

Annexure 5

Water Management Plan

REPORT

**PROVIDENCE LIFESTYLE VILLAGES
HAYNES LIFESTYLE VILLAGE
LOTS 45-47 CNR GRAY ROAD AND EIGHTH
ROAD, HAYNES**

WATER MANAGEMENT PLAN

MAY 2025



DEVELOPMENT
ENGINEERING
CONSULTANTS

Revision History:

Revision	Description	Checked	Approved	Date
0	Original Issue	SRA	SRA	17th January 2025
1	Updated to Adjust Drainage Strategy and Add Geotech Report	SRA	SRA	4th February 2025
2	Updated to Amend arrangement of Main Drain and Landscape Plan	SRA	SRA	23rd May 2025

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**URBAN WATER MANAGEMENT PLAN –
HAYNES LIFESTYLE VILLAGE
LOTS 45-47 CNR GRAY ROAD AND EIGHTH ROAD, HAYNES**

Summary

Estate Scale

- The development consists of a Lifestyle Village which will be owned and managed by a single entity. As a result, the design, construction and maintenance of the roads, services, drainage and landscaping will be undertaken by that entity.
- Detention/treatment basin will be constructed to contain the 1% AEP storm with outflow limited to the capacity of the Neerigen Brook.
- The outlet to the drainage basin will be controlled to predevelopment rates using a weir conjunction with the pipe sizing which will limit available outflow to below the Water Corporation allowance of 18.2l/s/ha for the 10% AEP and 29.9l/s/ha for the 1% AEP.
- The 1EY 1 hour storm will be detained and treated in the bioretention system with limited outflow to pre development rates. All other storms will be throttled to predevelopment flow rates.
- Subsoil drains will be provided within all road reserves which will control perched water on the sand/clay interface. Sewers will be installed with metal bedding and with sand backfill to trenches that will act as subsoils at the rear of lots to further control water.
- Subsoil drainage will be installed in the base of the detention basin to ensure that water will drain and the area will dry out after storm events.
- The management of the lifestyle village will ensure design and construction and maintenance is carried out (a) Provide soakage at source to accommodate drainage from allotments prior to overflow into the street drainage system (b) To utilize water efficient devices & appliances throughout their homes; and (c) To maximise the use Water & Nutrient-wise plants, and minimise the use of lawns.

Access Street Scale

- All piped drainage systems will be designed to accommodate the 20% AEP event including the overflow allowance from below ground storage installed for the allotments.

Allotment Scale

- Soakwell systems will be installed in roadways, which in association with the bioretention area in the basin, will treat the 1EY 1 hour AEP event. Flows beyond this event will overflow to the Neerigen Brook.
- All Lots will be provided with drainage connections given the soil conditions on the site.

Public Open Space Areas

- POS areas will be dealt with in two ways. In some areas – specifically within the Neerigen Brook foreshore reserve, the area will be shaped to form the “living stream”

The clubhouse surrounds and common areas abutting the eastern boundary will be filled to facilitate drainage and provided with connections to the street drainage system.

- Subsoil Drainage will be placed beneath the 1 in 1 year basin base area to ensure the base dries out after rainfall.

1 Planning Approval

Lots 45-47 Gray Road, Haynes consists of an area of approximately 7.26ha. The site is located within the suburb of Haynes within the City of Armadale and is located on the southern side of Gray Drive. It was used as a nursery for many years. From the late 1950's it was built up to the mid 1970's when the whole of the area was covered with buildings and shade areas. This continued until the mid 1990's when the area was slowly reduced and demolished until around 2008 when the final buildings were demolished.

A Development Approval (DA) (MRA-13252) dated 14th June 2021 for the development of a Lifestyle Village consisting of some 76 residential dwellings plus community facilities over some 4.0ha across Lots 46 and 47 has been procured for the site. Since that approval, the developers have made arrangements to acquire Lot 45 Gray Road, which will make the development more viable and an updated development approval is being sought across the greater area.

The revised proposed consists of some 140 lifestyle homes plus community facilities and a clubhouse.

The purpose of this report is to support the development application submission to provide "proof of concept" for the drainage strategy to confirm that the required drainage to confirm that the larger development can be satisfactorily implemented.

The site location plan and an aerial photograph of the site with the plan overlaid are also included in Attachment A to illustrate the current status of the subject land.

2 Previous Reporting

As part of the original Development Application Approval, a Water Management Strategy was prepared by 360 Environmental in August 2020.

The key outcomes of that report indicated the following:

- The site consisted of sandy gravel overlying clay.
- AAMGL was measured to grade from RL28.5 to RL25.00 grading from east to west following the clay layer and the general grade of the abutting Neerigen Brook Main Drain.
- Rainfall from the first flush will be infiltrated at source through the use of soakwells in road areas and a biofiltration area in the foreshore reserve.
- Minor (20%AEP) and major (1%AEP) rainfall events will be directed to a drainage basin located in the foreshore reserve which will detain peak flow rates entering Neerigen Brook to predevelopment levels.
- The Neerigen Brook Main Drain is to be converted into a living stream to improve the recreation and environmental value while continuing to provide sufficient flood storage and conveyance.

The report did not provide details in terms of predevelopment flows and outflows from the site, or details of the proposed basin(s) across the site.

3 Design Objectives

3.1 Development Objectives

In looking at the outcomes of the approved Water Management plan and the usual requirements for Better Urban Water Management, the objectives are as follows:

Protection of environmental assets from the potential impacts of development

<i>Objective:</i>	<i>Compliance:</i>
» Minimise changes to hydrology to prevent impacts on watercourses & wetlands	Lot and Road stormwater run-off will be directed to soakwells in the roadways and the end of line drainage swale.
» Manage & restore watercourses &/or wetlands	Stormwater will discharge into Neerigen Brook Main Drain, which in turn discharges into Wungong Brook and as a result water will need to be treated prior to outflow to limit impacts on the downstream waterways.

Surface water management to protect infrastructure, assets & receiving environments

<i>Objective:</i>	<i>Compliance:</i>
» Minimise changes to hydrology to prevent impacts on receiving environments	To ensure that post-development discharge peak flow rates match pre-development conditions
» Manage surface water flows from major events to protect infrastructure & assets	All allotments to be a minimum of 0.5m above the 1 in 100 year flood level. Detention basins to be provided to ensure that outflow is limited to predevelopment outflows while maximizing the usability and aesthetic quality of the POS

Water Quality management Measures for Urban Development

<i>Objective:</i>	<i>Compliance:</i>
» Achieve pollutant load reduction from stormwater runoff generated from the development.	Ensure that surface water is routed through vegetated bio retention treatment and through detention basins prior to any outflow All water for the 1 in 1 year -1 hour storm to be contained on site without outflow. Non Structural measures including Education of residents and village management strategies in regards to management measures to minimise nutrient loading.

Water Conservation and Improvement in Water use Efficiency

<i>Objective:</i>	<i>Compliance:</i>
» To minimise the use of scheme water outside of the home and to use water as efficiently as possible - both within & outside of the home	All irrigation to the village common areas and verge areas will be from a bore. Houses will be design to incorporate water efficient devices & appliances and landscape strategies will be planting of "Water-wise" & "Nutrient-wise" gardens.

3.2 Water Quantity Objectives

The drainage requirements for developments within this area are controlled by the requirements of the Shire of Armadale and the Water Corporation which are outlined below.

Item	Description	Requirement	Source / Comment
1	Water Quality	1EY 1 hour storm to be Detained on site without outflow	DWER requirements
2	ARI for pipe design – Standard Drainage	20% AEP	Standard Council requirement
3	ARI for detention basin design	1% AEP years with outflow limited to below predevelopment levels	Standard Council requirement
4	Flow rates	Pre-development flow rate to match post-development rate	Standard Council requirement
5	Min. lot freeboard	0.5m above basin 1% AEP flood level 0.3m above 1% AEP HGL in Road System	Standard Council requirement developments
6	Basin Criteria Side slopes – In POS	Max. 1 in 4	As required by Landscapers
7	Run-off coefficients	0.90 – for road reserves Urban Residential Allotments 0.82 0.25 –POS/Rural Areas 1.0 – Drainage basin Area	Per Council requirements Per “at Lot Connection Underground Storage Calculations in Appendix C

4 Site Characteristics

4.1 Geotechnical

Geotechnical investigations were carried out by Galt Geotechnics in June 2020 on Lots 46 and 47 and further investigation was undertaken by Structerre in January 2025.

The investigation indicated that the site generally consisted of the following:

- Sand/Gravelly Sand/Sandy Gravel – 0.1m to 0.2m depth
- Sand/Silty Sand – 0.5m to 1.0m depth
- Clayey Sand – 0.5m to 1.8m depth
- Sandy Clay- to maximum depth of 2.5m.

Excavations were carried out at the start of winter and water was encountered in 3 test holes out of the 12 excavated. The test holes were evenly spaced across the site and did not seem to have any logical reason for the variability which related to the variability of the soil.

The report made recommendations on drainage characteristics and recommended fill depths, with key outcomes as follows:

- The existing site soils indicated some moderate permeability of the tested soils, the natural site material is not suitable for long term infiltration.
- Subsoil drainage is recommended to control perching of subsurface water on the clay base.
- Existing residential developments have required a significant horizon of permeable fill and if soakage is the proposed disposal mechanism, a minimum of 1.2m should be available above the clay and the base of soakwells should be a minimum of 0.3m above the clay base.

The material is relatively impervious and will require filling to accommodate structural requirements and free drainage.

For the purposes of completeness the relevant geotechnical reports are included in Appendix D.

4.2 Environmental

The wetland mapping for the area indicates that the nearest Resource Enhancement Category Wetland is Wungong Brook which is approximately 500m west of the site, but connected via the Neerigen Brook.

4.3 Surface Water

In essence the land falls from east to west and grades towards Neerigen Brook meaning that the whole of the site area is divided into two catchments being north of the brook and south of the brook. Both catchments generally grade towards the brook, but the southern side of Lot 45 grades to the west into a culvert beneath Glenlossie Ave as shown in Drawing L03 in Appendix B, which will be redirected as part of the development works.

The outflows have been based on the design flows for the Neerigen Brook which were provided by the Water Corporation as part of work done by DEC for an abutting site.

Table 4.1 – Predevelopment Flows Per unit Area Used to Size Drainage Outflows

AEP	1EY (l/s/ha)(Calc)	20% AEP (l/s/ha)	10% AEP (l/s/ha)	1% AEP (l/s/ha)
Pre - Development Flow per hectare (l/s)	5.1	13.90	18.2	29.9

The flows for the 10% AEP and the 1% AEP were agreed with the Water Corporation and the flows for the 1EY and the 20% AEP were factored based on the relative volumetric flows and storm intensities for the lower ARI storms relative to those provided.

The catchment areas north and south of the brook are 5.12ha and 2.61ha respectively meaning that peak outflows are as follows:

Table 4.2 – Predevelopment Flows for each Catchment

Catchment	Area(Ha)	AEP/Maximum Outflow			
		1EY (l/s)	20% AEP (l/s)	10% AEP (l/s)	1% AEP (l/s)
Northern Catchment	5.12	26.1	71.1	93.1	153
Southern Catchment	2.61	13.3	36.3	47.5	78

4.4 Groundwater

Urbaqua undertook groundwater monitoring across the area for the MRA between 2013 and 2016, which supported the geotechnical investigations which indicated that the water more or less followed the underlying clay levels of the site. Based on visual assessment, the area is wet over the winter months and dry over summer meaning groundwater is in fact surface water perching on the clay substrate.

Groundwater levels are shown on Drawing L03 and L04 in Appendix B, which indicate that the water levels are around 1.0m below existing surface levels, although it is likely that during winter rainfall, the surface will be wet. These water levels have been extracted from the MRA planning for the area and do not reflect the levels of the Brook which are some 2.0m lower than the plotted contours.

Given the water is not at the surface in those areas of the drain, the logic that the water is actually controlled by the level of the clay is clearly correct.

As part of the development works, the surface of the natural soils will be shaped to mimic the surface levels, essentially creating a substrate level shaped to enable water to flow towards subsoil drainage systems and avoid subsurface ponding.

It is proposed that an extensive subsurface network of subsoils drains will be established to ensure that subsurface storage will drain after rainfall events.

There is an existing groundwater bore in place on Lot 45 (Licence 55402) with an allocation of 26600kl/annum which is proposed to be used for irrigation of the foreshore reserve and the lifestyle village.

4.5 Actions to Address Acid Sulphate Soils &/or Contamination

4.5.1 Acid Sulphate Soils:

Regional mapping indicates that the site has a moderate to low chance of containing acid sulphate soils (ASS) within 3m of natural surface. Work on the project is likely to be undertaken in summer and dewatering will not be required.

In the event dewatering is required, site conditions will prohibit the use of dewatering spears and hence the natural soils will remain sodden apart from the trench meaning that there will be little impact on ASS soils. Pumped effluent will be monitored for pH and total acidity to ensure that there is no risk of ASS.

5 Water Sustainability Initiatives

As per normal requirements the following water saving initiatives will be implemented:

- Limiting water through a minimum of 3 star efficiency household plumbing fixtures – encouraged by the government through financial incentives.
- Covering all new swimming pools as now required by legislation.
- Encouragement of waterwise garden measures including;
 - Flow regulators – such as hose nozzles and timer switches.
- Use of “waterwise” gardens through appropriate irrigation and use of native species as proposed in Section 5.2.3.

These measures will be implemented as part of the delivery and maintenance of the Lifestyle Village

5.1 Alternative Water Supply Scheme

No “alternative” water supply scheme is to be used in this development – reticulated water supply will be provided to all allotments.

5.2 Wastewater Management

Standard Water Corporation reticulated sewer is to be used for all new allotments in the area.

6 Stormwater and Groundwater Management

6.1 Flood Protection

6.1.1 General Drainage Approach

The stormwater drainage strategy is proposed to detain as much water on site within subsurface storage and swales. Lot connections will be provided to each allotment, which will be directed to soakwells within the road system. The soakwells will be drained by subsoil systems and will surcharge and flow along the road system when the soakwells fill.

Any overflow and subsoil flows will be conveyed through a piped drainage system to bioretention/detention basins located on the western side of the development abutting Neerigen Brook Main Drain. Outflow from the drainage basin will be detained on site for the 1EY 1 hour storm (Including the first 15mm) and smaller ARI events. Level in the basin will surcharge to higher levels with higher outflows for larger events, but outflows will still remain below predevelopment rates.

6.1.2 1% AEP Storm

6.1.2.1 Neerigen Brook Main Drain Upgrade

Based on the hydraulic modelling from the Water Corporation, the 10% AEP and 1% AEP flood levels will be at RL25.97 and 26.61 respectively. The peak flows are 8.55m³/s and 13.55m³/s for the 10% and 1% AEP floods at the same location.

The site level at the western side of the site is around RL26.6 on the northern side of the brook and around RL26.20m AHD on the southern side of the drain meaning the levels are actually above the 10% AEP flood level and pretty well level with the 1% AEP flood level.

The Water Corporation has also prepared plans detailing the proposed conversion of Neerigen Brook into a living stream. This has been accommodated on the sketches in L05 and L06 in Appendix B, with the Water Corporation proposal and the flood modelling also shown in Appendix B.

6.1.2.2 Internal Drainage

The earthworks design will be prepared to ensure that the major storm events are controlled. The sites will be shaped to follow the natural fall of the land towards Neerigen brook and from east to west.

The 1% AEP will be routed through the drainage basins in the foreshore reserve and the drainage basin on the northern side of the drain is more or less equivalent to the flood levels of the brook. The southern basin is actually lower than the 1% AEP level for the Neerigen Brook, although the peak storm for the development will be essentially based on a short

sharp storm and the peak flow for the brook will be a longer storm. The two will not occur at the same time, but the basins will be submerged for the 1% AEP event in the Brook.

Lot levels will be set above road levels and at least 0.5m above the 1% AEP flood level of the Brook, meaning that even if water floods areas of roads, it will surcharge and flood to the downstream swale areas and Neerigen Brook, thereby providing the design flood routes as required by proper drainage management.

The total catchment for the subject area will be shaped to drain to the detention basin in the northern part of the site. This basin will flood to the levels calculated below and the outflow will be limited to the pre development flow rates.

Table 5.1 – Drainage Basin Areas of Inundation and Storage Volumes

Details	Basin Description	
	Northern Basin	Southern Basin
Gross Catchment (Ha)(10%AEP)	5.28	2.64
Impervious catchment (C ₁ %)	3.67	1.51
Storage Provided m ³ (1% AEP)	1006	383
Peak Outflow (1% AEP) l/s	156l/s	79l/s
TWL (1%AEP) mAHD	RL 26.60mAHD	RL 26.00mAHD
Site Area Required/Area of Inundation (m ²) – 1%AEP	1,573	650
Storage Provided m ³ (20%AEP)	209	189
Peak Outflow (20%AEP) l/s	73l/s	35l/s
TWL (20%AEP) mAHD	RL 26.21mAHD	RL 25.62mAHD
Site Area Required/Area of Inundation (m ²) – 20%AEP ARI	983	380
Storage Provided m ³ (1EY)	461	154
Peak Outflow (1EY) l/s	25.80l/s	13.4l/s
TWL (1EY) mAHD	RL 26.19mAHD	RL 25.52mAHD
Site Area Required/Area of Inundation (m ²) – 1 Yr ARI	910	315
Base Level mAHD	RL 25.40mAHD	RL 24.90mAHD

The 1% AEP event plan is shown in Drawing U-04 in Appendix B.

6.2 Stormwater Management System

6.2.1 1EY – 1 hour events

The 1 in 1 year event is typically recognised as the storm which generates most nutrients and particulate matter.

The water quality treatment will actively manage stormwater with the aim to achieve minimum standard reduction targets as prescribed by the Department of Water.

It is proposed that the 1 in 1 year ARI 1 hour storm will be detained on site with limited outflow in accordance with DWER requirements to ensure that all water is treated via a bio retention system prior to outflow. This is proposed to be undertaken at the various levels as outlined in the following sections.

6.2.1.1 Allotments

Lots discharge to a series of soakwells which will be installed within the roadways. The soakwells will infiltrate to the adjacent subsoil system installed interconnecting the

soakwells. The subsoil will drain the area to the end of line basins such that outflows will be treated via the bioretention area prior to discharge. When the soakwells fill during a storm, the water will rise then be conveyed via the street drainage system to the downstream basin.

The various catchments of the Lot drainage and their connection points are detailed in Drawing U04 in Appendix B.

6.2.1.2 Roadways

Road storm water run-off from urban streets will be directed through a pipe system into the proposed end of line basins which will be constructed with bio-retention properties to ensure maximum nutrient uptake. The design of the detention basin will ensure that the 1EY - 1 hour storm from the roadways is detained and treated on site prior to overflow.

Sediment will be trapped in the pits provided throughout the development.

6.2.1.3 Detention Basins

The detention basins will be required to limit the outflow from the site for all storms.

The outlet will consist of a pipe outlet with a weir in front with subsoil beneath the basin as shown in Drawing L05 and L06 in Appendix B.

Subsoils will be installed in the base of both basins to ensure that basins drain after rainfall events. Subsoils connected to the Neerigen Brook are above the base flow level of the swale.

The specification of filter media according to the Adoption Guidelines for Stormwater Biofiltration Systems⁵ is as outlined below:

Sieve/Details	% Passing
2.36mm	97-100%
1.18mm	90-100%
0.6mm	75-100%
0.3mm	40-60%
0.15mm	20-30%
0.075mm	<3%
Organic Content	<5%
pH Range	5.5-7.5
PRI	>10

Tests will be undertaken to ensure compliance with this specification prior to delivery of the material to site.

Bio-retention areas will be planted using native sedges in accord with the Vegetation Guidelines for Stormwater Biofilters in the South-west of Western Australia⁶.

Details and cross sections of the basins are shown in Drawings U-04 in Appendix B.

6.2.2 20% AEP event

For the design nuisance storm event (20% AEP), storm water runoff from road pavements will be piped to the detention basins as shown in the 20% AEP event plan in Drawing U-05 in Appendix B.

All piped drainage systems will be designed to accommodate the 20% AEP event, including allowance for direct connections from allotments. The detention basin will be designed to detain the various storms to predevelopment flows.

6.2.3 Non Structural Management Practices

Non-structural measures will also be employed to reduce the sources of nutrients. These measures involve providing advice to lot purchasers and stakeholders to reduce nutrient sources from the application of garden fertilisers and eroded particulate matter particularly from the new urban areas during the housing construction phase and in establishment of gardens.

Minimisation of nutrient loading will be achieved through:

- Education of local residents and Village maintenance personnel; and
- By implementing frequent street and storm water maintenance programs – particularly during housing construction.
- By planting and using appropriate native species.

All landscaping and maintenance will be installed as part of the Lifestyle Village development which will ensure correct planting and maintenance is implemented.

6.3 *Post- Development Groundwater Levels and Fill Requirements*

6.3.1 Groundwater Level Management

Given the clay substrate of the site, the stripped natural ground surface will be earth-worked and shaped to direct flows perched on the subsurface towards sub-soil lines located in road verges.

Subsoil lines will be installed on a single side of the road, together with sewers laid on metal bedding at the rear of Lots. The sewers will be backfilled with sand and the trench in conjunction with the metal bedding will act as a subsoil. The flows along the trenches will be intercepted by subsoils where the sewer and the drains intersect on road crossings. This will control perching of water on the impervious clay layer and assist with lot drainage of back yard areas.

6.3.2 Groundwater Quality Management Strategies

Given the soil conditions on the site and the relatively shallow groundwater, the subsoils system will establish a controlled groundwater level which will limit the rise of the water. Outflows will be directed into the drainage basins to be treated in conjunction with stormwater in the end of line basins prior to discharge into the Neerigen Brook.

6.3.3 Finished Lot Levels (Relative to the phreatic line)

All lots will be raised through the placement a minimum of 0.8m of imported free draining fill above the underlying clay layer and the associated subsoil drainage.

7 Landscape Concept

7.1 Proposed Public Open Space Development

The development indicates open space areas abutting Ripplemead Ave in the southern part of the site and abutting the entry off Gray Drive. Active areas will be incorporated within the Clubhouse site. Probably the largest landscaped area will be the Neerigen Brook Foreshore reserve. This will be shaped to suit the required living stream area and landscape plans will be prepared in conjunction with the City to ensure that it meets with their requirements.

The drainage areas abutting the brook which will be planted with sedges and other nutrient loving plants such as *Baumea Juncea* and *Juncus subsecundus* together with additional suitable species such as *Juncus pallidus* and *Ficinia nodosa*.

Detailed landscape plans will be provided as part of building plans to provide further insight into the proposals and allow the Shire to provide more detailed comments on the matter. A concept plan has been shown in Appendix B of this document.

Native plants will be used together with low water requirement grasses to ensure that water requirements are minimised.

7.2 POS Credits and Areas of Inundation:

POS credits do not apply to this development as it is a development rather than a subdivision. The Open Space that will be developed is for the private use of residents, with the exception of the Neerigen Brook Foreshore reserve which will be handed over to the Shire for public use.

This will be constructed by the developer and handed over to the Shire.

7.3 Protection of Environmental Assets

Due to the proximity of Wungong Brook the proposed drainage strategy outlined herein will ensure that the quality of downstream waters does not further deteriorate resulting from the proposed development.

7.4 Irrigation Requirements for Landscape Areas

7.4.1 Water Source and Requirements

The development is located within the Perth Groundwater Area and a licence is required to irrigate. There is an existing bore located in Lot 45 (Licence 55402) with an allocation of 26600kl/annum, which is included in Appendix E.

The water requirements for the lifestyle village will be around 4,000 square metres and the Foreshore reserve will be around 15,000 square metres and allowing the 7,500Kl/ha/annum which is allowable by DWER, the maximum required water allocation will be 3,000kl/annum for the lifestyle village and 11,250kl/annum for the foreshore meaning there is sufficient allocation within the current licence.

7.4.2 Irrigation Schedules

In general, watering will be 10mm three times per day for initial establishment over a period of approximately 1 month, depending on the weather and the time of the year. This will be

reduced to 10mm once per day for a period of approximately 2 months again dependant on the time of year. The watering is then reduced to 10mm every two days.

Establishment irrigation for street trees and the sedges and natives is expected to be used for a period of 1 to 2 years after planting depending on the species, the prevailing weather and the time of planting. The basins will be temporarily irrigated to establish vegetation for the first 2 years year after planting and this should be on a separate station to enable it to be readily turned off.

As part of the civil works a minimum of 400mm of improved soil will be placed within the bioretention areas to ensure free drainage and nutrient retention prior to planting. Higher PRI sand will be used to assist with nutrient retention.

Irrigation will be programmed and maintained to minimize the water used across the site, with the following mechanisms to minimize water use.

Monitoring and Adjustment: The system will be checked regularly to detect faults and ensure water is being used effectively and efficiently.

In general the system will be checked at a frequency of

- November to April - Once per fortnight.
- May to October - Once a Month.

All sprinklers will be checked to fully pop-up and retract; that bubblers and that nozzles are free of blockages; and sprinklers are providing adequate coverage. Particular attention will be paid to irrigation of transplanted mature trees and street trees to ensure they are receiving adequate water.

The watering regime for planted areas shall reflect the plant's needs in accordance with the plant type and natural rainfall, in accordance with the Water Corporation of WA "Waterwise" guidelines. Watering will be monitored throughout the year and adjusted accordingly to ensure appropriate watering. Watering (Other than testing) will only take place within the hours stipulated by the Water Corporation (Currently 6.00pm to 9.00am)

In general the Irrigation Schedule will be as outlined below, which are based on the landscape hydrozones

- Turf will be separated from shrubbery and turf and shrubbery will be supplied by different stations of irrigation and will be scheduled separately.
- Areas of turf subject to lower wear which are in sheltered environments and/or are not visually prominent will be scheduled to receive a lesser amount of irrigation than areas of turf which are subject to high levels of wear, in exposed environments and/or visually prominent locations;
- Lower water use shrubbery is scheduled to receive a lesser amount of water than higher water use shrubbery; and,
- Irrigation is to be progressively withdrawn from areas of native shrubbery over 3-5 years.

7.5 Management of Disease Vectors and Nuisance Insects

7.5.1 Insect and Disease Control

The foreshore landscape area will be subject to a 2 year maintenance period by the developer and thereafter, landscaping will be maintained by Council. The internal landscaping will be maintained by the Lifestyle Resort.

Basins will be monitored for insects and standing water and plant health. Where evident, steps will be taken to remove pests and or contain disease and keep all plant material in a healthy condition.

The low retention times (meaning less than the 96 hours recommended by Department of Health) in combination with the regular flushing of the basins during rainfall events will assist in controlling insect breeding.

Insect numbers will be monitored and if numbers appear to be increasing to unacceptably high levels, measured by regular resident complaints and /or visible high numbers, the infested areas will be treated by an approved pesticide of low toxicity. Pesticides shall be used in strict accordance with the manufacturer's instructions at minimum rates.

Biodegradable pesticides shall be used wherever possible.

Care will be taken in application of chemicals to minimize any toxic affect on plant, animal or person. Chemicals used in plant maintenance will be applied in accord with Health department Standards and Regulations.

7.5.2 Use of Herbicides and Pesticides

Application will only be made by Licensed Pesticide Operators. Chemical sprays will be used only in still conditions and during weekday early mornings or otherwise when public use of the site is likely to be at a minimum. Chemicals will only be applied strictly in accordance with Health Department regulations and the Manufacturer's recommendations.

Pesticides will not be applied within 10 metres of water bodies. Only "aquatic fauna safe" herbicide ("Round up Bi-Active") will be used within 20 metres of water bodies.

During application, the contractor will take all precautions necessary to avoid overspray, drift or contamination away from the target vegetation.

8 Managing Subdivision Works

8.1 Background:

The DWER Stormwater Manual provides guidelines and information on best management practices that can be applied at land development and construction sites to improve stormwater management and environmental performance. These guidelines will be employed to generate a site specific plan for this development to implement best management practices on this site.

The guidelines recognize that poorly managed land development sites can often be a major source of stormwater pollution. Certain construction activities can allow pollutants to be transported primarily via existing stormwater systems or over-land flow to adjoining water bodies. As a result, the plan will address the common sources of pollutants from construction activities include those from:

- Litter & waste storage areas- that allow materials to be blown by wind or washed away by rainfall into existing stormwater systems.
- Wash-down areas– poor practices can allow pollutants to enter stormwater systems.
- Placement & storage of delivered products- particularly sand and soil stockpiles where such materials may be tracked by vehicles onto roads, or blown, or washed on to roads which then get into existing stormwater systems.

8.2 Proposed Management Strategies:

The plan for the site will be in the form of an Environmental Management Plan (EMP) which will be required to be prepared by the contractor prior to the commencement of any construction activities on the site.

The plan should address the following items:

- litter and waste management practices for both non-hazardous & hazardous materials;
- vehicle & equipment washing-down practices;
- water conservation practices;
- erosion and sediment control;
- product placement & storage practices;
- dewatering activities as required and;
- any other practices that may adversely impact upon receiving water bodies.

9 Monitoring

9.1 General

Pre-development sampling of the groundwater on site was undertaken by Urbaqua between 2004 and 2016 at a point in Neerigen Brook (Referred to as WM01), which is immediately downstream of the site.

The results indicated:

- Median Total Nitrogen was 2.00mg/l above the Operational Water Objective of 1.3mg/l and the
- Median Total Phosphorous was 0.04mg/l which was below the Operational Water Objective of 0.09mg/l

A post development monitoring programme will be implemented to measure groundwater levels and quality. The monitoring is proposed to be two years post –development of the final stage of the lifestyle village.

It is proposed that the Total Phosphorous and the Total Nitrogen will be measured in winter months when the drain is flowing in April, June and August.

A report will be submitted annually to Council and DWER in December each year following commencement of development works.

Given the relatively impervious nature of the soil on the site, groundwater monitoring is not proposed as the groundwater quality is likely to be independent of the stormwater system of the site.

9.2 Contingency Response

The initial results will be compared to those measured each year and from the predevelopment monitoring.

In the event that it is identified during the developers monitoring period that the median of the bore values for each parameter exceeds the measurements by 20% for two consecutive samples or;

A parameter in any bore exceed twice the maximum of all measured levels.

Council and DWER will be notified and the matter will be investigated and rectified at the developers cost.

The investigation will follow the proposed approach:

- Confirm if the high level of the sample is not due to contamination or natural variation.
- Determine if the exceedance is an isolated occurrence, project related or a regional issue.

The possible contingency measures are as follows:

1. Identify and remove or mitigate any source of contamination.
2. Review of operational practices such as in irrigation or fertiliser use in key areas and review of timing.
3. Modify the stormwater system by
 - (a) Soil amendment in high nutrient areas.
 - (b) Increased planting of water and nutrient thirsty plants.
 - (c) Potential installation of further basins.

The measures employed and the timing will be resolved at the time with the DWER and Council once the test results have been confirmed and agreed and the methodology and structure of the contingency measures are also agreed.

10 Implementation Plan

10.1 Commitments

The developer is committed to:

- 1) Physical Outcomes – To be undertaken at the time of construction.
 - Installing the physical measures as outlined within this report.
 - Installing detention basin designed and constructed to manage flows up to and including the 1% AEP storm event.
 - Basins will be landscaped and maintained by the Village Management for the 2 year maintenance period.
- 2) Non Structural – To be undertaken as part of the implementation of construction and in management of the lifestyle village.
 - To utilise water efficient devices & appliances throughout their homes, and to encourage all purchasers to install Water & Nutrient-wise plants.

10.2 Maintenance Arrangements (Incl. Roles, Responsibilities & Funding)

10.2.1 Internal to Allotments

Each property owner will be encouraged to regularly inspect and clean their internal drainage systems including gutters, pipework – at least on an annual basis. In the event of blockages, this will be resolved by the lifestyle village management in conjunction with the house owner.

10.2.2 Stormwater System

Over the summer period, particulate matter will build up in the storm water drainage system, within the trapped pit bases and silt traps. In the initial years of housing construction this will be from soil washed into the storm water system, although leaves, litter and grass clippings are more likely to reach the system in the longer term.

Although the system will operate with these small volumes of litter and leaves without their removal, if left for long periods of time they will break down and contribute to higher nutrient outflows from the site. As a result a regular maintenance programme is necessary with the following periodic maintenance required:

- Cleaning of drainage infrastructure. This is by sucking debris from trapped drainage pits, and removal of rubbish the bases of bio retention basins.
- Regular Street Sweeping to remove particulate build-up on the road surface and in gutters.
- Appropriate disposal or composting of grass clippings ensuring that they do not reach the storm water system. As an example, use of blowers and suchlike to blow clippings into stormwater systems is not supported.

Drainage infrastructure maintenance should at least occur on a biannual basis - just prior to winter & again in the middle of winter and obviously more regularly during periods of major housing construction.

Street sweeping will be employed as a measure to reduce sand drift from subdivisional works and housing construction activities being mixed with stormwater flow. The developer will be responsible for street sweeping for the life of the lifestyle village as all the internal roads are the responsibility of the management.

Trapped pits in conjunction with the flat site grades will control silt loadings and reduce inlet scour.

It is anticipated that only standard Council checks and cleaning maintenance requirements will need to be applied to the drainage system developed for this subdivision – with suggested maintenance frequencies as outlined in Table 9.1 below.

Table 9.1 –Maintenance Responsibilities for Drainage Elements of the Proposed development

#	Drainage Element:	Maintenance and Inspection Frequency:	Responsibility:
1	Internal allotment drainage systems	Annually inspection & clean-out (as necessary) – just prior to winter rains	House Owner
2	Street Sweeping	Quarterly as a minimum but more regularly as required. Surrounding roads to be swept as necessary during house construction.	Developer/Village Management

#	Drainage Element:	Maintenance and Inspection Frequency:	Responsibility:
3	Vegetated bio-retention basin and landscaped detention basins	<u>During developer maintenance period:</u> Regular maintenance which including sediment removal, weed control/removal, infill planting, rubbish collection, removal of dead plants and any remediation of structures where damage has occurred. Inspect, clean-out & maintain structures tri-annually – just prior to winter & then around June / July & again in Oct / Nov. Base and Batters of Basin to be monitored for building sediment removed prior to initial planting	Village management will be responsible for this for 2 year maintenance period the this will revert to the Council.
		<u>After developer maintenance period:</u> Inspect, clean-out & maintain plants (as required) as part of standard Council POS maintenance program	Council/ Village management
4	Drainage culverts, standard table drains, pipes, pits.	<u>During developer maintenance period:</u> Inspect, clean-out & maintain structures annually – just prior to winter (& then again in Aug / Sept if necessary)	Village Management
		<u>After developer maintenance period:</u> Inspect, clean-out & maintain structures at least annually – just prior to winter – but inspection frequency will need to be higher during home construction phase. Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / Aug – but inspection frequency will need to be higher during home construction phase	Village management for the life of the Village
5	Base of swales & bio-retention basins	Initial formal inspection & assessment of performance of bases (say) at around year 3 & then every 5 – 10 years.	Council

10.3 Assessment and Review

It is not expected that this WMP for this development will need to be reviewed after it is approved by the relevant authorities.

11 References:

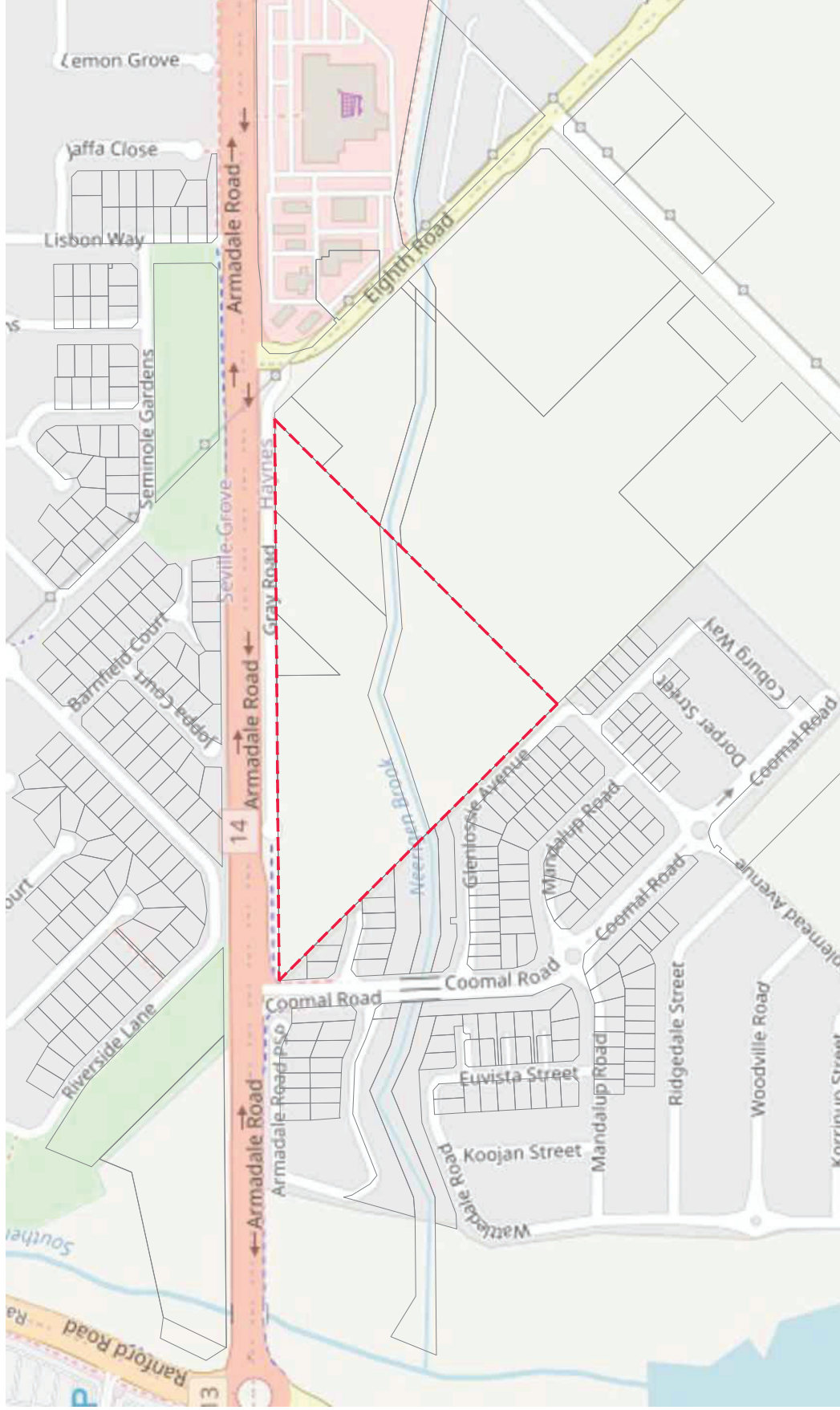
1. Water Management Strategy: Lots 46 and 47 Gray Road Haynes, 360 Environmental– August 2020 Revision 2.
2. Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia
3. Adoption Guidelines for Stormwater Biofiltration Systems, Cooperative Research Centre for Water Sensitive Cities, 2015.
4. Vegetation Guidelines for Stormwater Biofilters in the South-west of Western Australia, Monash Water for Liveability Centre, Monash University, 2014.

APPENDIX A – OVERALL PLANS

- **L01 - Location Plan**
- **L02 – Development Plan Overlaid on Aerial Photograph**



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PROJECT:
**PROVIDENCE LIFESTYLE VILLAGE
LOTS 48 & 47 GRAY ROAD, HAYNES
STAGE 1**
W.A.P.C. No. - 161077

DRAWING:
**LOCAL WATER MANAGEMENT STRATEGY
LOCALITY PLAN**

SCALE	DATE	PROJECT NUMBER	DESIGNED BY	CHECKED BY	APPROVED BY	REV. NO.
1:2000	17/07/24	HAYNLV01	AS	AS	AS	A

DRAWING NUMBER
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LOCALITY PLAN

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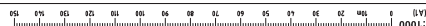
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LOTS 46 & 47 GRAY ROAD, HAYNES
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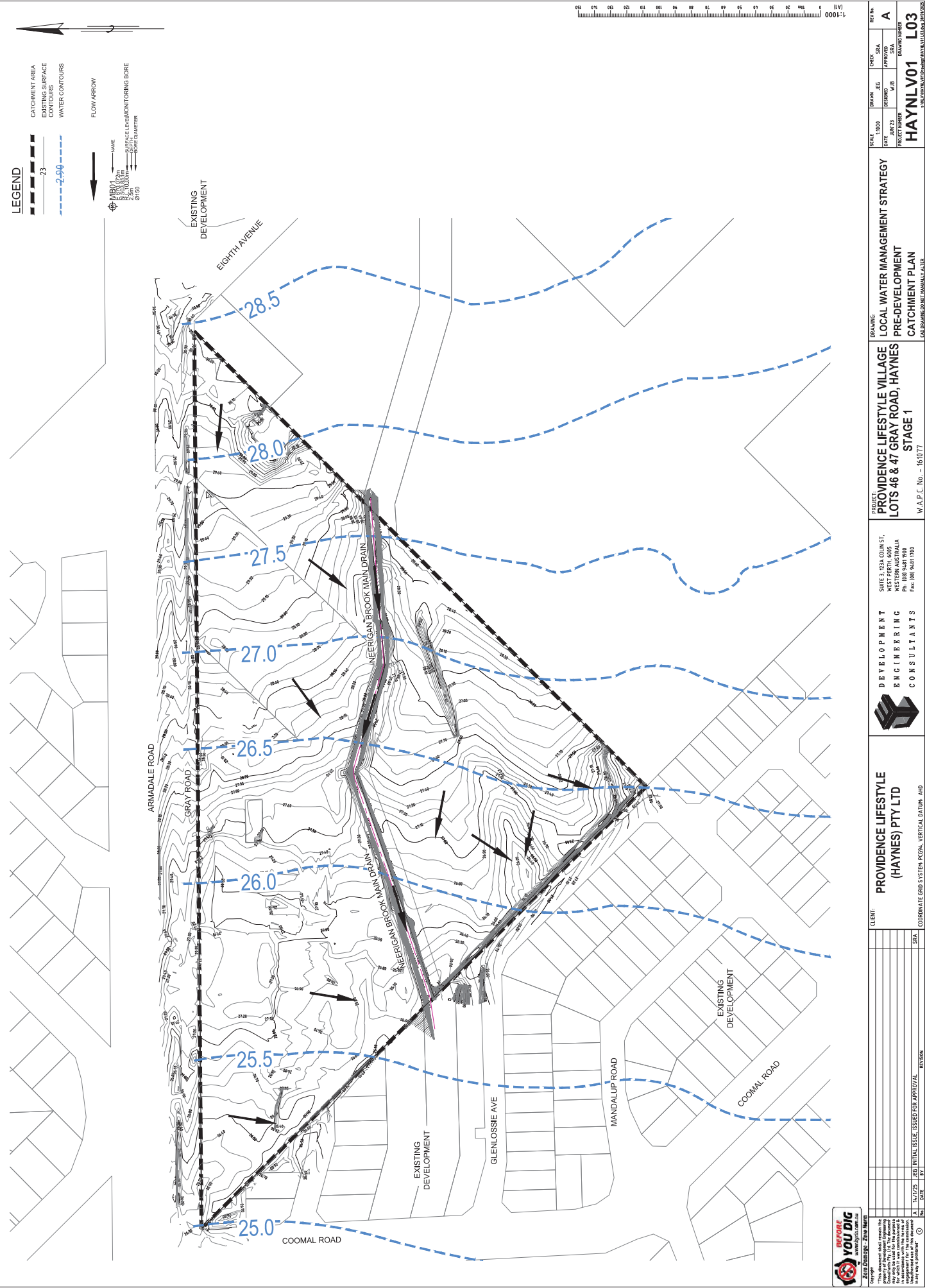
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HAYNLV01 L02



APPENDIX B – DRAINAGE STRATEGY PLANS

- **L03 – Predevelopment Catchment Plan**
- **L04 – Post Development Catchment Plan**
- **L05 – Drainage Basin Details**
- **L06 – Pit and Headwall Details**





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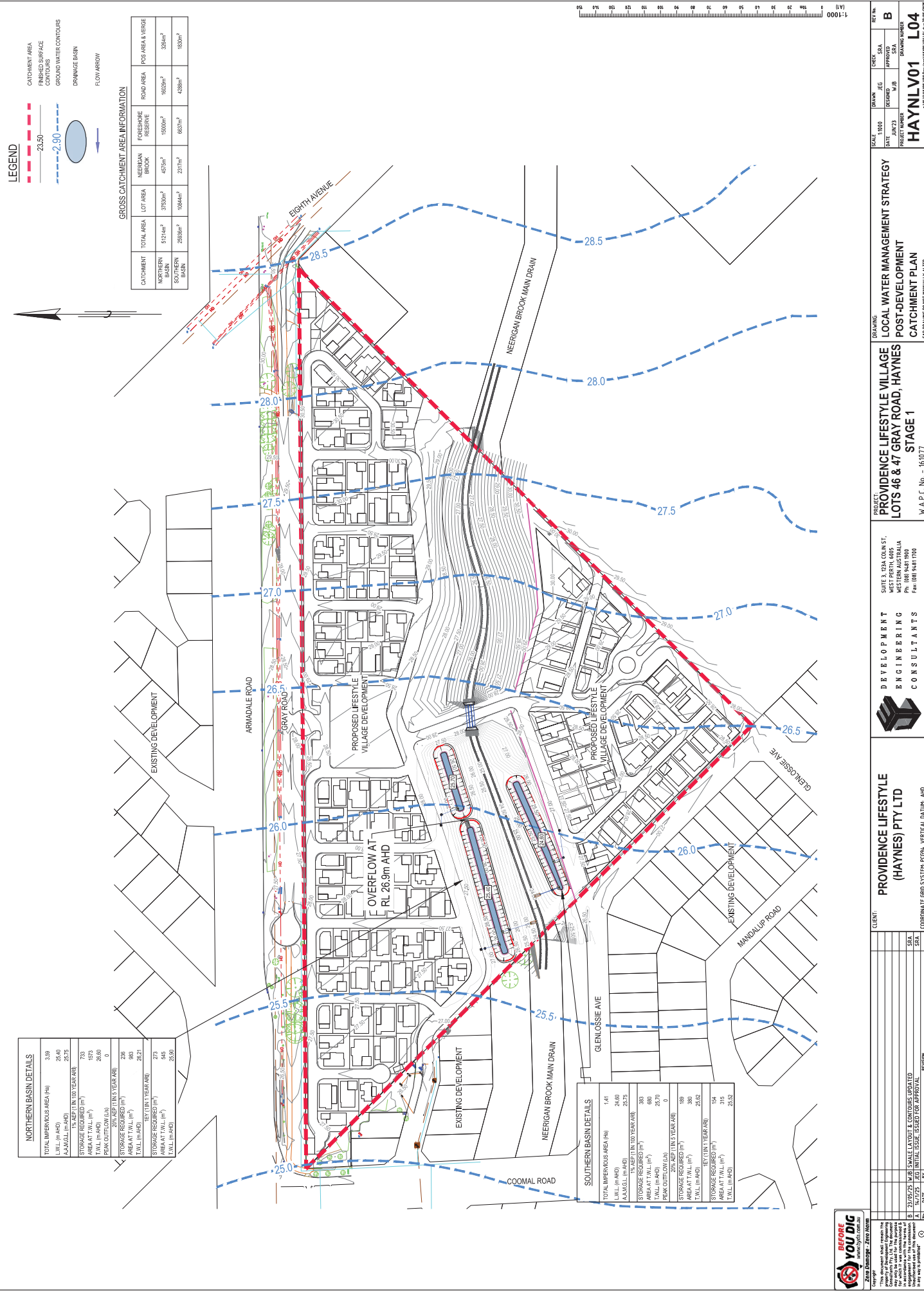
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LOTS 48 & 47 GRAY ROAD, HAYNES
STAGE 1
W.A.P.C. No. - 161077

DRAWING: LOCAL WATER MANAGEMENT STRATEGY
PRE-DEVELOPMENT
CATCHMENT PLAN

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NORTHERN BASIN DETAILS	
TOTAL IMPERVIOUS AREA (H)	3.59
L.W.L. (m AHD)	25.40
A.A.M.G.L. (m AHD)	25.75
STORAGE REQUIRED (m³)	793
AREA AT T.W.L. (m²)	1975
T.W.L. (m AHD)	25.60
PEAK OUTFLOW (L/s)	0
20% AEP (1 IN 50 YEAR ARI)	738
STORAGE REQUIRED (m³)	980
AREA AT T.W.L. (m²)	25.21
T.W.L. (m AHD)	25.73
STORAGE REQUIRED (m³)	44
AREA AT T.W.L. (m²)	25.00
T.W.L. (m AHD)	

SOUTHERN BASIN DETAILS	
TOTAL IMPERVIOUS AREA (H)	1.41
L.W.L. (m AHD)	24.90
A.A.M.G.L. (m AHD)	25.75
STORAGE REQUIRED (m³)	383
AREA AT T.W.L. (m²)	690
T.W.L. (m AHD)	25.75
PEAK OUTFLOW (L/s)	0
20% AEP (1 IN 50 YEAR ARI)	189
STORAGE REQUIRED (m³)	315
AREA AT T.W.L. (m²)	25.02
T.W.L. (m AHD)	

GROSS CATCHMENT AREA INFORMATION

CATCHMENT	TOTAL AREA	LOT AREA	NEERIGAN BROOK FORESHORE RESERVE	ROAD AREA	POD AREA & VERGE
NORTHERN BASIN	9714m²	3700m²	475m²	10000m²	354m²
SOUTHERN BASIN	2558m²	1044m²	6837m²	438m²	1830m²

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1 - 10/07/25 JED: INITIAL ISSUE, ISSUED FOR APPROVAL
2 - 10/07/25 JED: INITIAL ISSUE, ISSUED FOR APPROVAL

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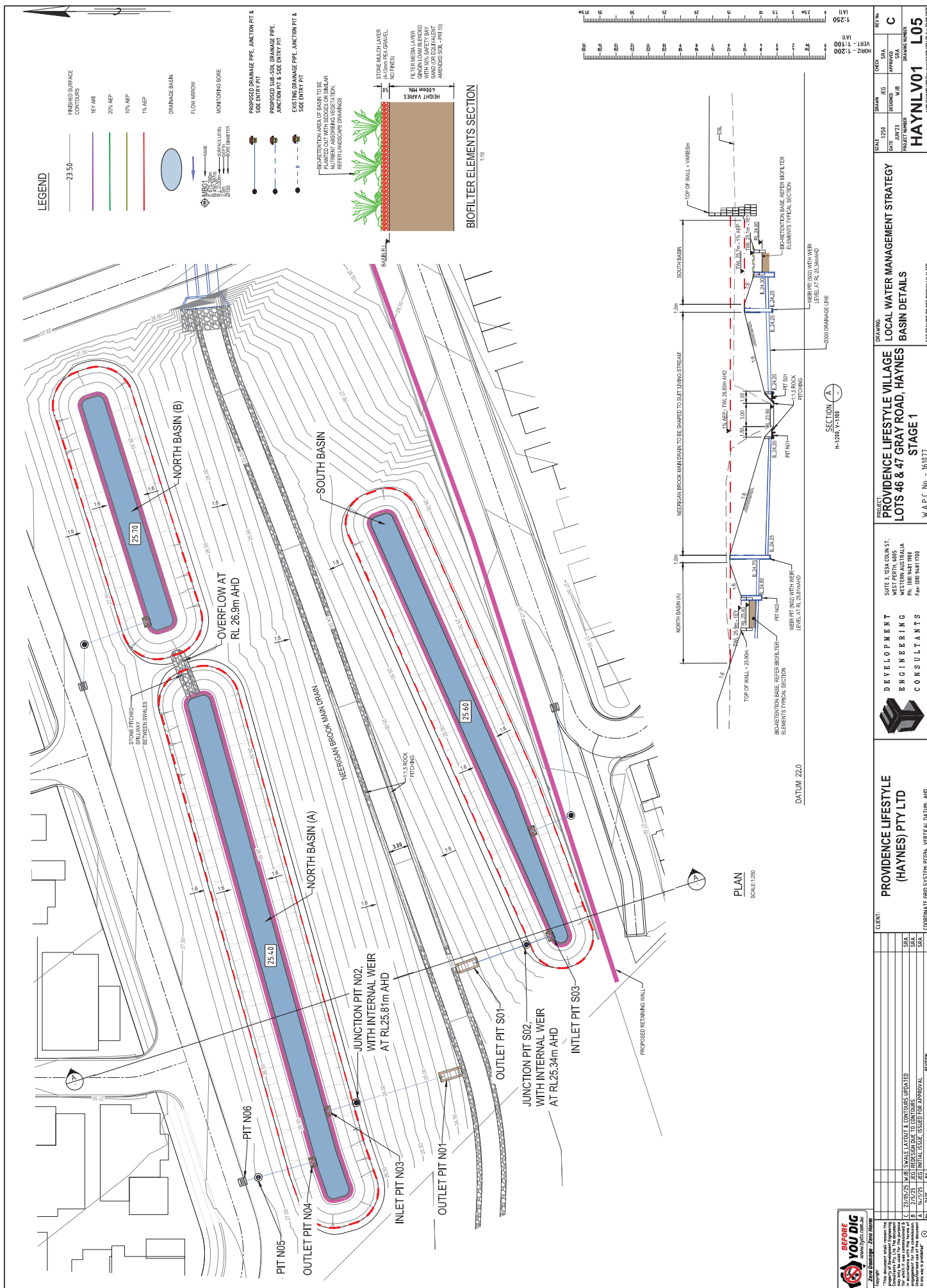
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W.A.P.C. No. - 161077

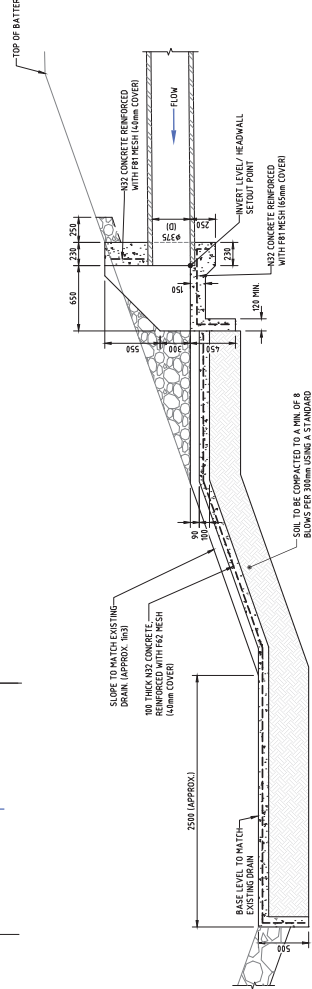
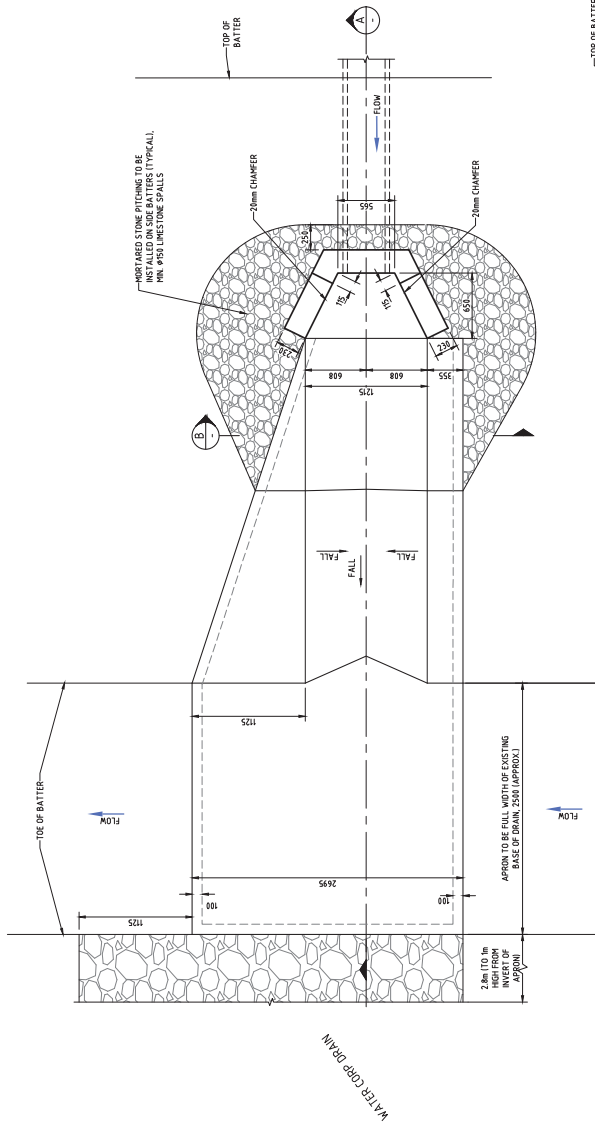
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LCA DRAWING (POST-DEVELOPMENT)

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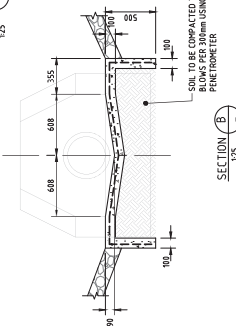
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CHECKED BY: JED
APPROVED BY: B

REV. NO. 1
REV. DATE 10/07/25
REV. BY B



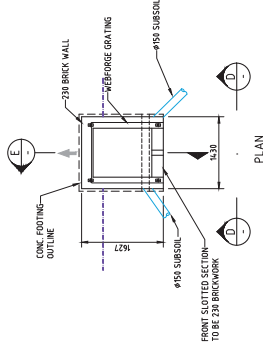


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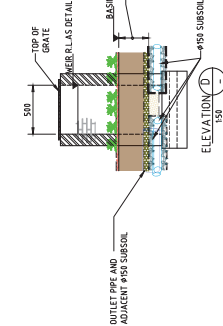


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PLAN DG16-3-11



PLAN
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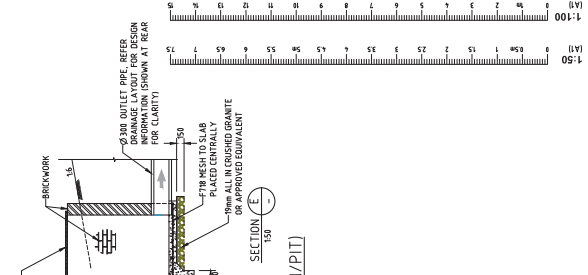
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INLET CONTROL STRUCTURE N3/S3 BASIN/PIT

1:50

NOTES:

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2. ALL CONCRETE SHALL BE TYPE 10/10 MIX WITH 10% FINE AGGREGATE.
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INLET CONTROL STRUCTURE N1/S1 MAIN DRAIN INLET

1:50



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PROVIDENCE LIFESTYLE VILLAGE
LOTS 48 & 47 GRAY ROAD, HAYNES
STAGE 1

DRAWING:
LOCAL WATER MANAGEMENT STRATEGY
PIT & HEADWALL DETAILS

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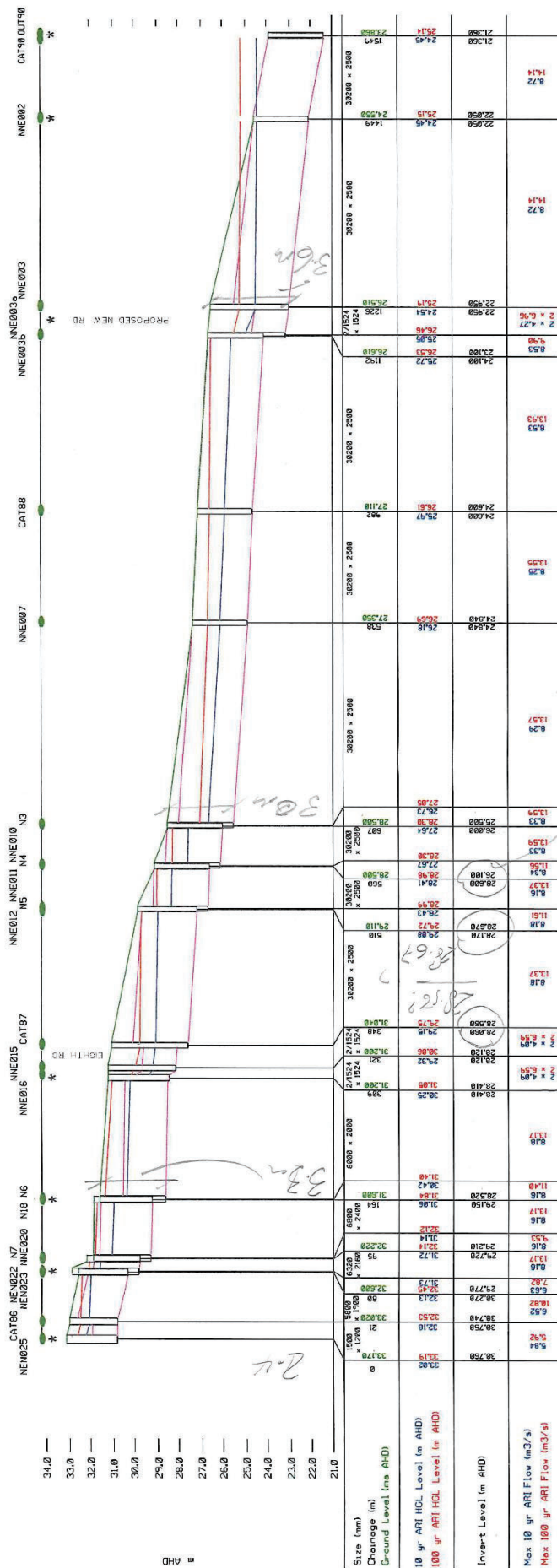
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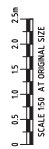
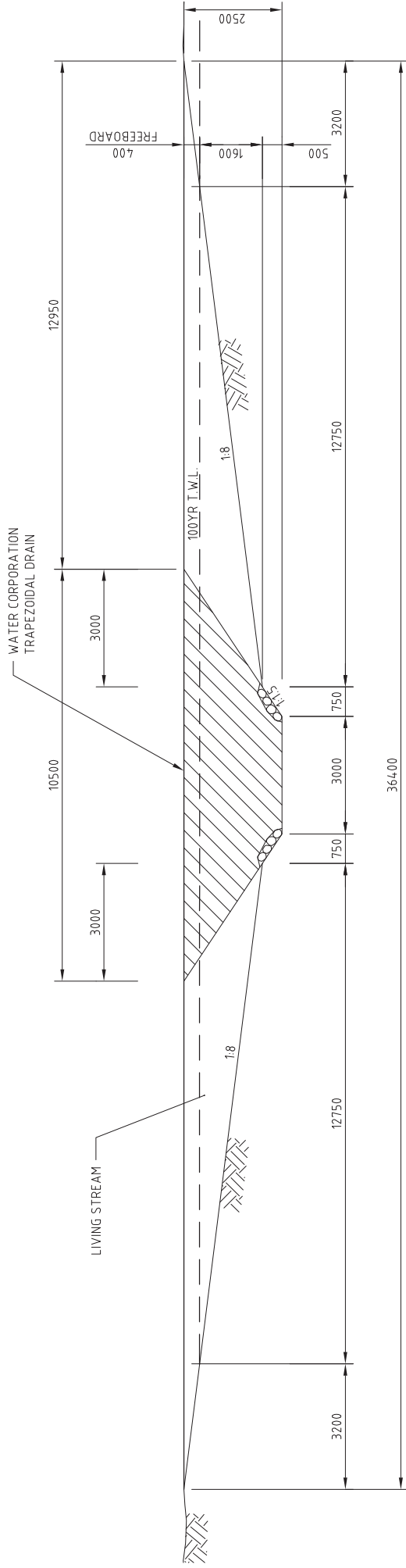


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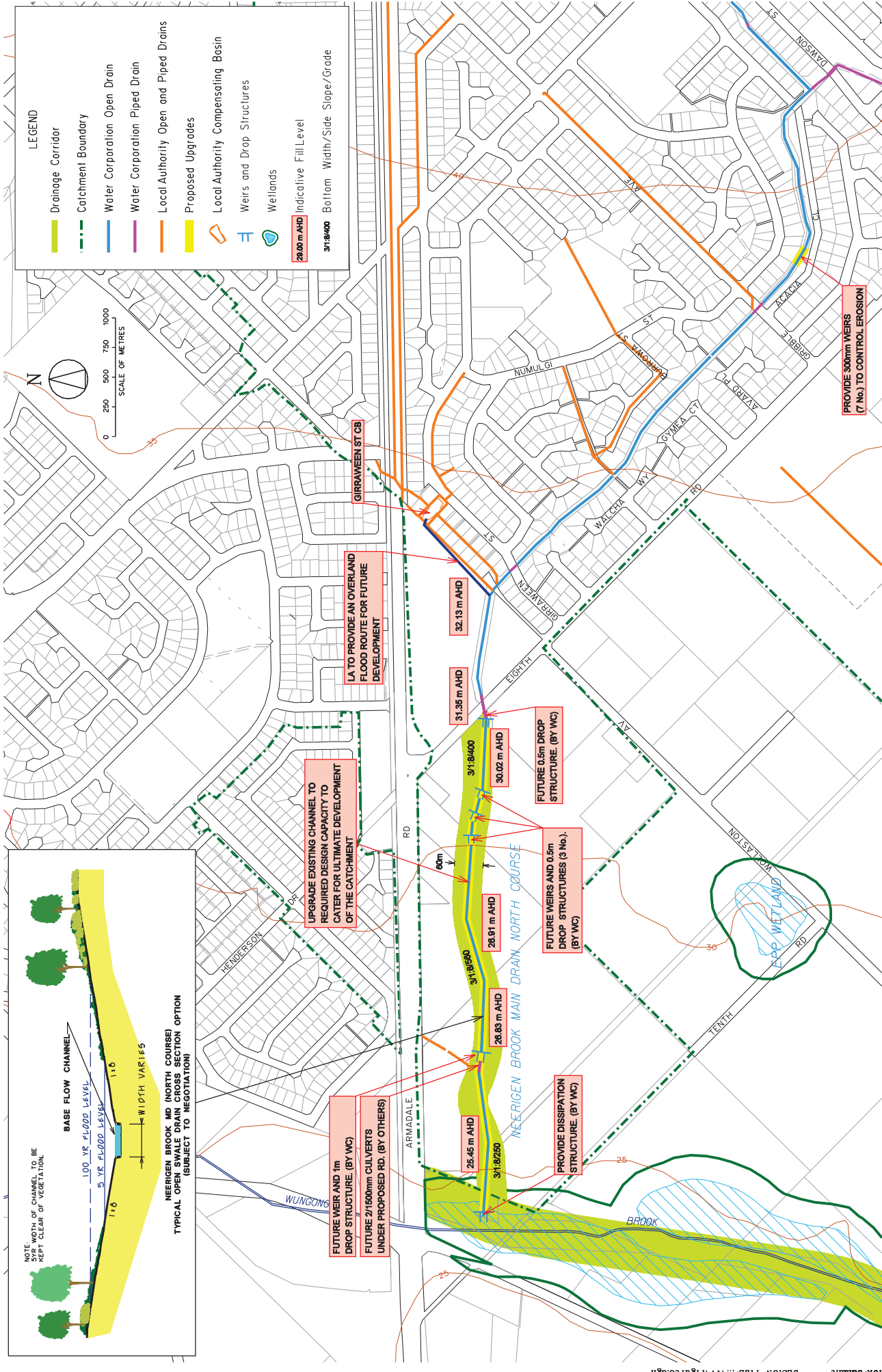
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Figure 4



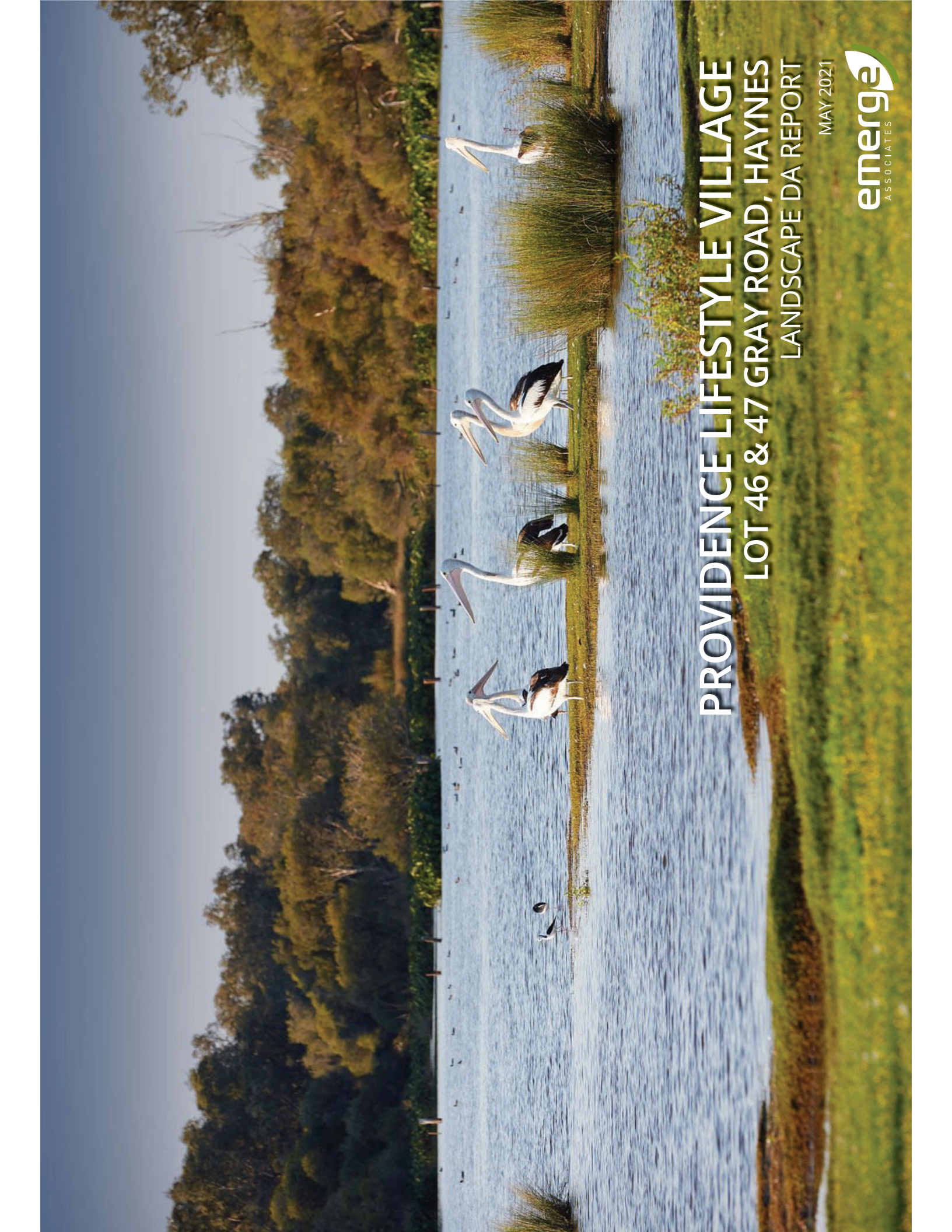
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THE INFORMATION CONTAINED HEREIN IS SUBJECT TO ONGOING REVIEW AND AMENDMENTS AND SHOULD BE READ IN CONJUNCTION WITH THE ASSOCIATED REPORT.



UPGRADED NEERIGEN BROOK MAIN DRAIN, NORTH COURSE
Page 55 Figure 3





PROVIDENCE LIFESTYLE VILLAGE LOT 46 & 47 GRAY ROAD, HAYNES LANDSCAPE DA REPORT

MAY 2021

emerge
ASSOCIATES

1.0 Landscape Masterplan

LEGEND

--- EXTENT OF WORKS

01 ENTRY ROAD

02 ENTRY SIGNS

03 LANDSCAPED VERGE

04 FORMAL PAVING TO CLUBHOUSE/
COMMUNITY BUILDING, TREES TO TRE GRATES

05 FLUSH KERB ENVIRONMENT WITH FEATURE
PAVING TO ROAD

06 FEATURE PAVED PLAZA TO NEERIGEN
FORESHORE TO PROVIDE EXTENSION FROM
CLUBHOUSE/COMMUNITY BUILDING. PLAZA
INCLUDES DECKING TO INTERACT WITH
NEERIGEN BROOK, ARBOR & PICNIC SETTINGS

07 2.1m DUAL USE FOOTPATH

08 ROLL ON TURF

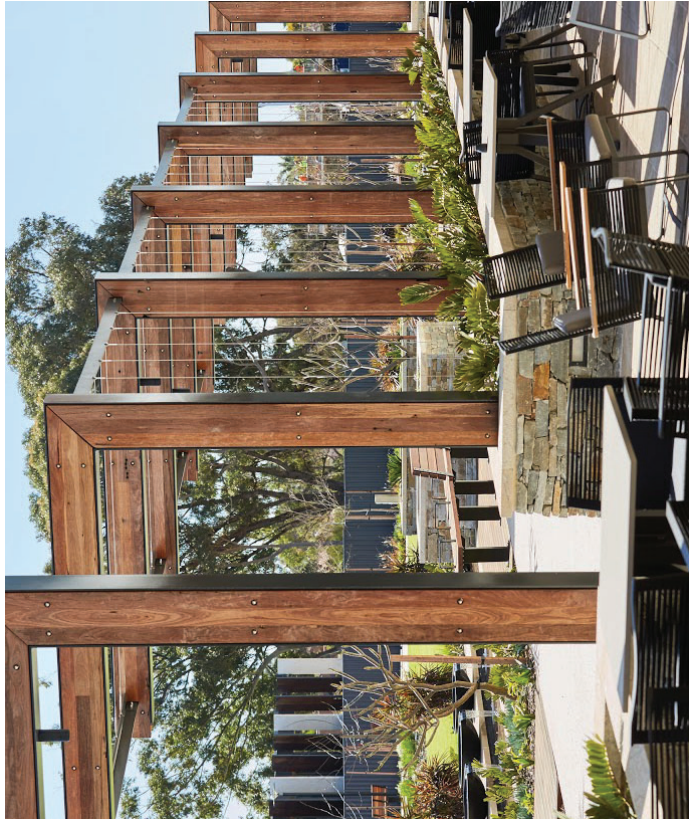
09 DECKING TO NEERIGEN BROOK

10 SHADE STRUCTURES & BENCH SEATING

11 REVEGETATION PLANTING



2.0 Character Images



APPENDIX C – DRAINAGE CALCULATIONS

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Northern Basin
Designer: SRA



Location:	Gray Road, Haynes		
Nearest grid cell:	Latitude	31.1375(S)	Longitude 115.9875(E)

Data to be input

Rainfall AEP (percentage)	10		ARI	v Descriptor v
1 EY - 1hr impervious catchment (Ha)	1.12		9.49	Infrequent
Required bio-retention area (2%) (m ²)	223			
Required storage (1EY - 1hr) (m ³)	168			
Available storage (m ³)	592			
Soakage outflow (L/s/m ²)	0.000	0.01 m/day		
Likely Subsoil Flow (m ³ /day)	95.45			
Likely Subsoil Flow (l/s)	1.10			
Allowable Outflow (l/s) (1 yr)	5.10	l/s/ha	26.89	
Allowable Outflow (l/s) (5 yr)	13.90	l/s/ha	73.29	
Allowable Outflow (l/s) (10 yr)	18.20	l/s/ha	95.96	Based on Agreed Flows for Haynes Shopping Centre
Allowable Outflow (l/s) (100 yr)	29.89	l/s/ha	157.61	Proportional Based on WC calculated Flows

Catchment details	Roads	Lots	Open Space/Foreshore	Drainage basin	Total
Gross area (Ha)	1.24	2.6666	1.2075	0.1573	5.2727
Runoff coefficient (C ₁₀)	0.90	0.82	0.12	1.00	
ARI multiplier	1.00	1.00	0.91	1.00	
Runoff coefficient (C _v)	0.90	0.82	0.11	1.00	
Impervious area (Ha)	1.12	2.19	0.13	0.16	3.59

Allowable Outflow

95.96 l/s

0.68 Effective C

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Northern Basin
Designer: SRA



T _c (min)	T _c (hr)	I (mm/hr)	Q _{IN} (L/s)	V _{IN} (m ³)	Preliminary height (m)	Q _{OUT} (soakage) (L/s)	V _{OUT} (soakage) (m ³)	Net storage (after soakage) (m ³)	Time of water in basin (hr)	V _{OUT} required (m ³)	Q _{OUT} (L/s)
10	0.17	74.40	743	446	0.30	0.0	0	446	1.7	0	0.0
15	0.25	60.20	601	541	0.30	0.0	0	541	2.0	0	0.0
20	0.33	51.00	509	611	0.30	0.0	0	611	2.3	19	15.7
30	0.50	39.90	398	717	0.30	0.0	0	717	2.7	125	69.4
45	0.75	31.46	314	848	0.30	0.0	0	848	3.2	256	94.8
60	1.00	25.70	256	923	0.30	0.0	0	923	3.5	331	92.1
90	1.50	19.80	198	1067	0.30	0.0	0	1067	4.0	475	88.0
120	2.00	16.50	165	1186	0.30	0.0	0	1186	4.5	594	82.5
150	2.50	14.40	144	1293	0.30	0.0	0	1293	4.9	702	78.0
180	3.00	12.80	128	1380	0.30	0.0	0	1380	5.2	788	73.0
240	4.00	10.93	109	1571	0.30	0.0	0	1571	6.0	979	68.0
300	5.00	9.46	94	1699	0.30	0.0	0	1699	6.4	1107	61.5
360	6.00	8.37	84	1804	0.30	0.0	0	1804	6.8	1212	56.1
480	8.00	7.11	71	2044	0.30	0.0	0	2044	7.7	1452	50.4
720	12.00	5.37	54	2315	0.30	0.0	0	2315	8.8	1723	39.9
960	16.00	4.50	45	2589	0.30	0.0	0	2589	9.8	1997	34.7
1440	24.00	3.30	33	2846	0.30	0.0	0	2846	10.8	2254	26.1
2880	48.00	1.93	19	3329	0.30	0.0	0	3329	12.6	2737	15.8
4320	72.00	1.39	14	3596	0.30	0.0	0	3596	13.6	3004	11.6

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Northern Basin
Designer: SRA



Calculation of storage in above ground basin

Lower tier drainage basin dimensions:
Side slopes 1: Length (m) Breadth (m)
0 109 5

RL (Base)				Treatment		
Area at TWL		storage above		The designated height allows		
TWL (mAHD)	Height (m)	Area (m ²)	Average area	Volume (m ³)	LWL (m ³)	storage for
25.4	0	545	2180	0	0	Static water level
25.9	0.5	545	2180	273	273	First 15mm
25.9	0.5	545	2180	273	273	1EY
25.9	0.5	545	2180	273	273	Top of Lower Tier
TOTAL STORAGE TO TOP OF LOWER TIER				273	m ³	

Middle tier drainage basin dimensions:
Side Slopes 1: Length (m) Breadth (m)
6 109 5

RL (Base)		25.9		Total storage		
Total depth to		Area at TWL		above LWL		
TWL (mAHD)	Height (m)	TWL (m)	Area (m ²)	Average area	Volume (m ³)	The Designated Height allows Storage for
25.9	0	0.5	545	2180	0	Bottom of Middle Tier
26.19	0.29	0.79	954	2986	217	1EY
26.21	0.31	0.81	983	3042	236	20% AEP
26.29	0.39	0.89	1100	3269	319	10% AEP
26.6	0.7	1.2	1573	4166	733	1% AEP
26.6	0.7	1.2	1573	4166	733	Top of Middle Tier
TOTAL STORAGE TO TOP OF MIDDLE TIER				1006	m ³	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Northern Basin
Designer: SRA



Outflow Configuration

Weir Level: 26.15 mAHD

Flow over Weir (Low ARI Storms)

$Q = 1.84 \times L \times (H)^{1.5}$

L : width of weir
H: height of weir

Q (m ³ /sec)	L (m)	H (m)	TWL	TWL for Storage	Difference	1EY 20% AEP 10% AEP 1% AEP
0.027	0.50	0.09	26.24	26.19	0.05	
0.073	0.50	0.19	26.34	26.21	0.13	
0.096	0.50	0.22	26.37	26.29	0.08	
0.158	0.50	0.31	26.46	26.60	-0.14	

Flow through Orifice (For 100 year ARI Storms)

$Q = C_D \cdot A_o \cdot \text{Sqrt}(19.62 \cdot dH)$

Cd= 0.61

Q (m ³ /sec)	Width of Hole (mm)	Depth of Hole (mm)	Ao (sqm)	Equiv Dia(mm)	dH(m)	Allowable DH
0.158	230	230	0.0529	260	1.215940186	1% AEP 1.200

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Southern Basin
Designer: SRA



Location:	Gray Road, Haynes		
Nearest grid cell:	Latitude	31.1375(S)	Longitude 115.9875(E)

Data to be input

Rainfall AEP (percentage)	63.2		ARI	v Descriptor v
1 EY - 1hr impervious catchment (Ha)	0.39		1	Very Frequent
Required bio-retention area (2%) (m ²)	77			
Required storage (1EY - 1hr) (m ³)	58			
Available storage (m ³)	154			
Soakage outflow (L/s/m ²)	0.000		0.01 m/day	
Likely Subsoil Flow (m ³ /day)	32.97			
Likely Subsoil Flow (l/s)	0.38			
Allowable Outflow (l/s) (1 yr)	5.10	l/s/ha	13.49	
Allowable Outflow (l/s) (5 yr)	13.90	l/s/ha	36.76	
Allowable Outflow (l/s) (10 yr)	18.20	l/s/ha	48.13	Based on Agreed Flows for Haynes Shopping Centre Proportional Based on WC calculated Flows
Allowable Outflow (l/s) (100 yr)	29.89	l/s/ha	79.05	

Catchment details	Roads	Lots	Open Space/Foreshore	Drainage basin	Total
Gross area (Ha)	0.43	1.0644	1.0784	0.0728	2.6444
Runoff coefficient (C ₁₀)	0.90	0.82	0.12	1.00	
ARI multiplier	1.00	1.00	0.62	1.00	
Runoff coefficient (C _v)	0.90	0.82	0.07	1.00	
Impervious area (Ha)	0.39	0.87	0.08	0.07	1.41

Allowable Outflow
13.49 l/s

0.53 Effective C

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
 Client: Providence Lifestyle Village
 Location: Southern Basin
 Designer: SRA



T _c (min)	T _c (hr)	I (mm/hr)	Q _{IN} (L/s)	V _{IN} (m ³)	Preliminary height (m)	Q _{OUT} (soakage) (L/s)	V _{OUT} (soakage) (m ³)	Net storage (after soakage) (m ³)	Time of water in basin (hr)	V _{OUT} required (m ³)	Q _{OUT} (L/s)
10	0.17	38.90	153	92	0.30	0.0	0	92	0.7	0	0.0
15	0.25	31.50	124	111	0.30	0.0	0	111	0.8	0	0.0
20	0.33	26.80	105	126	0.30	0.0	0	126	1.0	0	0.0
30	0.50	21.10	83	149	0.30	0.0	0	149	1.1	0	0.0
45	0.75	16.69	65	177	0.30	0.0	0	177	1.3	22	8.3
60	1.00	13.70	54	193	0.30	0.0	0	193	1.5	39	10.8
90	1.50	10.70	42	227	0.30	0.0	0	226	1.7	72	13.3
120	2.00	8.90	35	251	0.30	0.0	0	251	1.9	97	13.4
150	2.50	7.74	30	273	0.30	0.0	0	273	2.1	119	13.2
180	3.00	6.90	27	292	0.30	0.0	0	292	2.2	138	12.7
240	4.00	5.87	23	331	0.30	0.0	0	331	2.5	176	12.3
300	5.00	5.05	20	357	0.30	0.0	1	356	2.7	202	11.2
360	6.00	4.46	17	378	0.30	0.0	1	377	2.9	223	10.3
480	8.00	3.77	15	426	0.30	0.0	1	425	3.2	271	9.4
720	12.00	2.84	11	481	0.30	0.0	1	480	3.6	326	7.5
960	16.00	2.39	9	539	0.30	0.0	2	538	4.1	383	6.7
1440	24.00	1.76	7	596	0.30	0.0	2	594	4.5	440	5.1
2880	48.00	1.07	4	725	0.30	0.0	5	720	5.5	566	3.3
4320	72.00	0.80	3	809	0.30	0.0	7	802	6.1	647	2.5

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Southern Basin
Designer: SRA



Calculation of storage in above ground basin

Lower tier drainage basin dimensions:
Side slopes 1: Length (m) Breadth (m)
0 44 5.5

RL (Base)

Area at TWL				Treatment storage above		The designated height allows storage for
TWL (mAHD)	Height (m)	Area (m ²)	Average area	Volume (m ³)	LWL (m ³)	
24.9	0	242	968	0	0	Static water level
25.36	0.46	242	968	111	111	First 15mm
25.4	0.5	242	968	121	121	Top of Lower Tier

TOTAL STORAGE TO TOP OF LOWER TIER 121 m³

Middle tier drainage basin dimensions:
Side Slopes 1: Length (m) Breadth (m)
6 44 5.5

RL (Base)

Total depth to				Area at TWL		Total storage above LWL	The Designated Height allows Storage for
TWL (mAHD)	Height (m)	TWL (m)	Area (m ²)	Average area	Volume (m ³)		
25.4	0	0.5	242	968	0	121	Bottom of Middle Tier
25.52	0.12	0.62	315	1113	33	154	1EY
25.62	0.22	0.72	380	1236	68	189	20% AEP
25.68	0.28	0.78	420	1312	92	213	10% AEP
26	0.6	1.1	650	1733	262	383	1% AEP
26.1	0.7	1.2	728	1870	331	452	Top of Middle Tier
TOTAL STORAGE TO TOP OF MIDDLE TIER				452	m ³		

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Haynes Lifestyle Village, Gray Road Haynes
Client: Providence Lifestyle Village
Location: Southern Basin
Designer: SRA



Outflow Configuration

Weir Level: 25.5 mAHD

Flow over Weir (Low ARI Storms)

$Q = 1.84 \times L \times (H)^{1.5}$

L : width of weir
H: height of weir

Q (m ³ /sec)	L (m)	H (m)	TWL	TWL for Storage	Difference	1EY 20% AEP 10% AEP 1% AEP
0.013	0.50	0.06	25.56	25.52	0.04	
0.037	0.50	0.12	25.62	25.62	0.00	
0.048	0.50	0.14	25.64	25.68	-0.04	
0.079	0.50	0.19	25.69	26.00	-0.31	

Flow through Orifice (For 100 year ARI Storms)

$Q = C_D \cdot A_o \cdot \text{Sqrt}(19.62 \cdot dH)$

Cd= 0.61

Q (m ³ /sec)	Width of Hole (mm)	Depth of Hole (mm)	Ao (sqm)	Equiv Dia(mm)	dH(m)	Allowable DH
0.079	163	163	0.026569	184	1.2124686	1% AEP 1.200

APPENDIX D – GEOTECHNICAL REPORT

Report on
GEOTECHNICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
LOTS 46 & 47 GRAY ROAD, HAYNES

Submitted to:

Serenitas
c/- McDowall Affleck Pty Ltd
69 Great Northern Highway
MIDLAND WA 6056

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50 Edward Street
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3. Project Objectives	1
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FIGURE

FIGURE 1:	SITE AND LOCATION PLAN
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APPENDICES

APPENDIX A:	CONCEPT SKETCH
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APPENDIX G:	UNDERSTANDING YOUR REPORT

1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics Pty Ltd's (Galt's) geotechnical study for the proposed residential development at Lots 46 and 47 Gray Road, Haynes ("the site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site is irregular in shape and covers a plan area of 3.96 hectares. The site is occupied by a house to the north-east. It is generally covered in grass and there are a few scattered trees with areas of concrete slabs and paving, mostly in the central portion of site but also scattered in the eastern half of site. Other building rubble and metal rebar is also scattered across the site. The Neerigen Brook is located along the southern boundary.

Published contour mapping shows the site surface levels fall from RL 30 m AHD to the east to RL 26 m AHD to the west.

Historically the site comprised cultivated land/market gardens. We further note that the western portion of the site was previously used by an earthworks contractor for a site compound during the early stages of the adjacent Springtime Riverside residential development to the south-west.

The supplied concept sketch indicates the development will comprise a subdivision of about 76 lots with associated access roads. The average subdivided lot size is indicated as 260 m². A drainage basin will probably be located near the south-west corner. The concept sketch is presented in Appendix A and is also superimposed on a recent aerial photograph of the site in Figure 1.

3. PROJECT OBJECTIVES

The objectives of the study were to:

- ✦ assess subsurface soil and groundwater conditions across the site;
- ✦ provide a site classification(s) in accordance with AS 2870-2011 "Residential Slabs and Footings";
- ✦ provide recommendations and geotechnical design parameters for earth retaining structures;
- ✦ recommend appropriate site preparation procedures including compaction and approved fill criteria;
- ✦ provide recommendations for excavations and slopes;
- ✦ assess the permeability of the soils at the site for potential on-site disposal of stormwater by infiltration; and
- ✦ provide a subgrade California bearing ratio (CBR) value for pavement thickness design by others.

4. FIELDWORK

Fieldwork was carried out on 18 & 19 June 2020 and comprised of:

- ✦ A walkover and inspection of the site;
- ✦ drilling of machine auger boreholes at 12 locations (BH01 to BH12) extending to depths of between 2.2 m and 2.5 m;
- ✦ testing with a dynamic cone penetrometer (DCP) adjacent to each borehole extending to depths of between 0.2 m and 1.8 m;
- ✦ infiltration testing using the 'inverse auger hole' method at 4 locations at depths of between 0.54 m and 0.81 m below ground level; and
- ✦ collection of samples for laboratory testing.

General

Our geotechnical engineer selected and located the test locations, drilled the boreholes, logged the materials encountered in the boreholes, performed the infiltration testing and penetrometer testing and collected samples for laboratory testing.

The investigation was carried out in general accordance with AS1726-2017 “Geotechnical site investigations”.

The approximate test locations are shown on Figure 1, Site and Location Plan and details. Photographs of the site are presented in Appendix B

Boreholes

Boreholes were drilled using a utility mounted EVH Scout 1750 drill rig equipped with a 90 mm nominal diameter solid auger and a V bit. The drill rig was supplied and operated by Galt. Borehole reports along with a list of notes and abbreviations and the method of soil description used on the reports are presented in Appendix C. Photographs of the core recovered from each borehole are presented below each report. A summary of the boreholes is presented in Table 1.

Table 1: Summary of Tests

Test Name	Test Depth (m)	Depth to Groundwater (m)	Reason for Termination	Stratigraphy
BH01	2.5	NE	Target Depth	FILL: Sandy GRAVEL over Clayey SAND over Sandy CLAY
BH02	2.4			
BH03	2.4			
BH04	2.4			
BH05	2.4			
BH06	2.4	0.3		SAND over Clayey SAND over Sandy CLAY
				Silty SAND over Sandy CLAY
BH07	2.2	NE	Refusal	FILL: GRAVEL, over SAND over Silty SAND over Sandy CLAY
BH08	2.5	2.4	Target Depth	SAND over Sandy CLAY
BH09	2.5	NE		SAND over Clayey SAND over Sandy CLAY
BH10	2.5			
BH11	2.4			
BH12	2.5	1.6		

Notes: 1. NE – Not encountered
2. Possible fill is present in the upper part of BH08 to BH12

Dynamic Cone Penetrometer Tests

DCP tests were carried out in accordance with AS 1289.6.3.2. Tests were carried out adjacent to each borehole and the results of the tests are presented in Appendix D.

Infiltration Tests

Infiltration tests were undertaken using the ‘inverse auger hole’ method described by Cocks¹. The results of the infiltration testing are presented in Appendix E and are summarised in Table 2.

¹ Cocks, G (2007), “Disposal of Stormwater Runoff by Soakage in Perth Western Australia”, Journal and News of the Australian Geomechanics Society, Volume 42 No. 3, pp 101-114.

Table 2: Summary of Infiltration Test Results

Test Name	Pipe Embedment (m)	Soil Description	Minimum Unsaturated Hydraulic Conductivity ¹ , k (m/day)		
			Test 1	Test 2	Test 3
BH01/IT01	0.76	Clayey SAND	2.6	2.4	2.4
BH04/IT02	0.64	Clayey SAND	2.9	2.6	2.5
BH09/IT03	0.54	SAND over Sandy CLAY	4.8	4.3	4.0
BH11/IT04	0.81	SAND/Silty SAND over Sandy CLAY	0.4	-	-

Note: 1. Tests 2 & 3 were not conducted at BH11/IT04 due to very slow infiltration rates
2. Refer to Section 7.10 for further commentary on infiltration testing.

5. LABORATORY TEST RESULTS

Laboratory testing was conducted by Western Geotechnical and Laboratory Services, a NATA accredited laboratory. The testing comprised determination of:

- ✦ particle size distribution on 4 samples;
- ✦ Atterberg limits and linear shrinkage on 4 samples;
- ✦ dry density-moisture content relationship using Modified compactive effort on 2 sample; and
- ✦ soaked California bearing ratio (CBR) on 2 remoulded sample;

The laboratory test results are presented in Appendix E along with the test methods followed and a summary of the test results is presented in Table 3.

Table 3: Summary of Laboratory Test Results

Test Name	Sample Depth (m)	Soil Class AS1726 2017	% Gravel	% Sand	% Fines	LL (%)	PI (%)	LS (%)	MMDD (t/m ³)	OMC (%)	CBR (%)	CBR Swell (%)
BH02	0.2 – 0.6	Clayey SAND (SC)	-	68	32	23	12	5.5	2.06	9.5	19	0
BH04	1.0 – 1.5	Clayey Sandy GRAVEL (GC)	36	34	30	44	26	11.0	-	-	-	-
BH07	0.2 – 0.5	SAND (SP)	-	98	2	NO	NP	0.0	1.92	12.0	25	0.0
BH12	1.05	Clayey SAND (SC)	24	42	34	41	24	10.0	-	-	-	-

Notes: LL – Liquid Limit PI – Plasticity Index LS – Linear Shrinkage NO – Not Obtainable NP – Non plastic
MMDD – Maximum Modified Dry Density OMC – Optimum Moisture Content
CBR – California Bearing Ratio (sample prepared to 95% MMDD with 4.5 kg surcharge and 4 day soak)

6. SOIL CONDITIONS

6.1 Geology

The Armadale sheet of the 1:50,000 scale Environmental Geology series map indicates that the area is underlain by SANDY CLAY – white grey to brown, fine to coarse grained, subangular to rounded sand, clay of moderate plasticity, gravel and silt layers near scarp.

The findings of our investigation are generally consistent with the geological mapping. The main exceptions are the thin layers of fill and sand above the clayey soils.

6.2 Subsurface Conditions

The subsurface conditions are somewhat variable, however can generally be summarised by the following profile:

- ✦ FILL: SAND/Gravelly SAND/Sandy GRAVEL: variable proportions of sand and medium grained, angular crushed igneous rock, present from ground surface and extending to depths ranging from 0.1 m to 0.2 m; overlying;
- ✦ SAND/Silty SAND (SP/SM): fine to coarse grained, grey-white to grey-brown, trace to with non-plastic fines, variable moisture content, loose to medium dense, extending to depths ranging from 0.5 m to 1.0 m; overlying
- ✦ Clayey SAND (SC): fine to coarse grained, grey, with about 15% to 30% low plasticity fines, moist, typically medium dense/stiff, extending to depths ranging from 0.5 m to 1.8 m; overlying
- ✦ Sandy CLAY (CI): medium plasticity, variable combinations of orange-brown and grey, with 30-50% fine to coarse grained sand, with fine to medium grained gravel, moist, typically stiff or harder, extending to the maximum investigated depth of 2.5 m.

Variations

For the specific soil descriptions and stratigraphy at each test location, reference must be made to the borehole reports in Attachment C.

Some variations to the general profile above include:

- ✦ No SAND/Silty SAND in BH01 to BH04.
- ✦ Silty SAND extending from 1.0 m to 1.8 m in BH07.
- ✦ Clayey Sandy GRAVEL (wet) in place of Sandy CLAY (moist) in BH04. This higher gravel and sand content of this material appears to have allowed stormwater to infiltrate deeper into the soil profile in this area.

6.3 Groundwater

The Perth Groundwater Atlas (1997) shows the maximum groundwater level is close to the current ground levels.

Groundwater was encountered in the boreholes at the following locations and depths:

- ✦ BH06 – 0.3 m.
- ✦ BH08 – 2.4 m.
- ✦ BH12 – 1.6 m.

The groundwater generally appears to be stormwater runoff that has perched on the in-situ clayey soils.

7. GEOTECHNICAL ASSESSMENT

7.1 Site Classification

We consider the site is geotechnical capable of supporting the proposed residential development.

We have assessed the site classification for the site in accordance with AS 2870-2011 “Residential Slabs and Footings”. In its current condition, we consider that the site is “Class P”. We consider that the site classification can be improved to a Class S or Class A site provided that:

- ✦ The following minimum thickness of inert granular fill is present above the in-situ clayey soils:
 - Class S – minimum 0.6 m.
 - Class A – minimum 1.8 m.
- ✦ Suitable drainage control measures are in place to ensure the in-situ clayey soils do not become saturated.
- ✦ Our recommended site preparation guidelines in Section 7.4 are followed.

7.2 Construction Issues and Drainage

We note that shallow clayey soils are present at the site and our site observations are that storm-water runoff has perched on these clayey soils in some areas of the site. We note that shallow perched groundwater may cause difficulties during construction including:

- ✦ heaving and rutting of saturated silty/clayey soils when trafficked; and
- ✦ softening of silty/clayey soils when water is allowed to pond at the base of excavations.

Based on the above, we recommend that:

- ✦ earthworks are carried out in the summer months, although we note that earthworks conducted in summer may face other issues such as dust control and rapid drying out of soils;
- ✦ clayey soil horizons are shaped to drain towards drainage systems;
- ✦ site levels are raised with free draining, structural fill; and
- ✦ subsoil drains are used where required to provide adequate drainage away from structures.

As discussed in Section 7.10, notwithstanding the infiltration test results showing that the clayey sand at the site is moderately permeable, we do not consider that any long-term infiltration capacity should be assumed for clayey soils at the site.

7.3 Dewatering

We note that some limited dewatering may be required during construction particularly where deep excavations are made into the soil profile during the wetter times of the year.

Where significant groundwater inflows are encountered, we consider that dewatering will be achieved by shaping the base of excavations to a perimeter drain and/or sump and removing the water with a pump.

7.4 Site Preparation

The site preparation measures outlined below are aimed at the general preparation of the site prior to the construction of buildings and pavements. Landscaped areas will not require this preparation.

The following site preparation measures must be followed:

- ✦ Demolish existing house if required and remove the associated debris. All buried structures, rubbish, concrete and service connections must also be removed. Given the significant concrete present on site, processing and reuse as general fill may be possible as per the advice in Section 7.7.

- ✦ Remove the surface grass and any vegetation, including grubbing out of roots. In general, we expect that a 100 mm strip is adequate for most of the site. However locally deeper stripping and excavation may be required particularly where trees are present.
- ✦ Strip the upper SAND/Silty SAND and stockpile, exposing the underlying Clayey SAND/Sandy CLAY. The thickness of uncontrolled sand fill typically ranges from about 0.1 m to 0.3 m over most of the site.
- ✦ Moisture condition and compact the exposed ground, to achieve the level of compaction specified in Section 7.4 to a depth of at least 0.3 m. Areas that do not respond to compaction (i.e. areas that rut or heave), will require over-excavation and replacement with approved compacted fill in accordance with Section 7.6.
- ✦ Excavations into in-situ clayey soils must be backfilled in an engineered manner with similar clayey soil (minimum 30% fines). This is to prevent storm water run-off potentially infiltrating granular backfill and perching on and softening the in-situ clayey soils.
- ✦ Grade the surface to drain – typically a minimum grade of 1% is considered acceptable.
- ✦ Where fill is required, use approved fill, placed and compacted in layers no greater than 0.3 m loose thickness. Each layer must be placed and compacted to achieve the minimum level of compaction specified in Section 7.6. The minimum required density in Section 7.6 must be achieved to a depth of at least 0.9 m below slabs and footings.

7.5 Excavations and Slopes

Boreholes were drilled with a utility mounted EVH Scout 1750 drill rig equipped with a 90 mm diameter solid auger. The auger drilling generally progressed with ease through the upper sand/silty sand and reduced to a slow to moderate rate through the deeper clayey soils.

We consider that excavations in the in-situ sandy and clayey soils will be readily achieved to a depth of about 2 m using standard earthmoving equipment (i.e. 10 tonne or larger excavator). Deeper excavations will likely require a larger 20 to 30 tonne excavator equipped with a rock bucket.

We note that some limited dewatering may be required during construction particularly where deep excavations are made into the soil profile during the wetter times of the year.

Where significant groundwater inflows are encountered, we consider that dewatering will be achieved by shaping the base of excavations to a perimeter drain and/or sump and removing the water with a pump.

Excavations in the upper SAND/Silty SAND/Clayey SAND at the site must be battered at slopes no steeper than 1V:2H for temporary slopes and 1:3H for permanent slopes above the water table. Even at these slopes angles, erosion and rilling is likely to occur especially during significant rainfall events. In the underlying Sandy CLAY, slopes should be no steeper than 1V:1H above the water table (for temporary slopes open less than a week). Surcharges (such as plant and soil stockpiles) must not be placed at or near the crest of excavations.

A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

7.6 Compaction

Approved granular fill and the *in situ* sands must be compacted using suitable compaction equipment to achieve a dry density ratio (DDR) of at least 95% MMDD (maximum modified dry density) as determined in accordance with AS 1289.5.2.1 at a moisture content within 2% of optimum moisture content (OMC).

Where clean sand (<15% gravel, <5% fines) is used as fill, a Perth sand penetrometer (PSP) may be used for compaction control in accordance with AS 1289.6.3.3. As a preliminary guide, the following minimum blow counts may be assumed to correspond to a dry density ratio of 95% MMDD:

- ✦ Depth range 0 m to 0.15 m: SET
- ✦ Depth range 0.15 m to 0.45 m: 8 blows
- ✦ Depth range 0.45 m to 0.75 m: 10 blows
- ✦ Depth range 0.75 m to 1.05 m: 12 blows (or 6 blows for depth range 0.75 m to 0.9 m)

We recommend that an on-site PSP correlation is undertaken to determine the PSP blow count correlating to a DDR of 95% MMDD. The correlation must:

- ✦ be done on site;
- ✦ use the nuclear density gauge (NDG) to determine density at a minimum of 5 points with varying density to a depth of 300 mm below surface;
- ✦ include at least 1 point where the dry density ratio is in excess of 95% MMDD;
- ✦ use a calibrated PSP to determine the PSP blow count from 150 mm to 450 mm at each of the NDG test points; and
- ✦ be plotted on a chart of PSP blow count vs DDR.

Clayey soils (Clayey SAND/Sandy CLAY with fines content > 30%) must be moisture conditioned within 2% of optimum moisture content (OMC) and compacted using suitable compaction equipment to a minimum dry density ratio of 95% SMDD (standard maximum dry density) as determined in accordance with AS 1289.5.1.1.

Compaction testing of in-situ soils or site derived fill containing a fines content greater than 5% and/or gravel content 15% must be done using a nuclear density gauge (NDG) in accordance with AS 1289.5.8.1.

Over-excavation and replacement of loose materials must be done where the minimum dry density ratio cannot be achieved.

Granular fill must be placed and compacted in horizontal layers of not greater than 300 mm loose thickness while clayey fill must be placed and compacted in layers no greater than 250 mm loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken when compacting in the vicinity of existing structures, such as adjacent properties. This is particularly important if vibratory compaction is being carried out. Tynan (1973)² provides guidance on the selection of compaction equipment for use adjacent to structures.

Large compaction equipment (self-propelled vibrating rollers, etc.) must not be used within 2 m behind retaining walls. Hand compaction plant (e.g. plate compactors) must be used.

Compaction must be verified by testing:

- ✦ at the base of excavations to a minimum depth of 0.45 m for sand or 0.3 m for clayey soil;
- ✦ through the full thickness of any fill; and
- ✦ to a minimum depth of 0.9 m below slabs, footings and pavements.

² Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australia Road Research Board, Special Report No. 11.

The frequency of testing should be as follows:

- ✦ on each lift of fill at the rate of 1 test per 500 m³ or 1 test per 1,000 m² whichever is greater;
- ✦ at each spread footing location;
- ✦ at 10 m centres along gravity retaining wall footings and strip footings; and
- ✦ at 15 m centres below on-ground slabs and pavements.

Further to this, we recommend footings be inspected by a geotechnical engineer prior to blinding.

7.7 Approved Fill

Imported granular fill must comply with the material requirements as stated in AS 3798-2007, "Guidelines on Earthworks for Commercial and Residential Developments".

We recommend the use of quarry-derived, clean imported sand (<5% fines (<0.075 mm) and <1% organics) for bulk filling of the site.

The in-situ sand and silty sand is generally suitable for re-use as low permeability inert granular fill, provided that any over-sized materials (> 0.2 m in diameter) or large putrescible particles (large fragments of wood, metal, household rubbish) are removed.

We recommend that reuse of the lower clayey sand/sandy clay is generally limited to shaping the clayey horizon and/or backfilling deep excavations in the clayey profile to prevent stormwater runoff infiltrating the backfilled excavation. Reuse as structural fill is not recommended as:

- ✦ the materials will likely be difficult to moisture condition and compact; and
- ✦ there will likely be adverse implications on site classification and drainage if used as structural fill.

Rather than disposing the existing concrete on site, it may be possible to crush down the concrete to achieve a suitable material for reuse as general fill. This would generally involve crushing the material down to a maximum particle size of 200 mm and blending with a suitable proportion of sand to fill all voids between the concrete particles.

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

7.8 Retaining Structures

Retaining structures may be designed in accordance with AS 4678-2002 "Earth-Retaining Structures". Imported granular fill that conforms to the requirements outlined in Section 7.7 must be used for gravity retaining wall backfill i.e. imported free draining sand fill with less than 5% fines.

The following parameters are appropriate for in-situ sand and approved granular fill that is compacted to the requirements of Section 7.6.

- ✦ Angle of internal friction, $\phi = 35^\circ$
- ✦ Coefficient of active earth pressure $K_a = 0.27$
- ✦ Coefficient of passive earth pressure $K_p = 3.90$
- ✦ At rest coefficient of earth pressure $K_0 = 0.43$
- ✦ Bulk unit weight: 18 kN/m^3 above the water table

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

It is important to note that some ground movement is to be expected behind any soil retaining system, including gravity retaining walls.

Unless a suitable drainage layer is placed behind the wall such that a build-up of pore pressure is prevented, the retaining wall must be designed to accommodate water pressure behind the wall (10 kPa per metre height).

7.9 Pavement Subgrades

We consider that a subgrade design California bearing ratio of 5% may be assumed provided that the site preparation guidelines in Section 7.4 are carried out on the subgrade prior to construction of the pavement and adequate drainage control measures are in place to ensure the subgrade remains well drained in service.

We consider that the subgrade design CBR can be improved to the following values with the following minimum thicknesses of select granular fill above the clayey soils (Clayey SAND/Sandy CLAY)

- ✦ CBR 10% - minimum 0.3 m sand (minimum CBR 10%, CBR swell < 0.5%).
- ✦ CBR 15% - minimum 0.5 m sand (minimum CBR 15%, CBR swell < 0.5%).

Where pavements are boxed into the clayey subgrade, it is essential that the pavement is properly sealed and provided with subsoil drainage to ensure that stormwater runoff or groundwater cannot infiltrate the formation.

7.10 Stormwater Disposal

Based on the infiltration test results we note that:

- ✦ The upper sand/silty sand (which has an almost negligible thickness) will probably have an unsaturated hydraulic conductivity in the range of about 0.5 to 2.0 m/day when compacted.
- ✦ The lower clayey sand/sandy clay will have a very low hydraulic conductivity and should be modelled as impermeable.

We note that the residential development in the area have involved placement of a significant thickness of permeable structural sand fill (typically in the order of 1.5 m to 2.0 m). We consider that on-site disposal of stormwater by infiltration using soakwells may be suitable for the site provided that:

- ✦ A minimum 1.2 m of permeable approved sand fill is present above any clayey soil horizon.
- ✦ The bases of soak wells are at least 0.3 m above any clayey soil horizon.

The hydraulic conductivity of any imported sand fill must be confirmed prior to use.

Soak wells should be placed outside a line of 1V:2H extending below the edge of the nearest footing subject to local council regulations. Discharge from soak wells has been known to promote densification of loose sandy soils, leading to settlements of footings and slabs. Soak wells should be carefully wrapped with geotextile to prevent migration of sand and fines into the soak well.

8. CLOSURE

We draw your attention to Appendix G of this report, “Understanding your Report”. The information provided within is intended to inform you as to what your realistic expectations of this report should be. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

A handwritten signature in black ink, appearing to read 'Harry Chambers'.

Harry Chambers

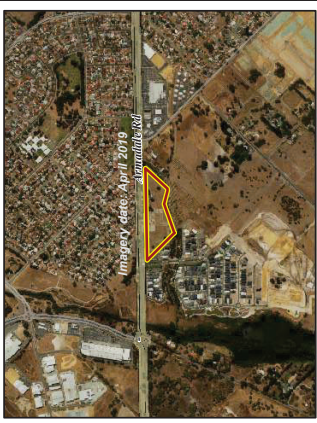
Geotechnical Engineer

A handwritten signature in black ink, appearing to read 'Owen Woodland'.

Owen Woodland CPEng

Geotechnical Engineer

O:\Jobs\2020\J2001129 - MAPL SI Gray Rd Haynes\03 Correspondence\J2001129 001 R Rev1.docx



- Legend**
- Site Boundary
 - ◆ Borehole
 - ◆ Borehole / Infiltration Test



NOTES
Aerial Imagery and Cadastre sourced from Landgate/SUP

SCALE	1:2,000	(A3)
DRAWN	DAC	
DATE DRAWN	3/07/2020	
CHECKED	HWC	
DATE CHECKED	3/07/2020	
PROJECTION	GDA 1994 MGA Zone 50	



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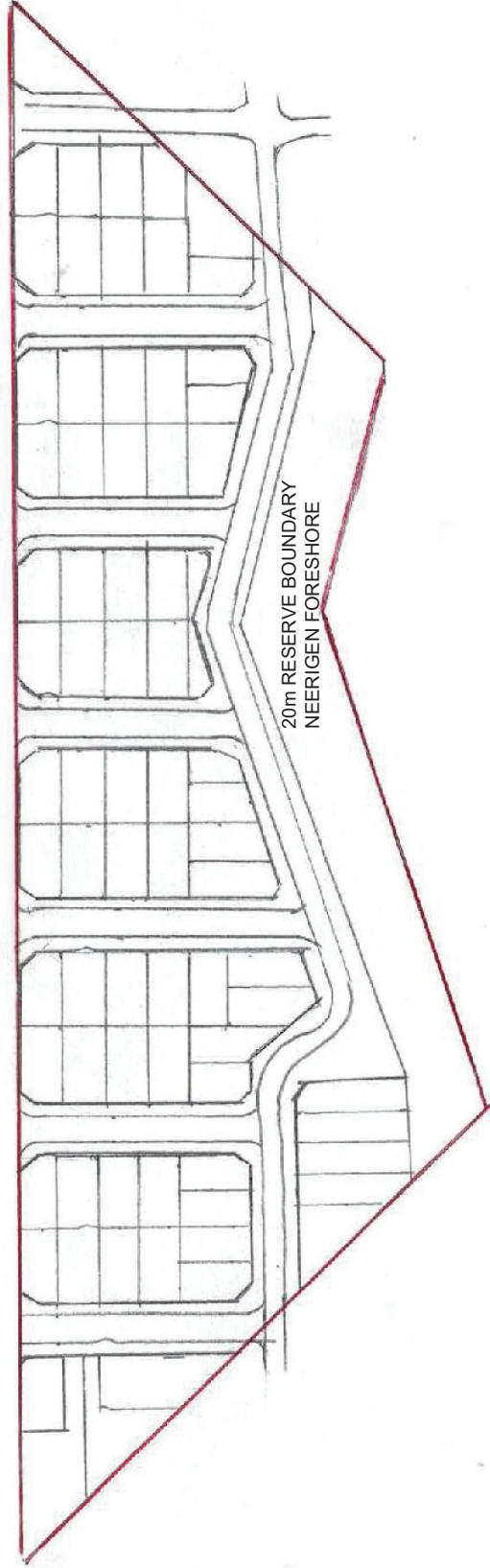
CLIENT	SERENITAS
PROJECT	PROPOSED RESIDENTIAL DEVELOPMENT
LOCATION	LOTS 46 AND 47 GRAY ROAD HAYNES

TITLE	SITE & LOCATION PLAN
JOB No	J2001129
Fig No	FIGURE 1
Rev	A



Appendix A: Concept Sketch

BOUNDARY



GRAY RD SUBDIVISION SKETCH

76 PROPOSED SITES

TYPICAL SITE SIZE 12m x 21.5m

AVERAGE SITE SIZE 260m²

SCALE 1:2000



Appendix B: Site Photographs



Photograph 1: General view of the site to the west



Photograph 2: Concrete slabs (possible strip footings) on the western side of the site



Photograph 3: Various concrete slabs and household furniture near the centre of the site



Photograph 4: General view near existing house on the eastern side of the site



Photograph 5: General view of proposed Neerigen Foreshore along the southern boundary



Photograph 6: View of existing Neerigen Brook along the southern boundary

Appendix C: Borehole Reports

METHOD OF SOIL DESCRIPTION BOREHOLE AND TEST PIT REPORTS



GRAPHIC LOG & SOIL CLASSIFICATION SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES / BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	GM	Silty GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

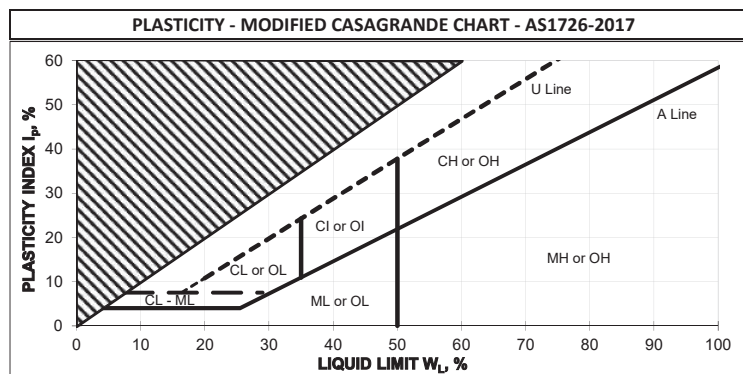
NOTE: Dual classification given for soils with a fines content between 5% and 12%.

SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-2017. Material properties are assessed in the field by visual/tactile methods in combination with field and laboratory testing techniques (where used).

NOTE: AS 1726-2017 defines a fine grained soil where the total dry mass of fine fractions (<0.075 mm particle size) exceeds 35%.

PARTICLE SIZE		
Soil Name	Particle Size (mm)	
BOULDERS	>200	
COBBLES	63 to 200	
GRAVEL	Coarse	19 to 63
	Medium	6.7 to 19
	Fine	2.3 to 6.7
SAND	Coarse	0.6 to 2.36
	Medium	0.21 to 0.6
	Fine	0.075 to 0.21
FINES	SILT	0.002 to 0.075
	CLAY	<0.002



RESISTANCE TO EXCAVATION		
Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

MOISTURE CONDITION	
Symbol	Term
D	Dry
M	Moist
W	Wet

CEMENTATION	
Cementation	Description
Weakly cemented	Soil may be easily disaggregated by hand in air or water
Moderately cemented	Effort is required to disaggregate the soil by hand in air or water

CONSISTENCY		
Symbol	Term	Undrained Shear Strength (kPa)
VS	Very Soft	0 to 12
S	Soft	12 to 25
F	Firm	25 to 50
St	Stiff	50 to 100
VSt	Very Stiff	100 to 200
H	Hard	>200

ORGANIC SOILS	
Material	Organic Content % of dry mass
Inorganic soil	<2%
Organic soil	2% to 25%
Peat	>25%

DENSITY		
Symbol	Term	Density Index (%)
VL	Very Loose	<15
L	Loose	15 to 35
MD	Medium Dense	35 to 65
D	Dense	65 to 85
VD	Very Dense	>85

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS



METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

▶	Water Inflow	▼	Water Level
◀	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

$$TCR = \text{Total Core Recovery (\%)} = \frac{CRL}{TCL} \times 100$$

$$RQD = \text{Rock Quality Designation (\%)} = \frac{ALC > 100}{TCL} \times 100$$

TCL Length of Core Run

CRL Length of Core Recovered

ALC>100 Total Length of Axial Lengths of Core Greater than 100 mm Long

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 19/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY
ADV	m		0.0				SP	FILL: Gravely SAND, fine to coarse grained, sub-angular to sub-rounded, grey brown, 30-40% fine to coarse grained gravel, with fines, trace organics	D	Density inferred from DCP
			0.5				SC	Clayey SAND: fine to coarse grained, grey, 10-20% low plasticity fines	M	L - MD
			1.0					Sandy CLAY: medium plasticity, red-brown, 40-50% fine to coarse grained sand, trace gravel	St	
			1.5				CI		D - M	
			2.0					Slight increase in gravel content		
			2.5					Hole terminated at 2.50 m Target depth Groundwater not encountered		

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 19/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADV	E		0.0					GP	FILL: Sandy GRAVEL, medium to coarse grained, angular to sub-angular, blue grey, 30-40% fine to coarse grained sand, brown, with fines, trace organics		L		Density inferred from DCP
			0.5		B(BH02-1)			SC	Clayey SAND: fine to coarse grained, grey, with about 30% low plasticity fines		F - St		
			1.0		B(BH02-2)				Sandy CLAY: medium plasticity, orange brown, 45-55% fine to coarse grained sand, trace gravel		St		
			1.5					CI			D - M		
			2.5						Hole terminated at 2.40 m Target depth Groundwater not encountered				

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 19/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY
ADV	E		0.0				GP	FILL: Sandy GRAVEL, medium to coarse grained crushed igneous rock, angular to sub-rounded, blue grey, 30-40% fine to coarse grained sand, brown, trace fines, trace organics		Density inferred from DCP
			0.5		B(BH03-1)		SC	Clayey SAND: fine to coarse grained, grey, 10-20% low plasticity fines	L - MD	
			1.0					Sandy CLAY: medium plasticity, yellow, 40-50% fine to coarse grained sand	F - St	
	F		1.5				CI	becoming low to medium plasticity, red-brown, trace gravel (<5%) with gravel (15-20%)	D - M	
			2.5					Hole terminated at 2.40 m Target depth Groundwater not encountered		

Sketch & Other Observations



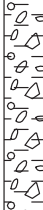
Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 18/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADV	E		0.0					GP	FILL: Sandy GRAVEL, medium to coarse grained, angular to sub-angular, blue grey, 30-40% fine to coarse grained sand, brown, trace fines, trace organics	M	L - MD		Density inferred from DCP
			0.5			SC	Clayey SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown, 10-25% low plasticity fines						
			1.0	B(BH04-1)		GC	Clayey Sandy GRAVEL: fine to medium grained, orange-brown, approximately 30-40% fine to coarse grained sand, approximately 30% medium plasticity fines						
			1.5							W			
			2.0							D			
			2.5						Hole terminated at 2.40 m Target depth Groundwater not encountered				

Sketch & Other Observations



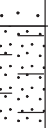
Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 18/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADV	E		0.0					SP	FILL: Gravelly SAND, fine to coarse grained, sub-angular to sub-rounded, grey brown, 30-50% medium to coarse grained gravel (crushed igneous rock), trace fines trace organics				Density inferred from DCP
							SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown, with fines, trace gravel			L - MD		
			0.5				SC	Clayey SAND: fine to coarse grained, grey, 20-30% low plasticity fines			D - M		
	1.0					CI	Sandy CLAY: medium plasticity, orange brown to red, 40-50% fine to coarse grained sand, trace gravel			F - St			
	1.5							VSt					
	F	2.0						Slight increase in gravel content			D		
		2.5							Hole terminated at 2.40 m Target depth Groundwater not encountered				

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129	Contractor: Galt	Date: 19/06/2020
Client: Serenitas	Drill Rig: EVH Scout 1750	Logged: PA
Project: Proposed Residential Development	Inclination: -90°	Checked Date: 02/07/2020
Location: Lots 46 & 47 Gray Road, Haynes		Checked By: HWC

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY
ADV	E		0.0					SAND: fine to coarse grained, sub-angular to sub-rounded, grey, trace fines, trace organics in top 100 mm	M-W	L
			0.5				SP	Clayey SAND: fine to coarse grained, grey, 10-20% low plasticity fines		MD
			1.0				SC	Sandy CLAY: medium plasticity, brown, 40-50% fine to coarse grained sand, trace gravel		F
			1.5				Cl			St
			2.0							
			2.5					Hole terminated at 2.40 m Target depth Groundwater encountered at 0.3 m		

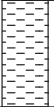
Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129	Contractor: Galt	Date: 18/06/2020
Client: Serenitas	Drill Rig: EVH Scout 1750	Logged: PA
Project: Proposed Residential Development	Inclination: -90°	Checked Date: 02/07/2020
Location: Lots 46 & 47 Gray Road, Haynes		Checked By: HWC

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADV	E		0.0					SP	FILL: GRAVEL, medium grained, angular, grey, inferred crushed igneous rock aggregate	D - M	L - MD		Density inferred from DCP
				B(BH07-1)				SAND: fine to coarse grained, sub-angular to sub-rounded, brown grey, trace fines					
			0.5	B(BH07-2)			SP						
	1.0					SM	Silty SAND: fine to coarse grained, brown, 10-20% non-plastic fines						
	2.0					CL	Sandy CLAY: low plasticity, orange brown, 50-60% fine to coarse grained sand, trace gravel (<5%)	D					
	F-H								Hole terminated at 2.20 m Refusal Groundwater not encountered				
			2.5										

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 18/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
ADV	E		0.0				SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown (white from 0.1 to 0.2 m), with fines, trace gravel	D - M	L - MD	Density inferred from DCP
			0.5								
			1.0				Cl	Sandy CLAY: medium plasticity, orange brown, 40-50% fine to coarse grained sand, trace gravel	F - St		
			1.5					M			
			2.0								
			2.5						W		
								Hole terminated at 2.50 m Target depth Groundwater encountered at 2.4 m			

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 18/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY
ADV	m		0.0				SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown (white from 0.1 to 0.2 m), with fines, trace gravel, possible fill		L
			0.5					Sandy CLAY: medium plasticity, orange brown, 40-50% fine to coarse grained sand, trace gravel	D - M	
			1.0						St - VSt	
			1.5				CI		M	
			2.0							
			2.5						W	
								Hole terminated at 2.50 m Target depth Groundwater not encountered		

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129
Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 & 47 Gray Road, Haynes

Contractor: Galt
Drill Rig: EVH Scout 1750
Inclination: -90°

Date: 18/06/2020
Logged: PA
Checked Date: 02/07/2020
Checked By: HWC

Drilling				Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY
ADV	E		0.0				SP	SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown, with fines, trace organics, trace gravel	M	L - MD
			0.5		B(BH10-1)		SC	Clayey SAND: fine to coarse grained, grey, 10-20% low to medium plasticity fines, trace gravel (<5%)		
			1.0					Sandy CLAY: low to medium plasticity, orange brown, 40-50% sand, trace gravel (<5%)	D - M	St - VSt
	F		2.0				CL - CI	low plasticity fines, trace gravel (5-10%)		
			2.5					Hole terminated at 2.50 m Target depth Groundwater not encountered		

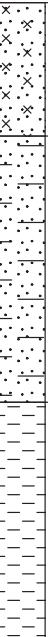
Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129	Contractor: Galt	Date: 18/06/2020
Client: Serenitas	Drill Rig: EVH Scout 1750	Logged: PA
Project: Proposed Residential Development	Inclination: -90°	Checked Date: 02/07/2020
Location: Lots 46 & 47 Gray Road, Haynes		Checked By: HWC

Drilling				Sampling		Field Material Description							
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY	DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/V	E		0.0					SM-SP	Silty SAND/SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown, with non-plastic fines, trace gravel, possible fill	D - M	D		Density inferred from DCP
			0.5						Sandy CLAY/Clayey SAND: fine to coarse grained, grey mottled orange, 30-40% low to medium plasticity fines				
	F		1.0		B(BH11-1)			SC/CI	Sandy CLAY/Clayey SAND: fine to coarse grained, grey mottled orange, 30-40% low to medium plasticity fines	M			
	1.5							CI	Sandy CLAY: medium plasticity, orange brown, 50-60% fine to coarse grained sand, trace gravel				
			2.0										
			2.5						Hole terminated at 2.40 m Target depth Groundwater not encountered				

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Job Number: J2001129	Contractor: Galt	Date: 18/06/2020
Client: Serenitas	Drill Rig: EVH Scout 1750	Logged: PA
Project: Proposed Residential Development	Inclination: -90°	Checked Date: 02/07/2020
Location: Lots 46 & 47 Gray Road, Haynes		Checked By: HWC

Drilling				Sampling				Field Material Description			
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	SOIL CLASS	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY
ADV	m		0.0						SAND: fine to coarse grained, sub-angular to sub-rounded, grey brown, trace fines, trace gravel, trace organics, possible fill	D - M	D
			0.5					SP			
			1.0		B(BH12-1)			SM	Silty SAND: fine to coarse grained, grey, 10-20% non-plastic to low plasticity fines	M	
			1.5					CI/SC	Clayey SAND/Sandy CLAY: medium plasticity, orange brown, 30-40% fine to coarse grained sand, with fine to medium grained gravel	M - W	
			2.0								
			2.5								
									Hole terminated at 2.50 m Target depth Groundwater encountered at 1.6 m		

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

Appendix D: Dynamic Cone Penetrometer Test Results

DYNAMIC CONE PENETROMETER FIELD TEST DATA
(AS 1289.6.3.2)

Client: Serenitas
Project: Proposed Residential Development
Location: Lots 46 and 47 Gray Road, Haynes

Job No: J2001129
Date: 18-Jun-20
Engineer: PA



Test No:	DCP01	DCP02	DCP03	DCP04	DCP05	DCP06	DCP07	DCP08	DCP09
Location:	BH01	BH02	BH03	BH04	BH05	BH06	BH07	BH08	BH09
Depth (mm)	No of Penetrometer Blows per 100 mm Depth Interval								
0-100	1	1	1	2	1	2	1	1	1
100-200	4	6	3	3	3	1	1	2	2
200-300	3	4	3	3	2	2	3	2	2
300-400	5	4	3	2	2	3	2	2	2
400-500	2	3	2	1	2	3	1	3	3
500-600	1	3	1	2	6	3	2	2	4
600-700	2	3	2	5	2	3	7	3	5
700-800	10+	3	3	8	2	1	8	2	5
800-900		2	3	10+	5	2	4	2	6
900-1000		10	4		3	4	3	3	7
1000-1100			4		2	4	2	5	
1100-1200					2		2		
1200-1300					3		2		
1300-1400					2		3		
1400-1500					6		4		
1500-1600					7		2 HB		
1600-1700					6				
1700-1800					6				
1800-1900									

Test No:	DCP10	DCP11	DCP12						
Location:	BH10	BH11	BH12						
Depth (mm)	No of Penetrometer Blows per 100 mm Depth Interval								
0-100	1	9	1						
100-200	2	10+	6						
200-300	2		9						
300-400	2		10						
400-500	2		10+						
500-600	3								
600-700	2								
700-800	2								
800-900	2								
900-1000	5								
1000-1100	6								
1100-1200									
1200-1300									
1300-1400									
1400-1500									
1500-1600									
1600-1700									
1700-1800									

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2
HB: Hammer bounce (refusal)
0 = Penetration due to hammer weight only
R: Refusal

Appendix E: Infiltration Test Results

Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics	Spreadsheet author:	ORW	17-Oct-09
Job No: J2001129	Client: Serenitas		
Project: Residential Development	Location: Gray Road, Haynes		
Calc by: PA			
BH Name: BH01/IT01			
Test Depth: 0.76 m			

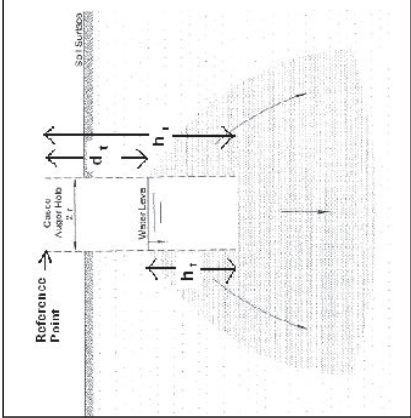
$$K = 1.15r \frac{\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)}{t - t_0}$$

REFERENCE: Cocks, G. Disposal of Stormwater Runoff by Soakage in Perth Western Australia. Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp 101-114

Parameter	Description	Value	Units
K	Permeability		m/s
r	radius of test hole	0.05	m
t	time since start of measurement		s
h _r	reference point height above base	1.14	m
d _t	depth from reference point to water at time t		m
h _t	Water column height at time t		m
h ₀	h _t at t=0		m

Spreadsheet Legend

Required input	
Calculated field	
Comment field	
Field not used	
Fixed field	



Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.38	0.76	1.7E-04	14.7
20	0.48	0.66	9.9E-05	8.5
40	0.495	0.645	7.2E-05	6.2
60	0.505	0.635	5.7E-05	4.9
80	0.51	0.63	4.7E-05	4.1
100	0.515	0.625	4.1E-05	3.5
120	0.52	0.62	3.6E-05	3.1
140	0.525	0.615	3.3E-05	2.9
160	0.53	0.61	3.1E-05	2.6
180	0.535	0.605		
AVERAGE			6.5E-05	5.6

Test 2

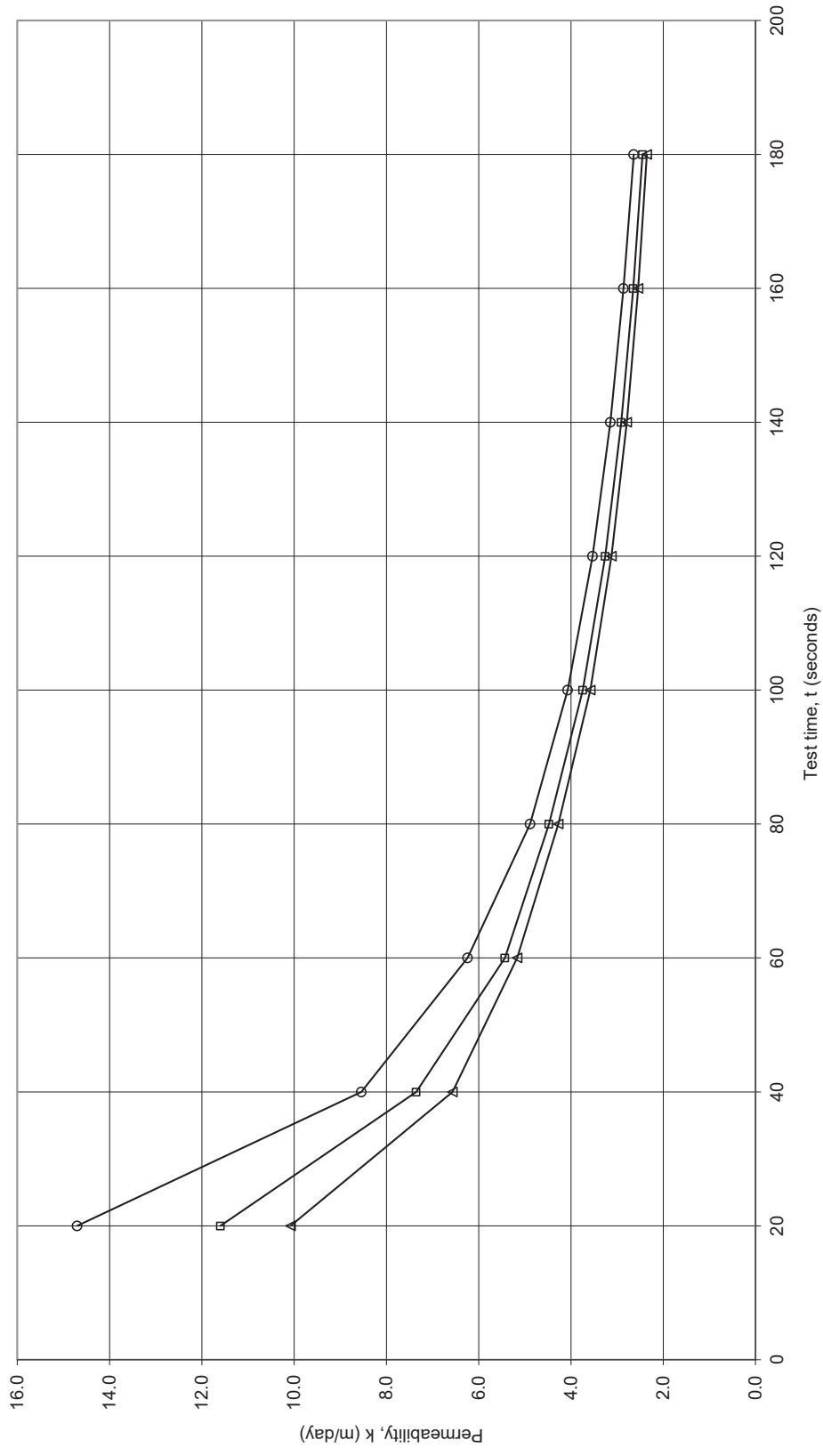
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.38	0.76	1.3E-04	11.6
20	0.46	0.68	8.5E-05	7.4
40	0.48	0.66	6.3E-05	5.4
60	0.49	0.65	5.2E-05	4.5
80	0.5	0.64	4.3E-05	3.7
100	0.505	0.635	3.8E-05	3.3
120	0.51	0.63	3.4E-05	2.9
140	0.515	0.625	3.1E-05	2.6
160	0.52	0.62	2.8E-05	2.4
180	0.525	0.615		
AVERAGE			5.6E-05	4.9

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.38	0.76	1.2E-04	10.1
20	0.45	0.69	7.6E-05	6.6
40	0.47	0.67	6.0E-05	5.2
60	0.485	0.655	4.9E-05	4.3
80	0.495	0.645	4.1E-05	3.6
100	0.5	0.64	3.6E-05	3.1
120	0.505	0.635	3.2E-05	2.8
140	0.51	0.63	2.9E-05	2.5
160	0.515	0.625	2.7E-05	2.4
180	0.52	0.62		
AVERAGE			5.2E-05	4.5

Permeability by Inverse Auger Hole Method

BH01/IT01



Permeability Calculation - Inverse Auger Hole Method

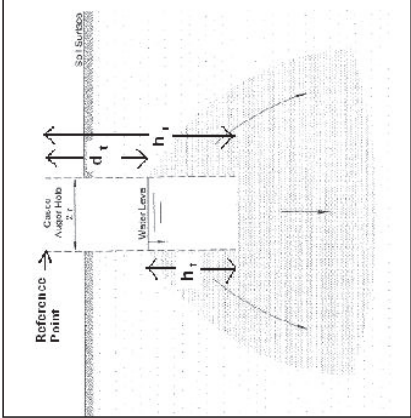
Galt Geotechnics	Spreadsheet author:	ORW	17-Oct-09	
Job No: J2001129	Client: Serenitas			
Project: Residential Development	$\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)$$K = 1.15r$$t - t_0$			
Location: Gray Road, Haynes				
Calc by: PA				
BH Name: BH04/IT02				
Test Depth: 0.64				
m				
K = 1.15r				
$\log_{10}(h_0 + \frac{1}{2}r) - \log_{10}(h_t + \frac{1}{2}r)$				
t - t ₀				
REFERENCE: Cocks, G. <i>Disposal of Stormwater Runoff by Soakage in Perth Western Australia</i> , Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114				

REFERENCE: Cocks, G. Disposal of Stormwater Runoff by Soakage in Perth Western Australia. Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp 101-114

Parameter	Description	Value	Units
K	Permeability		m/s
r	radius of test hole	0.05	m
t	time since start of measurement		s
h _r	reference point height above base	1.14	m
d _t	depth from reference point to water at time t		m
h _t	Water column height at time t		m
h ₀	h _t at t=0		m

Spreadsheet Legend

Required input
Calculated field
Comment field
Field not used
Fixed field



Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.5	0.64	1.6E-04	13.8
20	0.58	0.56	1.0E-04	8.8
40	0.6	0.54	7.5E-05	6.5
60	0.61	0.53	6.2E-05	5.4
80	0.62	0.52	5.4E-05	4.7
100	0.63	0.51	4.7E-05	4.1
120	0.635	0.505	4.2E-05	3.6
140	0.64	0.5	2.5E-05	2.2
160	0.6	0.54	3.4E-05	2.9
180	0.645	0.495		
AVERAGE			6.7E-05	5.8

Test 2

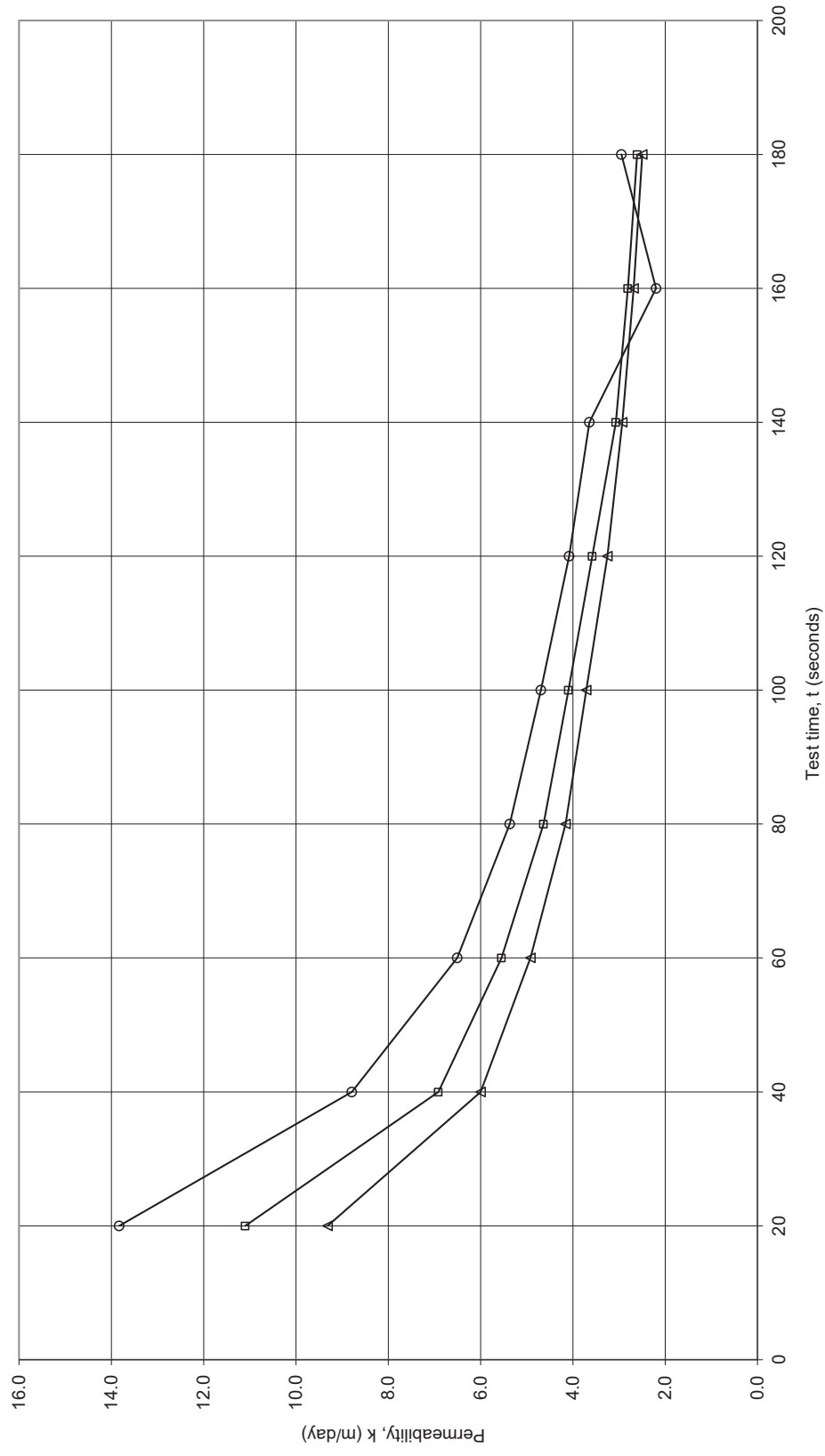
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.5	0.64	1.3E-04	11.1
20	0.565	0.575	8.0E-05	6.9
40	0.58	0.56	6.4E-05	5.5
60	0.595	0.545	5.4E-05	4.6
80	0.605	0.535	4.7E-05	4.1
100	0.615	0.525	4.1E-05	3.6
120	0.62	0.52	3.5E-05	3.1
140	0.62	0.52	3.2E-05	2.8
160	0.625	0.515	3.0E-05	2.6
180	0.63	0.51		
AVERAGE			5.7E-05	4.9

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.5	0.64	1.1E-04	9.3
20	0.555	0.585	6.9E-05	6.0
40	0.57	0.57	5.7E-05	4.9
60	0.585	0.555	4.8E-05	4.2
80	0.595	0.545	4.3E-05	3.7
100	0.605	0.535	3.8E-05	3.3
120	0.61	0.53	3.4E-05	2.9
140	0.615	0.525	3.1E-05	2.7
160	0.62	0.52	2.9E-05	2.5
180	0.625	0.515		
AVERAGE			5.1E-05	4.4

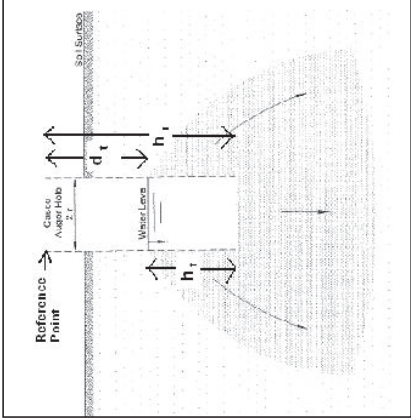
Permeability by Inverse Auger Hole Method

BH04/IT02



Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics		Spreadsheet author:	ORW	17-Oct-09
Job No: J2001129				
Client: Serenitas				
Project: Residential Development				
Location: Gray Road, Haynes				
Calc by: PA				
BH Name: BH09/IT03				
Test Depth: 0.54				
m				
Spreadsheet Legend				
Required input				
Calculated field				
Comment field				
Field not used				
Fixed field				
Parameter		Description		
K		Permeability		
r		radius of test hole		
t		time since start of measurement		
h _r		reference point height above base		
d _t		depth from reference point to water at time t		
h _t		Water column height at time t		
h ₀		h _t at t=0		
K = 1.15r		$\log_{10}(\frac{1}{2}r + h_0) - \log_{10}(\frac{1}{2}r + h_t)$		
		t - t ₀		
REFERENCE: Cocks, G. Disposal of Stormwater Runoff by Soakage in Perth Western Australia. Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp101-114				



Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.6	0.54		
20	0.74	0.4	3.6E-04	30.7
40	0.75	0.39	1.9E-04	16.6
60	0.76	0.38	1.4E-04	12.0
80	0.765	0.375	1.1E-04	9.3
100	0.765	0.375	8.6E-05	7.5
120	0.77	0.37	7.4E-05	6.4
140	0.775	0.365	6.6E-05	5.7
160	0.78	0.36	6.0E-05	5.2
180	0.785	0.355	5.5E-05	4.8
AVERAGE			1.3E-04	10.9

Test 2

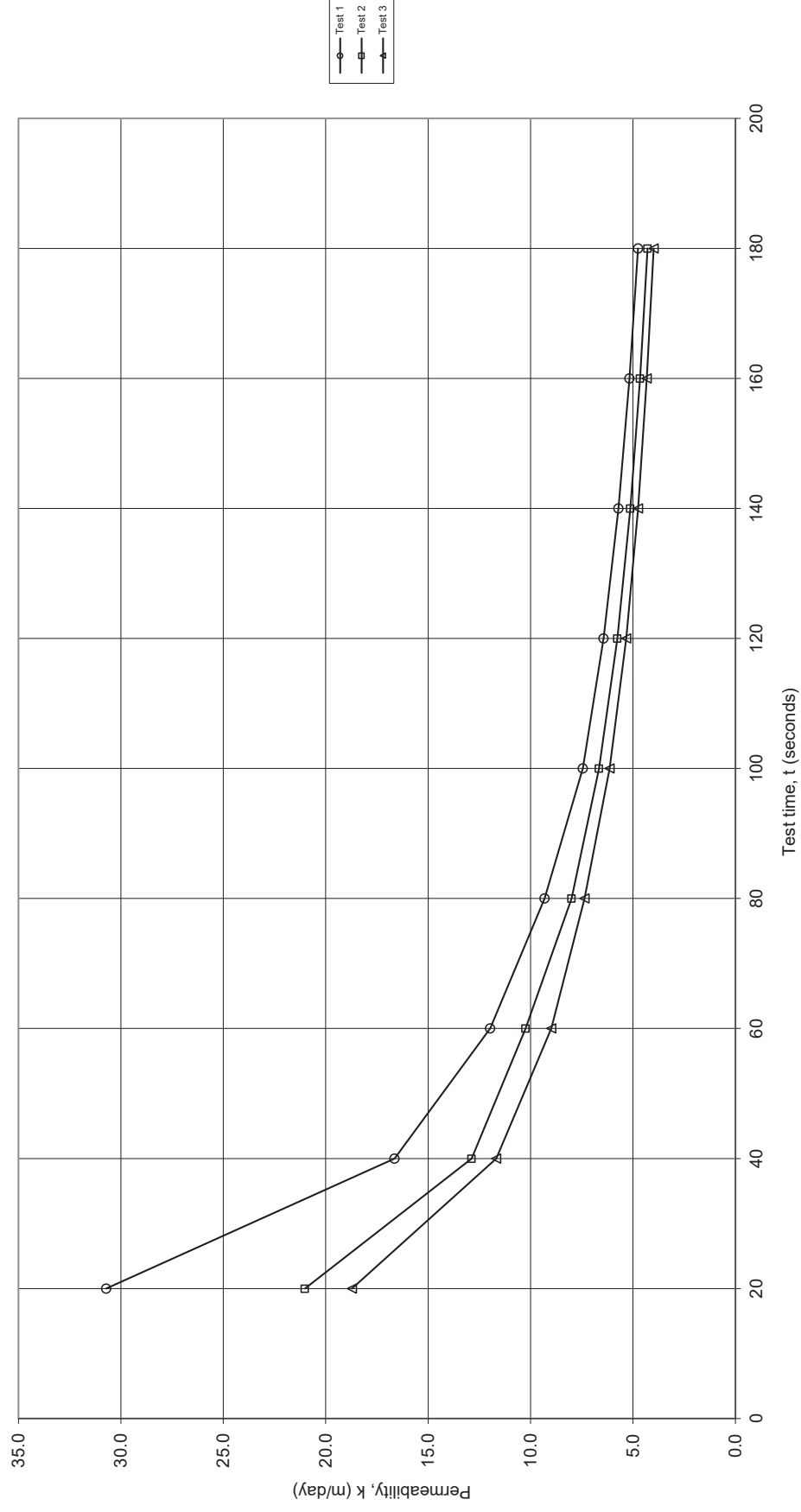
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.6	0.54		
20	0.7	0.44	2.4E-04	21.0
40	0.72	0.42	1.5E-04	12.9
60	0.74	0.4	1.2E-04	10.2
80	0.745	0.395	9.3E-05	8.0
100	0.75	0.39	7.7E-05	6.7
120	0.755	0.385	6.7E-05	5.8
140	0.76	0.38	5.9E-05	5.1
160	0.765	0.375	5.4E-05	4.7
180	0.77	0.37	5.0E-05	4.3
AVERAGE			1.0E-04	8.7

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.6	0.54		
20	0.69	0.45	2.2E-04	18.7
40	0.71	0.43	1.4E-04	11.7
60	0.725	0.415	1.0E-04	9.0
80	0.735	0.405	8.5E-05	7.4
100	0.74	0.4	7.1E-05	6.1
120	0.745	0.395	6.2E-05	5.3
140	0.75	0.39	5.5E-05	4.8
160	0.755	0.385	5.0E-05	4.3
180	0.76	0.38	4.6E-05	4.0
AVERAGE			9.2E-05	7.9

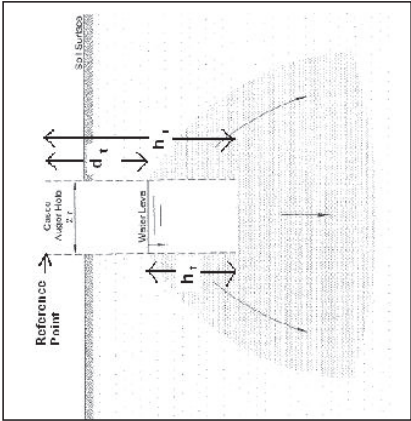
Permeability by Inverse Auger Hole Method

BH09/IT03



Permeability Calculation - Inverse Auger Hole Method

Galt Geotechnics		Spreadsheet author:	ORW	17-Oct-09
Job No: J2001129		Client: Serenitas		
Project: Residential Development		$\log_{10}\left(h_0 + \frac{1}{2}r\right) - \log_{10}\left(h_t + \frac{1}{2}r\right)$		
Location: Gray Road, Haynes		$K = 1.15r \frac{t - t_0}{t - t_0}$		
Calc by: PA		REFERENCE: Cocks, G. Disposal of Stormwater Runoff by Soakage in Perth Western Australia. Journal and News of the Australian Geomechanics Society, Volume 42 No 3 September 2007, pp 101-114		
BH Name: BH11/IT04		Parameter	Description	Value
Test Depth: 0.81 m		K	Permeability	m/s
Spreadsheet Legend		r	radius of test hole	0.05 m
		t	time since start of measurement	s
		h _r	reference point height above base	1.14 m
		d _t	depth from reference point to water at time t	m
		h _t	Water column height at time t	m
		h ₀	h _t at t=0	m



Test 1

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0	0.33	0.81		
20	0.35	0.79	3.0E-05	2.6
40	0.36	0.78	2.3E-05	2.0
60	0.36	0.78	1.5E-05	1.3
80	0.36	0.78	1.1E-05	1.0
100	0.36	0.78	9.1E-06	0.8
120	0.36	0.78	7.6E-06	0.7
140	0.36	0.78	6.5E-06	0.6
160	0.36	0.78	5.7E-06	0.5
180	0.36	0.78	5.1E-06	0.4
AVERAGE			1.3E-05	1.1

Test 2

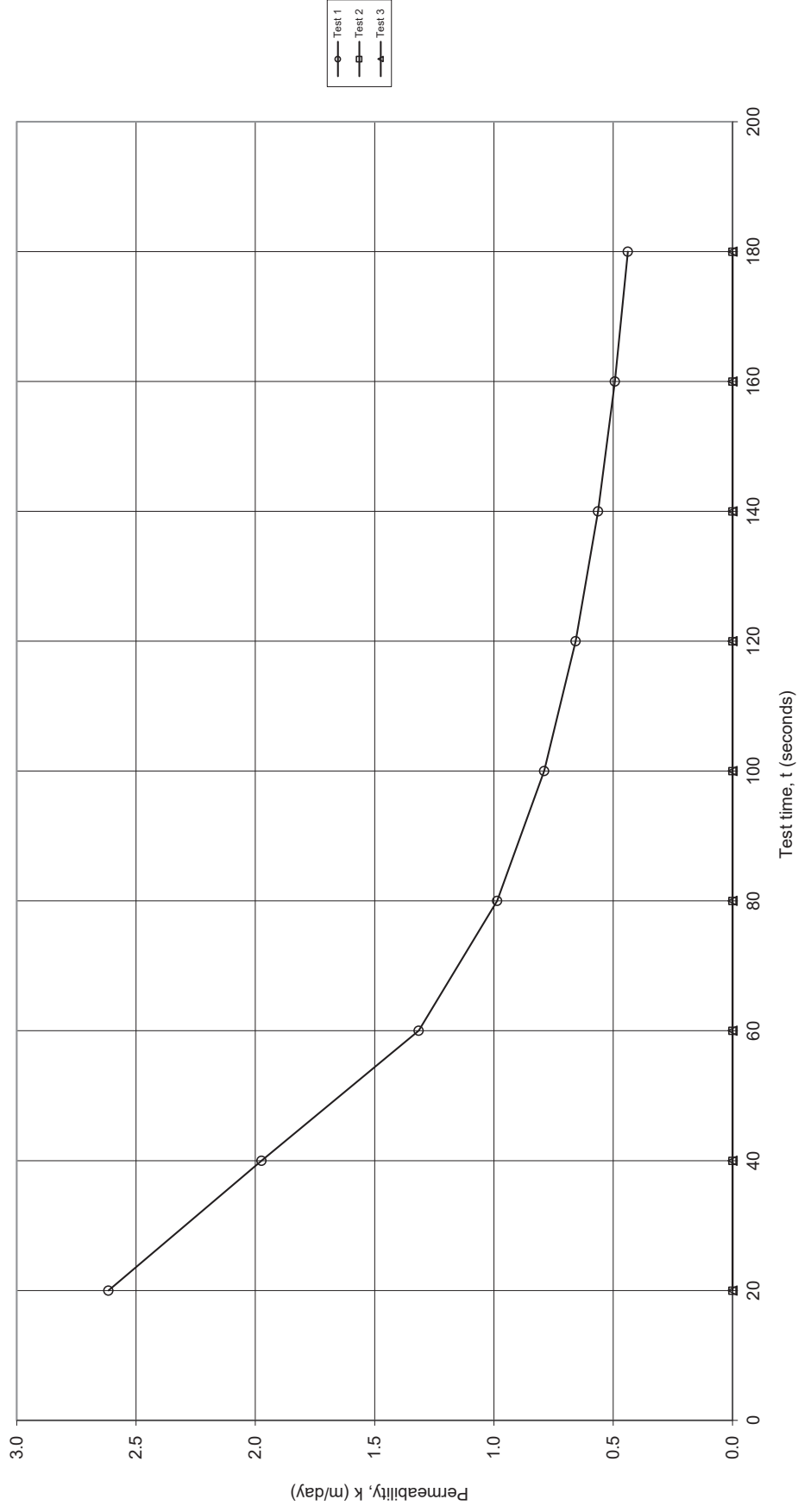
t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0				
20				
40				
60				
80				
100				
120				
140				
160				
180				
AVERAGE			#DIV/0!	#DIV/0!

Test 3

t (s)	d _w (m)	h _t (m)	K (m/s)	K (m/day)
0				
20				
40				
60				
80				
100				
120				
140				
160				
180				
AVERAGE			#DIV/0!	#DIV/0!

Permeability by Inverse Auger Hole Method

BH111/IT04



Appendix F: Laboratory Test Results



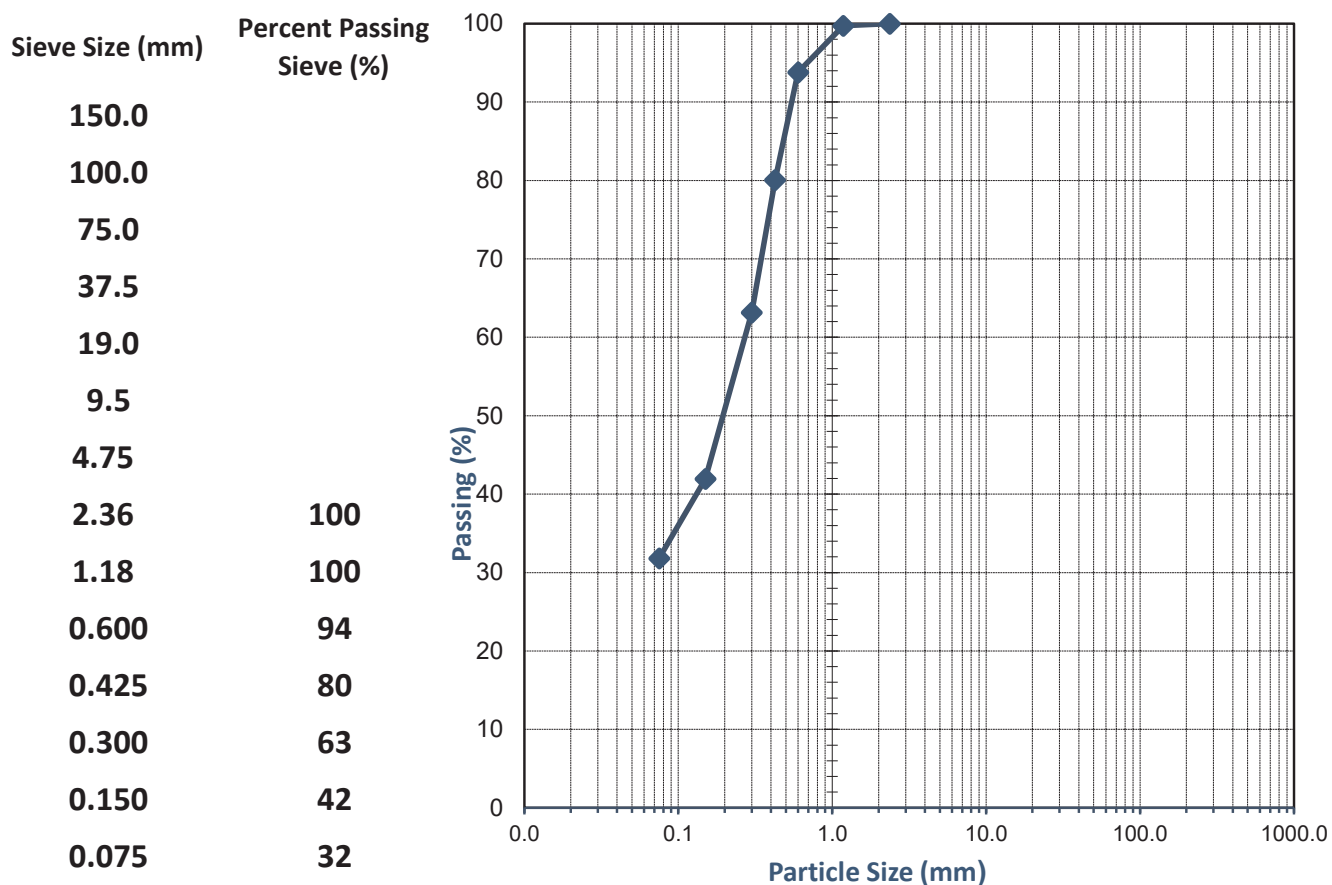
TEST REPORT - AS 1289.3.6.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7000_1_PSD
Project:	Proposed Residential Development	Sample No.	WG20/7000
Location:	Lots 46 & 47 Gray Road, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH02 0.2-0.6m	Date Tested:	26-06-2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 02-July-2020



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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7000_1_PI
Project:	Proposed Residential Development	Sample No.	WG20/7000
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH02 0.2 - 0.6m	Date Tested:	29-06-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	Sampled by Client, Tested as Received
History of Sample:	Oven Dried <50°C
Method of Preparation:	Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	23
AS 1289.3.2.1	Plastic Limit (%)	11
AS 1289.3.3.1	Plasticity Index (%)	12
AS 1289.3.4.1	Linear Shrinkage (%)	5.5
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	-

Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 30-June-2020



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7000_1_MMDD
Project:	Proposed Residential Development	Sample No.	WG20/7000
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH02 0.2 - 0.6m	Date Tested:	26-06-2020

TEST RESULTS - Modified Maximum Dry Density

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time:

24 Hours

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%):

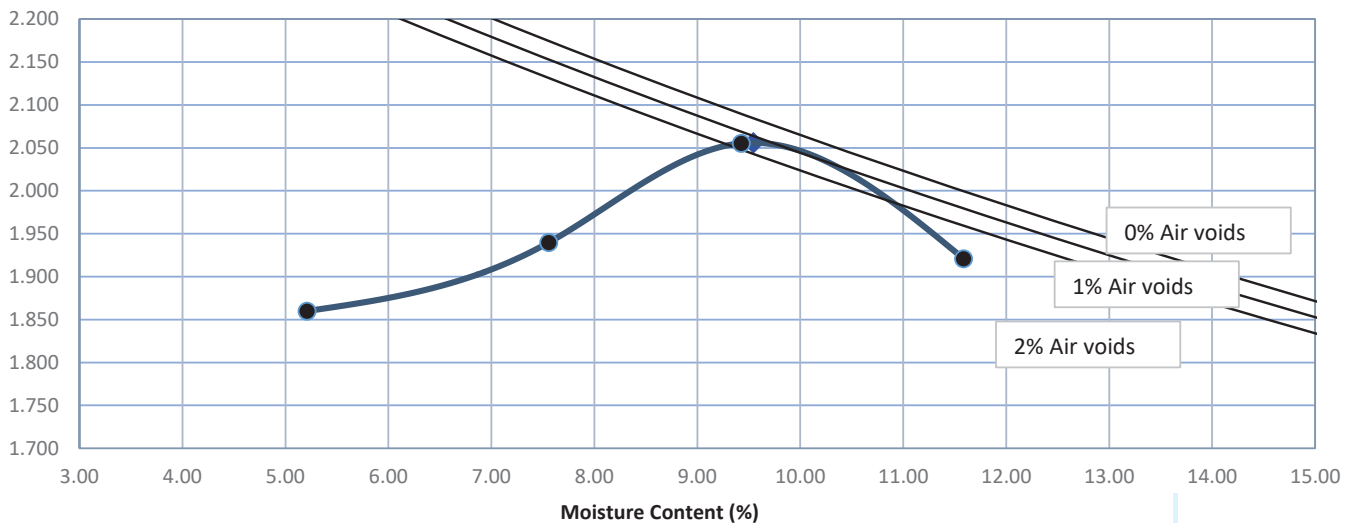
0

Material + 37.5mm (%):

-

Moisture Content (%)	5.2	7.6	9.4	11.6	
Dry Density (t/m ³)	1.860	1.940	2.055	1.921	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

2.06

Optimum Moisture Content (%)

9.5

Comments: The above air void lines are derived from a calculated apparent particle density of 2.602 t/m³

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 28-June-2020



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.6.1.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7000_1_SCBR
Project:	Proposed Residential Development	Sample No.	WG20/7000
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH02 0.2 - 0.6m	Date Tested:	2-07-2020

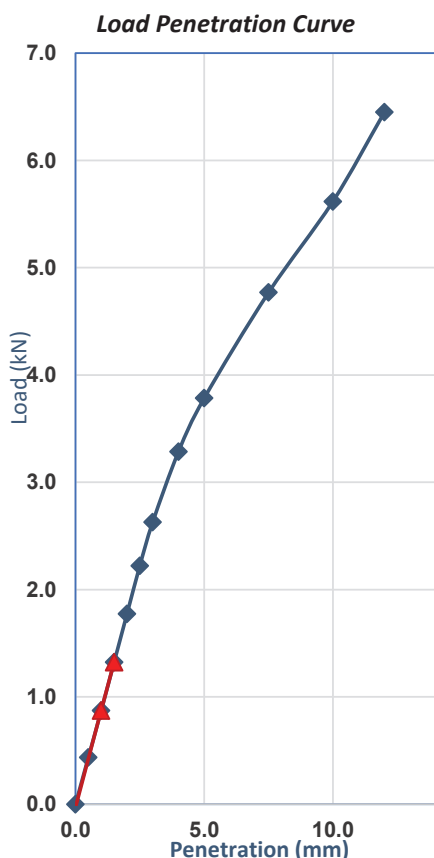
TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description:

Sandy Clay

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details

Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	24 Hours
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m ³)	2.06	Optimum Moisture (%)	9.5
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction

Dry Density (t/m ³)	1.96	Moisture Content (%)	9.7
Density Ratio (%)	95.0	Moisture Ratio (%)	102.0

Specimen Conditions After Soak

Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	9.00	Measured Swell (%)	0.0
Dry Density (t/m ³)	1.96	Dry Density Ratio (%)	95.0
Moisture Content (%)	11.7	Moisture Ratio (%)	123.0

Specimen Conditions After Test

Top 30mm Moisture (%)	10.7	Remaining Depth (%)	10.4
-----------------------	------	---------------------	------

Correction applied to Penetration: 0mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 19%

Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 03-July-2020



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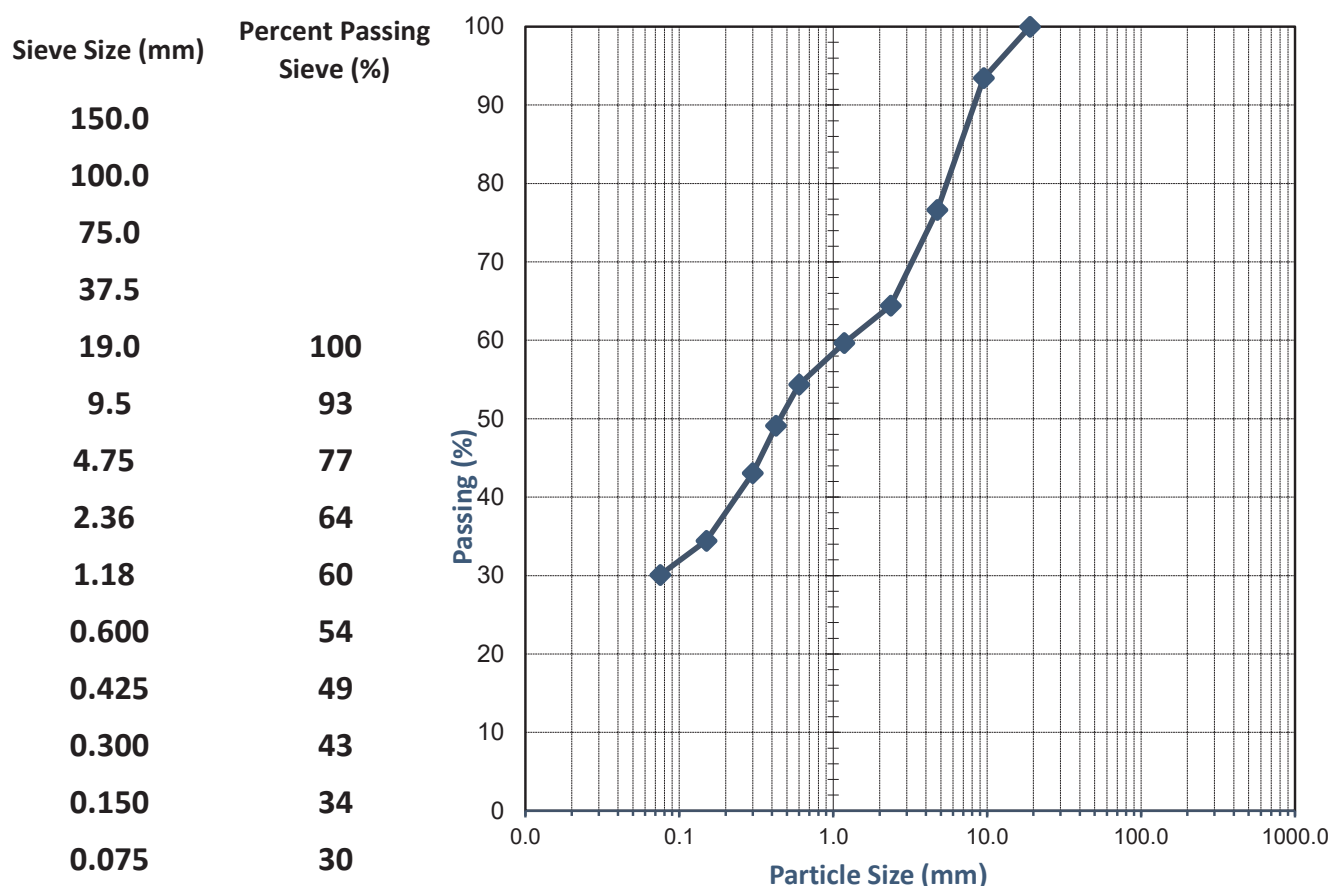
TEST REPORT - AS 1289.3.6.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7001_1_PSD
Project:	Proposed Residential Development	Sample No.	WG20/7001
Location:	Lots 46 & 47 Gray Road, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH04 1.0-1.5m	Date Tested:	26-06-2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 30-June-2020



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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	McDowwall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7001_1_PI
Project:	Proposed Residential Development	Sample No.	WG20/7001
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH04 1.0 - 1.5m	Date Tested:	29-06-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	Sampled by Client, Tested as Received
History of Sample:	Oven Dried <50°C
Method of Preparation:	Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	44
AS 1289.3.2.1	Plastic Limit (%)	18
AS 1289.3.3.1	Plasticity Index (%)	26
AS 1289.3.4.1	Linear Shrinkage (%)	11.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	-

Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 30-June-2020



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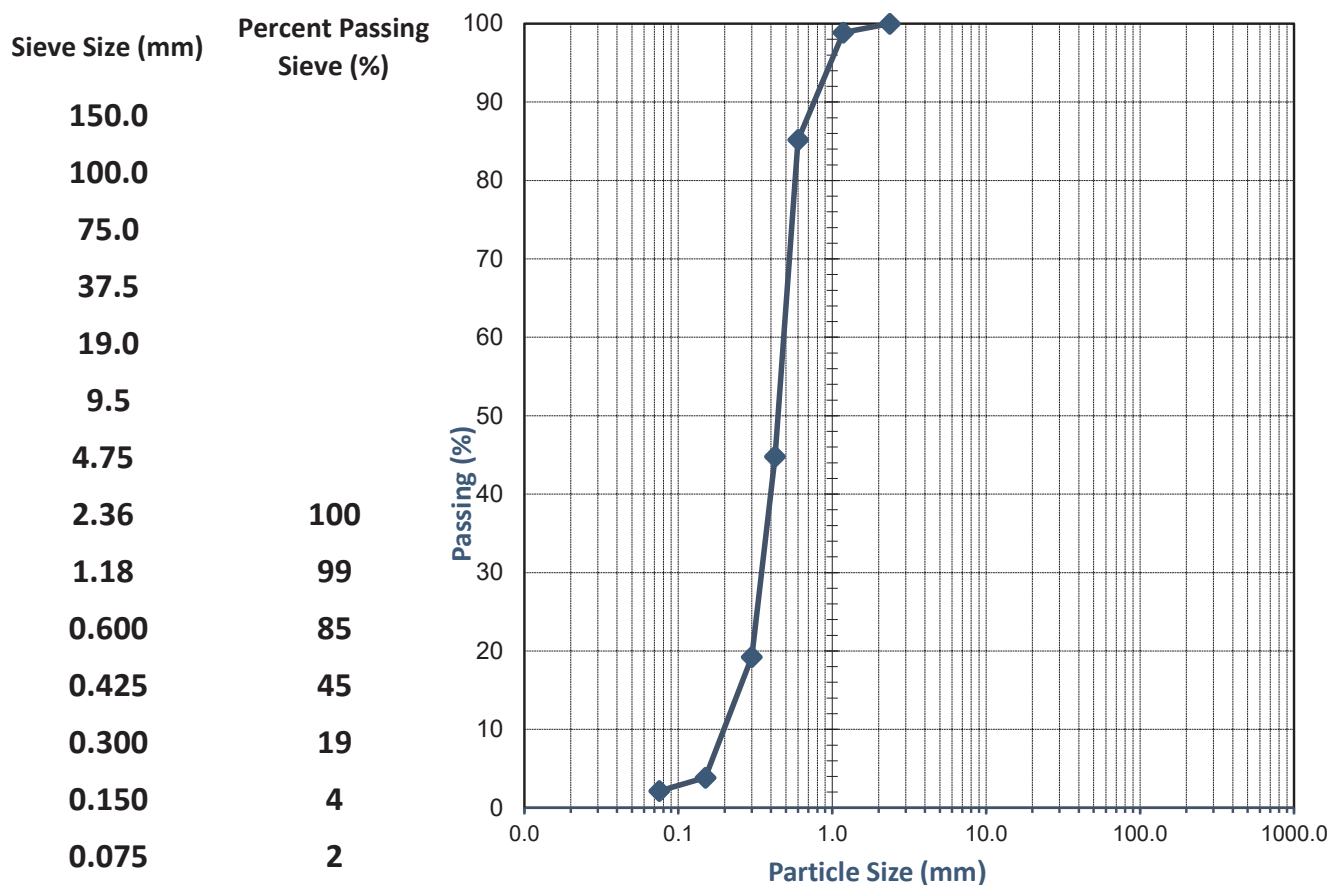
TEST REPORT - AS 1289.3.6.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7002_1_PSD
Project:	Proposed Residential Development	Sample No.	WG20/7002
Location:	Lots 46 & 47 Gray Road, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH07 0.2-0.5m	Date Tested:	26-29/6/20

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 02-July-2020



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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	McDowall Affeck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7002_1_PI
Project:	Proposed Residential Development	Sample No.	WG20/7002
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH07 0.2 - 0.5m	Date Tested:	29-06-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	Sampled by Client, Tested as Received	
History of Sample:	Oven Dried <50°C	
Method of Preparation:	Dry Sieved	
AS 1289.3.1.1	Liquid Limit (%)	Not Obtainable
AS 1289.3.2.1	Plastic Limit (%)	Non-Plastic
AS 1289.3.3.1	Plasticity Index (%)	Non-Plastic
AS 1289.3.4.1	Linear Shrinkage (%)	0.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	-

Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 30-June-2020



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7002_1_MMDD
Project:	Proposed Residential Development	Sample No.	WG20/7002
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH07 0.2 - 0.5m	Date Tested:	26-06-2020

TEST RESULTS - Modified Maximum Dry Density

Sampling Method:

Sampled by Client, Tested as Received

Sample Curing Time:

2 Hours

Method used to Determine Liquid Limit:

Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%):

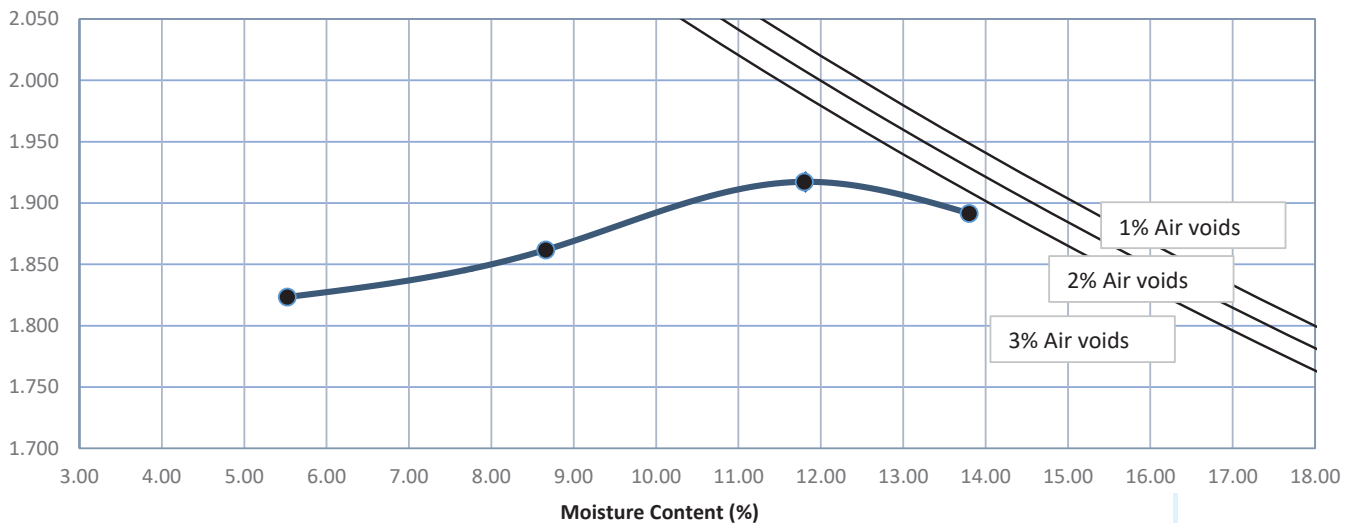
0

Material + 37.5mm (%):

-

Moisture Content (%)	5.5	8.7	11.8	13.8	
Dry Density (t/m ³)	1.823	1.862	1.917	1.892	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³)

1.92

Optimum Moisture Content (%)

12.0

Comments: The above air void lines are derived from a calculated apparent particle density of 2.702 t/m³

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 28-June-2020



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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.6.1.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7002_1_SCBR
Project:	Proposed Residential Development	Sample No.	WG20/7002
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH07 0.2 - 0.5m	Date Tested:	2-07-2020

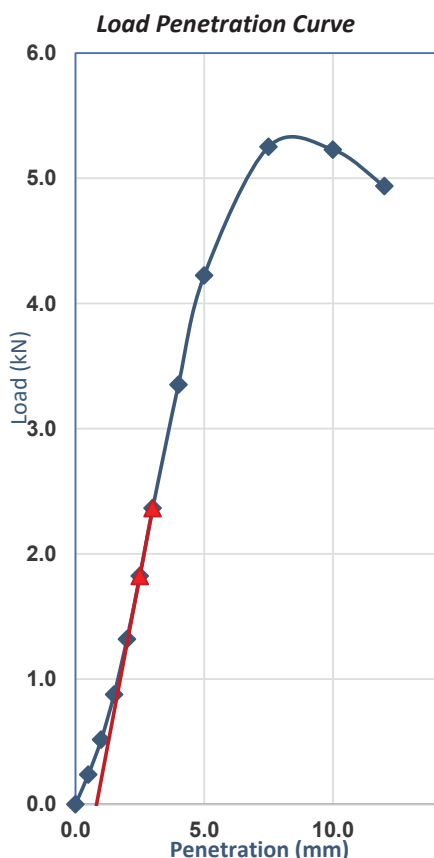
TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description:

Sand

Sampling Method:

Sampled by Client, Tested as Received



Compaction Details

Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	2 Hours
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m ³)	1.92	Optimum Moisture (%)	12.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction

Dry Density (t/m ³)	1.82	Moisture Content (%)	12.2
Density Ratio (%)	95.0	Moisture Ratio (%)	103.0

Specimen Conditions After Soak

Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	9.00	Measured Swell (%)	0.0
Dry Density (t/m ³)	1.82	Dry Density Ratio (%)	95.0
Moisture Content (%)	13.3	Moisture Ratio (%)	112.5

Specimen Conditions After Test

Top 30mm Moisture (%)	11.8	Remaining Depth (%)	12.0
-----------------------	------	---------------------	------

Correction applied to Penetration: 0.8mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 25%

Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 03-July-2020



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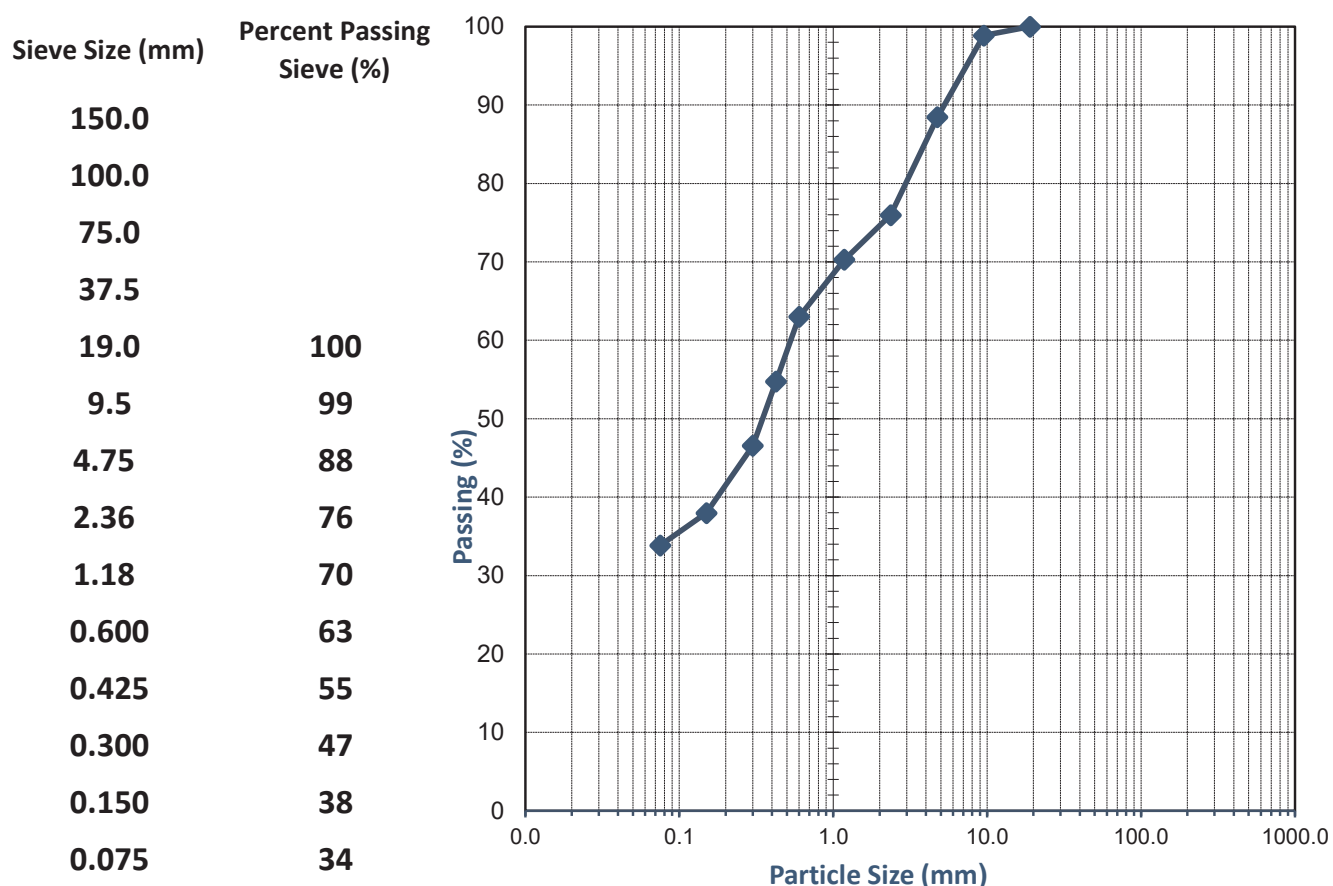
TEST REPORT - AS 1289.3.6.1

Client:	McDowall Affleck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7003_1_PSD
Project:	Proposed Residential Development	Sample No.	WG20/7003
Location:	Lots 46 & 47 Gray Road, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH12 1.0-1.5m	Date Tested:	26-06-2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method:

Sampled by Client, Tested as Received



Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 30-June-2020



Accreditation No. 20599

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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	McDowell Affeck Pty Ltd	Ticket No.	S1369
Client Address:	-	Report No.	WG20/7003_1_PI
Project:	Proposed Residential Development	Sample No.	WG20/7003
Location:	Lots 46 and 47 Gray Rd, Haynes	Date Sampled:	Not Specified
Sample Identification:	BH12 1.0 - 1.5m	Date Tested:	29-06-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	Sampled by Client, Tested as Received
History of Sample:	Oven Dried <50°C
Method of Preparation:	Dry Sieved

AS 1289.3.1.1	Liquid Limit (%)	41
AS 1289.3.2.1	Plastic Limit (%)	17
AS 1289.3.3.1	Plasticity Index (%)	24
AS 1289.3.4.1	Linear Shrinkage (%)	10.0
AS 1289.3.4.1	Length of Mould (mm)	250
AS 1289.3.4.1	Condition of Dry Specimen:	Curled

Comments:

Approved Signatory:

Name: Kirk McConachy

Function: Laboratory Manager

Date: 30-June-2020



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Appendix G: Understanding Your Report

UNDERSTANDING YOUR REPORT

GALT FORM PMP11 Rev3

1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- ✦ the project objectives as we understood them and as described in this report;
- ✦ the specific site mentioned in this report; and
- ✦ the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- ✦ the report was not written for you;
- ✦ the report was not written for the site specific to your development;
- ✦ the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- ✦ the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.

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Geotechnical Investigation



Job No: J473627

Development Engineering Consultants

Lot 45 Gray Road, Haynes, WA

30/1/2025

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Privacy & Confidentiality Notice

This report, the information herein and any attachment are intended solely for the named client. The 'client' is defined as the person or persons named in this report, or the purchaser of the services. If you are not a named client, please delete the report and any attachments. Any use or disclosure of the contents of either is unauthorised and may be unlawful.

Disclaimer

This report is for Structerre only to use in design. Any design by anyone else for any structure must be specifically approved by Structerre. If used by anyone else for anything other than a Structerre design or structure, Structerre takes no responsibility.

1. Project Details

1.1 Introduction

At the request of Development Engineering Consultants, Structerre Consulting (Structerre) have conducted a Geotechnical Investigation at Lot 45 Gray Road, Haynes. The purpose of the investigation was to provide the following for residential subdivision purposes:

- An assessment of subsurface soil profile and groundwater conditions across the proposed area of development;
- Site classification in accordance with AS 2870-2011 Residential Slabs and Footings;
- Wind Classification in accordance with AS 4055-2012 Wind Loads for Housing;
- Recommendations for stormwater drainage design;
- Provision of a footing detail considering anticipated surface movement and sand pad thickness.
- Site preparation requirements (earthworks), including site traffic, excavation, reuse of materials and batter slopes, compaction requirements, expected shrinkage and bulking factors, and sub-surface settlement of fill during compaction
- Recommendations on earthworks and site preparation requirements including use of existing materials as fill or for use in public open space, recommendations on imported materials, compaction methods, testing, expected shrinkage and bulking factors, plasticity, sub-surface settlement during compaction of fill and future settlement, dewatering requirement, if necessary;
- Preliminary pavement design parameter, indicative California Bearing Ratio (CBR) values determined from penetrometer results and ground conditions encountered
- Earth pressure coefficients for granular backfill for retaining wall design.

This report details the scope of the geotechnical investigation, present and interpretation of ground conditions and material properties across the site, provides geotechnical design parameters for the design of the proposed infrastructure, and evaluates the suitability of materials for use in earthworks. Interpretation of site conditions is based on the subsurface lithology revealed during the investigation programme, visual assessment of the in-situ materials and the results of in situ field tests.

Structerre were provided with a site plan showing surface the proposed development and the location in relation to the site boundaries.

1.2 Site Description

The site is located at Lot 45 Gray Road, Haynes, City of Armadale. Gray Road lies to the north of the site, orchard to the south and southeast and residential properties to the southwest and west. Neerigen Brook dissects the site, running east to west.

The site is generally flat and level as is the surrounding topography. At the time of the field investigation, the site currently is use as an orchard.

1.3 Field Investigation – Scope of Works

The field investigation was carried out on 12 January 2025 and comprised:

- Eight (8) Sample Retrieval Probes (SRP) to a depth of 2.5m over the site for material assessment and soil profiling;
- Two (2) In situ percolation tests to determine the permeability of the materials within the upper 1.0m; and
- Eight (8) Dynamic Cone Penetrometer (DCP) tests in accordance with AS 1289.6.3.3-1997 to a depth of 1.0m for evaluation of relative densities of the upper layers.

The locations are shown on the attached site plan in Appendix 1.

Suitably qualified geotechnical personnel from Structerre supervised all the fieldwork, interpreted and described the materials encountered in this report. They are in accordance with the guidelines presented in AS1726-2017, “Geotechnical Site Investigations”.

2. Desk Study

2.1 Geological Setting

The Armadale sheet 1: 50,000 Environmental Geology Series (Part Sheets 2033 I and 2133 IV, 1986) prepared by the Geological Survey of Western Australia indicates that the following geological layers underlie the site:

- Sandy CLAY (Cs) – white-grey to brown, fine to coarse grained, subangular to rounded sand, clay of moderate plasticity, gravel, and silt layers near scarp (Guildford Formation, Qpa).

2.2 Ground Surface and Groundwater Level

The Perth Groundwater Atlas (Waters & Rivers Commission) indicates the ground surface level at this site was approximately 28.0m Australian Height Datum (AHD).

The 2019 groundwater level at the site was approximately 23.5m AHD and the historical maximum was indicated to be approximately 25.5m AHD. It should be noted that the groundwater levels can vary significantly due to seasonal variation and the data from the recorded maximum levels should be used only as a guide.

2.3 Earthquake Coefficient

In accordance with AS 1170.4-2007 Structural Design Actions the site is located within an area with an earthquake acceleration coefficient of between 0.09 and 0.10.

2.4 Wind Classification

In accordance with AS 4055-2012 Wind Loads for Housing, wind classification of this site falls within the non-cyclonic “N1 – N2” category.

3. Results of the Investigation

3.1 Subsurface Soil Profile

The subsurface soil profile presented below was determined from the ground conditions encountered within the boreholes and through the interpretation of the DCP test results:

Table 1 – Subsurface Soil Profile

Depth to Base of Strata (m)	Material Description
0.1 – 0.2 (Ave. 0.2)	Topsoil
0.7 – 0.8 (Ave. 0.8)	NATURAL: SAND (medium grained), trace gravel, medium dense grading to very dense (BH2 – BH4) only
0.6 – 1.2 (Ave. 0.9)	NATURAL: Gravelly SAND (medium grained), medium dense (BH3 and BH6) only
1.5 – 2.5 (Ave. 2.1)	NATURAL: Clayey SAND (medium to coarse grained), medium plasticity, trace gravel, medium dense grading to very dense
Not Penetrated (>2.5m)	NATURAL: Sandy CLAY (medium grained), medium plasticity, with gravel, firm grading to stiff (BH3 to BH5 and BH8) only

The soils encountered are consistent with the expected site conditions as predicted from the Environmental Geology Map. It is important to note that there may be pockets of fill on site that are deeper than that encountered by the investigation boreholes. The subsurface soil conditions encountered are presented in the bore logs, within Appendix C.

3.2 Groundwater

Groundwater was not encountered in any of the boreholes during or immediately after drilling. The water is expected to perch at 0.2m, above the more cohesive materials.

3.3 Percolation Testing

Percolation testing of the in-situ soils was undertaken in two locations. Results of the testing are summarised below:

Table 2 – In Situ Percolation Test Results

Test Location	Testing Depth	Soil Type	Permeability
BH4	0 – 1.0m	SAND to clayey SAND trace gravel	0.3m/day
BH7	0 – 1.0m	Clayey SAND trace gravel	1.0m/day

The percolation results indicate that the encountered ground conditions are generally not suitable for infiltration.

3.4 Laboratory Test Results

Samples were tested by Structerre's in-house NATA accredited laboratory for Particle Size Distribution as per AS1289.3.6.1, Plasticity Index / Linear Shrinkage as per AS1289.3.1.2 – 3.4.1.

3.4.1 Atterberg Limits

Results of the testing are presented in Appendix 4 summarised below:

Table 3 – Atterberg Limit Test Results

Sample Identification	BH01 @ 1.0m – 1.5m	BH06 @ 1.0m – 1.4m
Liquid Limit (%)	37	48
Plastic Limit (%)	14	20
Plasticity Index (%)	23	28
Linear Shrinkage (%)	8	11
Material Passing 0.075mm (%)	35	41

Test results indicate that the natural clayey SAND and sandy CLAY has moderate shrink swell capacity or degree of expansion.

4. Geotechnical Construction Considerations

4.1 Site Classification

AS 2870-2011 Residential Slabs and Footings provides guidance on site classification for residential slabs and footing design based on the expected ground surface movement and depth of expected moisture changes.

Table 4 – Classification Based on Site Reactivity

AS 2870-2011 Residential Slabs and Footings – Clause 2.1.2 Table 2.1	
Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes ($0 < y_s \leq 20\text{mm}$)
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes ($20 < y_s \leq 40\text{mm}$)
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes ($40 < y_s \leq 60\text{mm}$)
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes ($60 < y_s \leq 75\text{mm}$)
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes ($y_s > 75\text{mm}$)
Clause 2.1.3 Classification of Other Sites	
P	Sites which include soft or unstable foundations such as soft clay or silt or loose sands, landslip, mine subsidence, collapsing soils and soils subject to erosion, reactive sites subject to abnormal moisture conditions and site that cannot be classified in accordance to Table 2.1

Based on results of this investigation the site can be upgraded to a Class “S” in accordance with AS 2870-2011 provided that all unsuitable materials are removed and replaced with engineer-controlled sand fill materials in accordance with the earthwork recommendations outlined in Section 4.3 of this report.

Footings suitable for this site should be adopted to accommodate expected ground surface movements of approximately $y_s < 20\text{mm}$ associated with the presence of moderate reactive sandy CLAY deposits within the building site.

4.2 Drainage

The existing ground conditions are not suitable for on-site disposal of stormwater runoff through the use of soakwells. It is recommended that all stormwater from roofed, paved and driveway areas be collected and detained to reduce peak flow rates prior to discharging off site as per council requirement.

On site drainage through the use of soakwells may be appropriate subject to the level of free draining sand cover placed above the insitu reactive materials.

It is recommended that The Client confirms the permeability rates following the completion of the earthworks.

4.3 Earthworks

All earthworks shall be undertaken in accordance with AS 3798-2007 Guidelines on earthworks for commercial and residential developments and are to include but not limited to include the following:

4.3.1 Earthworks Equipment

It is considered that standard small to medium sized earthmoving equipment would be appropriate for the proposed development.

The ground surface was generally competent and should not pose significant issues to either excavation or site traffic movements. Near surface materials may become saturated during the wetter months of the year, which may impede site movement.

4.3.2 Clearing and Topsoil Stripping

All surface vegetation (i.e. grass and bushes) to be stripped and removed off site. Trees should be grubbed, stockpiled and mulched for use in landscaping areas within the proposed subdivision. Loose ground resulting from the removal of vegetation (i.e. trees) should be profiled, compacted and in filled with suitably compacted fill.

Based on the investigation the topsoil is approximately 0.2m thick. The encountered topsoil may be used as is in landscape areas but is not suitable for use as structural fill.

Alternatively, screening and blending of topsoil may provide suitable structural fill provided vegetation, roots and stumps are removed. Should this be engaged, it is recommended to blend topsoil with clean sand in ratio to provide an organic content of <2% by mass.

Typically, a suitable blended material is achieved by blend ratio (clean sand/topsoil) of 2:1. Any blended material should not be placed in the upper 0.6m fill profile, however where drainage is a consideration placement should be at further depth.

Additionally, it is recommended monitoring of the screening and blending process be conducted during the works, which would include the following:

- Sampling of the topsoil sources to determine organic content
- Site visit, supervision and testing to determine the appropriate blending process
- Ongoing monitoring and testing of the blending process at a frequency of 1 visit per 2000m³.

4.3.3 Proof Compaction

The near surface sand materials can be proof compacted by utilising the following methodology:

- Apply a minimum of 4 passes with a self-propelled, smooth drum vibratory roller (operating in high amplitude mode) allowing a minimum of 20% overlap. The surface should then be given an additional minimum of 4 passes with the vibrating roller operating in low amplitude. Areas that deform excessively under rolling should be removed and replaced with clean sand. On completion of vibratory rolling, the roller should be operated in static mode, applying a minimum of 2 passes over the site.

Should the base materials be cohesive, the following proof compaction methodology can be utilising:

- Moisture condition to +/- 2% of standard optimum moisture content (AS1289 5.1.1)
- Apply a minimum of 6 passes with a self-propelled, pad foot vibratory roller (operating in static amplitude mode) allowing a minimum of 20% overlap.

All weak areas, which deform excessively under rolling, should be removed and replaced with clean sand/crushed limestone. After excavation and proof compaction, the excavated base is to be inspected and approved by a representative from this office prior to backfilling. At this stage it can be assessed whether any further materials need to be removed or whether further compaction of the base is required.

The compaction requirements are set out below, as per AS3798:2007

Table 5 – Compaction Requirements

Item	Application	Minimum relative compaction %	
		Minimum density ratio (Standard Compaction Effort) (Cohesive soils)	Minimum density index (Cohesionless soils)
1	Residential - lot, fill, house, sites	95	70
2	Fill to support pavements		
	General Fill	95	70
	Subgrade (to a depth of 0.3m)	98	75

4.3.4 Cohesionless Sand Structural Fill

A minimum of 0.6m sand cover is to be placed or maintained above the natural reactive clay soils to achieve a Class "S" site (i.e. $y_s < 20\text{mm}$).

The ground level can be built up to design levels with imported fill, as required. The imported fill should consist of free draining sand with not more than 5% passing a 75 μ m sieve and be free of organic matter and other deleterious materials. Generally, the fill sand materials should be placed in layers not exceeding 300mm loose thickness and compacted to achieve the criteria stated in the above table.

It is recommended that a Perth Sand Penetrometer (PSP) / Density correlation be undertaken to confirm the PSP requirements. However, the following criteria can be used as a guide:

- A minimum of 7 PSP blows over the interval 150 – 450mm, 9 PSP blows over the interval 450 – 750mm and 11 PSP blows over the interval 750 – 1050mm.

At completion, the earthworks should be inspected and approved by a representative from this office.

4.4 Pavement Design

Experience from using the Guildford Clay as pavement subgrade indicates that problems associated with drainage and uneven wearing are common. It is recommended that a layer of cohesionless material (sand or limestone gravel) be placed over the excavated and compacted clay surface. A recommended CBR of 12% may be adopted for imported granular fill materials (95% of MMDD in accordance with AS 1289 5.2.1-2003).

For detailed design and construction of the pavements, it is recommended that the CBR values be verified with laboratory Soaked CBR testing on the anticipated subgrade material.

4.5 Retaining Walls

Retaining walls proposed to be installed at the site will likely support sandy soils. Where imported granular backfill is to be used in conjunction with retaining walls, the geotechnical properties will vary depending upon the nature of the granular materials imported.

For cohesion-less free draining sand, the following parameters can be used as a guide for design purposes:

- Angle of internal friction, $\phi = 33^\circ$
- Coefficient of active earth pressure $K_a = 0.29$
- Coefficient of passive earth pressure $K_p = 3.39$
- At rest coefficient of earth pressure $K_0 = 0.46$
- Bulk density 18 kN/m³

Retaining structures should be designed in accordance with AS 4678-2002 Earth Retaining Structures. Where significant eccentric and/or horizontal loading is applied, further assessment will be required. Additionally, handheld compaction equipment is utilised within 2.0m of the walls, to reduce the potential increase in lateral pressure on the retaining wall.

Retaining wall design should ensure adequate drainage to the rear of the wall. It is recommended that the drainage comprises free draining sand and/or weepholes that are interconnected with a suitable sized perforated drainage pipe.

Experience indicates that excavation immediately in front of retaining walls (i.e. due to service installation) may cause movement to the wall to occur. This can lead to cracking of adjoining structures and needs to be accounted for in the design and construction sequencing of the new works.

5. Conclusions

A site investigation has been carried out at the site of the proposed residential development to assess the geotechnical conditions. Parameter and design recommendations are incorporated in the body of the report. The following conclusions have been drawn from the site investigation:

- The average subsurface soil profile encountered comprised topsoil to 0.2m, sand trace gravel to 0.8m (Bh2 to BH4) only, gravelly sand to 0.9m (Bh3 and BH6) only, clayey sand trace gravel to 2.1m and underlain by sandy clay with gravel (BH3 to BH5 and BH8) only to the investigated depth of 2.5m.
- Groundwater or perched water was not encountered across the site to the investigated depth of -2.5m.
- It is considered that the site is not suitable for on-site drainage in its current state.
- The site can be classified as Class "S" in accordance with AS 2870-2011 provided that the recommended earthworks are undertaken.
- The full scope of the recommended earthworks is presented in Section 4.3, but generally comprises:
 - Stripping of topsoil and unsuitable materials
 - Proof compaction of the base
 - Placement of sand fill to required level
 - Compaction to final level
- In general, small to medium sized earthworks equipment are considered suitable for the proposed development.
- Site movement and excavations should not pose a significant issue. However, note that the near surface materials may become saturated during the wet months of the year and impede site movements.
- Recommended earthworks include stripping of topsoil and any unsuitable materials, proof compaction of the base, excavation of loose materials (where necessary), placement of engineered fill and compaction of final level.

6. Limitation of Field Investigations

This report has been prepared in accordance with general accepted consulting practice for Development Engineering Consultants using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

The conclusions and recommendations in this report are based on the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions.

If ground conditions encountered during construction are different to that described in this report, this office should be notified immediately.

Should you require further information or clarification of any of the recommendations provided within this report, please contact the undersigned.

For and on behalf of **Structerre Consulting**.

Signature

David Harding

Geotechnical Supervisor

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wageotechengineering@structerre.com.au



Signature

Mel Castle

Geotechnical Manager

31 January 2025

Job #	Revision	Authored	Checked	Authorised
J473627	0	MM	DH	Mel Castle

7. References

Department of Water – Perth Groundwater Atlas

Geological Survey of Western Australia 1:50,000 Environmental Geology Series

AS 1170.4-2007 Structural design actions – Earthquake actions in Australia

AS 1289.3.1.2-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the liquid limit of a soil

AS 1289.3.2.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the plastic limit of a soil

AS 1289.3.3.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Calculation of the plasticity index of a soil

AS 1289.3.4.1-2009 Methods of testing soils for engineering purposes – Soil classification tests – Determination of the linear shrinkage of a soil

AS 1289.6.3.2-1997 Methods of testing soils for engineering purposes – Soil strength and consolidation tests – Determination of the penetration resistance of a soil – 9kg dynamic cone penetrometer test

AS 1726-2017 Geotechnical site investigation

AS 2870-2011 Residential slabs and footings

AS 3798-2007 Guidelines on earthworks for commercial and residential developments

AS 4055-2012 Wind loads for housing

Appendix A – Site Location



Note: Showing approximate test locations only

LEGEND



Borehole



Depths of Non-reactive Material

PROJECT:

Lot 45 Gray Road, Haynes

PROJECT #: D352241

JOB #: J473627

CLIENT:

Development Engineering Consultants

SCALE:	NTS
--------	-----

TITLE: Geotechnical Investigation Site Plan

DATE: 12 Jan '25

CHECKED BY: _____

CHECKED BY:	DH
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Appendix B – Site Photos



PHOTO 1 - Facing south from the driveway



PHOTO 2 - Facing north from BH7 location



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PROJECT:

**Development Engineering
Consultants**

PROJECT #: D352241

CLIENT:

Lot 45 Gray Road, Haynes

JOB #: J473627

SCALE: NTS

TITLE: Site Photographs

DATE: 12 Jan '25

DRAWN BY: MM

CHECKED BY: DH



PHOTO 3 - Facing south from BH4 location



PHOTO 4 - Facing north from BH3 location



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PROJECT:

**Development Engineering
Consultants**

PROJECT #: D352241

CLIENT:

Lot 45 Gray Road, Haynes

JOB #: J473627

SCALE: NTS

TITLE: Site Photographs

DATE: 12 Jan '25

DRAWN BY: MM

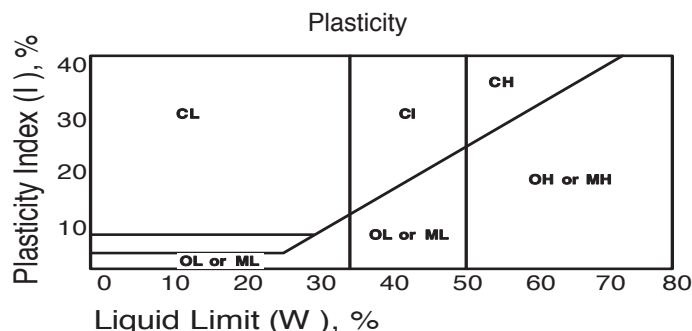
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Appendix C – Borelogs & Terminology

BORELOG TERMINOLOGY

Particle Size Distribution

Major Division	Subdivision	Size
Boulders		>200mm
Cobbles		200 - 63mm
Gravel	Coarse	63 - 20mm
	Medium	20- 6mm
	Fine	6 - 2.36mm
Sand	Coarse	2.36 - 0.6mm
	Medium	0.6 - 0.2mm
	Fine	0.2 - 0.075mm



Consistency of Cohesive Soils

Term	Undrained Strength S_u (kPa)	Field Guide
Very Soft	< 12	Exudes between the fingers when squeezed in hand
Soft	12 - 25	Can be moulded by light finger pressure
Firm	25 - 50	Can be moulded by strong finger pressure
Stiff	50 - 100	Cannot be moulded by Fingers. Can be indented by thumb.
Very Stiff	100 - 200	Can be indented by thumb nail
Hard	> 200	Can be indented with difficulty by thumb nail.
Friable	-	Crumbles or powders when scraped by thumbnail

Consistency/Density of Non-Cohesive Soils

Moisture Content

Term	Density Index (%)	SPT "N" Value Comparison	
Very Loose	< 15	0 - 4	D Dry
Loose	15 - 35	4 - 10	M Moist
Medium Dense	35 - 65	10 - 30	W Wet
Dense	65 - 85	30 - 50	S Saturated
Very Dense	> 85	> 50	

Minor Components

Term	Assessment Guide	Proportion of Minor Component In:
Trace	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component	Coarse grained soils: < 5 % Fine grained soils: <15%
With	Presence easily detected by feel or eye, soil properties little different to general properties of primary component	Coarse grained soils: 5 - 12 % Fine grained soils: 15 - 30%

Soil Legend

 FILL	 CLAY	 GRAVEL	 CONCRETE
 TOPSOIL	 SILT	 LIMESTONE	 COMBINATIONS
 PEAT	 SAND	 BEDROCK	eg: Clay, Silty, Sandy

USCS

GW Well graded gravel	SC Clayey sand	OL Organic low plasticity silt	CL Low plasticity clay
GP Poorly graded gravel	SM Silty sand	ML Low plasticity silt	CI Intermediate plasticity clay
SW Well graded sand		MH High plasticity silt	CH High plasticity clay
SP Poorly graded sand		OH Organic high plasticity silt	PT Peat

DOC:GE:3.003

WA | QLD | NSW | VIC

Date Drilled: 10/01/2025
Drill Rig
Drill Supplier
Logged/Checked: Margie Mortera

Depth: m

2/8

Date Drilled: 12/01/2025
Drill Rig
Drill Supplier
Logged/Checked: Margie Mortera

Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP Results
0.2	Non-Soil		TS	Topsoil			
0.8	Natural		SP	Natural SAND SP: medium dense, yellow, medium grained, dry.	D	MD	
1.2			SP	Natural Gravelly SAND SP: medium dense, brown, medium grained, coarse sized gravel, dry.			
			CI	Natural Sandy CLAY CI: stiff, medium plasticity, red mottled grey, fine grained sand, trace medium sized gravel, inorganic, moist.	M	St	
BH3 Terminated at 2.5m (Target Depth)							



Depth: m

This report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

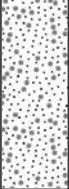


Borehole Record: BH4

Project: Lot 45 Gray Rd Haynes
Location: Gray Rd, Haynes WA
Loc Comment:
Job No: D352241 / J473627

Position: Easting: 403846.04
Northing: 6442629.44
Elevation: 28.00(m)
Inclination:

Date Drilled: 12/01/2025
Drill Rig
Drill Supplier
Logged/Checked: Margie Mortera

Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP Results 
0.2	Non-Soil		TS	Topsoil			
0.4	Natural		SP	Natural SAND SP: medium dense, yellow, medium grained, trace medium sized gravel, dry.	D	MD	
0.8							
1.0			SC	Natural Clayey SAND SC: medium dense, medium plasticity clay, yellow mottled brown, coarse grained, trace medium sized gravel, moist.	M		
1.6							
2.0			CI	Natural Sandy CLAY CI: stiff, medium plasticity, red mottled yellow, medium grained sand, trace medium sized gravel, inorganic, moist.		St	
				BH4 Terminated at 2.5m (Target Depth)			



Depth: m

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STRUCterre consulting Borehole Record: BH5							
Project: Lot 45 Gray Rd Haynes Location: Gray Rd, Haynes WA Loc Comment: Job No: D352241 / J473627				Position: Easting: 403889.91 Northing: 6442591.09 Elevation: 28.70(m) Inclination:		Date Drilled: 12/01/2025 Drill Rig Drill Supplier Logged/Checked: Margie Mortera	
Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP Results
0.1	Non-Soil		TS	Topsoil			
	Natural		SC	Natural Clayey SAND SC: medium dense, medium plasticity clay, brown, medium grained, trace medium sized gravel, dry.	D	MD	
1							
1.5							
			CI	Natural Sandy CLAY CI: stiff, medium plasticity, red, medium grained sand, with medium sized gravel, inorganic, dry.		St	
2							
				BH5 Terminated at 2.5m (Target Depth)			
 Depth: m							
This report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.							

Date Drilled: 12/01/2025
Drill Rig
Drill Supplier
Logged/Checked: Margie Mortera

Depth: m

6/8



Borehole Record: BH7

Project: Lot 45 Gray Rd Haynes
Location: Gray Rd, Haynes WA
Loc Comment:
Job No: D352241 / J473627

Position: Easting: 403983.24
Northing: 6442674.04
Elevation: 29.05(m)
Inclination:

Date Drilled: 12/01/2025
Drill Rig
Drill Supplier
Logged/Checked: Margie Mortera

Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	DCP Results
0.2	Non-Soil		TS	Topsoil			5, 7
0.8	Natural		SC	Natural Clayey SAND SC: medium dense, medium plasticity clay, pale yellow, medium grained, trace medium sized gravel, dry.	D	MD	5, 15, 12, 9, 6, 4
1			SC	Natural Clayey SAND SC: medium dense, medium plasticity clay, yellow mottled red, medium grained, trace medium to coarse sized gravel, dry.			
2							
				BH7 Terminated at 2.5m (Targey Depth)			



Depth: m

This report must be read in conjunction with accompanying notes and abbreviations. It has been prepared for geotechnical purposes only, without attempt to assess possible contamination. Any references to potential contamination are for information only and do not necessarily indicate the presence or absence of soil or groundwater contamination.

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Appendix D – Laboratory Test Results

Sample No. 39991 **Client** Geotechnical
Job No. J473627 **Project** Lot 45 Grays Rd, Haynes

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

SAMPLE DETAILS

BH No. / Depth BH1 1.0-1.5m Sampling Method Client
 Sample History 50°C Oven Dried Sample Preparation AS 1289 1.1

ATTERBERG LIMITS

Description	Method	Result (%)
Liquid Limit	AS 1289.3.1.2	37
Plastic Limit	AS 1289.3.2.1	14
Plasticity Index	AS 1289.3.3.1	23
Linear Shrinkage	AS 1289.3.4.1	8
Nature of Shrinkage		Cracked

PARTICLE SIZE DISTRIBUTION

Method: AS 1289.3.6.1
Description: Particle size distribution by sieve analysis

Sieve Size (mm)	% Passing
19.0	100
2.36	86
0.425	60
0.075	35

AS 1726:2017 Clause 6.1

Material Description: Clayey SAND trace gravel

AS Group Symbol: SC



Accreditation Number 18742

Soils Analysis Workbook V 4.05 09-Oct-24

Ben Stroop
 Authorized Signatory Senior Laboratory Technician



Date: 23-Jan-25

AS 1289.3.6.1 Report Feb 18

Sample No. 39992 **Client** Geotechnical
Job No. J473627 **Project** Lot 45 Grays Rd, Haynes

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

SAMPLE DETAILS

BH No. / Depth BH6 1.0-1.4m Sampling Method Client
 Sample History 50°C Oven Dried Sample Preparation AS 1289 1.1

ATTERBERG LIMITS

Description	Method	Result (%)
Liquid Limit	AS 1289.3.1.2	48
Plastic Limit	AS 1289.3.2.1	20
Plasticity Index	AS 1289.3.3.1	28
Linear Shrinkage	AS 1289.3.4.1	11
Nature of Shrinkage		Flat

PARTICLE SIZE DISTRIBUTION

Method: AS 1289.3.6.1
Description: Particle size distribution by sieve analysis

Sieve Size (mm)	% Passing
19.0	100
2.36	71
0.425	58
0.075	41

AS 1726:2017 Clause 6.1

Material Description: Sandy CLAY with gravel
AS Group Symbol: Cl or Ol



Accreditation Number 18742

Soils Analysis Workbook V 4.05 09-Oct-24

Ben Stroop
 Authorized Signatory Senior Laboratory Technician



Date: 23-Jan-25

AS 1289.3.6.1 Report Feb 18

APPENDIX E –GROUNDWATER ALLOCATION

← Licence details

☒ Selected

1 of 1

Licence Number:	55402
Licence Type:	Groundwater Licence
Issue Date:	25/11/2015
Expiry Date:	24/11/2025
Licence Allocation:	26600 KL
Parties:	Lupica, Giuseppe, Linda Lupica
Postal Address:	45 Gray Rd Haynes WA 6112 Australia
Groundwater Area:	Perth
Groundwater Subarea:	City of Armadale
Aquifer:	Perth - Superficial Swan
Surface Water Area:	
Surface Water Subarea:	
Surface Water Resource:	
Licence Address:	Lot 45 On Diagram 56878 Volume/Folio 1536/110 Lot 45 Gray Rd Haynes
Security Interests:	No
Convictions:	No
Agreements:	No
Notations:	No
Directions:	No

