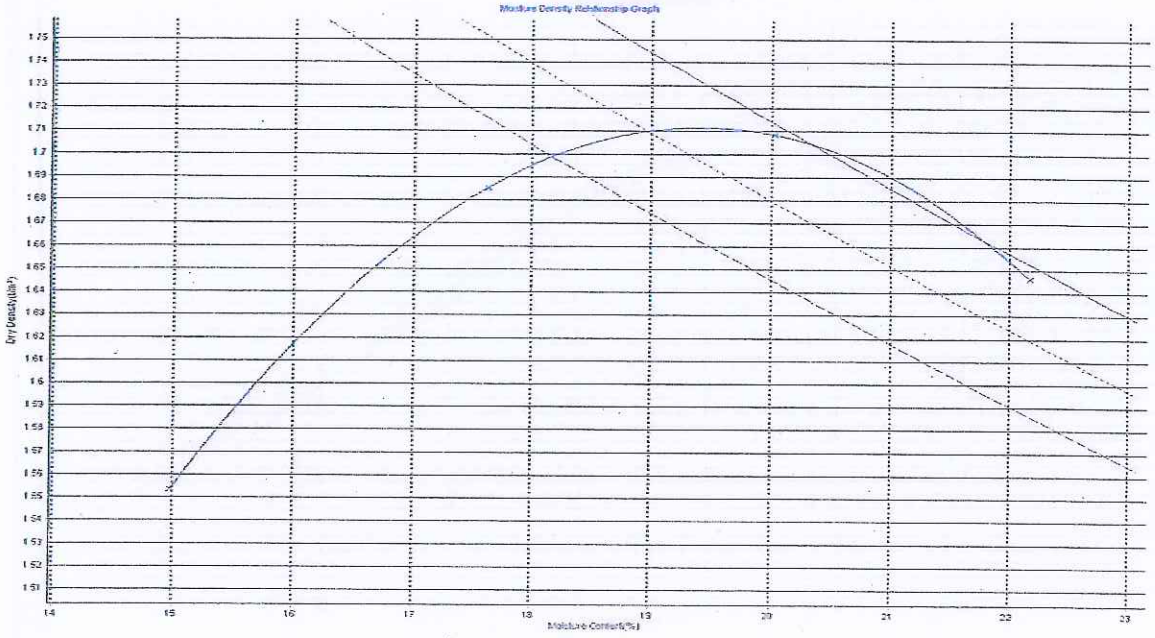
# Moisture Density Relationship Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 3 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | |
| Location | NE Shep Growth Area , Shepparton | Test Method : | AS1289.5.1.1 |
| Lab No: | 11724 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 5 | |
| Date Tested: | 8/04/2011 | Start Depth (mm) : 500 | |
| Sampled By: | David Melrose | End Depth (mm) : 2000 | |
| Sample Method: | AS1289.1.2.1 | Silty Clay with trace Sand (CI) | |
| Material Source: | Site | | |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Item Number : | - |



| | | | |
|---|---|---|---|
| Maximum Size (mm) : | 19.0 | Moisture Content Test Method : | AS1289.2.1.1 |
| Oversize (%) : | - | Oversize Test Method : | - |
| **MDD (t/m³) :** | **1.712** | Oversize Density (t/m³) : | |
| **OMC(%) :** | **19.4** | | |

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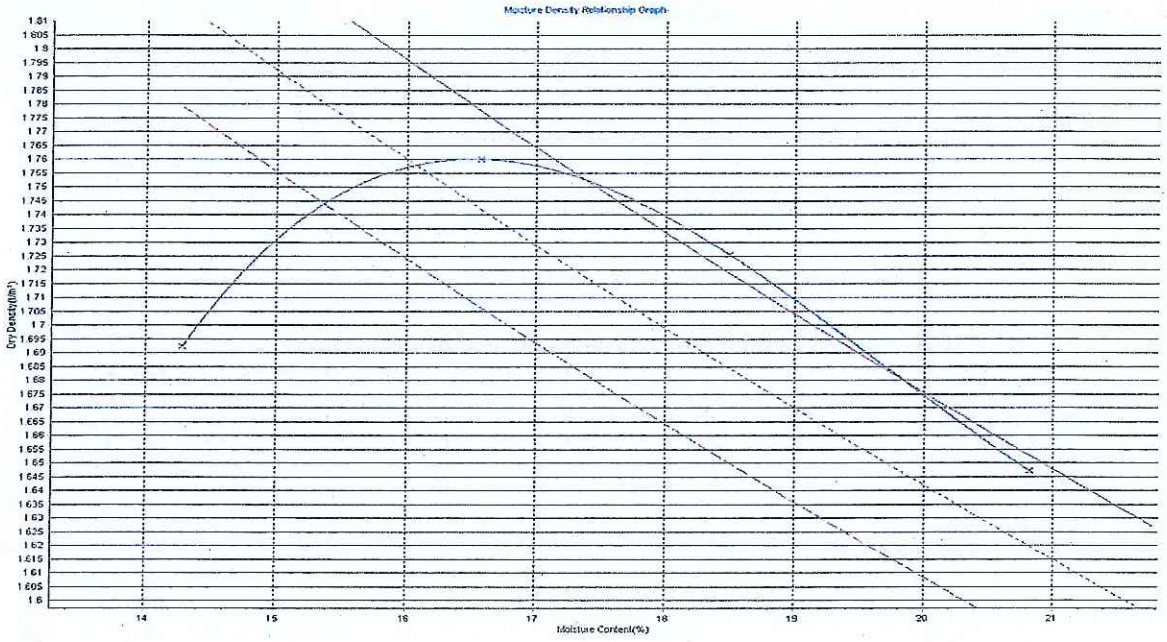
# Moisture Density Relationship Report

| | | | |
|---|---|---|---|
| Client: | **Reeds Consulting** | Report Number: | **30170 - 3** |
| Client Address: | **Level 6, 440 Elizabeth Street Melbourne VIC 3000** | | |
| Job Number: | **30170** | Report Date: | **18/04/2011** |
| Project: | **Geotechnical Investigation** | Order Number: | |
| Location | **NE Shep Growth Area , Shepparton** | Test Method : | **AS1289.5.1.1** |
| Lab No: | **11725** | Sample Location | |
| Date Sampled: | **1/04/2011** | Bore Hole : 8 | |
| Date Tested: | **8/04/2011** | Start Depth (mm) : 2000 | |
| Sampled By: | **David Melrose** | End Depth (mm) : 3000 | |
| Sample Method: | **AS1289.1.2.1** | Silty Clay with trace Sand (CI) | |
| Material Source: | **Site** | | |
| For Use As: | **Investigation** | Lot Number: | - |
| Remarks: | - | Item Number : | - |



| | | | |
|---|---|---|---|
| Maximum Size (mm) : | **19.0** | Moisture Content Test Method : | **AS1289.2.1.1** |
| Oversize (%) : | - | Oversize Test Method : | - |
| **MDD (t/m³) :** | **1.760** | Oversize Density (t/m³) : | |
| **OMC(%) :** | **16.5** | | |

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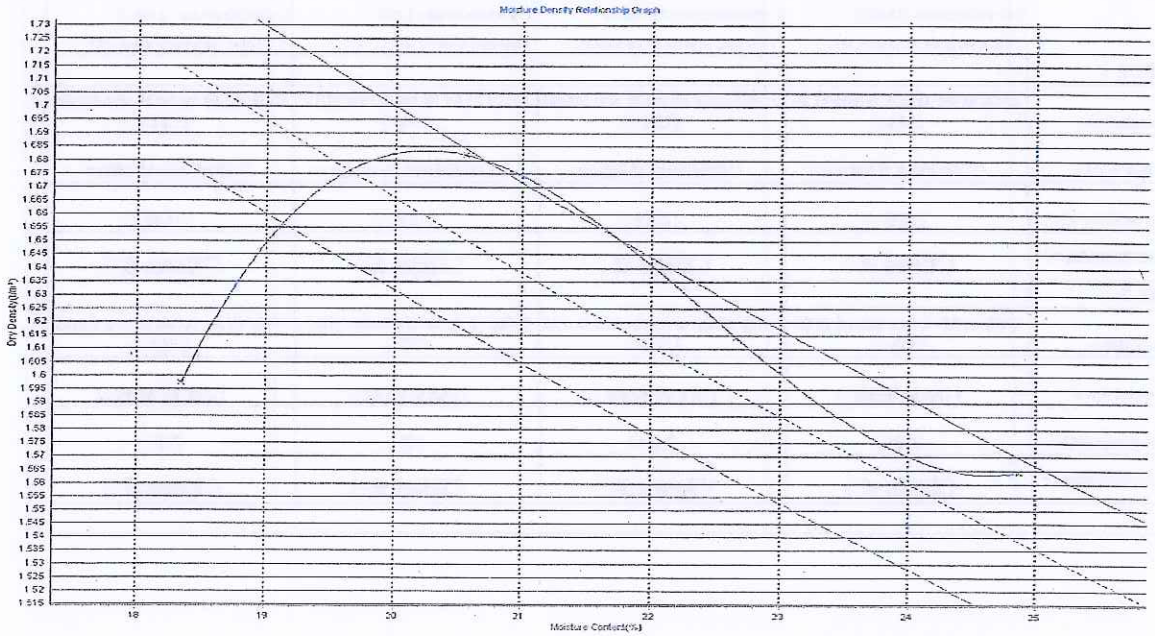
# Moisture Density Relationship Report

| | | | |
|---|---|---|---|
| Client: | Reeds Consulting | Report Number: | 30170 - 3 |
| Client Address: | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | | |
| Job Number: | 30170 | Report Date: | 18/04/2011 |
| Project: | Geotechnical Investigation | Order Number: | |
| Location | NE Shep Growth Area , Shepparton | Test Method : | AS1289.5.1.1 |
| Lab No: | 11726 | Sample Location | |
| Date Sampled: | 1/04/2011 | Bore Hole : 10 | |
| Date Tested: | 8/04/2011 | Start Depth (mm) : 800 | |
| Sampled By: | David Melrose | End Depth (mm) : 1500 | |
| Sample Method: | AS1289.1.2.1 | Clay with trace Sand & Gravel (CI-CH) | |
| Material Source: | Site | | |
| For Use As: | Investigation | Lot Number: | - |
| Remarks: | - | Item Number : | - |



| | | | |
|---|---|---|---|
| Maximum Size (mm) : | 19.0 | Moisture Content Test Method : | AS1289.2.1.1 |
| Oversize (%) : | - | Oversize Test Method : | - |
| MDD (t/m³) : | 1.684 | Oversize Density (t/m³) : | |
| OMC(%) : | 20.3 | | |

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# Emerson Class Number Report

| | | | |
|---|---|---|---|
| Client : | Reeds Consulting | Report Number: | 30170 - 2 |
| Client Address : | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | Report Date: | 18/04/2011 |
| Job Number : | 30170 | Order Number: | |
| Project : | Geotechnical Investigation | Test Method: | AS 1289.3.8.1 |
| Location : | NE Shep Growth Area , Shepparton | | |



| Lab No : | 11721 | 11722 | 11723 | 11724 |
|---|---|---|---|---|
| ID No : | - | - | - | - |
| Lot No : | - | - | - | - |
| Item No : | - | - | - | - |
| Sampling Method : | AS1289.1.2.1 | AS1289.1.2.1 | AS1289.1.2.1 | AS1289.1.2.1 |
| Date Sampled : | 1/4/2011 | 1/4/2011 | 1/4/2011 | 1/4/2011 |
| Date Tested : | 13/4/2011 | 13/4/2011 | 13/4/2011 | 13/4/2011 |
| Material Source : | Site | Site | Site | Site |
| For Use As : | Investigation | Investigation | Investigation | Investigation |
| Sample Location : | Bore Hole : 1<br>Start Depth (mm) : 1000<br>End Depth (mm) : 1500<br>Clay with trace Sand (CI-CH) | Bore Hole : 2<br>Start Depth (mm) : 500<br>End Depth (mm) : 1600<br>Silty Clay with trace Sand (CI) | Bore Hole : 4<br>Start Depth (mm) : 200<br>End Depth (mm) : 2000<br>Silty Clay with Sand (CL-CI) | Bore Hole : 5<br>Start Depth (mm) : 500<br>End Depth (mm) : 2000<br>Silty Clay with trace Sand (CI) |
| **TEST 1** | | | | |
| Soil Description : | **Clay with trace Sand (CI-CH)** | **Silty Clay with trace Sand (CI)** | **Silty Clay with Sand (CL-CI)** | **Silty Clay with trace Sand (CI)** |
| Type of Water Used : | **Distilled Water** | **Distilled Water** | **Distilled Water** | **Distilled Water** |
| Temperature of Water (°C) : | **20.0** | **20.0** | **20.0** | **20.0** |
| Emerson Class Number : | **Class 4** | **Class 2** | **Class 5** | **Class 5** |
| **TEST 2** | | | | |
| Soil Description : | **Clay with trace Sand (CI-CH)** | **Silty Clay with trace Sand (CI)** | **Silty Clay with Sand (CL-CI)** | **Silty Clay with trace Sand (CI)** |
| Type of Water Used : | **Tap Water** | **Tap Water** | **Tap water** | **Tap Water** |
| Temperature of Water (°C) : | **20** | **20** | **20** | **20** |
| Emerson Class Number : | **Class 4** | **Class 5** | **Class 6** | **Class 5** |
| Remarks : | | | | |

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APPROVED SIGNATORY

David Sleep
NATA Accred No:5023

FORM NUMBER

**RP052-7**

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# Emerson Class Number Report

| | | | |
|---|---|---|---|
| Client : | Reeds Consulting | Report Number: | 30170 - 2 |
| Client Address : | Level 6, 440 Elizabeth Street Melbourne VIC 3000 | Report Date: | 18/04/2011 |
| Job Number : | 30170 | Order Number: | |
| Project : | Geotechnical Investigation | Test Method: | AS 1289.3.8.1 |
| Location : | NE Shep Growth Area , Shepparton | | |



| | | | | |
|---|---|---|---|---|
| Lab No : | 11725 | 11726 | | |
| ID No : | - | - | | |
| Lot No : | - | - | | |
| Item No : | - | - | | |
| Sampling Method : | AS1289.1.2.1 | AS1289.1.2.1 | | |
| Date Sampled : | 1/4/2011 | 1/4/2011 | | |
| Date Tested : | 13/4/2011 | 13/4/2011 | | |
| Material Source : | Site | Site | | |
| For Use As : | Investigation | Investigation | | |
| Sample Location : | Bore Hole : 8<br>Start Depth (mm) : 2000<br>End Depth (mm) : 3000<br>Silty Clay with trace Sand (CI) | Bore Hole : 10<br>Start Depth (mm) : 800<br>End Depth (mm) : 1500<br>Clay with trace Sand & Gravel (CI-CH) | | |
| **TEST 1** | | | | |
| Soil Description : | **Silty Clay with trace Sand (CI)** | **Clay with trace Sand & gravel (CI-CH)** | | |
| Type of Water Used : | **Distilled Water** | **Distilled Water** | | |
| Temperature of Water (°C) : | **20.0** | **20.0** | | |
| Emerson Class Number : | **Class 2** | **Class 6** | | |
| **TEST 2** | | | | |
| Soil Description : | **Silty Clay with trace Sand (CI)** | **Clay with trace Sand & gravel (CI-CH)** | | |
| Type of Water Used : | **Tap Water** | **Tap Water** | | |
| Temperature of Water (°C) : | **20** | **20** | | |
| Emerson Class Number : | **Class 4** | **Class 6** | | |
| Remarks : | | | | |

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