GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL INVESTIGATION

FOR

MRZ DESIGNS

Lot 2, 32 Castle Circuit, Seaforth, New South Wales

Report No: 24/0234

Project No: 32577/8400D-G

February 2024

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1. INTRODUCTION

This report presents the results of a Geotechnical Investigation carried out by STS Geotechnics Pty Limited (STS) for the proposed new dwelling to be constructed on Lot 2, 32 Castle Circuit, Seaforth NSW.

Following documents were provided to assist in the preparation of this report:

- Survey plan prepared by Burton and Field Pty Ltd, 'Plan Showing Detail & Levels Over Lot 2 in DP 503699 No. 32 Castle Circuit Seaforth', dated 28/08/2023, Ref. E5026-76342, Issue A.
- Architectural plans prepared by MRZ Designs, 'Lot 2 #32 Castle Circuit, Seaforth 2092', dated 20/12/2023, Job Number. MRZ-23-741.

Based on the architectural drawings, the site development will be limited to a two-storey dwelling with a basement and swimming pool. The garage floor has RL 84.5 metres AHD, whereas the existing ground level is RL 84.4 to 88.75 metres AHD. STS therefore estimates that the proposed works will require excavating up to about 4 metres below the existing ground surface, however, additional excavation may be required for footings or service trenches.

The purpose of the investigation was to assess the subsurface conditions and provide geotechnical advice and recommendations addressing the following:

- Subsurface conditions,
- Site Classification according to AS2870,
- Excavation conditions,
- If required, vibration control during rock excavation,
- Safe batter slopes,
- Retaining wall design parameters,
- Foundation design parameters including foundation options, and
- Exposure classification in according with AS2870 and AS2159.

The investigation was undertaken in accordance with STS proposal P24-027 dated January 17, 2024.

Our scope of work did not include a contamination assessment.

2. NATURE OF THE INVESTIGATION

2.1. Fieldwork

The fieldwork consisted of the drilling of four (4) boreholes numbered BH1 to BH4 inclusive, at the locations shown on attached Drawing No. 24/0234. Borehole locations were selected on site based on access availability for the drill rig. Borehole BH1 was drilled using a track mounted Christie drilling mini rig. Soils were drilled using rotary solid flight augers. Boreholes BH2, BH3 and BH4 were advanced using a handheld push tube device, owned, and operated by STS. Soil strengths were assessed by carrying out Dynamic Cone Penetrometer (DCP) tests adjacent to each borehole location.

Drilling operations were undertaken by one of STS's senior geotechnician who also logged the subsurface conditions encountered.

Representative soil samples were collected from the boreholes for subsequent laboratory testing.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

2.2. Laboratory Testing

To assess the soils for their aggressiveness, a soil sample was tested to determine the following:

- pH,
- Sulphate content (SO_4),
- Chloride content (Cl) and
- Electrical Conductivity (EC).

To assist with determining the Site Classification, a representative sample was tested to determine their Shrink/Swell index.

The detailed test reports are given in Appendix B.

3. GEOLOGY AND SITE CONDITIONS

The Sydney geological series sheet at a scale of 1:100,000 indicates that the site is underlain by Triassic Age Hawkesbury Sandstone. Rocks within this formation generally comprise medium to coarse-grained quartz sandstone and very minor shale and laminite lenses.

At the time of the fieldwork, the site was occupied by double storey brick house. The site area is approximately 1347 square metre. The surface profile slopes approximately 10 metres to

the south. The site is bound by Castle Circuit to the east, and residential dwellings in the adjoining properties.

4. SUBSURFACE CONDITIONS

When assessing the subsurface conditions across a site from a limited number of boreholes, there is the possibility that variations may occur between test locations. The data derived from the site investigation programme are extrapolated across the site to form a geological model and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour regarding the proposed development. The actual condition at the site may differ from those inferred, since no subsurface exploration programme, no matter how comprehensive, can reveal all subsurface details and anomalies, particularly on a site such as this where there has been previous development.

The subsurface conditions generally comprise topsoil/fill overlying clayey silty sands, silty sand, and weathered sandstone. Topsoil/fill materials are present from the surface to a depth of 0.8 metres. Loose becoming medium dense natural clayey silty sands and silty sands underlie the topsoil to depths of 1.0 and 1.4 metres. In BH1, weathered sandstone underlies the sands to the depth of auger refusal, 1.5 metres. In BH2, BH3 and BH4 push tube refusal occurred on weathered sandstone at the depth of 1.0 to 1.3 metres.

Groundwater was not observed during drilling works.

The subsurface conditions observed are recorded on the borehole logs given in Appendix A. An explanation of the terms used on the logs is also given in Appendix A. Notes relating to geotechnical reports are also attached.

5. DISCUSSION

5.1. Site Classification to AS2870

The classification has been prepared in accordance with the guidelines set out in the "Residential Slabs and Footings" Code, AS2870 – 2011. Site classifications are not relevant to these types of development; however, the classification is provided in the event some high-level footings are required.

The sample collected for shrink swell testing was unsuitable. Experience has shown that at times, the shrink swell index can be estimated by dividing the soil Plasticity Index (PI) by a factor of 10. The soil tested at this site has a PI of 4.0% which implies the shrink swell index is estimated as 0.4% per ΔpF.

Because there are trees and an existing dwelling present, abnormal moisture conditions (AMC) prevail at the site. (Refer to Section 1.3.3 of AS2870).

Because of the presence of AMC and greater than 400mm of fill being present, the site is classified as a Problem Site (P). Because the fill does not appear to be placed as controlled engineered fill, it is not considered appropriate to reclassify this site.

Foundation design and construction consistent with this classification shall be adopted as specified in the above referenced standard and in accordance with the following design details.

5.2. Excavation Conditions & Vibration Control During Rock Excavation

Based on the subsurface conditions observed in the boreholes, bulk excavations on the site are expected to encounter topsoils/fill, clayey silty sands, silty sands and weathered sandstone.

Based on our experience in this geological setting, medium and/or high strength rock and ironstone bands could be encountered before reaching the final excavation depth. However, the presence of this rock can only be confirmed by carrying out additional cored boreholes.

Excavators without assistance should be able to remove the soils and some of the weathered rock. If medium to high strength rock and ironstone bands are encountered, these will likely require breaking up with a rock breaker. Experience suggests that these materials could be present below the depth of auger and push tube refusal noted on the borehole logs.

When undertaking rock breaking, care will be required to ensure that the structures on the subject site and buildings or other developments on adjacent properties are not damaged when excavating the rock. Excavation methods should be adopted which limit ground vibrations at the adjoining structures to not more than 5 mm/sec. Vibration monitoring may be required to verify that this is achieved.

Table 5.1 – Recommendations for Rock Breaking Equipment

Distance from adjoining structure (m)	**Maximum Peak Particle Velocity 5 mm/sec**	
	Equipment	Operating Limit (% of Maximum Capacity)
1.5 to 2.5	Hand operated jackhammer only	100
2.5 to 5.0	300 kg rock hammer	50
5.0 to 10.0	300 kg rock hammer or 600 kg rock hammer	100 50

The limits of 5 mm/sec are expected to be achievable if rock breaker equipment or other excavation methods are restricted as indicated in Table 5.1.

Use of other techniques (e.g., grinding, rock sawing), although less productive, would reduce or possibly eliminate risks of damage to property through vibration effects transmitted via the ground. Such techniques may be considered if an alternative to rock breaking is required.

If rock sawing is carried out around excavation boundaries in not less than 1-metre-deep lifts, a 900 kg rock hammer could be used at up to 100% maximum operating capacity with an assessed peak particle velocity not exceeding 5 mm/sec, subject to observation and confirmation by a geotechnical engineer at the commencement of excavation.

It should be noted that vibrations that are below threshold levels for building damage may be experienced at adjoining developments.

It would be appropriate before commencing excavation to undertake a dilapidation survey of any adjacent structures that may potentially be damaged. This will provide a reasonable basis for assessing any future claims of damage.

5.3. Safe Batter Slope

In the short term, dry cut slopes in the fill and natural sands should remain stable at an angle of 2(H) to 1(V). In the long-term dry cut slopes formed at an angle of 3(H) to 1(V) should remain stable. Slopes cut at this angle would be subject to erosion unless protected by topsoil and diversion drains at the crest of the slopes. Subject to inspections by a suitably experienced geotechnical engineer, it should be possible to have near vertical cuts in medium and high strength sandstone. The above temporary batters are stable provided that all surcharge loads, including construction loads, are kept at a distance of at least 2h (where 'h' is the height of the batter in metres) from the crest of the batter. If steeper batters are to be used, then these must be supported by shotcrete and soil nail system designed by a suitable experienced structural or geotechnical engineer.

Where space for temporary batters is not available, a suitable retention system will be required for the support of the entire depth of excavation and must be installed prior to any excavation commencing. Because of the surface sandy layer present, a contiguous pile system is expected to be best suited to the site conditions observed.

It is of course important that the onsite excavations do not endanger the adjacent properties. Excavations on the subject site should not extend below the zone of influence of any adjacent structure footings, without first installing temporary support or discussing the works with a geotechnical engineer.

5.4. Retaining Wall Design Parameters

The parameters used to proportion retaining wall support depends on whether the walls can be permitted to deflect. For walls, which cannot be permitted to deflect, an at rest earth pressure coefficient (Ko) of 0.6 and 0.5 should be adopted for the loose and medium dense sands present respectively. For walls that can be allowed to deflect, an active earth pressure

coefficient (Ka) of 0.4 and 0.3 should be adopted for the loose and medium dense sands. A passive earth pressure coefficient (Kp) of 2.5 and 3.0 may be used for the loose and medium dense sands respectively, and 4.5 for weathered sandstone. A bulk density of 19 kN/m^3 may be used for the natural soils and 23 kN/m^3 for the weathered sandstone. If anchors or props are used for additional support, a rectangular pressure distribution should be used.

As with all retaining walls, allowance must be made for ground surface slope, presence of groundwater and surcharge loads.

5.5. Foundation Design

Due to the potential for differential settlements, we do not recommend founding any structural loads within topsoil/fill materials and loose natural soils.

High level pad and/or strip footings founded in medium dense natural sands may be proportioned using an allowable bearing pressure of 100 kPa. For any high-level foundations, the minimum depth of founding must comply with the requirements of AS2870.

Piles, footings, and slabs founded in weathered sandstone may be proportioned using an allowable end bearing pressure of 800 kPa. For piled foundations, an allowable adhesion value of 80 kPa may be adopted for the portion of the shaft in weathered sandstone. When piles are founded in sandstone the adhesion within the overlying soils must be ignored.

To ensure the bearing values given can be achieved, care should be taken to ensure the base of the excavations is free of all loose material prior to concreting. To this end, it is recommended that all excavations be concreted as soon as possible, preferably immediately after excavating, cleaning, inspecting and approval. Pier excavations should not be left open overnight. The possibility of groundwater inflow needs to be considered when drilling the piers and pouring concrete.

Based on the test results and subsurface conditions, footings and slabs founded in the soils may be designed for soil movements consistent with a *Slightly Reactive (S)* classification.

During foundation construction, should the subsurface conditions vary to those inferred in this report, a suitably experienced geotechnical engineer should review the design and recommendations given above to determine if any alterations are required.

5.6. Soil Aggressiveness and Salinity

The aggressiveness or erosion potential of an environment in building materials, particularly concrete and steel is dependent on the levels of soil pH and the types of salts present, generally sulfates and chlorides. To determine the degree of aggressiveness, the test values obtained are compared to Tables 6.4.2 (C) and 6.5.2 (C) in AS2159 – 2009 Piling – Design and Installation. The test results are summarised in Table 5.2.

Table 5.2 – Soil Aggressiveness Summary Table

Sample No.	Location	Depth (m)	pH	Chloride (mg/kg)	Sulfate (mg/kg)	Electrical Conductivity (dS/m)	
						$EC_{1:5}$	EC_e
S1	BH1	0.2	7.1	570	50	0.303	4.0

The soils on the site are above groundwater. Therefore, soil conditions B are considered appropriate (AS2159).

In accordance with AS2159-2009 the exposure classification for the onsite soils is non-aggressive to both concrete and steel. In accordance with AS2870-2011 the soils are classified as A1.

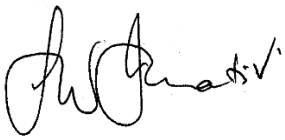
Reference to DLWC (2002) "Site Investigations for Urban Salinity" indicates that an EC_e value of 4.0 dS/m is consistent with the presence of *slightly to moderately saline* soils.

6. FINAL COMMENTS

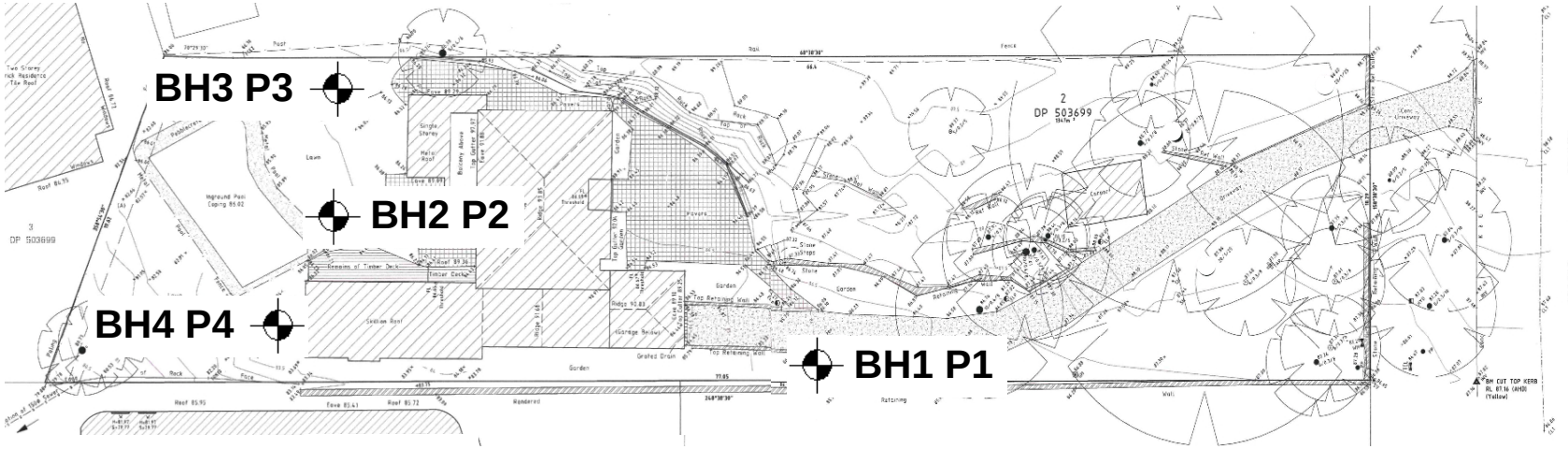
During construction, should the subsurface conditions vary from those inferred above, we would be contacted to determine if any changes should be made to our recommendations.

The exposed bearing surfaces for footings should be inspected by a geotechnical engineer to ensure the allowable pressure given has been achieved.

Manoj Shrestha
Geotechnical Engineer
STS Geotechnics Pty Limited



Laurie Ihnativ
Principal Geotechnical Engineer
STS Geotechnics Pty Limited



STS Geotechnics Pty. Ltd.	Scale: Unknown	Date: February 2024
Client: MRZ DESIGNS		
GEOTECHNICAL INVESTIGATION **32 CASTLE CIRCUIT, SEAFORTH** **BOREHOLE AND PENETROMETER LOCATIONS**		Project No. 32577/8400D-G Drawing No: 24/0234

Important Information

GEOTECHNICS PTY LTD
CONSULTING GEOTECHNICAL ENGINEERS

INTRODUCTION

These notes have been provided to outline the methodology and limitations inherent in geotechnical reporting. The issues discussed are not relevant to all reports and further advice should be sought if there are any queries regarding any advice or report. When copies of reports are made, they should be reproduced in full.

GEOTECHNICAL REPORTS

Geotechnical reports are prepared by qualified personnel on the information supplied or obtained and are based on current engineering standards of interpretation and analysis.

Information may be gained from limited subsurface testing, surface observations, previous work and is supplemented by knowledge of the local geology and experience of the range of properties that may be exhibited by the materials present. For this reason, geotechnical reports should be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Where the report has been prepared for a specific purpose (eg. design of a three-storey building), the information and interpretation may not be appropriate if the design is changed (eg. a twenty storey building). In such cases, the report and the sufficiency of the existing work should be reviewed by STS Geotechnics Pty Limited in the light of the new proposal.

Every care is taken with the report content, however, it is not always possible to anticipate or assume responsibility for the following conditions:

- Unexpected variations in ground conditions. The potential for this depends on the amount of investigative work undertaken.
- Changes in policy or interpretation by statutory authorities.
- The actions of contractors responding to commercial pressures.

If these occur, STS Geotechnics Pty Limited would be pleased to resolve the matter through further investigation, analysis or advice.

UNFORSEEN CONDITIONS

Should conditions encountered on site differ markedly from those anticipated from the information contained in the report, STS Geotechnics Pty Limited should be notified immediately. Early identification of site anomalies generally results in any problems being more readily resolved and allows re-interpretation and assessment of the implications for future work.

SUBSURFACE CONDITIONS

Logs of a borehole, recovered core, test pit, excavated face or cone penetration test are an engineering and/or geological interpretation of the subsurface conditions. The reliability of the logged information depends on the drilling/testing method, sampling and/or observation spacings and the ground conditions. It is not always possible or economic to obtain continuous high quality data. It should also be recognised that the volume or material observed or tested is only a fraction of the total subsurface profile.

Interpretation of subsurface information and application to design and construction must take into consideration the spacing of the test locations, the frequency of observations and testing, and the possibility that geological boundaries may vary between observation points.

Groundwater observations and measurements outside of specially designed and constructed piezometers should be treated with care for the following reasons:

- In low permeability soils groundwater may not seep into an excavation or bore in the short time it is left open.
- A localised perched water table may not represent the true water table.
- Groundwater levels vary according to rainfall events or season.
- Some drilling and testing procedures mask or prevent groundwater inflow.

The installation of piezometers and long term monitoring of groundwater levels may be required to adequately identify groundwater conditions.

SUPPLY OF GETEOECHNICAL INFORMATION OR TENDERING PURPOSES

It is recommended tenderers are provided with as much geological and geotechnical information that is available and that where there are uncertainties regarding the ground conditions, prospective tenders should be provided with comments discussing the range of likely conditions in addition to the investigation data.

APPENDIX A – BOREHOLE LOGS AND EXPLANATION SHEETS

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: MRZ Designs	Project: 32577/8400D-G	**BOREHOLE NO.:**	**BH 1**
Project: 32 Castle Circuit, Seaforth	Date : January 30, 2024		
Location: Refer to Drawing No. 24/0234	Logged: PS Checked By: MT	Sheet 1 of 1	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
	S1 @ 0.2 m	0.5	TOPSOIL/FILL: CLAYEY SAND: fine to medium grained, dark grey, rootlets	SC		D
	D	1.0	CLAYEY SILTY SAND: fine to medium grained, grey Grading with grey/yellow	SC/SM	LOOSE MEDIUM DENSE	D-M
		1.5	WEATHERED SANDSTONE:	XW	EXTREMELY LOW STRENGTH	D
		2.0 2.5	AUGER REFUSAL AT 1.5 M ON WEATHERED SANDSTONE			

D - disturbed sample U - undisturbed tube sample B - bulk sample

WT - level of water table or free water N - Standard Penetration Test (SPT)

S - jar sample

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

Contractor: STS

Equipment: Mini Christie

Hole Diameter (mm): 100

Angle from Vertical (^{o}): 0

Drill Bit: Spiral

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: MRZ Designs	Project: 32577/8400D-G	**BOREHOLE NO.: BH 2**
Project: 32 Castle Circuit, Seaforth	Date : January 30, 2024	
Location: Refer to Drawing No. 24/0234	Logged: PS Checked By: MT	Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			TOPSOIL/FILL: CLAYEY SAND: fine to medium grained, dark grey	SC		D
		0.5	CLAYEY SILTY SAND: fine to medium grained, grey/brown	SC/SM	LOOSE	D-M
		1.0	SILTY SAND: fine to medium grained, brown, trace gravel	SM	MEDIUM DENSE	M
		1.5	PUSH TUBE REFUSAL AT 1.3 M ON WEATHERED SANDSTONE			
		2.0				
		2.5				

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Push Tube
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: MRZ Designs	Project: 32577/8400D-G	**BOREHOLE NO.: BH 3**
Project: 32 Castle Circuit, Seaforth	Date : January 30, 2024	
Location: Refer to Drawing No. 24/0234	Logged: PS Checked By: MT	Sheet 1 of 1

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
		0.5	TOPSOIL/FILL: CLAYEY SAND: fine to medium to coarse grained, dark grey	SC		D
		1.0	SILTY SAND: fine to medium grained, brown, trace gravel	SM	MEDIUM DENSE	M
		1.5	PUSH TUBE REFUSAL AT 1.3 M ON WEATHERED SANDSTONE			
		2.0				
		2.5				

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Push Tube
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

STS Geotechnics Pty Ltd

GEOTECHNICAL LOG - NON CORE BOREHOLE

Client: MRZ Designs	Project: 32577/8400D-G	**BOREHOLE NO.:**	**BH 4**
Project: 32 Castle Circuit, Seaforth	Date : January 30, 2024		
Location: Refer to Drawing No. 24/0234	Logged: PS Checked By: MT	Sheet 1 of 1	

WATER TABLE	SAMPLES	DEPTH (m)	DESCRIPTION OF DRILLED PRODUCT Soil Name, grain size /plasticity, colour; secondary constituents (Inc. Description) , minor constituents including other remarks	SYMBOL	CONSISTENCY (cohesive soils) or RELATIVE DENSITY (sands and gravels)	MOISTURE
			FILL: CLAYEY SAND: fine to medium grained, dark grey, trace of gravel	SC		D-M
		0.5	CLAYEY SILTY SAND: fine to medium grained, grey Grading to brown, trace of gravel	SC/SM	MEDIUM DENSE	D-M
		1.0	PUSH TUBE REFUSAL AT 1.0 M ON WEATHERED SANDSTONE			
		1.5				
		2.0				
		2.5				

D - disturbed sample
U - undisturbed tube sample
B - bulk sample
WT - level of water table or free water
N - Standard Penetration Test (SPT)
S - jar sample

Contractor: STS
Equipment: Push Tube
Hole Diameter (mm): 100
Angle from Vertical (^{o}): 0
Drill Bit: Spiral

NOTES: See explanation sheets for meaning of all descriptive terms and symbols

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STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Dynamic Cone Penetrometer Test Report

Project: 32 CASTLE CIRCUIT, SEAFORTH
Client: MRZ DESIGNS
Address: PO Box 170, St. Clair
Test Method: AS 1289.6.3.2

Project No.: 32577/8400D
Report No.: 24/0233
Report Date: 2/2/2024
Page: 1 of 1

Site No.	P1	P2	P3	P4		
Location	Refer to Drawing No. 24/0234	Refer to Drawing No. 24/0234	Refer to Drawing No. 24/0234	Refer to Drawing No. 24/0234		
Date Tested	30/1/2024	30/1/2024	30/1/2024	30/1/2024		
Starting Level	Surface Level	Surface Level	Surface Level	Surface Level		
Depth (m)	Penetration Resistance (blows / 150mm)					
0.00 - 0.15	1	1	1	2		
0.15 - 0.30	2	1	2	2		
0.30 - 0.45	2	1	2	1		
0.45 - 0.60	2	4	3	7		
0.60 - 0.75	2	7	8	6		
0.75 - 0.90	1	3	5	10		
0.90 - 1.05	2	2	4	4		
1.05 - 1.20	8	8	6	Refusal		
1.20 - 1.35	4/50	5	3			
1.35 - 1.50	Refusal	Refusal	Refusal			
1.50 - 1.65						
1.65 - 1.80						
1.80 - 1.95						
1.95 - 2.10						
2.10 - 2.25						
2.25 - 2.40						
2.40 - 2.55						
2.55 - 2.70						
2.70 - 2.85						
2.85 - 3.00						
3.00 - 3.15						
3.15 - 3.30						
3.30 - 3.45						
3.45 - 3.60						
3.60 - 3.75						

Remarks: * Pre drilled prior to testing

Approved Signatory.....
Technician: PS
Orlando Mendoza - Laboratory Manager

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EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD

HA	Hand Auger	**ADH**	Hollow Auger	**NQ**	Diamond Core - 47 mm
DT	Diatube Coring	**RT**	Rotary Tricone bit	**NMLC**	Diamond Core - 52 mm
NDD	Non-destructive digging	**RAB**	Rotary Air Blast	**HQ**	Diamond Core - 63 mm
AD*	Auger Drilling	**RC**	Reverse Circulation	**HMLC**	Diamond Core - 63 mm
***V**	V-Bit	**PT**	Push Tube	**EX**	Tracked Hydraulic Excavator
***T**	TC-Bit, e.g. AD/T	**WB**	Washbore	**HAND**	Excavated by Hand Methods

PENETRATION RESISTANCE

L	**Low Resistance**	Rapid penetration/ excavation possible with little effort from equipment used.
M	**Medium Resistance**	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	**High Resistance**	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	**Refusal/Practical Refusal**	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

Standing Water Level **Partial water loss**

Water Seepage **Complete Water Loss**

GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.
GWNE	GROUNDWATER NOT ENCOUNTERED - Borehole/ test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/ test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Testing to AS1289.6.3.3 2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
S1	Jar sample – number indicates sample number
D	Disturbed Sample
B	Bulk disturbed Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
PP	Pocket Penetrometer test expressed as instrument reading in kPa
DCP	Dynamic Cone Penetrometer (AS1289.6.3.1 1997)
PSP	Perth Sand Penetrometer (AS1289.6.3.2 1997)

GEOLOGICAL BOUNDARIES

———— = Observed Boundary (Position known)

– – – – – – – – – – = Observed Boundary (Position approximate)

– –?– –?– –?– – = Boundary (Interpreted or inferred)

ROCK CORE RECOVERY

TCR =Total Core Recovery (%)

$$= \frac{Length\ of\ core\ recovered}{Length\ of\ core\ run} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum Axial\ lengths\ of\ core > 100mm}{Length\ of\ core\ run} \times 100$$

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METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

FILL

COUBLES or BOULDERS

GRAVEL (GP or GW)

ORGANIC SOILS (OL, OH or Pt)

SILT (ML or MH)

CLAY (CL, CI or CH)

SAND (SP or SW)

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay

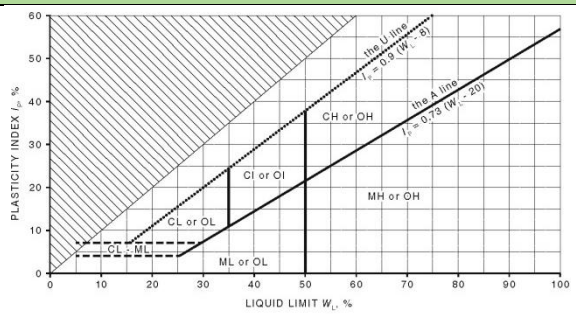
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions		Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	GRAVEL More than 50% of coarse fraction is >2.36mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM	Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC	Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW	Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP	Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM	Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC	Clayey sand, sandy-clay mixtures, medium to high dry strength.
FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	Liquid Limit less < 50%	ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL	Organic silts and organic silty clays of low plasticity, low to medium dry strength.
	Liquid Limit > than 50%	MH	Inorganic silts of high plasticity, high to very high dry strength.
		CH	Inorganic clays of high plasticity, high to very high dry strength.
		OH	Organic clays of medium to high plasticity, medium to high dry strength.
Highly Organic soil		PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit (w < PL); Moist, near plastic limit ($w \approx$ PL); Moist, wet of plastic limit (w < PL); Wet, near liquid limit ($w \approx$ LL), Wet, wet of liquid limit (w > LL),

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N" #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to 8
St	Stiff	>50 to ≤ 100	>8 to 15
VSt	Very Stiff	>100 to ≤ 200	>15 to 30
H	Hard	>200	>30
Fr	Friable	-	

DENSITY

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material. # SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add '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 soil: ≤ 15%
Add 'With'	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: >12% Fine grained soil: >30%

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TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) #	Field Guide
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

 # Rock Strength Test Results

▼ Point Load Strength Index, $Is_{(50)}$, Axial test (MPa)

● Point Load Strength Index, $Is_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically 20 x $Is_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
XW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

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CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Defect Spacing

Spacing/width (mm)	Descriptor	Symbol
<20	Extremely Close	EC
20-60	Very Close	VC
60-200	Close	C
200-600	Medium	M
600-2000	Wide	W
2000-6000	Very Wide	VW

Bedding Thickness (Stratification)

Term	Spacing (mm)
Thinly laminated	<6
Laminated	6 – 20
Very thinly bedded	20 – 60
Thinly bedded	60 – 200
Medium bedded	200 – 600
Thickly bedded	600 – 2,000
Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation: **Vertical Boreholes –** The dip (inclination from horizontal) of the defect.
Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description
Clean	CN	No visible coating or infilling
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy

DEFECT APERTURE

Aperture	Abbr.	Description
Closed	CL	Closed.
Open	OP	Without any infill material.
Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

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APPENDIX B – LABORATORY TEST RESULTS

STS GEOTECHNICS PTY LTD
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STS Geotechnics Pty Ltd
14/1 Cowpasture Place, Wetherill Park NSW 2164
Phone: (02)9756 2166 | Email: enquiries@stsgeo.com.au

Atterberg Limits and Linear Shrinkage Report

Project: 32 CASTLE CIRCUIT, SEAFORTH — Project No.: 32577/8400D-L

Client: MRZ DESIGN & PTY LTD — Report No.: 24/0291

Address: PO BOX 170,ST CLAIR, 2759 — Report Date: 8/02/2024

Test Method: AS1289.3.1.2, 3.2.1, 3.4.1, 2.1.1 — Page: 1 of 1

Sampling Procedure: AS 1289.1.2.1 Clause 6.5.3 - Power Auger Drilling (Not covered under NATA Scope of Accreditation)

STS / Sample No.	8400D-L / 1					
Sample Location	Borehole 1, Refer to Drawing No. 24/0234					
Material Description	Clayey Silty Sand, grey (SC/SM)					
Depth (m)	0.6 - 0.9					
Sample Date	30/01/2024					
Sample History	Oven Dried					
Method of Preparation	Dry Sieve					
Liquid Limit (%)	**19**					
Plastic Limit (%)	**15**					
Plasticity Index	**4**					
Linear Shrinkage (%)	**2.0**					
Mould Size (mm)	127					
Crumbing	N					
Curling	N					

Remarks:

Approved Signatory..... .....

Technician: DH

Orlando Mendoza - Laboratory Manager

CERTIFICATE OF ANALYSIS

Work Order	: **ES2403091**	Page	: 1 of 2
Client	: **STS Geotechnics**	Laboratory	: Environmental Division Sydney
Contact	: ENQUIRES STS	Contact	: Customer Services ES
Address	: Unit 14/1 Cowpasture Place Wetherill Park 2164	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 32560/32564/32577	Date Samples Received	: 31-Jan-2024 14:40
Order number	: 2024-031	Date Analysis Commenced	: 01-Feb-2024
C-O-C number	: ----	Issue Date	: 07-Feb-2024 15:14
Sampler	: IS, PS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 5		
No. of samples analysed	: 5		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	32560/S1	32560/S2	32560/S3	32564/S1	32577/S5
			Sampling date / time	29-Jan-2024 00:00	29-Jan-2024 00:00	29-Jan-2024 00:00	30-Jan-2024 00:00	30-Jan-2024 00:00
Compound	CAS Number	LOR	Unit	ES2403091-001	ES2403091-002	ES2403091-003	ES2403091-004	ES2403091-005
				Result	Result	Result	Result	Result
EA002: pH 1:5 (Soils)								
pH Value	----	0.1	pH Unit	**4.8**	**4.7**	**4.4**	**5.6**	**7.1**
EA010: Conductivity (1:5)								
Electrical Conductivity @ 25°C	----	1	µS/cm	**136**	**148**	**145**	**129**	**303**
EA055: Moisture Content (Dried @ 105-110°C)								
Moisture Content	----	0.1	%	**19.0**	**22.2**	**24.3**	**12.4**	**24.2**
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**40**	**60**	**50**	**100**	**50**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	10	mg/kg	**170**	**180**	**180**	**470**	**570**