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FINAL REPORT
GEOTECHNICAL INVESTIGATION
KINTYRE ADVANCEMENT PROJECT
RUDALL RIVER REGION, WESTERN AUSTRALIA
for
Canning Resources Pty Limited

CRAE R/N 23039

DAMES & MOORE

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Ref: SJD:sor/15780-018-361/DK:218-B604.DOC/PER
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21 October 1996

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Attention: Ms Bronwyn Roberts/Mr Bruce Hawley

Dear Madam/Sir

FINAL REPORT
GEOTECHNICAL INVESTIGATION
KINTYRE ADVANCEMENT PROJECT
RUDALL RIVER REGION, WESTERN AUSTRALIA

We are pleased to enclose three copies of our final report. We trust this report meets with your requirements. If you have any queries, please do not hesitate to contact the undersigned.

Yours faithfully
DAMES & MOORE

D.C. Elias *CPEng*
Consultant-in-Charge
Geotechnical Services

Ref: SJD:sor/15780-018-361/DK:218-B604/PER

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TABLE OF CONTENTS

Page N°

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

FINAL REPORT
GEOTECHNICAL INVESTIGATION
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1.0 INTRODUCTION

Canning Resources Pty Limited (Canning Resources) propose to develop a uranium mine and associated treatment facilities at Kintyre in the Rudall River region of Western Australia. The project will be located on the western edge of the Great Sandy Desert in the Eastern Pilbara Region of Western Australia, approximately 1,200km north-northeast of Perth, and 70km south of Telfer. The project area is shown on Figure 1, and is located to the north of the Rudall River National Park.

Dames & Moore was appointed as Geotechnical Consultants to carry out the geotechnical investigation as per Canning Resources Professional Appointment CR10054, dated 3 July 1996.

2.0 PROPOSED CONSTRUCTION AND OPERATIONS

2.1 GENERAL

The project will involve an open-cut mine and associated treatment facilities to initially produce 1,200tpa of U_3O_8, with the potential of increasing production up to 2,000tpa, over a twenty year period. There is also a potential to extend the project life as further resources are identified in the area.

The area required for the mining, processing and disposal of waste and water will be approximately 3km^2 . The uranium recovery plant is planned to cover an area of approximately 250m by 250m, and is planned to be located south of the Kintyre Hill (Kintyre Hill is shown on Figures 2 and 4). Tailings disposal and evaporation ponds are also planned to be located to the south, or southwest, of the Kintyre Hill. Associated infrastructure will include an accommodation village, power supply, workshops, warehouse, and an upgraded airstrip and access road. The associated infrastructure will require an additional area of approximately $1km^2$.

The total volume of material mined in any one year will vary according to final pit designs, stripping ratios, ore grades and processing requirements. Data presented in Table 1 are indicative of the volume of materials to be produced during the early years of mining in order to produce 1,200tpa of U_3O_8. The data show that the volume of material to be chemically treated, and therefore the resultant leach residue (tails) volume, is less than 1% of the total material mined.

TABLE 1

INDICATIVE AVERAGE VOLUME OF MATERIALS PRODUCED DURING THE EARLY YEARS OF MINING

Material Type	Production (tpa)	% of Material as a Proportion of Material Entering Dry Sorting
Total material mined	6,000,000	
Bulk Waste Rock	5,400,000	
Material to dry sorting	600,000	100
Waste Rock and BOGUM[2]	560,000	92.5
Acid Leach Feed	45,000	7.5
Leach Residue	42,000	7.0
Iron Precipitate	1,800[1]	0.3
U_3O_8 Product	1,200	0.2

Notes:
1 Including additional lime iron precipitate will be approximately 3,000tpa.
2 BOGUM is Below Ore Grade Uranium Mineralisation material.

Material volumes will increase as mining progresses from the Kintyre pit to the Whale and East Whale pits, due to increased stripping requirements. The volume of process waste products will increase proportionally as U_3O_8 production increases.

2.2 MINING, PROCESSING AND WASTE DISPOSAL

The project will involve the mining of the Kintyre, East Kintyre, Whale, East Whale and Pioneer deposits by conventional open pit methods. Mining could be undertaken either progressively or on a campaign basis.

Processing will be undertaken in two stages consisting of a predominantly dry upgrading phase, which minimises the amount of material that needs to be treated, and a wet phase where the uranium is recovered. The wet plant processing will be undertaken in three stages; leaching, iron pre-precipitation and uranium precipitation.

2.2.1 Leaching

The accept fraction from the dry plant will be finely ground before being acid leached. An oxidant (such as Caro's Acid) and sulphuric acid will be used to leach the uranium. The liquor will be directed to the iron pre-precipitation stage of processing. The remaining solids will be washed and filtered prior to disposal.

2.2.2 Iron Pre-precipitation

The liquor containing the uranium from the leach phase will contain impurities, such as iron, which will need to be removed prior to the recovery of the uranium. Precipitation of the iron will be achieved through the addition of lime to produce a mixed gypsum and iron hydroxide solid. The solid will be separated from the liquor and be disposed of in the tailings disposal area (separately from the leach residue). The liquor will be recycled back to the process.

2.2.3 Uranium Precipitation

Uranium in the liquor will be precipitated through the addition of hydrogen peroxide and sodium carbonate. The uranium crystals formed will be removed from the liquor using filters and clarifiers. The uranium will then be calcined to produce the uranium oxide product and robotically packaged prior to export. Process liquor will be recycled where possible. The remaining waste liquors will be directed to evaporation ponds for disposal.

2.2.4 Tailings

Two streams of tailings will be generated. These are:

- leach residue filter cake comprising the residual ground ore with most of the uranium removed; and
- iron precipitate which comprises mainly calcium sulphate (gypsum) and ferric hydroxide.

The leach residue will contain some radioactive material, equivalent to approximately 3%U, which must be managed accordingly. Disposal operations will be guided by the Code of Practice for the Near-surface Disposal of Radioactive Waste, 1992.

2.2.5 Wastewaters

Two principal wastewater streams from the project will be:

- waste filtrates from processing; and
- washwaters from equipment and floor hosings.

Waste filtrates and washwaters will be recycled where possible with the remaining waters directed to evaporation ponds which will be specifically designed to minimise seepage.

3.0 SCOPE OF WORK

The scope of work for the geotechnical investigation is defined in Canning Resources Professional Appointment CR10054. The scope was expanded during the fieldwork phase to include an investigation at the proposed location of a "domestic" waste disposal facility, and to include an additional borehole, with *in situ* permeability testing, for the proposed tailings disposal area.

The scope of work carried out is described in Sections 3.1 to 3.5, inclusive.

3.1 DESK-TOP STUDY

- Review of available data on geology and hydrogeology of the area.

3.2 FIELDWORK - MATERIALS SEARCH, EARTHEN PAD FOR METALLURGICAL TEST FACILITY, AND DOMESTIC WASTE DISPOSAL FACILITY

- "Drive over" assessment by a geotechnical engineer/engineering geologist; and
- excavation of 20 backhoe pits for investigation and sampling of materials encountered. These data were supplemented by existing geotechnical data in our files from previous studies in the general vicinity of the proposed Kintyre mine.

3.3 FIELDWORK - INVESTIGATION FOR TAILINGS AND WASTEWATER DISPOSAL FACILITIES

- Drilling and sampling of five boreholes to depths in the range 15.25m to 22.7m;
- backfilling the holes with a bentonite and cement mixture (this is necessary to ensure that future pathways for contaminants are not created by the drilling);
- collection of "undisturbed" samples using the Dames & Moore "U" type sampler;
- performance of Standard Penetration Tests in cohesive and cohesionless soils to assess the consistency/relative density and strength parameters, and to obtain samples for visual and laboratory identification purposes; and
- performance of *in situ* permeability tests, including drilling two additional holes to depths of 2.0m and 4.85m at the location of the fifth borehole in order to conduct *in situ* permeability tests in the near-surface cohesionless soils.

3.4 LABORATORY TESTING

- Laboratory testing of selected soil samples to assess physical and strength characteristics, including:
  - moisture and density;
  - particle size distribution by sieving and hydrometer;
  - Atterberg limits;
  - linear shrinkage;
  - moisture-density relationships;
  - permeability;
  - cohesion and friction angle by effective stress triaxial testing;
  - California Bearing Ratio (CBR);
  - erosion (pinhole test); and
  - pH.

3.5 REPORTING

- Preparation of a formal report detailing the results of the study, and including:
  - a map showing potential borrow sources and estimated quantities and qualities of materials available;
  - a plan showing locations of test pits and boreholes;
  - logs of test pits and boreholes;
  - results of laboratory analyses;
  - a description of subsurface conditions encountered in the proposed tailings and wastewater disposal areas;
  - a discussion of the proposed sites of the earthen pad for the metallurgical test facility, and the "domestic" waste disposal facility; and
  - a discussion on the suitability of the proposed waste disposal trenches and evaporation ponds with due consideration of the wastes and types of facilities.

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4.0 DESK-TOP STUDY

The desk-top study comprised a review of the CRA Exploration (CRAE) database of exploration boreholes drilled at the site, in order to assess the available geological data. On the basis of this database review, it was established that the logs of 64 exploration boreholes within the site indicated the presence of clay. Additionally, it was established that the borings listed in Table 2 were both within the preferred area for the tailings and waste disposal facilities, and contained significant "clay" layers.

TABLE 2

EXPLORATION BOREHOLES CONTAINING CLAY WITHIN PROPOSED WASTE DISPOSAL AREAS

Boring ID	Easting (m AMG)	Northing (m AMG)	Depth of Clay Layer[1]	
			From (m)	To (m)
KP196	404659.9	7528238	6	63
KP197	404666.9	7528437	6	74
KP198	404673.8	7528637	7	94
KP199	403867.6	7528465	7	82
KP200	403860.4	7528266	5	69
KP201	403853.4	7528066	3	35
KP202	403355.6	7528083	8	18
KP204	403361.8	7528282	9	40
KP206	403368.0	7528483	6	86

Note: 1. As described in logs of exploration boreholes provided by CRA Exploration.

On the basis of the above data and discussions with representatives from Canning Resources, the intended approximate location of the geotechnical investigation borings was established.

A review of available hydrogeological data (Dames & Moore, 1993) indicated that the level of the groundwater in the vicinity of the borings was approximately 355m to 357m RL. Additionally, survey plans indicated that the ground surface elevation on the vicinity varied from 376m to 380m RL. Therefore, a depth to groundwater varying from 26m to 23m could be expected.

5.0 FIELD INVESTIGATIONS

5.1 GENERAL

The geotechnical site investigation was carried out between 11 July 1996 and 22 July 1996 and comprised drilling of a total of seven boreholes and excavating 20 test pits. All testpitting work was carried out by a backhoe, and operator, made available by Canning Resources on site. Mud rotary drilling was carried out on behalf of J&S Drilling by Oz Drill. The testpit and borehole logs are presented in Appendix A.

During the geotechnical drilling, soil samples were typically taken in the boreholes at 1.5m intervals using a Dames & Moore "U" Type Sampler, or a Standard Penetration Test (SPT) split spoon sampler. The soil encountered was typically hard in consistency, therefore, the Dames & Moore sampler was advanced by blows from the SPT hammer, with the blow counts being converted to, and recorded as, equivalent SPT "N" values.

All work was supervised by a geotechnical engineer from Dames & Moore. Each phase of the fieldwork is discussed separately in Sections 5.2 to 5.5, inclusive.

5.2 PROPOSED DOMESTIC WASTE DISPOSAL FACILITY

Five test pits, numbered TP96-1 to TP96-5 inclusive, were excavated to depths in the range 1.1m to 2.1m at the Domestic Waste Disposal Facility site proposed by Canning Resources. The location of the excavated test pits are shown on Figure 3. The logs are presented in Appendix A.

5.3 PROPOSED METALLURGICAL TEST FACILITY

Five test pits were excavated to depths in the range 1.2m to 3.7m at the proposed Metallurgical Test Facility site, numbered TP96-6 to TP96-10, inclusive. The locations of the excavated test pits are shown on Figure 4. The logs are presented in Appendix A

5.4 PROPOSED ROAD CONSTRUCTION MATERIAL BORROW AREA

Ten test pits were excavated to depths in the range 1.2m to 2.7m on the northern side of the Kintyre Hill in order to investigate this area as a potential source of unsealed road construction material. The test pits are numbered TP96-11 to TP96-20, inclusive, and the locations are shown on Figure 4. The logs are presented in Appendix A.

5.5 PROPOSED EVAPORATION PONDS, TAILINGS DAMS AND TRENCH DISPOSAL AREA

Five boreholes, numbered DM96-1 to DM96-4, inclusive, and DM96-5B, were drilled to depths in the range 15.25m to 22.7m at potential locations for tailings and wastewater disposal. An additional two boreholes, numbered DM96-5A and DM96-5C, were drilled to depths of 2.0m and 4.85m, respectively, near the location of Borehole DM96-5B in order to carry out *in situ* permeability tests (falling head tests) in near-surface cohesionless soils. Table 3 presents a summary of the borehole depths and approximate locations derived from a hand held GPS unit. The approximate borehole locations are shown on Figure 2, and the logs are presented in Appendix A.

TABLE 3

BOREHOLE LOCATIONS AND DEPTHS

Boring No.	Easting* (m AMG)	Northing* (m AMG)	Depth Drilled (m)
DM96-1	403415	7528225	19.65
DM96-2#	403830	7528210	22.7
DM96-3	404298+	7528260+	21.15
DM96-4	402720	7528134	15.25
DM96-5A	403915	7528805	2.0
DM96-5B	403919▲	7528801▲	21.55
DM96-5C	403919▲	7528798▲	4.85

Notes:
*	Eastings and Northings are approximate only as they are based on the readout from a hand held GPS unit.
#	DM96-2 was drilled 4m north of KP200.
+	Based on the average of two readings.
▲	Based on offset from DM96-5A.

Falling head tests were carried out in all boreholes. The results are presented in Appendix B. Each falling head test was conducted at the required depth during the drilling of the borehole by:

(i) casing to the bottom of the borehole with HW casing;
(ii) drilling a hole with a BQ bit below the bottom of the casing, using water without drilling mud;
(iii) filling the hole with potable water to the top of the casing; and
(iv) recording the fall in water level below the top of the casing with time.

Generally, the test was repeated a number of times in each borehole so that a typical permeability value could be determined and inconsistencies could be minimised.

All boreholes were backfilled with a cement/bentonite mixture to ensure that future pathways for contaminants are not created by the drilling program.

6.0 LABORATORY TESTING

Laboratory classification, strength, permeability and compaction tests have been performed on selected samples recovered from the test pits and borings. Testing was conducted by Western Geotechnics.

The testing program comprised determinations of moisture content, density, Atterberg limits, linear shrinkage, particle size distribution, fines content, California Bearing Ratio (CBR soaked), permeability, moisture-density relationships (compaction), and erosion potential. A multi-stage consolidated-undrained triaxial compression test was conducted on one sample of hard clay. Clay mineralogy testing was conducted by Roger Townend & Associates on two selected samples.

The laboratory test certificates are presented in Appendix C. Table 4 presents the number of laboratory determinations undertaken for each type of test.

TABLE 4

SUMMARY OF LABORATORY TEST PROGRAM

Laboratory Test	Number of Tests Performed
Moisture Content	37
Density	5
Particle Size Distribution	29
Hydrometer Analysis	10
Percent Fines	4
Atterberg Limits	39
Modified Compaction	10
California Bearing Ratio (CBR soaked)	8
Pinhole Dispersion	2
pH (soil)	5
Falling Head Permeability	4
Consolidated Undrained Triaxial	1
Clay Mineralogy	2

7.0 SURFACE AND SUBSURFACE CONDITIONS

7.1 DOMESTIC WASTE DISPOSAL SITE

The domestic waste disposal site proposed by Canning Resources is located adjacent to hills, southwest of Camp Tracy (Figure 3). The ground at the location of the proposed site generally slopes away from the hills that are present to the south and east of the proposed site. The site was dry at the time of the investigation, with apparent drainage paths emanating from the adjacent hills, traversing the proposed site, heading north. The surface comprised sandy gravel, and was partially covered with low bushes and grasses. The elevation of the area to the west of the site was observed to be lower than that at the proposed site. This area to the west appears to be a former borrow area for road construction materials, and is labelled as such on Figure 3. This observation is supported by apparent revegetation lines on aerial photographs taken in 1988.

The five test pits excavated at the proposed domestic waste disposal site (TP96-1 to TP96-5, inclusive) were excavated to refusal at depths in the range 1.1m to 2.1m. Sandy silty gravel was observed to be present from the surface to the depths of refusal (in the range 1.8 to 2.1m) at the locations of Test Pits TP96-1 to TP96-3, inclusive, and to 1.0m, overlying highly to completely weathered siltstone in Test Pit TP96-5. Gravelly silty sand was observed from the surface to a depth of 0.4m, overlying highly to completely weathered siltstone, in Test Pit TP96-4.

No groundwater was observed at the time of the investigation.

7.2 METALLURGICAL TEST FACILITY

The proposed Metallurgical Test Facility site is located to the southwest of the Kintyre Hill (Figure 4). The ground at the proposed site is relatively flat with partial low scrub coverage, and the near surface soils comprise fine to medium grained, reddish brown sand and silty sand.

Four test pits, numbered TP96-6 to TP96-9, inclusive, were excavated at the four corners of the general area under consideration for the test facility site, and revealed similar subsurface conditions. The four pits were excavated to depths in the range 2.3m to 3.7m. The material intersected was generally granular, comprising:

- silty sand from the surface to the completion depth of 3.7m and 3.3m in TP96-6 and TP96-7 respectively; and
- approximately two metres of silty sand overlying gravelly sand and sandy gravel in test pits TP96-8 and TP96-9. These testpits were terminated at near refusal in the gravelly material.

The fifth test pit TP96-10 was excavated approximately 90m to the northeast of TP96-6, near the edge of Kintyre Hill (see Figure 4). The observed soil stratum at this location comprised 1.1m of orange brown sand, overlying weak, grey, highly weathered sandstone. This testpit was terminated at a depth of 1.2m.

7.3 PROPOSED ROAD CONSTRUCTION MATERIAL BORROW AREA

The proposed road construction material borrow area is located on the north side of Kintyre Hill (Figure 4). The ground at the location of the site generally slopes away from Kintyre Hill to the north. The surface comprised sandy gravel and gravelly sand, and was partially covered with low vegetation.

Ten testpits (TP96-11 to TP96-20 inclusive) were excavated to refusal at the proposed borrow site. The depths excavated before refusal was encountered ranged from 1.2m to 2.7m, with an average depth of 2.2m. The soil stratum observed to the depths investigated typically comprises sandy gravel and sandy silty gravel, with colouration varying from orange-brown in the near surface soils to light brown in the underlying soils. According to the Unified Soil Classification System, the proportion of gravel present is in the range 35 to 56%. Also, the percentage of fine material (silt and clay) ranges from 15 to 30%.

7.4 PROPOSED EVAPORATION PONDS, TAILINGS DAMS AND TRENCH DISPOSAL AREA

The proposed tailings and waste disposal area is located on a relatively flat, wide plain some 1km to 1.5km southwest of Kintyre Hill (Figure 2). The plain collects runoff from hills on its south and western boundaries, and has a gentle fall (approximately 1% slope) in an east-northeast direction over most of the area. A locally steeper slope is present in the western area of the site in the vicinity of DM96-4. The surface conditions over the site typically comprised orange-brown quartz sand with partial grass and spinifex cover with some areas supporting the growth of low shrubs.

Figure 5 presents a section through Boreholes DM96-4, DM96-1, DM96-2 and DM96-3 in an approximately east-west direction. No interpretation has been made between borings due to the large distance between the borings (more than 400m). However, the figure shows that the stratigraphy at each borehole location is relatively similar. The stratigraphy generally comprises cohesionless soils to depths in the range 2.4 to 7.0m overlying typically hard to friable silty sand clay, sandy silty clay and silty clay. The surficial cohesionless soils typically comprise orange-brown, medium dense to very dense silty sand, with occasional sandy clayey gravel and clayey silty sand layers near the transition to the underlying clay strata. At the location of DM96-5A, B, C, loose gravelly silty sand was observed from the surface to approximately 2.5m depth.

8.0 DISCUSSION

8.1 GENERAL

On the basis of the site investigation soil descriptions, *in situ* testing and laboratory testing, we have made an assessment of the suitability of the soil materials for their proposed purpose. The following sections discuss each location in turn.

8.2 PROPOSED DOMESTIC WASTE DISPOSAL FACILITY

We understand that at this site "domestic" waste from the camp and operations is proposed to be disposed. On this basis we consider that the disposal facility would be classified as Class III landfill site under the Department of Environment Protection (DEP), Office of Waste Management's "Draft Waste Acceptance Criteria for Landfill Sites in WA". The basis for this assumption is that a Class III site can accept putrescible waste, whereas for example, a Class II site cannot. The above mentioned draft document defines putrescible waste as: "*waste that will decompose and become offensive, particularly household waste*".

Furthermore the draft DEP document states that the requirements for a Class III landfill site are: *"that it is a Gazetted landfill site with approved management plan, meeting the requirements of the "Criteria for Landfill Management"* (Health Department, 1993).

The Health Department of Western Australia's, Criteria for Landfill Management, 1993, states that:

> *"As a general rule, landfill sites on sandy soils should be lined unless the operator can demonstrate that there are unlikely to be downstream groundwater users and the receiving environment can assimilate the impact of the leachate."*

Additionally, the documents states that:

> *"Stormwater contaminated with leachate or waste materials shall be collected and managed as if it were leachate unless analysis confirms the contamination is not significant."*

Also:

> *"Interceptor diversion drains shall be constructed to divert surface runoff from any area of the site that has been filled."*

On the basis of our interpretation of the above in conjunction with information obtained from the site investigation, and assuming that Canning Resources would use the site classification and criteria discussed above as a "best practice approach", we consider that:

- because the proposed rubbish tip is near the toe of hills and drainage pathways run through the proposed site area, the diversion of these surface waters would be necessary;
- it is likely that highly to completely weathered siltstone will underlie surficial soils and this may limit the excavation depth achieved by excavating equipment; and
- the surficial soils comprising sandy silty gravels and gravelly silty sand may need to be lined to mitigate the impact of leachate percolating through the soil. Figure 6 presents the particle size grading curves for selected soil samples taken from the site.

8.3 PROPOSED METALLURGICAL TEST FACILITY

We understand that a cut to fill earthworks operation is proposed for the metallurgical test facility site. Accordingly, the laboratory testing was aimed at assessing whether the surficial soils were suitable. Figure 7 presents the particle size grading curves for the soil samples taken at the proposed site. These grading curves indicate that the material comprises a sand with an appreciable fines content. The Atterberg limit test results indicate that the fines are predominantly silt as they have both a low Liquid Limit and Plasticity Index. We consider that these silty sands should be suitable for recompaction in the proposed cut and fill operation. Table 5 presents a summary of the compaction test results.

TABLE 5

SUMMARY OF COMPACTION TEST RESULTS

Test Pit No.	Modified Maximum Dry Density (tm^3)	Optimum Moisture Content (%)
TP96-6	2.16	7.0
TP96-7	2.09	9.5

Note that the *in situ* moisture content of the sample from TP96-7 was 8.1%, which is 1.4% below optimum.

8.4 PROPOSED ROAD CONSTRUCTION BORROW SITE

The material tested from the site of the proposed borrow pit for road construction materials comprised a sandy silty gravel and sandy clayey gravel. Figure 8 presents the particle size grading curves for the tested samples, and indicates the material is relatively well graded.

We have assessed the suitability of this material as a wearing course for an unsealed road in accordance with the Australian Road Research Board's Unsealed Road manual (Australian Road Research Board, 1993).

In general, we consider that the material gradings indicate the material is reasonably suitable for use in unsealed pavement construction. However, the following should be noted.

- Ideally, for ease of grading and construction, 100% of the construction material should be finer than 26.5mm. The grading curves indicate 10% to 25% of material is coarser than this size. Also, it has been noted on the logs that some cobbles and boulders are present. Because of this it may be prudent to screen material coarser than say 25mm; this would provide an added benefit of supplying a limited quantity of clean gravel which may be used for various specialised functions (e.g. drainage).

- The material gradings generally indicate a slight excess of fines (silt and clay) relative to the total proportion of material graded as medium grained sand or smaller. As such the stability of the material as an unsealed road wearing course will be dependent on the nature of the fines, see Figure 9.

- Atterberg limit data indicate that the Plasticity Index (PI) of the fines is within ARRB's recommended bounds for an unsealed road wearing coarse material. Additionally the results of Linear Shrinkage testing also indicates that the material falls within the recommended bounds for an unsealed road wearing coarse material.

- As a general rule of thumb suggested by ARRB, the product of PI and % passing the 0.425mm sieve can be used as a control to avoid materials which are lacking in strength as a result of the combined effect of high fines and high plasticity. The product PI x % passing 0.425mm sieve may be limited to a value of 400, which was achieved for all but one of the samples tested. The sample which failed on this account was from TP96-15.

- A total of eight samples were tested to determine their 4-day soaked CBR ratio. The results of this testing gave CBR values for the material varying from 16 to 45 with an average value of 25.

In summary, we consider that the area investigated to the north of the Kintyre Hill, as shown on Figure 4, is suitable as a borrow area for unsealed pavement construction.

An estimate has been made of the quantities of material available from the proposed borrow pit. This estimate is based on 75% of the average depth of the material intersected over the ten test pits excavated being recoverable for use. The proposed borrow area is approximately 200m long by 75m wide. Hence, we consider that in the order of 24,000m^3 of material (prior to bulking) should be available. Additionally, if gravel material of size greater than 26.5mm is removed, this volume could be reduced by about 15%, leaving approximately 20,000m^3.

8.5 PROPOSED EVAPORATION PONDS, TAILINGS DAMS AND TRENCH DISPOSAL AREA

8.5.1 General

The clay soil horizon targeted for trench disposal or as a construction material was intersected at each of the five locations drilled. The depth to the surface of the clay varied from 2.4m to 7.0m as previously discussed. Owing to the depth and hard consistency of the stratum, it was not possible to obtain sufficient material through the geotechnical drilling to conduct laboratory testing to assess moisture/density relationships or changes in permeability as a function of compaction water content. To obtain sufficient quantities of material for such testing, a deep excavation or large diameter drilling (possibly percussion type drilling) would be necessary. We consider that it would be more appropriate to undertake such testing during the detailed design stage.

The *in situ* testing of the soils indicated that the clay material was hard to friable (undrained shear strength >200kPa) as the SPT "N" value was consistently greater than 50 blows for 300mm penetration. Additionally the falling head permeability tests conducted during the geotechnical site investigation provided the following permeability (k) values for the various material types observed.

$k = 10^{-8}$ to 10^{-7} m/s	for	Hard Silty Sandy CLAY and Silty CLAY (tested at 9.0m depth in Borehole DM96-1, and at 6.0m depth in Boreholes DM96-2, DM96-3 and DM96-4). This material type was observed in all boreholes below depths in the range 2.4 to 7.0m.
$k = 2 \times 10^{-8}$ m/s	for	Very Dense Silty SAND (tested at 3.0m depth in Borehole DM96-5C). This material type was observed in all boreholes above, and sometimes overlying, the hard silty sandy clay. Please note that layers of loose to dense silty sand and dense to very dense sandy clayey gravel have also been observed overlying the hard silty sandy clay.
$k = 10^{-5}$ m/s	for	Loose Gravelly Silty SAND (tested at 0.5m depth in Borehole DM96-5A). This material type was only observed between the surface and 2.5m depth at the location of DM96-5.

Note that the falling head permeability tests were performed in unsaturated strata. Therefore, because the soil in the vicinity of the borehole may not be fully saturated, the classical interpretation of falling head tests does not strictly apply, and the "seepage" permeability may change with time.

Laboratory falling head permeability tests were conducted on four remoulded samples. The samples tested comprised one clay sample from each of DM96-1, DM96-2 and DM96-5B and one gravelly silty sand sample from DM96-5B. The results of this testing are summarised in Table 6. The laboratory results are an order of magnitude lower than the *in situ* test results, which is common when comparing these types of results. The *in situ* test results should be used for design.

TABLE 6

LABORATORY FALLING HEAD PERMEABILITY TEST RESULTS

Sample I.D.	Sample Depth	Material Description	Dry Density (t/m^3)	Permeability (m/s)
DM96-1, #8	7.5m	Silty Sand CLAY	1.79	7.8×10^{-10}
DM96-2, #4	6.0m	Sandy Silty CLAY	1.84	1.2×10^{-9}
DM96-5B, #7	9.0m	Silty Sandy CLAY	1.88	1.5×10^{-10}
DM96-5B, #2	3.0m	Gravelly Silty SAND	1.80	2.5×10^{-10}

The sieve analyses indicate that the clay generally comprises between 70% and 98% fines, whereas the surficial sands typically comprise between 17% and 44% fines. The lower proportion of fines, 17%, relates to the loose, near surface gravelly silty sand intersected at DM96-5B and the higher value of 44% fines was for the clayey silty sand at DM96-3. The falling head permeability test results are consistent with the range of typical values reported in texts for both the clay and the overlying cohesionless materials (Bowles, 1979). The apparently low permeability (2×10^{-8}m/s) measured in the silty sand at DM96-5C is not unusual for a soil with a significant fines fraction (measured as 35% at the location of DM96-5B).

The hydrometer test results indicate that the particle sizing of the clay stratum is relatively consistent in each of the boreholes drilled. Of the "clay" samples tested, the proportion passing the 75μm sieve (silt and clay) comprised 60% to 89% with the typical proportion in the range 75% to 85%. Furthermore, the proportion of material finer than 2μm (clay minerals and fine silt) varied from 19% to 48%.

Two clay mineralogy tests were conducted, one on sample DM96-1 # 14 from 16.5m depth and the other on DM96-3 # 9 from 13.5m depth. The XRF and XRD (x-ray fluorescence/diffraction) analyses of the two samples provided similar results. The laboratory analyst stated that a variation in results of the magnitude observed would typically be expected for a single sample which had been split in two and tested separately. The results indicate that of the total sample only approximately 5% of DM96-1 #14 and 8% of DM96-3 #9 comprises clay minerals. The remainder of the fine particles comprises fragments of the larger quartz, mica and feldspar crystals present in the soil.

The Atterberg limits of the clay material (see Figure 10) indicate that the clay is of intermediate to high plasticity. The average linear shrinkage of the clay material was approximately 13.6%. The pH of the clay ranged from 8.6 to 9.6.

8.5.2 Trench Disposal

On the basis of the observations made, *in situ* testing conducted during the geotechnical site investigation, and the results of laboratory analyses, aspects of the suitability of the site for trench disposal are discussed below.

The first item considered is the available depth of excavation for the proposed trench, and the proportion of this excavation which will be in clay. The depth to groundwater is typically 18m with a recorded peak level of 16.5m below ground surface in December 1988 (Dames & Moore, 1993). If the recommendations in NH&MRC (1993) are adopted as "best practise" and a 5m buffer is maintained between the groundwater table and the base of the trench, then a maximum excavation depth of 11.5m is possible. Furthermore, the depth to the surface of the clay varied from 2.4m to 7.0m, so it will be necessary to carefully select a site if the depth of excavation in clay is to be maximised. This assessment could be made via a series of shallow boreholes to tag the depths to the surface of the clay.

The permeability for the clay stratum has been interpreted from *in* situ and laboratory falling head permeability tests to be in the range 10^{-7}m/s to 10^{-8}m/s. Permeabilities in this range are typical of a silty clay. The publication "How to meet requirements for hazardous waste landfill design, construction and closure", USEPA (1990) states that the USEPA requires soil liners be built so that the hydraulic conductivity is equal or less than $1x10^{-9}$m/sec. On the basis of this requirement it is expected that the permeability of the *in situ* soil would need to be reduced to make it suitable as a clay liner. The permeability requirements will, however, need to be agreed with the regulatory authorities during the detailed design stage.

We have undertaken a preliminary slope stability assessment for the trench disposal assuming an average of 7m excavation into the clay at a slope of 0.5H : 1V. The relevant geotechnical parameters assigned to the soil strata are listed in Table 7.

TABLE 7

ASSIGNED GEOTECHNICAL ENGINEERING PARAMETERS

Soil Stratum	Drained	
	c'	ø'
Sand	0	32
Clay	60#	28.5#

Note: # Based on laboratory test results.

The undrained soil strength was estimated using the method described in Lambe & Whitman (1979). The undrained shear strength (Su) is related to the drained soil strength parameters (c' and ø') as follows:

$$Su = \frac{c'\ Cos\,\phi' + (P_o - 2A_f\ Su)\ Sin\,\phi'}{1 - Sin\,\phi'}$$

where: P_o is the overburden pressure
A_f is the pore pressure parameter

On the basis of the triaxial test results we consider that A_f is approximately 0.5, implying that the clay is lightly overconsolidated.

The results of this analysis indicate that the factor of safety (FOS) under undrained conditions is in excess of 3 but reduces to 2.2 if tension cracks are considered. For drained conditions the FOS calculated is approximately 2 if the slope is assumed to be locally saturated.

The effectiveness of soil in reducing gamma radiation from the residue is determined in terms of Half Value Layers (HVLs). A HVL is defined as the amount of soil cover which reduces the gamma radiation by 50%. Thompson (1993) indicates that the HVL for monazite using a siliceous sand is 0.17 metres. On the basis of the clay mineralogy testing and discussions with an external radiation consultant we consider that, at this stage, it is reasonable to assume that the clay will provide similar attenuation to that of a siliceous sand. We also consider that for preliminary design purposes a HVL of 0.2m be used.

8.5.3 Evaporation Ponds and Tailings Dams

On the basis of the laboratory test results the suitability of the clay stratum materials and silty sand as a low permeability liner for evaporation ponds and tailings dams are discussed below.

Although the *in situ* permeability of the clay and silty sands are relatively low (10^{-7}m/s to 10^{-8}m/s), permeabilities an order of magnitude lower may be required for compacted soil liners (USEPA, 1990). The permeability requirements will, however, need to be agreed with the regulatory authorities during the detailed design stage. Additionally, the relatively high linear shrinkage of the clay (average value of 13.6%) is likely to result in cracking of the clay liner and increased permeability unless it is prevented from drying out. One possible solution may be to cover the compacted clay with a compacted layer of the silty sand which would act as a barrier to prevent the clay from cracking and additionally would have a relatively low permeability. Alternatively, the tailings dam could be constructed from the silty sand material if adequate permeabilities could be achieved in its compacted state.

To establish whether these materials are suitable for a soil liner we consider that it will be necessary, in the detailed design stage, to obtain some bulk samples and conduct further laboratory testing. This laboratory testing should be aimed at establishing:

- moisture/density relationship for compaction of the clay;
- shrinkage versus compaction moisture content; and
- changes in permeability with compacted moisture content.

Such testing may indicate that adequate permeability can be achieved, in combination with low shrinkage, for material compacted slightly dry of optimum.

9.0 CONCLUSIONS

Based on a review of available information, the information obtained from the field and laboratory investigations, and assessment of this information as discussed in the previous sections of this report, it is concluded that:

DESK TOP STUDY

- a subsurface clay layer occurs in the area proposed by Canning Resources for the evaporation ponds, tailings dams and trench disposal;
- the range of depths that this clay stratum could be expected to be intersected varies from approximately 3m to 9m at the top and from approximately 18m to 94m at the base;
- the depth to groundwater may vary from approximately 26m to 23m;

PROPOSED DOMESTIC WASTE DISPOSAL FACILITY

- since the proposed rubbish tip is near the toe of hills and drainage pathways run through the proposed site area, the diversion of surface waters would be necessary;
- highly to completely weathered siltstone was observed in two testpits at depths of 1m or less and it is likely that this siltstone material will underlie surficial soils across the proposed site. This may limit the excavation depth achieved by excavating equipment;
- the surficial soils comprising sandy silty gravels and gravelly silty sand may need to be lined to mitigate the impact of leachate percolating through the soil; and

- the layout of the facility and composition of the facility including lining requirements, will also depend on the regulating framework under which the facility is to be designed and operated.

PROPOSED METALLURGICAL TEST FACILITY

- the silty sands encountered at the site would be suitable for recompaction and be suitable for use as engineering fill.

PROPOSED BORROW PIT FOR ROAD CONSTRUCTION MATERIALS

- in general, we consider that the laboratory test results indicate the material is reasonably suitable for use in unsealed pavement construction. (There are, however, some qualifications to this conclusion as discussed in section 8.4)
- an estimate of the quantities of material available from the proposed borrow pit indicates that approximately 20,000m^3 to 24,000m^3 (prior to bulking) of suitable material could be available from the area investigated shown on Figure 4.

TRENCH DISPOSAL

- The subsurface conditions across the area investigated are relatively consistent. Clay mineralogy testing indicated that the composition of the silty clay was also relatively uniform and that the fine grained soil comprised relatively small proportions of clay minerals.

- The falling head permeability tests conducted during the geotechnical site investigation provided the following permeability (k) values:

- $k = 10^{-8}$ to 10^{-7} m/s	for hard Silty Sandy CLAY
- $k = 2 \times 10^{-8}$ m/s	for very dense Silty SAND
- $k = 10^{-5}$ m/s	for loose Gravelly Silty SAND

- The falling head permeability test results are consistent with the range of typical values reported in texts for both the clay and the overlying cohesionless materials.

Ref: SJD:sor/15780-018-361/DK:218-0604.DOC/PER

- The results of laboratory falling head permeability tests concur with the *in situ* results, and on this basis we consider that the *in situ* permeability values should be used for design purposes.

- If the recommendations in NH&MRC (1993) are adopted as "best practise" and a 5m buffer is maintained between the groundwater table and the base of the trench, then a maximum excavation depth of 11.5m is possible;

- The corresponding depth to the surface of the clay varied from 2.4m to 7.0m, so it will be necessary to carefully select a site if the depth of excavation in clay is to be maximised.

- From geotechnical view-points it is expected that the area investigated would be suitable for a trench disposal facility. However, further detailed investigations will be required during the detailed design stage to confirm its suitability and determine the actual facility location and configuration.

EVAPORATION PONDS AND TAILINGS DAMS

- If the USEPA requirement for the hydraulic conductivity of a soil liner to be equal or less than $1x10^{-9}$m/sec is adopted, it is expected that the permeability of the *in situ* soil would need to be reduced, probably by recompacting, to make it suitable as an soil liner. However, depending on the regulatory requirements, the permeability of the *in situ* soils may be adequate for contaminant retention.

- The relatively high linear shrinkage of the clay (average value of 13.6%) indicates that cracking of the clay liner and increased permeability may occur unless significant moisture content variations are prevented.

Possible solutions may be to:

- cover the clay liner with a compacted layer of the silty sand which would act as a protective barrier to prevent the clay from cracking and additionally would have a relatively low permeability (approximately 10^{-7}m/s to 10^{-8}m/s); or
- construct the evaporation ponds and tailings dam from the silty sand if adequate permeabilities could be achieved in its compacted state.

10.0 REFERENCES

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* * *

Figures 1 to 10 and Appendices A to C are attached to complete this report.

Respectfully submitted
DAMES & MOORE

Alex Gower

S.J. Drummond
Staff Geotechnical Engineer

A.E. Gower
Staff Geotechnical Engineer

LIMITATIONS OF REPORT

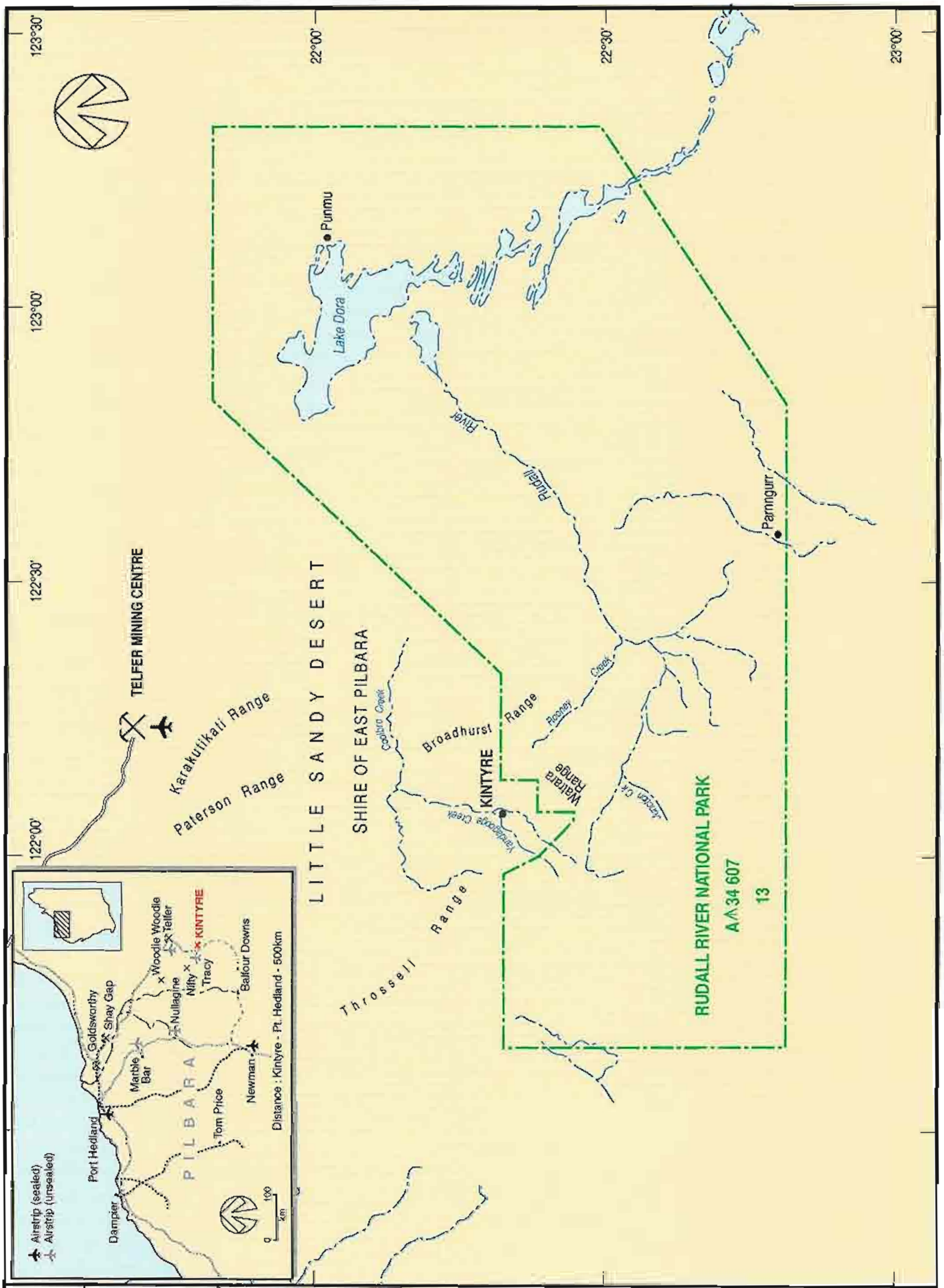
We have prepared this report for the use of Canning Resources Pty Limited in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been prepared for the use by parties other than the client, the owner and their respective consulting advisors. It may not contain sufficient information for purposes of other parties or for other uses.

It is recommended that any plans and specifications prepared by others and relating to the content of this report or amendments to the original plans and specifications be reviewed by Dames & Moore to verify that the intent of our recommendations is properly reflected in the design.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, subsurface conditions, including groundwater levels and contaminant concentrations, can change in a limited time. This should be borne in mind if the report is used after a protracted delay.

There are always some variations in subsurface conditions across a site which cannot be fully defined by investigation. Hence it is unlikely that the measurements and values obtained from sampling and testing during the investigation will represent the extremes of conditions which exist within the site.

Figures



Job No.	15780-018-361		Canning Resources Pty Limited GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT LOCALITY PLAN	Figure 1
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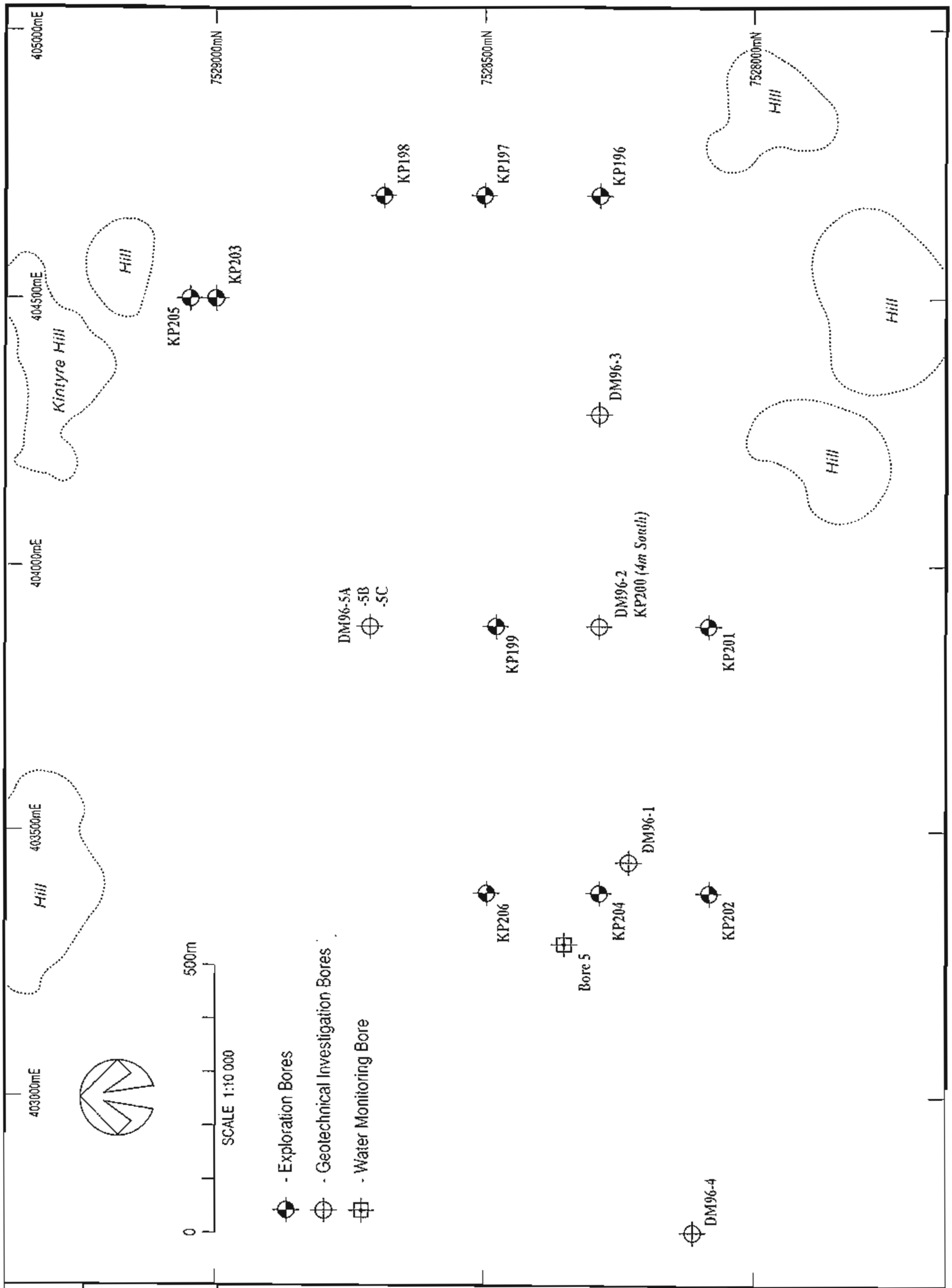
Chk'd By	EAN	27 Aug.'96		Revision Indicator 0
P. Mgr	AEG	27 Aug.'96		DAMES & MOORE



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Prep. By	AG	20 Aug.'96
Chk'd By	Cam	22/10/96
P. Mgr	SM	22/10/96

Canning Resources Pty Limited
GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT

SITE PLAN SHOWING
APPROXIMATE BOREHOLE LOCATIONS

Figure
2

Revision Indicator 1

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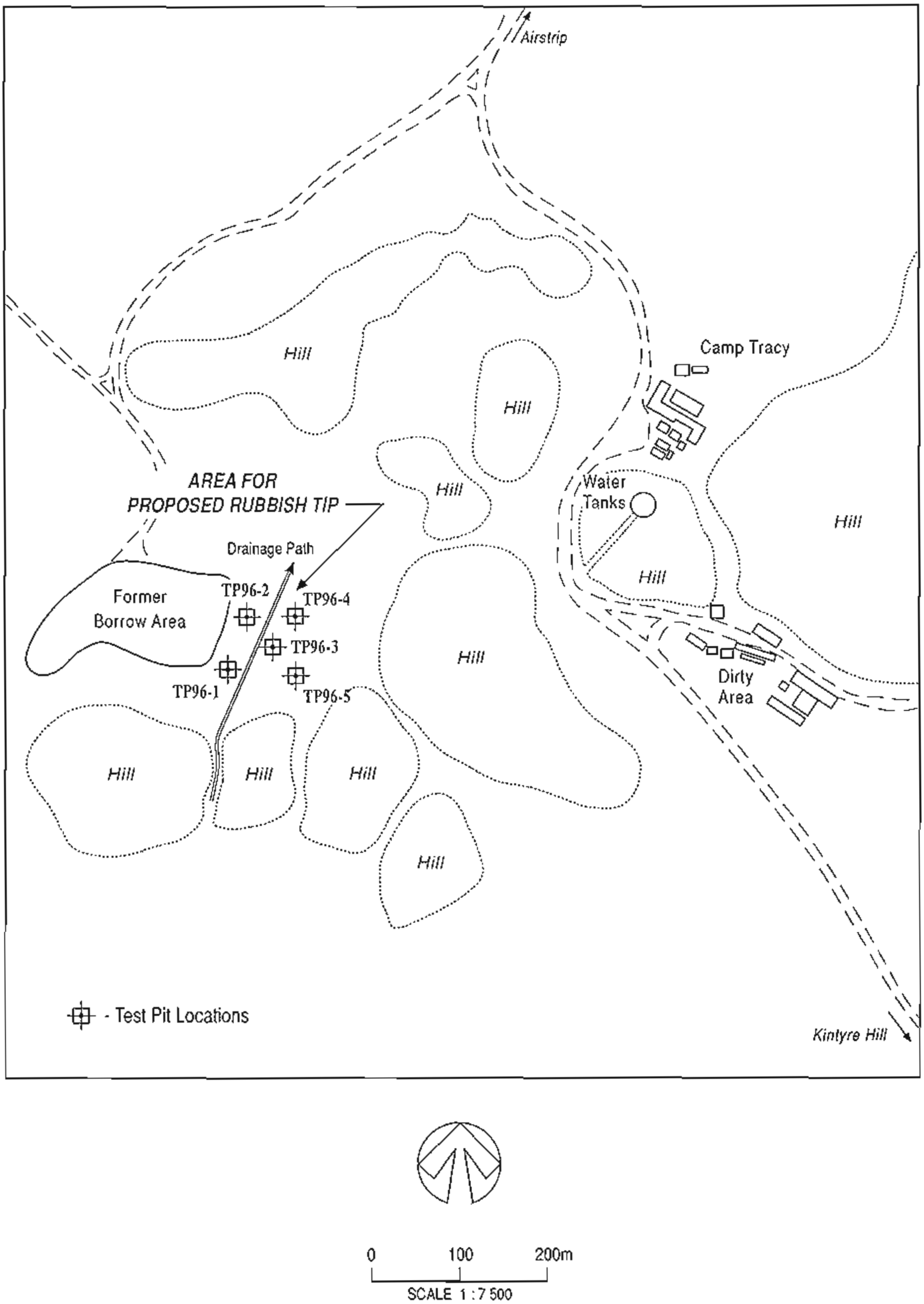


Job No.	15780-018-361	
Prep. By	SJD	29 Jul.'96
Chk'd By		27/8/96
P. Mgr	AEG	27 Aug 96

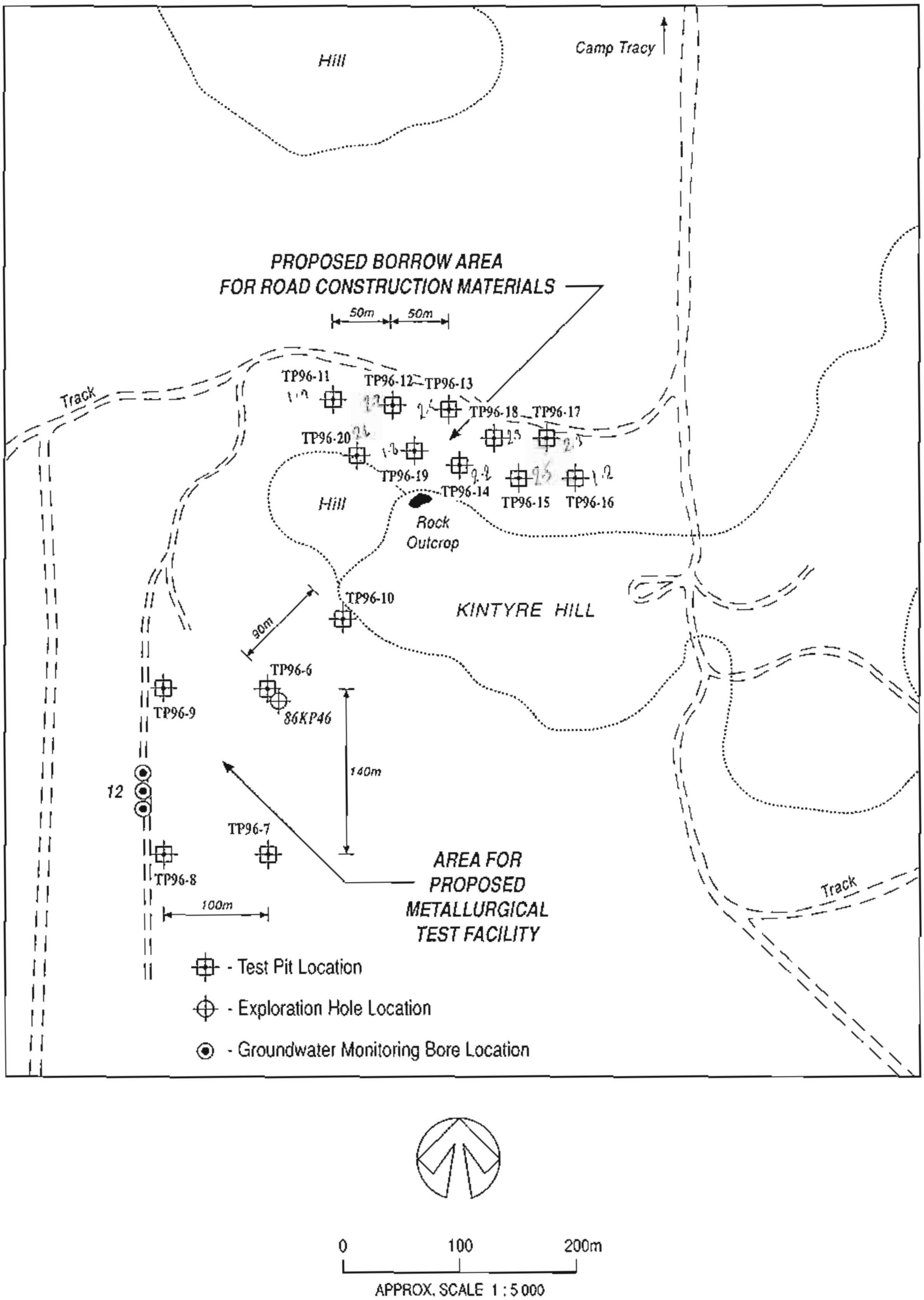
Canning Resources Pty Limited
GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT

SITE PLAN IN THE VICINITY OF CAMP TRACY

Figure
3

Revision Indicator	0

DAMES & MOORE



Job No.	15780-018-361	
Prep. By	SJD	07 Aug.'96
Chk'd By		27/8/96
P. Mgr		27 Aug '96

Canning Resources Pty Limited
GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT

SITE PLAN IN THE
VICINITY OF KINTYRE HILL

Figure
4

Revision Indicator 0

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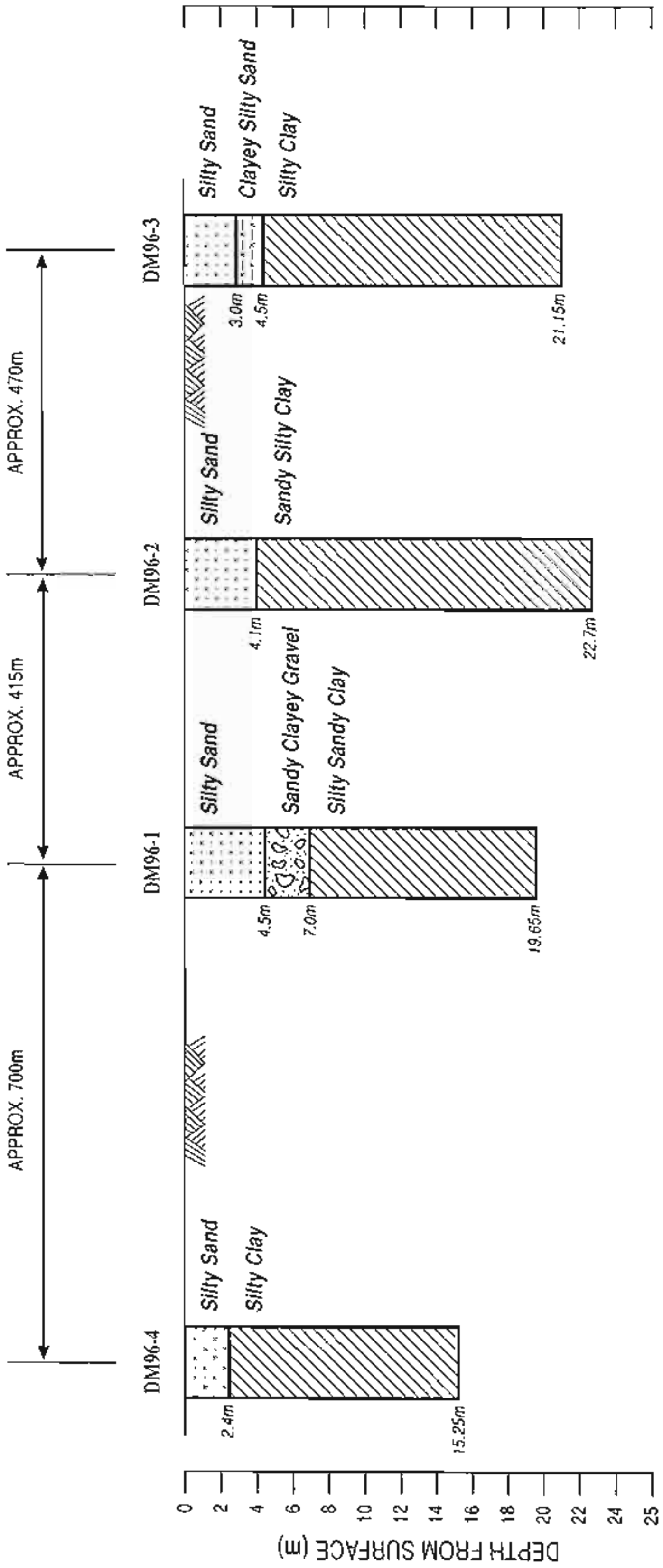


Job No.	15780-018-361	
Prep. By	AG	15 Oct.'96
Chk'd By		22/10/96
P. Mgr		22/10/96

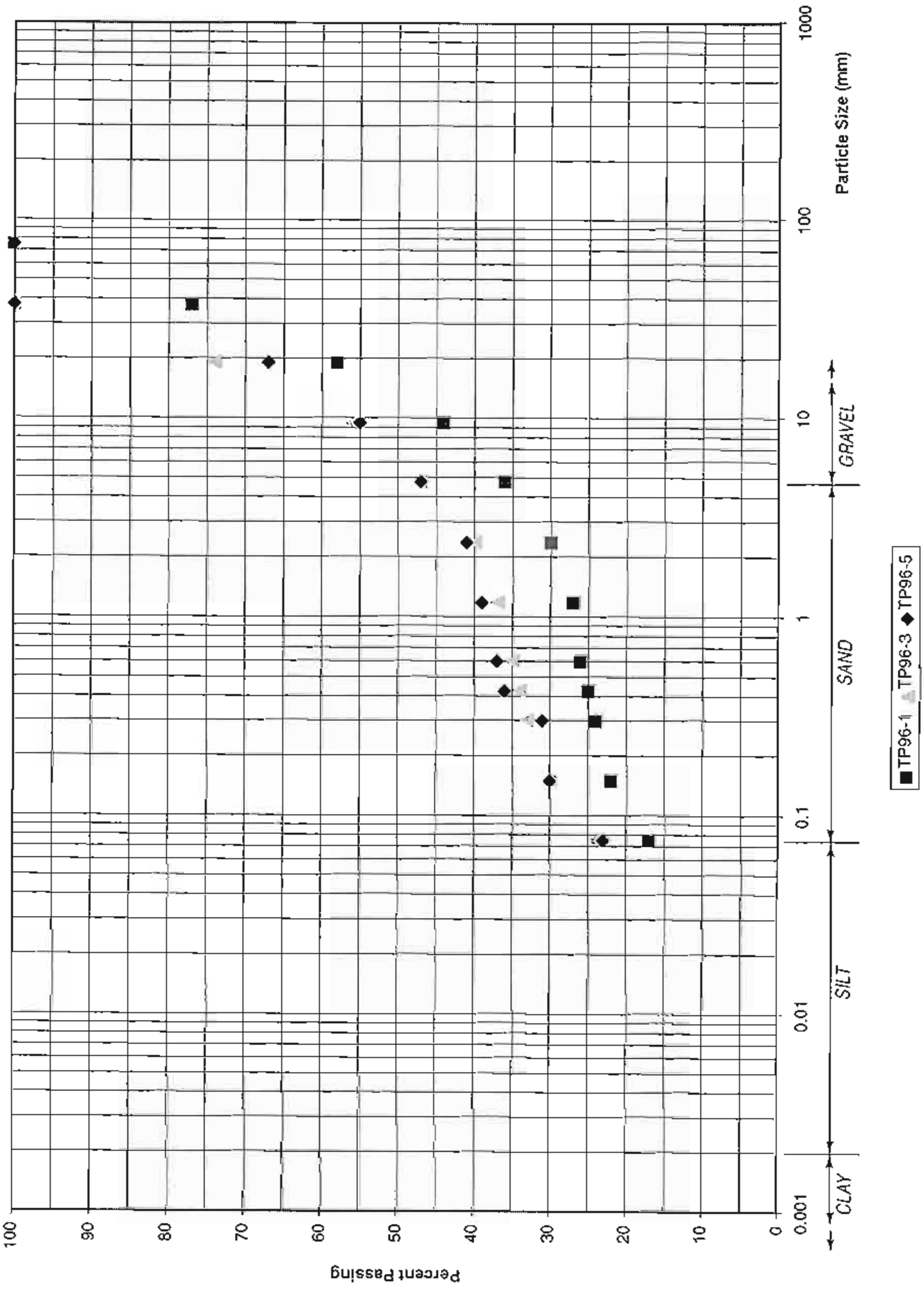
Canning Resources Pty Limited
GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT

INTERPRETTED GEOLOGICAL SECTION AT PROPOSED WASTE DISPOSAL AREA

Figure
5

Revision Indicator	0

DAMES & MOORE



Job No.	15780-018-361	
Prep. By	AG	23 Aug.'96
Chk'd By	Cen	27/8/96
P. Mgr	AEG	28 Aug '96

Canning Resources Pty Limited
GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT

PARTICLE SIZE GRADING CURVES
PROPOSED DOMESTIC WASTE DISPOSAL SITE

Figure
6

Revision Indicator 1

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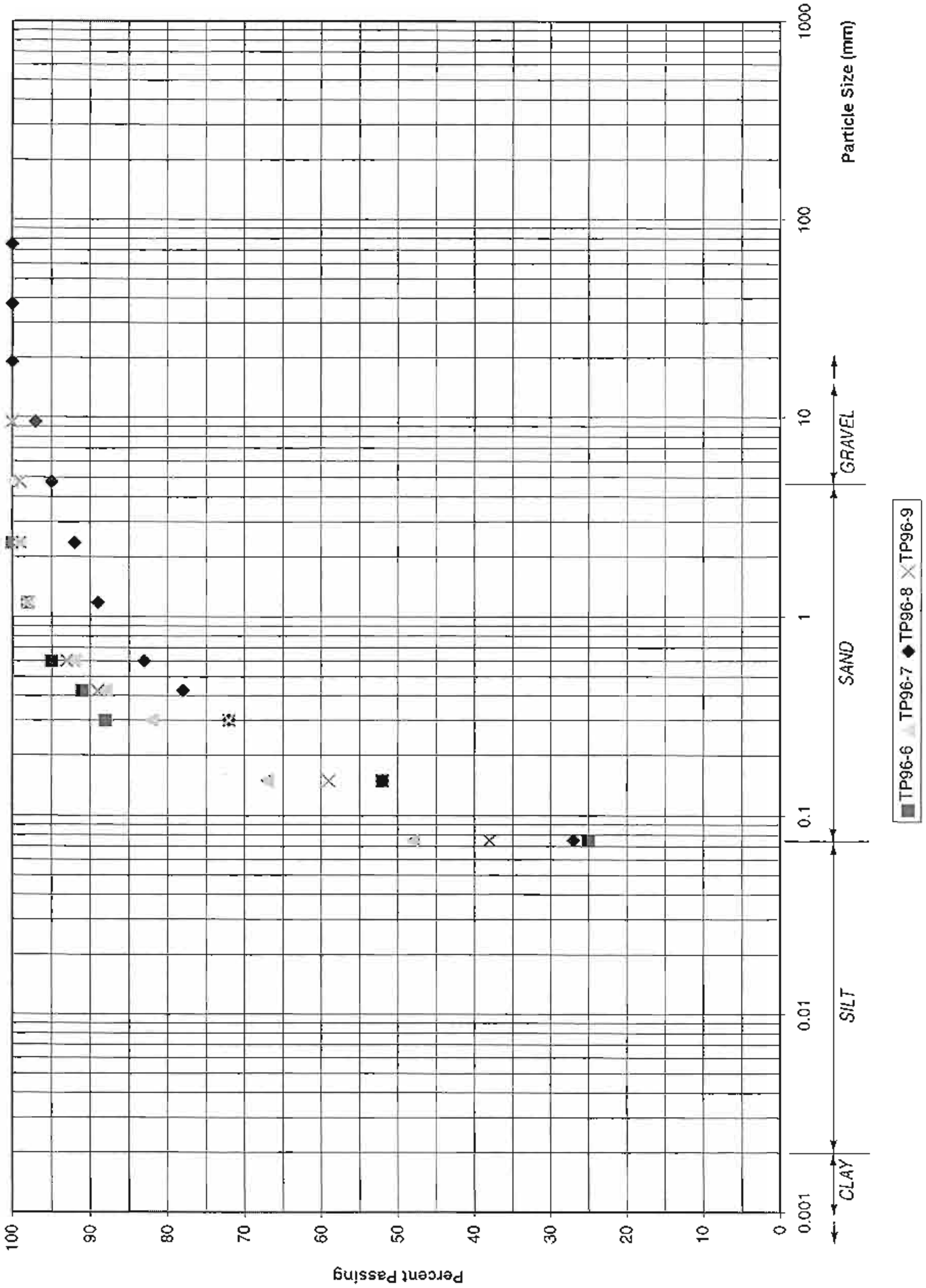

Job No.	15780-018-361	
Prep. By	AG	23 Aug.'96
Chk'd By		21/8/96
P. Mgr		28 Aug '96

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PARTICLE SIZE GRADING CURVES
PROPOSED METALLURGICAL TEST FACILITY

Figure
7

Revision Indicator 1

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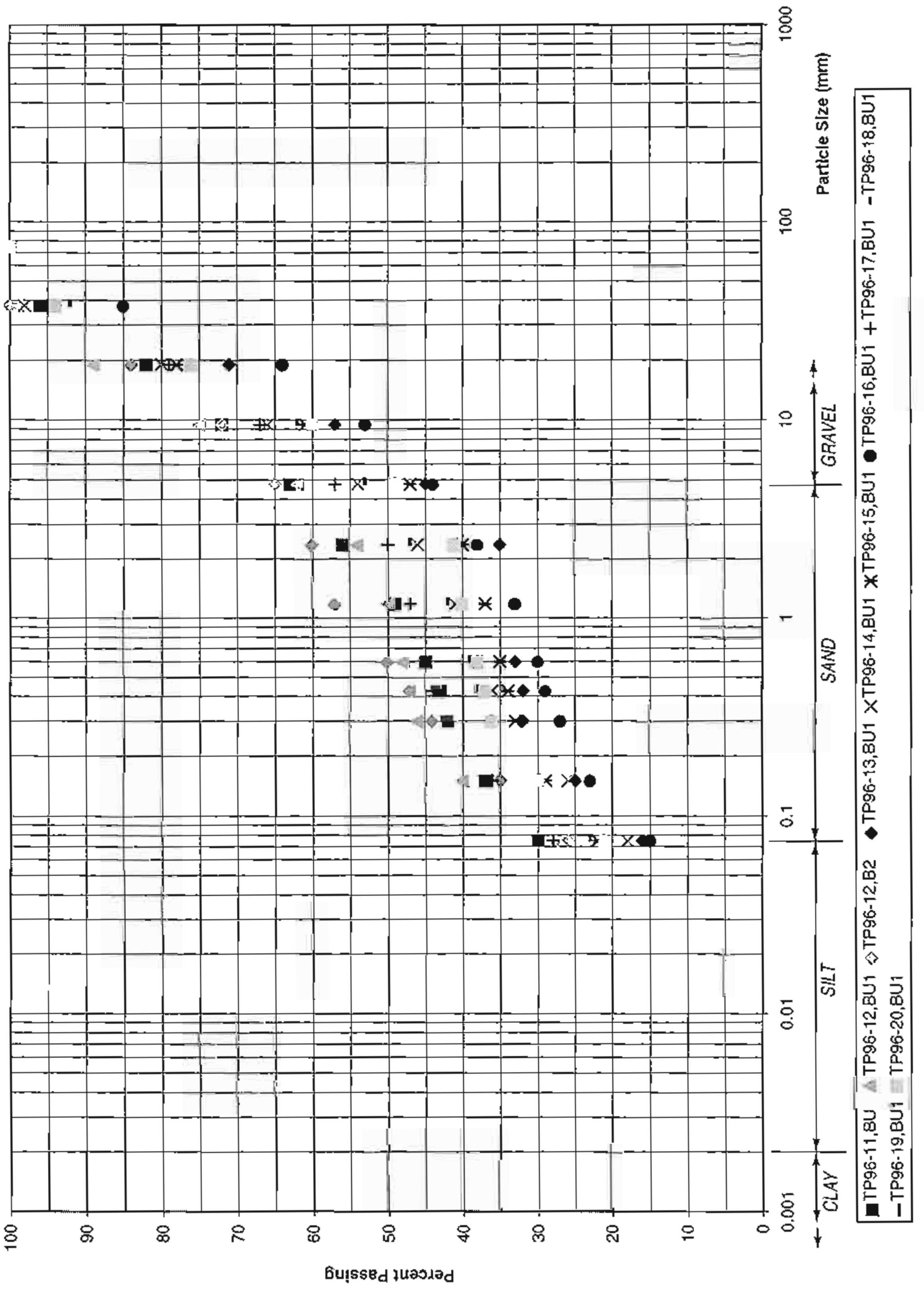

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Prep. By	AG	23 Aug.'96
Chk'd By		27/8/96
P. Mgr	AEG	28 Aug 96

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PARTICLE SIZE GRADING CURVES
PROPOSED ROAD CONSTRUCTION BORROW AREA

Figure
8

Revision Indicator 1

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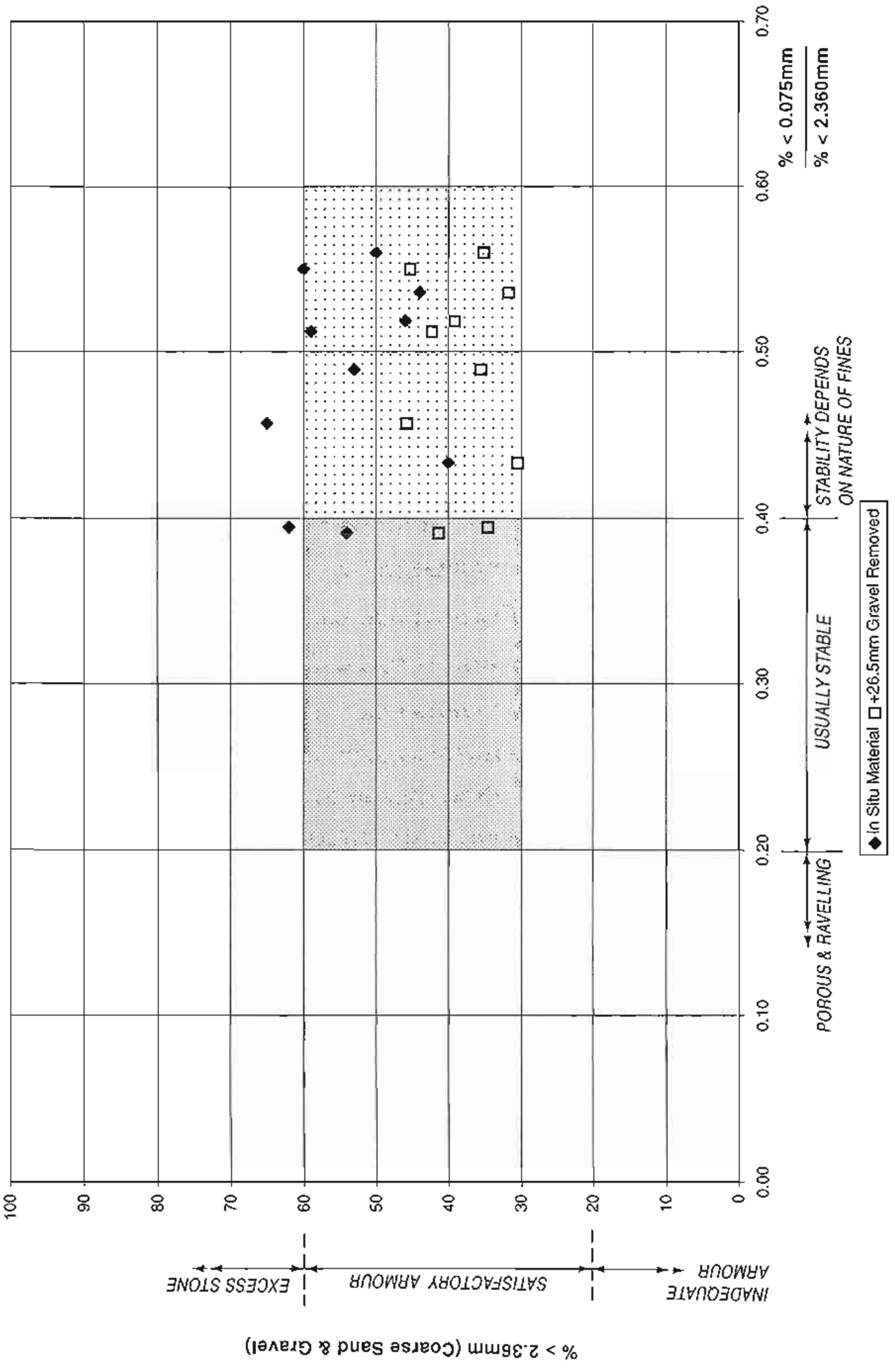
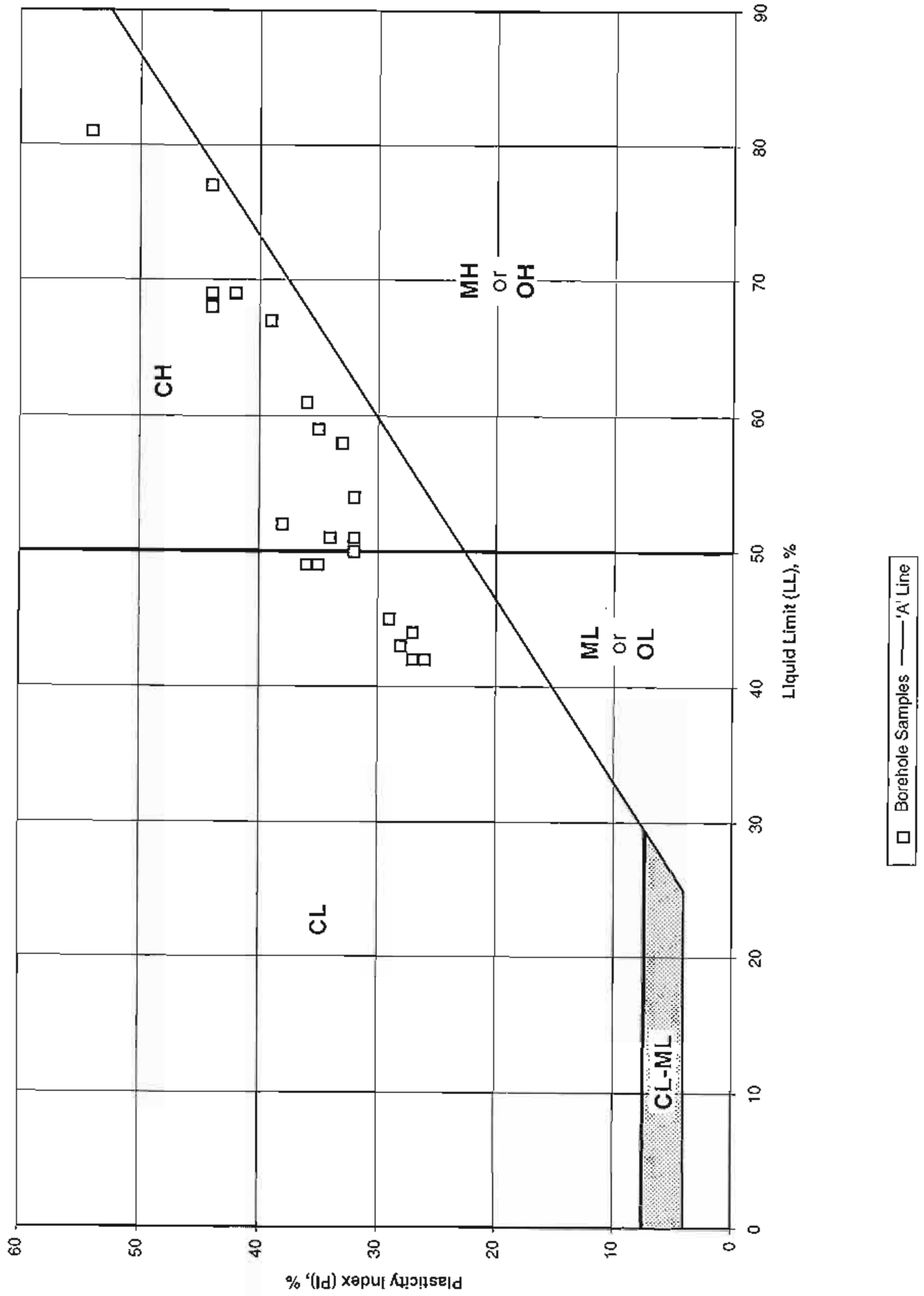


Job No.	15780-018-361		Canning Resources Pty Limited GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT	Figure 9		
Prep. By	AG	23 Aug.'96				
Chk'd By	Cih	27/8/96	GRADING REQUIREMENTS, UNSEALED ROAD BASE PROPOSED ROAD CONSTRUCTION BORROW AREA	Revision Indicator	1	
P. Mgr	AEGc	28 Aug 96		DAMES & MOORE		



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Chk'd By	[illegible]	27/8/96
P. Mgr	AEG	28 Aug 96

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GEOTECHNICAL INVESTIGATION - KINTYRE ADVANCEMENT PROJECT

**PLASTICITY CHART SELECTED CLAY MATERIAL
TAILINGS & WASTEWATER DISPOSAL AREA**

Figure
10

Revision Indicator	1

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Appendix A

APPENDIX A

BOREHOLE AND TEST PIT LOGS

APPENDIX A
BOREHOLE AND TEST PIT LOGS

The borehole and test pit positions are shown on Figures 2 to 4, inclusive, in the main text. Logs of the seven boreholes and twenty test pits undertaken in this geotechnical investigation are presented in this appendix on Figures A3 to A37, inclusive.

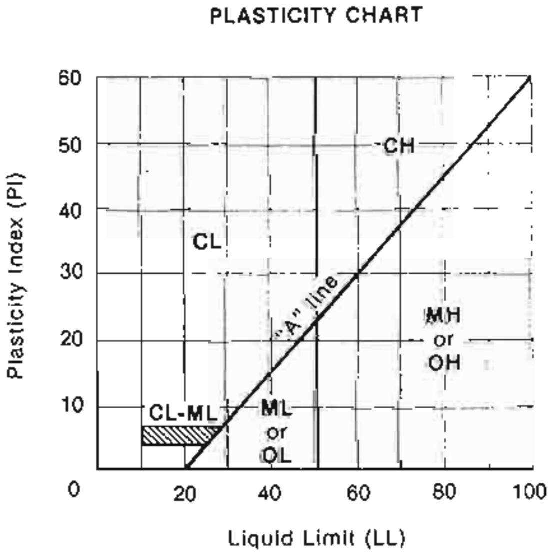
The soil descriptions used on the logs are based on the Unified Classification System, presented on Figure A1. Additionally a key to the borehole and test pit logs is presented on Figure A2.

*   *   *

The following figures are attached and complete this appendix.

Figure A1	-	Unified Soil Classification System
Figure A2	-	Key to Borehole Log
Figures A3 and A4	-	Log of Borehole DM96-1
Figures A5 to A7	-	Log of Borehole DM96-2
Figures A8 to A10	-	Log of Borehole DM96-3
Figures A11 and A12	-	Log of Borehole DM96-4
Figure A13	-	Log of Borehole DM96-5A
Figures A14 to A16	-	Log of Borehole DM96-5B
Figure A17	-	Log of Borehole DM96-5C
Figures A18 to A37	-	Log of Test Pits TP96-1 to TP96-20, inclusive

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL NAMES	LABORATORY CLASSIFICATION CRITERIA		
COARSE GRAINED SOILS More than half of material is larger than No. 200 (75 micron) sieve	Gravels More than half of coarse fraction larger than No. 4 (4·75 mm) sieve	Clean gravels Little or no fines	GW	Well graded gravels, gravel-sand mixtures, little or no fines.	Determine percentages of sand and gravel from grain-size curve. Depending on per cent fines (fraction smaller than No. 200 (75 micron) sieve) coarse grained soils are classified as follows: Less than 5%—GW, GP, SW, SP More than 12%—GM, GC, SM, SC 5 to 12%—*borderline* cases requiring dual symbols	$C_U = \frac{D_{60}}{D_{10}}$ greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.		Not meeting all gradation requirements for GW	
		Gravels with fines Appreciable amount of fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are *borderline* cases requiring dual symbols GM-GC
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with PI greater than 7	
	Sands More than half of coarse fraction smaller than No. 4 (4·75 mm) sieve	Clean sands Little or no fines	SW	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines Appreciable amount of fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are *borderline* cases requiring dual symbols SM-SC
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with PI greater than 7	
FINE GRAINED SOILS More than half of material is smaller than No. 200 (75 micron) sieve	Silts and Clays Liquid limit less than 50		ML	Inorganic silts, rock flour, silty or clayey fine sands, clayey silts with slight plasticity	 PLASTICITY CHART		
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and Clays Liquid limit greater than 50		MH	Inorganic silts, clayey silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays and silty clays of medium to high plasticity, organic silts.			
	Highly organic soils		Pt	Peat and other highly organic soils	High ignition loss, LL and PI decrease after drying, organic colour and odour		

Borderline classifications, used for soils possessing characteristics of two groups, are designated by dual symbols.

FIGURE A1
DAMES & MOORE

PROJECT : **KEY TO BOREHOLE LOG**

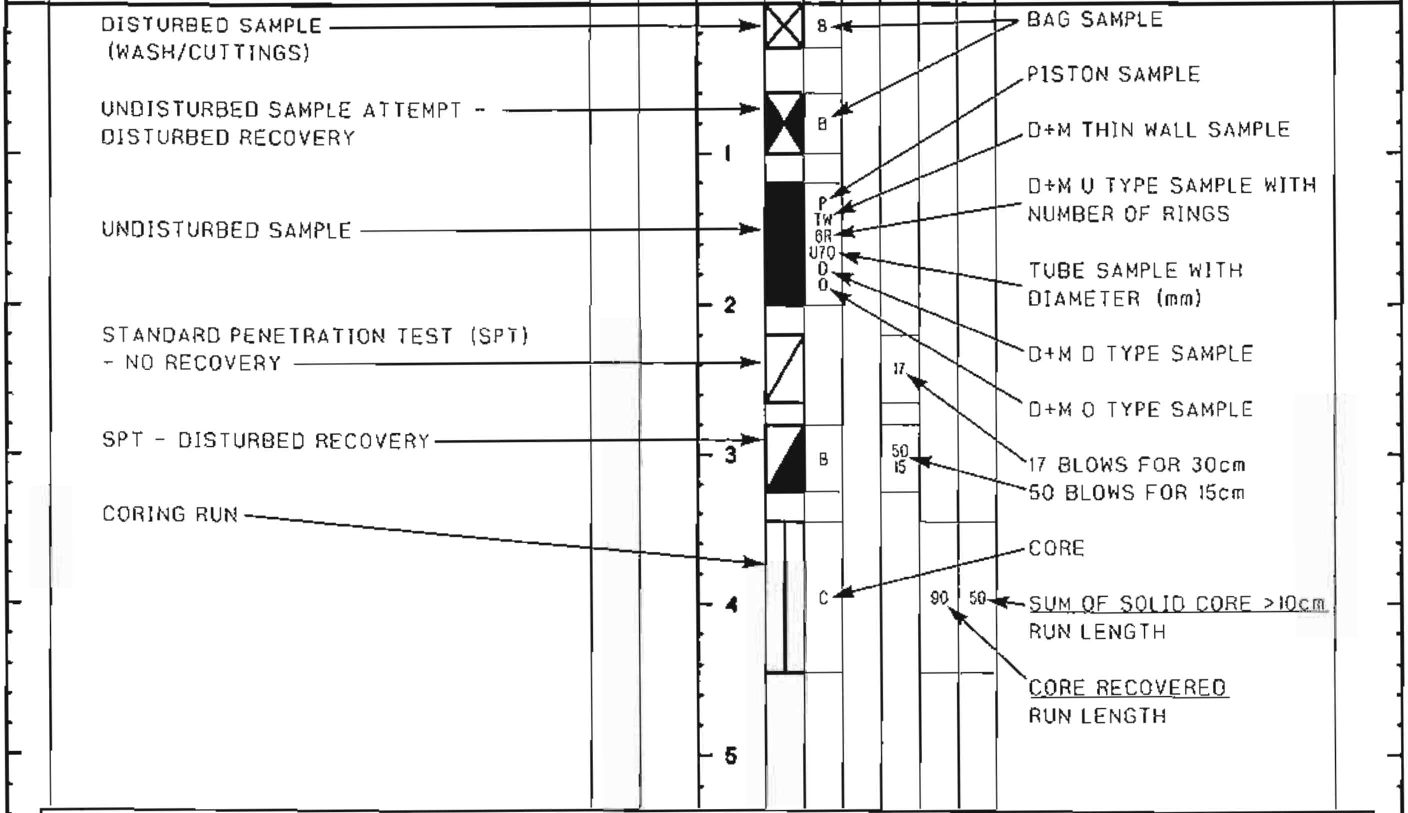
HOLE No.

CLIENT :

SHEET 1 OF 1

DRILLING RIG : BARREL TYPE : BIT TYPE :	HOLE DIRECTION VERT'	HOLE ANGLE FROM HORIZONTAL 90'	CO.ORD'S OF COLLAR N : E :	R.L. OF COLLAR	DATUM AHD

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	R.Q.D. (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)



DRILLING CON
DRILLER :
DATE/TIME COMMENCED
DATE/TIME COMPLETED :

TEST ABBREVIATIONS		DS	Direct Shear Test	PI	Plasticity Index
AL	Atterberg Limits	DT	Dispersion Test	PK	Packer Test
BD	Bulk Density	e	Void Ratio	PL	Plastic Limit
c'	Effective Cohesion	E	Youngs Modulus	PM	Pressuremeter Test
C_c	Compression Index	F	Percent Fines	PP	Pocket Penetrometer Test
C_r	Unload/reload Index	FH	Falling Head Test	PR	Poisson's Ratio
C_v	Coefficient of Consolidation	FV	Field Vane Test	PSD	Particle Size Distribution
CAR	Carbonate Content	G	Shear Modulus	RH	Rising Head Test
CH	Constant Head Test	HYD	PSD with Hydrometer	SG	Specific Gravity
CD	Consolidated Drained	LL	Liquid Limit	SL	Shrinkage Limit
CIU	Consolidated Isotropic Undrained	LS	Linear Shrinkage	SR	Undrained Shear Strength (Remoulded)
CON	Consolidation Test	m	Moisture Content	SS	Simple Shear
CU	Consolidated Undrained	m_v	Coefficient of volume charge	S_u	Undrained Shear Strength (Peak)
CYC	Cyclic Test	MDD	Maximum Dry Density	TV	Torvane Test
D_n	Particle size at which N% are smaller	MMD	Min/Max Density	TX	Triaxial Test
D_r	Relative Density	P	Permeability Test	UCS	Unconfined Compressive Strength
DD	Dry Density	PHI	Angle of Friction	UU	Unconsolidated Undrained

JOB No.	DATE
LOGGED BY	
APPROVED BY	

KEY TO BOREHOLE LOG

FIGURE A2
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT				HOLE No. **DM98-1**
CLIENT : Canning Resources Pty Limited				SHEET 1 OF 2
DRILLING RIG : GEMCO 210A	HOLE DIRECTION	HOLE ANGLE FROM HORIZONTAL	CO-ORDINATES	R.L. (m)	DATUM
BARREL TYPE : -	VERT.	90°	N: ~7528225		AHD
BIT TYPE : -			E: ~403415		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN
DATE/TIME COMMENCED : 14/07/98 - 09:15
DATE/TIME COMPLETED : 15/07/98 - 12:30

Surface Conditions. Relatively flat, fine to coarse orange brown quartz sand, sub-rounded to sub-angular; 50- 75% grass and spinefex cover.

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	DOWN HOLE DEPTH (m)	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
	Silty SAND, medium dense to dense, orange brown, fine to medium grained, sub-rounded to sub-angular, dry; 25% silt with some clay.	SM								
			1							
	dense from 1.5 to 3.0m, ~28% fines.			B	1	38	100		8, 17, 21 PSD, AL, M	
			2							
	grades, very dense, orange brown, white and beige mottled with light brown to beige, fine to coarse grained; from 3.0m.		3	B	2	55 150	100		55 for 150mm.	
			4							
PATERSON FORMATION	**Sandy Clayey GRAVEL**, very dense, orange brown, white and beige mottled with yellow and purple, fine to coarse grained, sub-rounded to sub-angular; 20% sand; well sorted quartz gravel.	GP		B	3	50 80	50		50 for 80mm, 50% recovery.	
			5	B	4				cuttings samples from 4.5 to 5.5m and 5.5 to 6.0m.	
	grades to clayey gravel from 5.5m.			B	5				37% gravel, 15% sand, 28% fines	
	grades mottled grey, brown and white, low plasticity, dry, 37% gravel (fine to coarse quartz); 35% sand (highly to completely weathered rock).	GW	6	B	6	50 150	80		* 9, 50 for 150mm, PSD + HYD, AL, M, pH	
	clayey gravel layer from 6.5 to 7.0m.			3A	7	72 70	100		* 28, 72 for 70mm @ 1145 14/7/98.	
	Silty sandy CLAY, hard, brownish grey, intermediate plasticity, dry; with some (15-20%) fine to medium sand.	CL CH	7						* 09:50, 14/7/98 stop drilling to weld D&M coupling to OZ drill coupling.	
				3A B	8 8B	75 50	100 100		80, 75 for 50mm. shoe sample bagged as sample 8B. PSD + HYD, PERM, AL, M, DENS.	
			8							
	(Falling head test conducted by casing to 9.0m, after taking sample at 9.2m, then drilling out fresh hole form 9.2 to 10.4m).		9	3A B	9 9B	116 50	100 100		90, 116 for 50mm. shoe sample bagged as 9B.	
									CONDUCTING FALLING HEAD TEST. PINHOLE, PSD + HYD, AL, M, DENS.	

data : DM98-1
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY	RKN	22/10/96

BOREHOLE LOG

FIGURE A3
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT	HOLE No. **DM98-1**
CLIENT : Canning Resources Pty Limited	SHEET 2 OF 2

DRILLING RIG : GEMCO 210A	HOLE DIRECTION VERT.'	HOLE ANGLE FROM HORIZONTAL 90'	CO-ORDINATES	R.L. (m)	DATUM AHD
BARREL TYPE : -			N: ~7528225		
BIT TYPE : -			E: ~403415		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN
DATE/TIME COMMENCED : 14/07/98 - 08:15
DATE/TIME COMPLETED : 15/07/98 - 12:30

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	DOWN HOLE DEPTH (m)	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Silty sandy CLAY**, hard, brown, intermediate plasticity, dry, with some (20%) fine sand.	CL CH								
				H	10	100 80	100		27, 100 for 80mm. D&M sampler.	
				B	10B		100		10B: PSD, AL, M.	
			11							
			12	B	11	85 100	100		85 for 100mm, 50 for 30mm. D&M sampler. 11: PSD, AL, M.	
			13							
				B	12	105 120	100		105 for 120mm.	
			14							
			15	B	13	100 120	100		100 for 120mm. PF, AL, M.	
			16							
				B	14	107 110	100		107 for 110mm.	
			17							
	grades light purple brown with some yellowish brown streaks with less sand from 18.0 to 19.6m.		18	B	15	100 115	100		100 for 115mm. AL, M.	
			19							
	grades silty clay, slightly moist; from 19.5m.									
				B	16	113 150	100		113 for 150mm. AL, M.	
	BOREHOLE COMPLETED at 19.65m									

data : DM98-1
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

BOREHOLE LOG

FIGURE A4
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

HOLE No. DM98-2

SHEET 1 OF 3

CLIENT : Canning Resources Pty Limited

DRILLING RIG : GEMCO 210A BARREL TYPE : - BIT TYPE : -	HOLE DIRECTION VERT.˙	HOLE ANGLE FROM HORIZONTAL 90˚	CO-ORDINATES N: ~7528210 E: ~403830	R.L. (m)	DATUM AHD

DRILLING COMPANY . J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 15/07/98 - 15.00
DATE/TIME COMPLETED : 18/07/98 - 17:30

Surface Conditions: Relatively flat, fine to coarse orange brown quartz sand, sub-rounded to sub-angular; 50- 75% grass and spinefex cover.

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Silty SAND,** dense to very dense, orange brown, fine grained, sub-rounded to sub-angular, dry; 20% silt with some clay.	SM										
				1								
	grades with 33% fines.					B	1	55 150	100		27, 55 for 150mm. PSD	
				2								
	fine to medium grained with some gravel from 3.0m (occasional fine quartz gravel inclusion).			3		B	2	50 50	100		17,50 for 140mm.	
	fine to coarse quartz gravel layer from 4.0 to 4.1m.			4								
	Sandy silty CLAY, hard, high plasticity, mottled orange brown and beige; 15% to 25% fine to medium sand with some gravel size completely weathered limestone inclusions.	CH				B	3	80	100		24, 80 for 150mm.	
				5								
	grades brown with orange brown mottle and white specks from 6.0 to 7.5 m.			6		3H B	4 4B	59 70	100		41, 59, for 70mm. 17.30 15/7/98 CONDUCTING WATER TEST. PERM, PSD + HYD , AL, M, DENS.	
				7								
	grades brown mottled with yellow and reddish brown from 7.5 to 9.0m.					B	5	58 20	80		12, 58, 35 for 20mm (11.45 18/7/98). PSD, AL, M.	
				8								
	grades grey and brown with reddish brown and yellow mottles with less sand (fine grains) from 9.0m.			9		B	6	100 120	100		100 for 120mm.	

data : DM98-2
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY	EM	12/10/98

BOREHOLE LOG

FIGURE A5
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT : Canning Resources Pty Limited

HOLE No. DM98-2

SHEET 2 OF 3

DRILLING RIG : GEMCO 210A	HOLE DIRECTION VERT.°	HOLE ANGLE FROM HORIZONTAL 90°	CO-ORDINATES	R.L. (m)	DATUM
BARREL TYPE : –			N: ~7528210		AHD
BIT TYPE : –			E: ~403830		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 15/07/98 – 15:00
DATE/TIME COMPLETED : 18/07/98 – 17:30

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Silty CLAY**, hard (friable), brown mottled with dark orange brown, high plasticity, dry; 5% fine sand.	CH										
					◢	B	7	50/50	100		50, 50 for 50mm. PF, AL, M, pH.	
	— grades brown below 11.0m.			11								
	— mottled yellow , orange brown and grey seam at 12.0m.			12	◢	B	8	85/100	100		30, 85, for 100mm.	
				13								
	— slightly moist with a few coarse gravel pieces from 13.5 to 15.0m.				◢	B	9	81/150	100		28, 81 for 150mm. PSD, AL, M.	
				14								
	— slightly moist, brown with orange red and yellow stained fractures, without sand.			15	◢	B	10	54/150	100		35, 54, for 150mm. AL, M.	
				16								
					◢	B	11	68/150	100		27, 68 for 150mm.	
				17								
				18	◢	B	12	89/140	100		21, 89 for 140mm. AL, M.	
				19								
					◢	B	13	50/100	100		28, 50 for 100mm.	

data : DM98-2
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	–
APPROVED BY	Dam	22/10/16

BOREHOLE LOG

FIGURE A6
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT	HOLE No. **DM98-2**
CLIENT : Canning Resources Pty Limited	SHEET 3 OF 3

DRILLING RIG : GEMCO 210A BARREL TYPE : - BIT TYPE : -	HOLE DIRECTION VERT.˚	HOLE ANGLE FROM HORIZONTAL 90˚	CO-ORDINATES N: ~7528210 E: ~403830	R.L. (m)	DATUM AHD

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 15/07/98 - 15:00
DATE/TIME COMPLETED : 18/07/98 - 17:30

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Silty CLAY**, brown with orange red and yellow stained fractures, hard (friable), high plasticity.	CH										
				21	◢	B	14	53 100	100		33, 53 for 150mm.	
	grades dark grey from 22.0m.			22								
					◢	B	15	50 105	100		45, 50 for 105mm. AL, M.	
	BOREHOLE COMPLETED AT 22.7m.			23								
				24								
				25								
				26								
				27								
				28								
				29								

data : DM98-2
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/98

BOREHOLE LOG

FIGURE A7
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

HOLE No. DM96-3

SHEET 1 OF 3

CLIENT : Canning Resources Pty Limited

DRILLING RIG : GEMCO 210A	HOLE DIRECTION	HOLE ANGLE FROM HORIZONTAL	CO-ORDINATES	R.L. (m)	DATUM
BARREL TYPE : –	VERT.'	90'	N: ~7528260		AHD
BIT TYPE : –			E: ~404298		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 17/07/96 – 08:30
DATE/TIME COMPLETED : 18/07/96 – 10:05

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
	Surface Conditions. Relatively flat, fine to coarse orange brown quartz sand, sub-rounded to sub-angular; 50- 75% grass and spinefex cover.											
PATERSON FORMATION	**Silty SAND**, medium dense, orange brown, fine to medium grained, dry; 35% fines.	SM		1								
	— with some black spots from 1.5m.			2	◢	B	1	24	75		9, 12, 12. PSD	
	Clayey silty SAND, very dense, orange brown, fine grained, dry; 44% fines.	SC		3	◢	B	2	63			11, 22, 41. PSD, AL, M.	
	— fine to coarse quartz gravel layer from 4.0 to 4.5m.			4								
	Sandy silty CLAY, hard, low plasticity, mottled brown, orange brown white and grey, dry; with 30% fine to coarse sand and a trace of gravel.	CL		5	◢ ☒	3B B	3 3B	100 180	100		100 for 180mm. 3 rings are separated. PINHOLE, PSD + HYD, AL, M, DENS, pH.	
	— grades without gravel from 6.0m. Brown from 6.0 to 7.0m (?).			6	◢	B	4	65 150	100		65 for 150mm. CONDUCTING FALLING HEAD TEST. 11.00-15.00 pulling out casing.	
				7	◢	B	5	50 75	100		40, 50, for 75mm @ 1535. PSD, AL, M.	
				8								
	— grades to a Silty CLAY with a trace of fine sand.			9	◢	B	6	75 120	100		75 for 120mm. PF, AL, M.	

data : DM96-3
script : SOILLOG3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	–
APPROVED BY		22/10/96

BOREHOLE LOG

FIGURE A8
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

HOLE No. **DM96-3**

SHEET 2 OF 3

CLIENT : **Canning Resources Pty Limited**

DRILLING RIG : GEMCO 210A BARREL TYPE : - BIT TYPE : -	HOLE DIRECTION VERT.'	HOLE ANGLE FROM HORIZONTAL 90'	CO-ORDINATES N: ~7528280 E: ~404298	R.L. (m)	DATUM AHD

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 17/07/96 - 08:30
DATE/TIME COMPLETED : 18/07/96 - 10:05

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	RL (m)
PATERSON FORMATION	**Silty CLAY,** hard (friable), brown, low plasticity, dry; with trace of fine sand.	CL										
						B	7	80 100	100		60 for 100mm. AL, M.	
	fine gravel fragments from 11.0 to 12.0m (highly weathered).			11								
	slightly moist from 12.0m.			12		B	8	55 100	100		55 for 100mm. 17.05, 17/7/96. AL, M.	
				13								
						B	9	64 80	100		64 for 80mm.	
				14								
				15		B	10	66 80	100		66 for 80mm.	
	grades with orange red and yellow stained fractures, slightly moist to moist, iron stained fractures at 45 deg.			16								
						B	11	57 70	100		57 for 70mm. AL, M.	
				17								
				18		B	12	62 120	100		40, 62 for 120mm.	
				19								
						B	13	50 90	100		42, 50 for 90mm.	

data : DM96-3
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

BOREHOLE LOG

FIGURE A9
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT : **Canning Resources Pty Limited**

HOLE No. **DM98-3**

SHEET 3 OF 3

DRILLING RIG : GEMCO 210A BARREL TYPE : – BIT TYPE : –	HOLE DIRECTION VERT.'	HOLE ANGLE FROM HORIZONTAL 90°	CO-ORDINATES N: ~7528260 E: ~404298	R.L. (m)	DATUM AHD

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 17/07/98 ~ 08:30
DATE/TIME COMPLETED : 18/07/98 – 10:05

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Silty CLAY**, hard, brown, low plasticity, slightly moist to moist.	CL										
	Silty CLAY, hard, dark grey, high plasticity, moist.	CH		21	◢	B	14	55 150	100		55 for 150mm. AL, M.	
	BOREHOLE COMPLETED AT 21.15m.											
				22								
				23								
				24								
				25								
				26								
				27								
				28								
				29								

data : DM98-3
script : SOILL063

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	–
APPROVED BY	Pen	22/10/96

BOREHOLE LOG

FIGURE A10
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT : Canning Resources Pty Limited

HOLE No. DM98-4

SHEET 1 OF 2

DRILLING RIG : GEMCO 210A	HOLE DIRECTION VERT.'	HOLE ANGLE FROM HORIZONTAL 90'	CO-ORDINATES	R.L. (m)	DATUM AHD
BARREL TYPE : –			N: ~7528134		
BIT TYPE : –			E: ~402720		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN
DATE/TIME COMMENCED : 18/07/98 - 11:45
DATE/TIME COMPLETED . 19/07/98 - 15:45

GEOLOGICAL UNIT	Surface Conditions: Gently sloping to the north-east, orange brown fine to coarse grained sand; sparse grass coverage. DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION (Permean Fluvioglacial)	**Silty SAND**, dense, orange brown, fine to medium grained, ~25% fines with free quartz gravel traces.	SM										
				1								
	— grades with 33% fines.				◢	B	1	41	80		7, 13, 28. PSD.	
				2								
	Silty CLAY, hard, dark brown, mottled with white, orange brown, yellow brown and black, high plasticity, with a trace of sand (10%) from 2.4 to 4.0m	CH										
				3	◢	B	2	80	100		18, 25, 35. HYD, AL, M, pH.	
				4								
	— grades greenish brown, prismatic structure, from 4.5 to 10.5m.				◢	B	3	42 10	100		21, 42, 8 for 10mm.	
				5								
	— with black prismatic gravel inclusions and white plate-like inclusions ; highly to completely weathered rock from 8.0 to 8.5m.			6	◢	B	4	50 80	100		42, 50 for 80mm. Attempted D&M "U" sampler but hole slightly deflected and too hard to install casing. AL, M CONDUCTING FALLING HEAD TESTS.	
				7								
					◢	B	5	50 100	100		21, 50, for 150mm.	
				8								
				9	◢	B	6	50 150	100		50 for 150mm. AL, M.	

data : DM98-4
script : SOILLOG3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	–
APPROVED BY	Am	22/10/96

BOREHOLE LOG

FIGURE A11
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT : Canning Resources Pty Limited

HOLE No. DM98-4

SHEET 2 OF 2

DRILLING RIG : GEMCO 210A	HOLE DIRECTION VERT.'	HOLE ANGLE FROM HORIZONTAL 90°	CO-ORDINATES	R.L. (m)	DATUM AHD
BARREL TYPE : –			N: ~7528134		
BIT TYPE : –			E: ~402720		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN
DATE/TIME COMMENCED : 18/07/98 – 11:45
DATE/TIME COMPLETED : 19/07/98 – 15:45

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION (Permean Fluvioglacial	**Silty CLAY**, hard, greenish brown, high plasticity.	CH										
	grades brown from 10.5m.				◢	B	7	58 150	100		58 for 150mm. AL, M.	
				11								
				12	◢	B	8	50 100	100		50 for 100mm.	
	highly weathered (rock) claystone layer from 12.8 to 13.0m (very hard drilling).											
				13								
					◢	B	9	58 140	100		58 for 140mm.	
				14								
				15	◢	–	–	60 90	100		60 for 90mm. No recovery, cone damaged, probably on rock piece.	
	MET REFUSAL AT 15.25m. (roller bit and blade bit scraping on rock).											
				16								
				17								
				18								
				19								

data : DM98-4
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	–
APPROVED BY		22/10/98

BOREHOLE LOG

FIGURE A12
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

HOLE No. DM98-5A

CLIENT: Canning Resources Pty Limited

SHEET 1 OF 1

DRILLING RIG: GEMCO 210A	HOLE DIRECTION VERT.°	HOLE ANGLE FROM HORIZONTAL 90°	CO-ORDINATES	R.L. (m)	DATUM AHD
BARREL TYPE: –			N: ~7528805		
BIT TYPE: –			E: ~403815		

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
	<u>Surface Conditions:</u> Relatively flat, orange brown, fine to coarse grained, quartz sand, 25% grass cover; adjacent to track.											
	Gravelly silty SAND, loose, orange brown, fine to coarse grained, sub-rounded to sub-angular; 25% fine grade	SP		1							Installing 1.0m HX casing to 0.5m BGL. Drilling BQ bit from 0.5 to 2.0 m to conduct falling head test.	
	DRILLING COMPLETED AT 2.0m.			2 3 4 5 6 7 8 9								

DRILLING COMPANY: J & S DRILLING / OZ DRILL
DRILLER: PETER O'LOCHLAN

DATE/TIME COMMENCED: 20/07/98 - 08:40
DATE/TIME COMPLETED: 20/07/98 - 07:00

data: DM98-5A
script: SOILLOG3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	–
APPROVED BY		22/10/96

BOREHOLE LOG

FIGURE A13
DAMES & MOORE

PROJECT :	GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT
CLIENT :	Canning Resources Pty Limited

HOLE No. DM96-5B

SHEET 1 OF 3

DRILLING RIG : GEMCO 210A	HOLE DIRECTION	HOLE ANGLE FROM HORIZONTAL	CO-ORDINATES		R.L. (m)	DATUM
BARREL TYPE : -	VERT.'	90'	N:	~7528801		AHD
BIT TYPE : -			E:	~403919		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 20/07/96 - 09:45
DATE/TIME COMPLETED : 21/07/96 - 07:20

Surface Conditions: Relatively flat, orange brown, fine to coarse grained, quartz sand, 25% grass cover

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Gravelly silty SAND**, loose, orange brown, fine to coarse grained, sub-rounded to sub-angular, dry; 25% fine gravel.	SM										
				1								
	grades with 17% fines					B	1	6	75		3, 3, 3. PSD.	
				2								
	Grades very dense, orange brown, mottled with black and and light yellow brown, fine to medium grained, sub-rounded to sub- angular, poorly graded; 35% fines with some fine gravel.											
				3		B	2	50 150	100		30, 50 for 150mm. PSD, PERM.	
				4								
						B	3	15 20	100		70, 15 for 20mm.	
				5								
	Clayey GRAVEL, fine gravel, very dense, white, quartz.	GC										
				6	☒	B	4	-			cuttings sample.	
	Silty sandy CLAY, hard, brown mottled with white, black and orange brown, low plasticity; with 15% fine sand.	CL				8	5	70 150	100		30, 70 for 150 mm.	
				7								
						8A B	8 8B		100		32, 90, 20 for 10mm. D&M "U" sampler. CIU, PSD + HYD, AL, M, DENS, pH.	
				8								
				9		5A 8	7 7B	100 140	100		35, 100 for 140mm. (11.30). PERM, PSD + HYD, AL, M, DENS.	

data . DM96-5B
script . SOILLOG3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY	~~[illegible]~~	22/10/96

BOREHOLE LOG

FIGURE A14
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT : Canning Resources Pty Limited

HOLE No. DM98-5B

SHEET 2 OF 3

DRILLING RIG : GEMCO 210A	HOLE DIRECTION	HOLE ANGLE FROM HORIZONTAL	CO-ORDINATES	R.L. (m)	DATUM
BARREL TYPE : -	VERT.˙	90˙	N: ~7528801		AHD
BIT TYPE : -			E: ~403919		

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN
DATE/TIME COMMENCED : 20/07/98 - 08:45
DATE/TIME COMPLETED : 21/07/98 - 07:20

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	DOWN HOLE DEPTH (m)	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	**Silty CLAY,** hard, brown with purplish brown and orange brown, low plasticity; with some fine sand.	CL								
				A B	8R 8B	100 115	100		100 for 115mm. 1 ring.	
			11							
			12	1A 8	9 98	108 120	100		108 for 120mm. PF, AL, M.	
			13							
				B	10	78 130	100		25, 24, 78 for 130mm.	
			14							
	grades brown, prismatic structure, high plasticity, from 15.0m without sand, with some black stained fractures.		15	B	11		100		65 for 150mm. HYD, AL, M.	
			16							
	mottled with grey and brownish yellow from 16.0 to 17.0m.			B	12	50 80	100		32, 50 for 80mm.	
			17							
	highly weathered claystone layer from 18.0 to 18.5m (hard drilling).		18						Change to roller bit to hack through rock.	
				B	13		100		73 for 120mm. AL, M.	
			19							

data : DM98-5B
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJO	-
APPROVED BY	JGm	22/10/98

BOREHOLE LOG

FIGURE A15
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT			HOLE No. **DM98-5B**	
CLIENT : Canning Resources Pty Limited			SHEET 3 OF 3	
DRILLING RIG : GEMCO 210A BARREL TYPE : - BIT TYPE : -	HOLE DIRECTION VERT.˙	HOLE ANGLE FROM HORIZONTAL 90˙	CO-ORDINATES N: ~7528801 E: ~403919	R.L. (m)	DATUM AHD

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED : 20/07/98 - 08:45
DATE/TIME COMPLETED : 21/07/98 - 07:20

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	R.L. (m)
PATERSON FORMATION	Silty CLAY, hard (friable), grey, low plasticity (highly weathered claystone).	CL			⧄			5 0	0		15 for 0mm. (16.00 20/7/98 stop work).	
				21	☒	B	14				cuttings sample.	
					⧄	-	-	30 50	0		30 for 50mm. Hammer bouncing.	
	BOREHOLE COMPLETED AT 21.55m.											
				22								
				23								
				24								
				25								
				26								
				27								
				28								
				29								

data : DM98-5B
script : SOILLOG3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		21/10/96

BOREHOLE LOG

FIGURE A16
DAMES & MOORE

PROJECT : GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT			HOLE No. **DM96-5C** SHEET 1 OF 1
CLIENT : **Canning Resources Pty Limited**			
DRILLING RIG : GEMCO 210A BARREL TYPE : - BIT TYPE : -	HOLE DIRECTION VERT.'	HOLE ANGLE FROM HORIZONTAL 90'	CO-ORDINATES N: ~7528798 E: ~403819

R.L. (m)	DATUM
	AHD

Surface Conditions: Relatively flat, orange brown, firm to coarse grained, quartz sand, 25% grass cover.

GEOLOGICAL UNIT	DESCRIPTION	UNIFIED SYMBOL	GRAPHIC LOG	DOWN HOLE DEPTH (m)	SAMPLE SYMBOL / CORE RUN	SAMPLE TYPE	SAMPLE No. / RUN No.	SPT N VALUE	RECOVERY (%)	RQD (%)	FIELD TESTS LABORATORY TESTS GROUNDWATER OBSERVATIONS CASING ADDITIONAL NOTES	RL. (m)
PATERSON FORMATION	**Gravelly silty SAND**, loose, orange brown, fine to coarse grained, sub-rounded to sub-angular, dry; 25% fine gravel.	SP		1 2								
	Silty SAND, very dense, orange brown, mottled with black and light yellow brown, fine to coarse grained, sub-rounded to sub-angular, poorly graded; 40% fines with a trace of fine gravel.	SM		3 4	◣	B	1	50 150	100		27, 50 for 150mm. PSD, AL, M. Installing HW casing to 3.0m BGL. Drilling with BQ bit from 3.0m to 4.55m conducting falling head test.	
	BOREHOLE COMPLETED at 4.85m.			5 6 7 8 9								

DRILLING COMPANY : J & S DRILLING / OZ DRILL
DRILLER : PETER O'LOCHLAN

DATE/TIME COMMENCED . 21/07/98 - 08:30
DATE/TIME COMPLETED : 21/07/98 - 08:25

data : DM96-5C
script : SOILLOG3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

BOREHOLE LOG

FIGURE A17
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

TEST PIT No. TP96-1

CLIENT: Canning Resources Pty Limited

DATE: 12 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 3

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy Silty GRAVEL,** orange brown, fine to coarse grained; 20% fine to medium grained sand with some cobbles, some grey-white quartz gravel; with 17% silty fines.		GM GC	.5 1 1.5	B1		17		
	REFUSAL AT 1.8m			2 2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-1
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A18
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

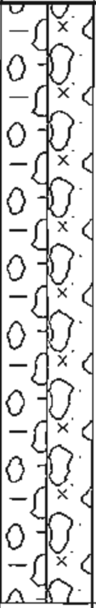
TEST PIT No. TP96-2

CLIENT: Canning Resources Pty Limited

DATE: 12 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 3

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy Silty GRAVEL,** orange brown, fine to coarse grained; 30% fine to medium grained sand with some cobbles and boulders and some silt (~15%).		GM GC	.5 1 1.5	B1				
	REFUSAL AT 2.0m **NOTE:** Met refusal due to a large boulder at 0.5m; moved about 1.0m south and excavated to refusal at 2.0m.			2 2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:
☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:
☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:
V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-2
script . TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A19
DAMES & MOORE

PROJECT: **GEOTECHNICAL SITE INVESTIGATION**
KINTYRE ADVANCEMENT PROJECT

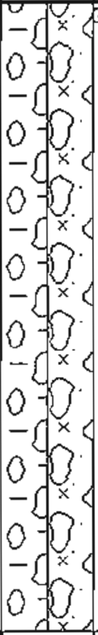
TEST PIT No. **TP98-3**

CLIENT: Canning Resources Pty Limited

DATE: 12 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 3

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m³)	Scintillation count (counts/s)
Paterson Formation	**Sandy Silty GRAVEL,** orange brown mottled with some grey, fine to coarse grained; 23% fine to medium grained sand; 24% silty fines; with a few pockets of hard grey sandy clay (<5%).		GM/GC	.5					
				1	B1		24		
				1.5					
				2					
	REFUSAL AT 2.1m			2.5					
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP98-3
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY	PAM	22/10/96

TEST PIT LOG

FIGURE A20
DAMES & MOORE

PROJECT: **GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT**

CLIENT: Canning Resources Pty Limited

DATE: 12 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 3

TEST PIT No. **TP96-4**

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Gravelly silty SAND,** orange brown, fine to medium grained; with ~25% rounded, fine to coarse gravel and with ~20% silt.		SM SC						
	SILTSTONE, highly to completely weathered, grey with yellow-brown and red-brown mottling.		RK	.5 1	B1				
	REFUSAL AT 1.1m **NOTE:** Met refusal in Siltstone (highly weathered) at 0.8m; moved 1.0m west and met refusal at 1.1m.			1.5 2 2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V	SHEAR VANE
P	HAND PENETROMETER
E	ESTIMATE ONLY

data : TP96-4
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A21
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT: Canning Resources Pty Limited

DATE: 12 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 3

TEST PIT No. TP96-5

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy Silty Gravel,** orange brown, fine to medium grained; with 53% fine to coarse gravel and 23% silt.		GM GC	.5	BI		23		
	SILTSTONE, highly to completely weathered, grey, grades to highly weathered.		RK	1					
	REFUSAL AT 1.5m			1.5 2 2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-5
script : TESTPIT3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY	Ecm	22/10/96

TEST PIT LOG

FIGURE A22
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT	TEST PIT No. **TP96-8**
CLIENT: Canning Resources Pty Limited	
DATE: 13 July 1996 **ELEVATION :** –	
MACHINE TYPE: CAT 428B	
PIT LOCATION : SEE FIGURE 4	

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Silty SAND,** reddish brown, fine to medium grained, sub-rounded to rounded, dry; 25% silt fines; with a trace of fine gravel.		SM						
				.5	BUl		25		
	grades, denser below 1.0m			1					
				1.5					
				2					
				2.5					
				3					
	with some quartz gravel from 3.5m			3.5					
	COMPLETED AT 3.7m								
				4					
				4.5					

TEST PIT TERMINATED AT:
■ TARGET DEPTH ☐ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:
☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:
V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-8
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	–
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A23
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

TEST PIT No. TP96-7

CLIENT: Canning Resources Pty Limited
DATE: 13 July 1996 **ELEVATION:** -
MACHINE TYPE: CAT 428B
PIT LOCATION: SEE FIGURE 4

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Silty SAND,** orange brown, fine to medium grained, sub-rounded, dry; ~15% silt;		SM						
	grades, denser below 0.5m			.5					
	gravelly from 0.5 to 0.8m								
	grades with silty and clayey fines, a trace of gravel.			1					
				1.5					
					BUI		48		
				2					
				2.5					
				3					
	COMPLETED AT 3.3m								
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:
☐ TARGET DEPTH ☐ REFUSAL
■ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:
☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:
V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-7
script : TESTPIT3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A24
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

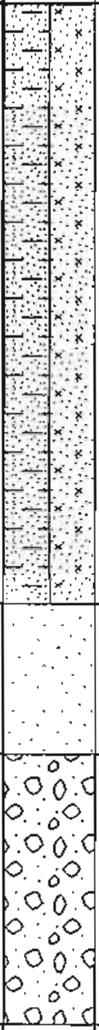
CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. TP96-8

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Silty SAND,** orange brown, fine to medium grained, sub-rounded, dry; silty fines with a trace of gravel.		SM SC	.5					
	grades denser, with some clay from 1.0m			1	B1		27		
				1.5					
	Gravelly Silty SAND, orange brown, fine to coarse grained, dry; 15% to 20% gravel with some silt and clay.		SP	2					
	Sandy GRAVEL, orange brown with dark grey and beige, fine to coarse grained; 30% sand with some silty clay. (highly weathered)		GP	2.5 3					
	COMPLETED AT 3.4m			3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ☐ REFUSAL

■ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-8
script : TESTPIT3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A25
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. TP96-9

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Silty SAND,** orange brown, fine to medium grained, sub-rounded to rounded, dry; silty fines with a trace of fine gravel.		SM SC						
	with a seam of quartz gravel at 0.5m			.5					
				1	B1		38		
				1.5					
	Gravelly Silty SAND, orange brown mottled with dark grey, fine to coarse grained, dry. (highly weathered)		SW	2					
	COMPLETED AT 2.3m			2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ☐ REFUSAL

■ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-9
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY	Pam	22/10/96

TEST PIT LOG

FIGURE A26
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** –

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. TP96–10

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**SAND,** orange brown, fine to medium grained, well sorted, dry; with a trace of silt (<5%).		SP						
				.5	B1				
				1					
	SANDSTONE, weak, grey speckled with beige/white and occasional yellow mottles, highly to moderately weathered.		RK						
	REFUSAL AT 1.2m			1.5					
				2					
				2.5					
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-10
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A27
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1998 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. TP98-11

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy silty GRAVEL,** orange brown, fine to coarse grained, dry; with 15% fine to medium sand.		GP	.5	B1				
	Sandy silty GRAVEL, fine to coarse grained, beige, sub-rounded to sub-angular; with 37% gravel and 30% silty fines.		GM GC	1	BUI		30		200
	— grades denser, sandy gravel below 1.7m			1.5					
	REFUSAL AT 1.8m			2					
				2.5					
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP98-11
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/98

TEST PIT LOG

FIGURE A28
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

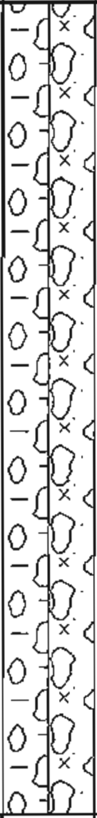
TEST PIT No. TP98-12

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m³)	Scintillation count (counts/s)
Paterson Formation	**Sandy silty GRAVEL,** orange brown, fine to coarse grained, dry; with 38% gravel and 28% silty fines.		GM GC						
					BU1		28		
				.5					
	grades, beige below 0.9m								
	grades denser, fine to medium grained, with 35% gravel and 28% silt, from 1.0m			1					
									250
				1.5					
					B2		28		
				2					
				2.5					
	COMPLETED AT 2.7m								
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:
☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:
☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:
V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

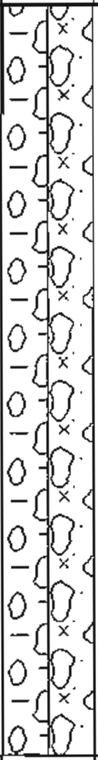
data . TP98-12
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A29
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT	TEST PIT No. **TP96-13**
CLIENT: Canning Resources Pty Limited	
DATE: 13 July 1996 **ELEVATION:** –	
MACHINE TYPE: CAT 428B	
PIT LOCATION: SEE FIGURE 4	

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m³)	Scintillation count (counts/s)
Paterson Formation	**Sandy GRAVEL,** orange brown, fine to coarse grained, dry; with 29% sand and 16% silty fines.		GM GC						
				.5	BU1		16		
	mottled with grey/beige from 1.0m; grades with increasing gravel content below 1.0m.			1					
									200
				1.5					
	a few coarse gravel size quartz fragments below 2.0m.			2					
				2.5					
	COMPLETED AT 2.5m								
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-13
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	–
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A30
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION KINTYRE ADVANCEMENT PROJECT

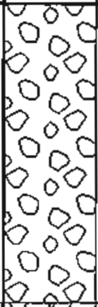
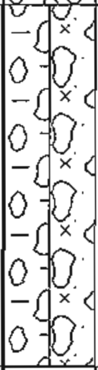
TEST PIT No. TP96–14

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** –

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy GRAVEL,** orange brown, fine to coarse grained, dry; with a few cobbles. grades to beige/yellowish beige gravelly sand from 0.9m.		GW	.5 1					
	Sandy silty GRAVEL, fine to coarse grained, beige/yellowish beige; with 46% gravel and 18% silty fines.		GM GC	1.5 2	BUI		18		220
	COMPLETED AT 2.2m			2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE

P HAND PENETROMETER

E ESTIMATE ONLY

data : TP96-14
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	–
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A31
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

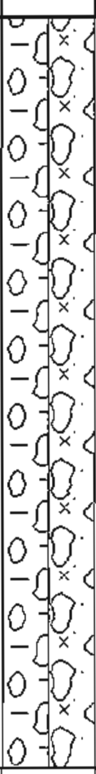
CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. **TP98-15**

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy clayey GRAVEL,** orange brown / reddish brown, fine to coarse grained, dry; with 53% gravel. — grades, reddish brown mottled with grey, yellowish brown and beige, with 25% sub-rounded, low sphericity gravel, with a few cobbles and boulders, plate (planar) structure, from 0.7m.		GM GC	.5 1 1.5 2	BU1 B2		22		225
	COMPLETED AT 2.5m			2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP98-15
script : TESTPIT3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A32
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

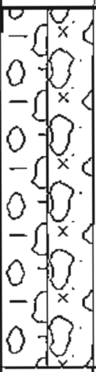
TEST PIT No. TP96-16

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy silty GRAVEL,** orange brown, fine to coarse grained, angular, dry; with 40% sand and some cobbles and boulders. — grades, light brown from 0.8m.		GM GC	.5 1	BUl		15		420 to 450
	COMPLETED AT 1.2m			1.5 2 2.5 3 3.5 4 4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-16
script : TESTPIT3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A33
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

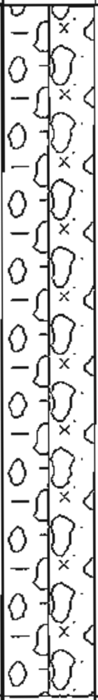
TEST PIT No. TP98-17

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1998 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy silty GRAVEL,** orange brown, fine to coarse grained, dry; with some cobbles and boulders.		GM GC						
	grades, light brown to beige with some reddish brown from 1.2m.			.5	BUI		28		
				1					
				1.5					
				2					
	COMPLETED AT 2.3m								
				2.5					
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP98-17
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A34
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

TEST PIT No. TP96-18

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy silty GRAVEL,** reddish brown, fine to coarse grained, dry; with 47% gravel and 23% silty fines.		GM GC						
				.5	BU1		23		
	— grades, beige from 0.9m.								
	Gravelly Silty SAND, beige, fine to coarse grained, sub-rounded to sub-angular; with 20% gravel and 10% silt.		SW	1					300
				1.5					
				2	B2				
	COMPLETED AT 2.3m			2.5					
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-18
script : TESTPIT3

JOB No. 15780-018-361		DATE
LOGGED BY	SJD	-
APPROVED BY	Ca	22/10/96

TEST PIT LOG

FIGURE A35
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

CLIENT: Canning Resources Pty Limited

DATE: 13 July 1996 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. TP96–19

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy clayey GRAVEL,** orange brown, fine to coarse grained, dry; with 51% fine to coarse gravel with a few cobbles and boulders.		GM GC						
	— grades, mottled with beige from 0.6m.			.5	BU1		21		
				1					180
				1.5					
	COMPLETED AT 1.8m			2					
				2.5					
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:
☐ TARGET DEPTH ■ REFUSAL
☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:
☒ BULK SAMPLE
■ TUBE SAMPLE

FIELD SHEAR STRENGTH:
V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP96-19
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY	PCM	22/10/96

TEST PIT LOG

FIGURE A36
DAMES & MOORE

PROJECT: GEOTECHNICAL SITE INVESTIGATION
KINTYRE ADVANCEMENT PROJECT

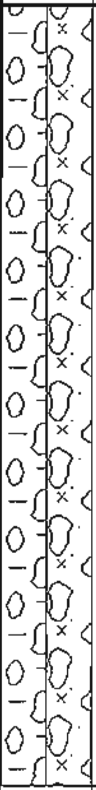
CLIENT: Canning Resources Pty Limited

DATE: 13 July 1998 **ELEVATION :** -

MACHINE TYPE: CAT 428B

PIT LOCATION : SEE FIGURE 4

TEST PIT No. TP98-20

GEOL. UNIT	DESCRIPTION	GRAPHIC LOG	UNIFIED SYMBOL	DEPTH (m)	SAMPLES	FIELD SHEAR STRENGTH (kPa)	% FINES (<0.075mm)	DRY DENSITY (t/m^3)	Scintillation count (counts/s)
Paterson Formation	**Sandy silty GRAVEL,** reddish brown to light brown, fine to coarse grained, dry; with 30% sand and some cobbles and boulders.		GM GC						
				.5	BU1		16		
	— grades, beige with yellowish patches from 1.0m			1					
									230
				1.5					
				2					
				2.5	B2				
	COMPLETED AT 2.8m								
				3					
				3.5					
				4					
				4.5					

TEST PIT TERMINATED AT:

☐ TARGET DEPTH ■ REFUSAL

☐ NEAR REFUSAL ☐ FLOODING

SAMPLE TYPE:

☒ BULK SAMPLE

■ TUBE SAMPLE

FIELD SHEAR STRENGTH:

V SHEAR VANE
P HAND PENETROMETER
E ESTIMATE ONLY

data : TP98-20
script : TESTPIT3

JOB No. 15780-018-381		DATE
LOGGED BY	SJD	-
APPROVED BY		22/10/96

TEST PIT LOG

FIGURE A37
DAMES & MOORE

Appendix B

APPENDIX B

FALLING HEAD PERMEABILITY TESTS

APPENDIX B

FALLING HEAD PERMEABILITY TESTS

This appendix presents both the raw data and a graphical presentation of the assessment of that data for the *in situ* falling head permeability tests.

* * *

The following figures are attached and complete this appendix.

Figures B1 to B6	-	Raw Data for Falling Head Permeability Tests at Boreholes DM96-1 to DM96-5C
Figure B7 to B12	-	Plots of Interpreted Permeability for Boreholes DM96-1 to DM96-5C

DM96-1

Length of casing = 10.1m
Diameter of casing = 110mm
Length of intake area = 1.2m
Diameter of intake area = 75mm

Note: the recorded drop is from the initial water level, ie. top of casing

Time		Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)
h:mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4
0:00:10	10			100	60
0:00:20	20	20		180	100
0:00:30	30	40		270	145
0:00:40	40		10	320	190
0:00:50	50		10		220
0:01:00	60	50	10	420	260
0:01:10	70			470	
0:01:15	75				
0:01:20	80	60		530	300
0:01:30	90	65	20	580	
0:01:40	100				345
0:01:45	105	75		650	
0:01:50	110				
0:02:00	120	80		690	380
0:02:15	135	95	40	720	400
0:02:30	150	100	45	750	430
0:02:45	165	120	50	770	
0:03:00	180	125	60	795	460
0:03:15	195			810	
0:03:30	210	130		830	495
0:03:45	225				
0:04:00	240	155	90	845	520
0:04:15	255				
0:04:30	270	180	150	860	535
0:04:45	285				
0:05:00	300	190	365	865	565
0:05:30	330		580		
0:06:00	360	230	870	875	595
0:06:30	390		1050		
0:07:00	420	270	1180	890	625
0:07:30	450				
0:08:00	480	300	1340	920	650
0:08:30	510				
0:09:00	540	325	1400	920	670
0:09:30	570				
0:10:00	600	350	1410	930	695
0:10:30	630				
0:11:00	660	360	1410		
0:11:30	690				
0:12:00	720		1410		
0:12:30	750				
0:13:00	780	400		960	
0:13:30	810				
0:14:00	840		1450		
0:14:30	870				
0:15:00	900	420		985	780
0:15:30	930				
0:16:00	960		1470		
0:16:30	990				
0:17:00	1020	435			
0:17:30	1050				
0:18:00	1080	455	1500		
0:18:30	1110				
0:19:00	1140				
0:19:30	1170				
0:20:00	1200	470	1500		
0:21:00	1260				
0:22:00	1320	485	1520		
0:22:30	1350				
0:23:00	1380				
0:24:00	1440	500			
0:25:00	1500		1530		
0:26:00	1560	515			
0:27:00	1620				
0:28:00	1680	525			
0:29:00	1740				
0:30:00	1800	540	1580		
0:31:00	1860				
0:32:00	1920				
0:33:00	1980				
0:34:00	2040				
0:35:00	2100	555			
0:36:00	2160				
0:37:00	2220				
0:38:00	2280				
0:39:00	2340				
0:40:00	2400	580			
0:44:00	2640				
0:45:00	2700	610			
0:50:00	3000	630			
0:55:00	3300	660			
1:00:00	3600	675			
1:10:00	4200	680			
1:11:00	4260				
1:20:00	4800				
1:30:00	5400	825			
1:40:00	6000	880			
1:41:00	6060				
1:45:00	6300				
1:50:00	6600				
1:51:00	6660				
2:00:00	7200				
2:10:00	7800				
2:15:00	8100				
2:20:00	8400				
2:30:00	9000				
2:35:00	9300				
2:45:00	9900				
3:00:00	10800				
3:15:00	11700				
14:30:00	52200				
14:58:00	53880	3470			

DM96-2

Length of casing = 7.1m
Diameter of casing = 110mm
Length of intake area = 1.42m
Diameter of intake area = 75mm

Note: the recorded drop is from the initial water level, ie. top of casing

Time		Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)
h:mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5
0:00:10	10	10	10	10	10	20
0:00:20	20	20	20	20	20	25
0:00:30	30	30	30	30	25	30
0:00:40	40	45	35	35	30	35
0:00:50	50	50	40	40	35	40
0:01:00	60	55	45	45	40	50
0:01:10	70	65	50		40	55
0:01:15	75					
0:01:20	80	70	55	55	45	60
0:01:30	90	80	65	60	50	65
0:01:40	100	85	70	65	50	70
0:01:45	105					
0.01:50	110	90	70	70	60	75
0:02:00	120	100	75	75	65	80
0:02:15	135	110	85	75	70	90
0:02:30	150	115	95	90	80	95
0:02:45	165	130	105	95	85	105
0:03:00	180	140	115	100	95	110
0.03.15	195					
0:03,30	210	160	130	115	105	130
0:03:45	225					
0 04.00	240	180	145	130	120	140
0.04:15	255					
0:04:30	270		160	145	135	155
0:04:45	285	200				
0:05:00	300	210	175	160	150	175
0:05.30	330	230	190	170	160	
0:06:00	360	240	200	190	175	200
0:06:30	390					
0:07:00	420	270	230	210	200	230
0:07:30	450					
0:08.00	480	305	255	240		255
0:08:30	510				230	
0:09:00	540		280	265	245	280
0.09:30	570	340				
0:10:00	600	350	300	275	265	305
0:10:30	630					

Time		Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)
h.mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5
0:11:00	660	370				
0:11:30	690					
0:12:00	720	390		320	310	
0:12:30	750				315	
0:13:00	780		355			
0:13:30	810					
0.14:00	840	410				
0:14:30	870					
0:15.00	900		395		360	
0.15.30	930					
0:16:00	960	455				
0:16:30	990					
0:17:00	1020					
0:17.30	1050				400	
0:18:00	1080					
0:18 30	1110					
0:19:00	1140					
0:19:30	1170					
0:20:00	1200	510			440	
0:21:00	1260					
0.22:00	1320					
0:22:30	1350				480	
0:23:00	1380					
0:24:00	1440					
0:25:00	1500	560			510	
0 26.00	1560					
0 27 00	1620					
0:28:00	1680				540	
0.29:00	1740					
0:30:00	1800	610			570	
0:31:00	1860					
0:32:00	1920					
0.33:00	1980					
0:34:00	2040					
0:35.00	2100					
0:36:00	2160				620	
0:37:00	2220					

Time		Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)
h:mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5
0:38:00	2280					
0:39:00	2340					
0.40:00	2400				660	
0:44:00	2640					
0:45:00	2700				700	
0:50:00	3000				735	
0.55:00	3300				760	
1:00:00	3600				780	
1.10:00	4200					
1:11.00	4260				840	
1:20:00	4800				880	
1:30.00	5400				935	
1:40:00	6000				970	
1.41.00	6060					
1:45:00	6300					
1:50:00	6600				1020	
1.51.00	6660					
2:00:00	7200				1080	
2.10:00	7800					
2:15:00	8100				1130	
2:20:00	8400					
2:30:00	9000					
2:35:00	9300					
2:45:00	9900					
3:00:00	10800					
3:15.00	11700					
14:30.00	52200					
14:58:00	53880					

FIGURE B2
DAMES & MOORE

DM96-3
Length of casing = 7.1m
Diameter of casing = 110mm
Length of intake area = 1.26m
Diameter of intake area = 75mm

Note: the recorded drop is from the initial water level, ie. top of casing

Time		Drop (mm)	Drop (mm)	Drop (mm)
h:mm:ss	Seconds	Test#1	Test#2	Test#3
0:00:10	10			
0:00:20	20			
0:00:30	30			
0:00:40	40			
0:00:50	50			
0:01:00	60			
0:01:10	70			
0:01:15	75			
0:01:20	80			
0:01:30	90			
0:01:40	100			
0:01:45	105			
0:01:50	110			
0:02:00	120			
0:02:15	135			
0:02:30	150			
0:02:45	165			
0:03:00	180			
0:03:15	195			
0:03:30	210			
0:03:45	225			
0:04:00	240			
0:04:15	255			
0:04:30	270			
0:04:45	285			
0:05:00	300		15	22
0:05:30	330			
0:06:00	360			
0:06:30	390			
0:07:00	420			
0:07:30	450			
0:08:00	480			
0:08:30	510			
0:09:00	540			
0:09:30	570			
0:10:00	600		23	38
0:10:30	630			
0:11:00	660			
0:11:30	690			
0:12:00	720			
0:12:30	750			
0:13:00	780			
0:13:30	810			
0:14:00	840			
0:14:30	870			
0:15:00	900	10	35	53
0:15:30	930			
0:16:00	960			
0:16:30	990			
0:17:00	1020			
0:17:30	1050			
0:18:00	1080			
0:18:30	1110			
0:19:00	1140			
0:19:30	1170			
0:20:00	1200	15	43	
0:21:00	1260			
0:22:00	1320			
0:22:30	1350			
0:23:00	1380			
0:24:00	1440			
0:25:00	1500		53	
0:26:00	1560			
0:27:00	1620			
0:28:00	1680			
0:29:00	1740			
0:30:00	1800	25	75	
0:31:00	1860			
0:32:00	1920			
0:33:00	1980			
0:34:00	2040			
0:35:00	2100			
0:36:00	2160			
0:37:00	2220			
0:38:00	2280			
0:39:00	2340			
0:40:00	2400	35		
0:44:00	2640			
0:45:00	2700			
0:50:00	3000	45		
0:55:00	3300			
1:00:00	3600	60		
1:10:00	4200	75		
1:11:00	4260			
1:20:00	4800	95		
1:30:00	5400	110		
1:40:00	6000			
1:41:00	6060			
1:45:00	6300			
1:50:00	6600			
1:51:00	6660			
2:00:00	7200			
2:10:00	7800			
2:15:00	8100	190		
2:20:00	8400			
2:30:00	9000	220		
2:35:00	9300			
2:45:00	9900			
3:00:00	10800	275		
3:15:00	11700			
14:30:00	52200			
14:58:00	53880			

DM96-4

Length of casing = 7.1m
Diameter of casing = 110mm
Length of intake area = 1.0m
Diameter of Intake area = 75mm

Note: the recorded drop is from the Initial water level, ie. top of casing

Time		Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)	Drop (mm)
h:mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5
0:00:10	10					
0:00:20	20					
0:00:30	30					
0 00 40	40					
0:00.50	50					
0:01:00	60					
0:01:10	70					
0:01:15	75					
0:01:20	80					
0:01:30	90					
0:01:40	100					
0:01:45	105					
0:01:50	110					
0:02:00	120			8	5	5
0:02:15	135					
0:02:30	150					
0:02:45	165					
0:03:00	180		10			
0:03:15	195					
0:03:30	210					
0:03:45	225					
0:04:00	240					
0:04:15	255					
0:04:30	270					
0.04:45	285					
0.05:00	300	5	12	14	12	12
0:05:30	330					
0:06:00	360					
0:06:30	390					
0:07:00	420					
0:07:30	450					
0:08 00	480					
0:08:30	510					
0:09:00	540					
0.09:30	570					
0:10:00	600	10	24	25	23	24
0:10:30	630					
0:11:00	660					
0:11:30	690					
0:12:00	720					
0:12:30	750					
0:13:00	780					
0:13:30	810					
0.14:00	840					
0:14:30	870					
0.15:00	900	15	36	36		36
0:15:30	930					
0:16:00	960					
0:16:30	990					
0:17:00	1020					
0:17:30	1050				42	
0:18:00	1080					
0:18 30	1110					
0:19:00	1140					
0:19:30	1170					
0:20:00	1200	20	50	50	48	47
0.21:00	1260					
0:22:00	1320					
0.22:30	1350					
0:23:00	1380					
0:24.00	1440					
0:25:00	1500	22	60	63	60	
0:26:00	1560					63
0:27:00	1620					
0:28:00	1680					
0:29:00	1740					
0:30 00	1800	28	70	72	71	70
0 31:00	1860					
0:32:00	1920					
0:33:00	1980					
0.34.00	2040					
0:35:00	2100	30	83			83
0:36:00	2160					
0:37:00	2220					
0:38:00	2280					
0:39:00	2340					
0:40:00	2400	33	95			95
0:44:00	2640					
0:45:00	2700		105			
0:50:00	3000					123
0.55.00	3300					
1:00:00	3600	118				149
1.10.00	4200	180				177
1:11:00	4260					
1:20:00	4800	240				202
1:30:00	5400	310				230
1:40:00	6000	350				
1:41:00	6060					
1:45:00	6300					268
1:50:00	6600					280
1:51:00	6660					
2:00:00	7200					300
2:10:00	7800					
2:15.00	8100					330
2:20:00	8400					
2:30:00	9000					
2.35.00	9300					365
2:45:00	9900					380
3.00:00	10800					400
3:15.00	11700					425
14:30:00	52200	1890				
14:58:00	53880					

FIGURE B4
DAMES & MOORE

DM96-5A
Length of casing = 1.08m
Diameter of casing = 110mm
Length of intake area = 1.35m
Note: Partial hole collapse of 0 63m
Diameter of intake area = 75mm

Note: the recorded drop is from the initial water level, ie. top of casing

Time		Drop (mm	Drop (mm	Drop (mm	Drop (mm	Drop (mm	Drop (mm)
h.mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5	Test#6
0:00:10	10	10	65	50	45	40	40
0:00:20	20	35	100	65	65	60	60
0:00:30	30	60	140	100	85	80	80
0:00:40	40	70	180	135	110	105	100
0:00:50	50	80	215	155	140	130	130
0:01:00	60	100	250	185		150	150
0:01:10	70				185	180	
0:01:15	75	120	290	215		180	185
0:01:20	80						
0:01:30	90	140	340	250	230	220	205
0:01:40	100						
0:01:45	105	165	380	285	260	250	235
0:01:50	110						
0:02:00	120	180	420	325	290	275	270
0:02:15	135	200	465	360	320	305	300
0:02:30	150	220	500	395	350	330	320
0:02:45	165	240	530	415	380	365	345
0:03:00	180	260	570	445	410	395	380
0:03:15	195	280	590	480	430	415	405
0:03.30	210	290	625	505	460	440	435
0:03:45	225	315	655	530	485	475	460
0:04:00	240	330	695	560	500	495	490
0:04:15	255		705				
0:04:30	270	370	735	605	550	540	510
0:04.45	285		760				
0:05:00	300	395	785	640	600	590	560
0:05:30	330	430	825	680	635	625	600
0:06:00	360	470	870	720	675	670	640
0:06:30	390	495	890	765	715	690	670
0:07:00	420	530	930	800	750	730	710
0:07.30	450	555	960	840	790	760	750
0:08:00	480	590	990	870	820	790	780
0:08:30	510	615	1030	910	850	820	810
0:09:00	540	640	1050	930	885	850	840
0:09:30	570	670	1090	965	915	880	870
0.10:00	600	700	1110	1000	950	910	900
0.10:30	630	725			970		
h:mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5	Test#6
0:11:00	660	750			990	965	960
0:11:30	690	775					
0 12:00	720	805	1200	1090		1020	1000
0:12:30	750	830					
0:13:00	780	855			1090		
0:13:30	810	880					
0:14:00	840	905				1100	
0:14:30	870	920					
0:15:00	900	955					
0.15:30	930	975					
0:16:00	960	1005					
0:16:30	990	1020					
0:17:00	1020	1050					
0:17:30	1050	1085					
0:18:00	1080	1125					
0:18.30	1110	1155					
0.19:00	1140	1205					
0:19:30	1170	1220					
0:20:00	1200	1260					
0:21:00	1260	1290					
0:22:00	1320	1325					
0:22:30	1350						
0:23:00	1380	1370					
0:24:00	1440	1405					
0:25:00	1500	1450					
0:26:00	1560	1480					
0:27:00	1620	1510					
0:28:00	1680	1530					
0:29:00	1740	1565					
0:30:00	1800	1590					
0:31:00	1860	1610					
0:32:00	1920	1640					
0:33:00	1980	1660					
0:34:00	2040	1680					
0:35:00	2100	1690					
0:36:00	2160	1715					
0:37:00	2220	1730					
h:mm:ss	Seconds	Test#1	Test#2	Test#3	Test#4	Test#5	Test#6
0:38.00	2280	1740					
0:39:00	2340	1760					
0:40:00	2400	1770					
0:44:00	2640	1810					
0:45:00	2700	1820					
0:50:00	3000	1875					
0:55:00	3300						
1.00:00	3600						
1:10:00	4200						
1:11:00	4260						
1:20:00	4800						
1:30:00	5400						
1.40:00	6000						
1:41:00	6060						
1:45:00	6300						
1:50:00	6600						
1:51:00	6660						
2:00:00	7200						
2:10:00	7800						
2:15:00	8100						
2:20:00	8400						
2:30:00	9000						
2:35:00	9300						
2:45.00	9900						
3:00:00	10800						
3:15.00	11700						
14:30:00	52200						
14:58:00	53880						

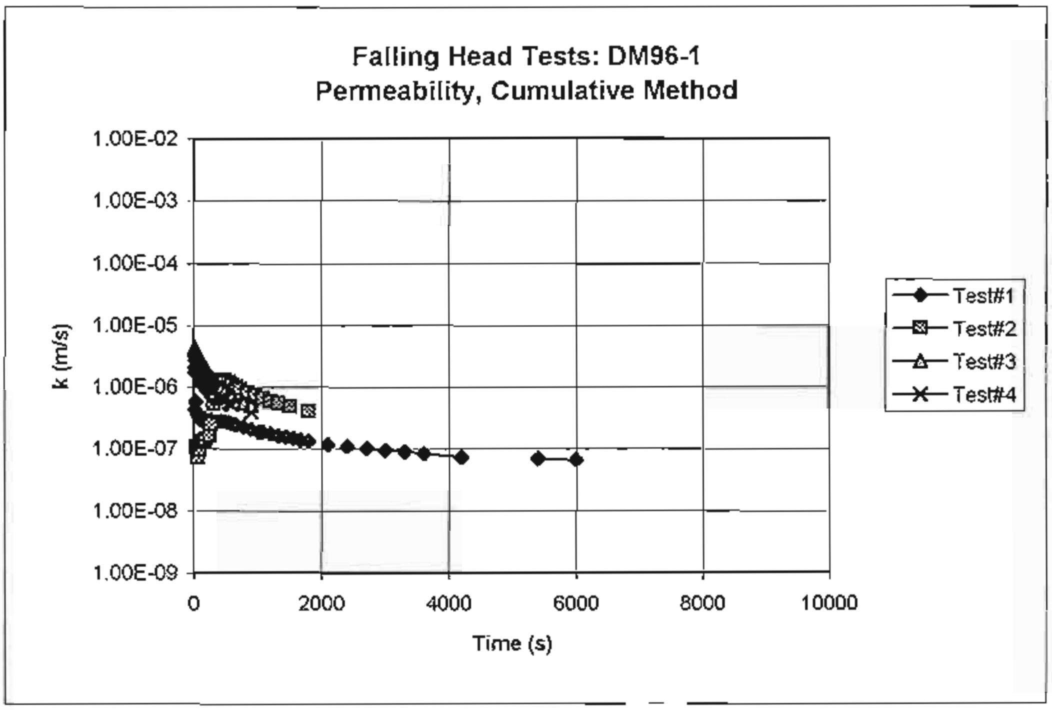
FIGURE B5
DAMES & MOORE

DM96-5C
Length of casing = 4.1m
Diameter of casing = 110mm
Length of intake area = 1.85m
Note: Partial hole collapse of 0.85m
Diameter of intake area = 75mm

Note: the recorded drop is from the initial water level, ie. top of casing

Time		Drop (mm)	Drop (mm)	Drop (mm)
h:mm:ss	Seconds	Test#1	Test#2	Test#3
0:00:10	10			
0:00:20	20			
0:00:30	30			
0:00:40	40			
0:00:50	50			
0:01:00	60			
0:01:10	70			
0:01:15	75			
0:01:20	80			
0:01:30	90			
0:01:40	100			
0:01:45	105			
0:01:50	110			
0:02:00	120			
0:02:15	135			
0:02:30	150			
0:02:45	165			
0:03:00	180			
0:03:15	195			
0:03:30	210			
0:03:45	225			
0:04:00	240			
0:04:15	255			
0:04:30	270			
0:04:45	285			
0:05:00	300	10	2	5
0:05:30	330			
0:06:00	360			
0:06:30	390			
0:07:00	420			
0:07:30	450			
0:08:00	480			
0:08:30	510			
0:09:00	540			
0:09:30	570			
0:10:00	600	15	8	9
0:10:30	630			
0:11:00	660			
0:11:30	690			
0:12:00	720			
0:12:30	750			
0:13:00	780			
0:13:30	810			
0:14:00	840			
0:14:30	870			
0:15:00	900			
0:15:30	930			
0:16:00	960			
0:16:30	990			
0:17:00	1020			
0:17:30	1050			
0:18:00	1080	25		
0:18:30	1110			
0:19:00	1140			
0:19:30	1170			
0:20:00	1200		13	15
0:21:00	1260			
0:22:00	1320			
0:22:30	1350			
0:23:00	1380			
0:24:00	1440			
0:25:00	1500			
0:26:00	1560			
0:27:00	1620			
0:28:00	1680			
0:29:00	1740			
0:30:00	1800	40	23	21
0:31:00	1860			
0:32:00	1920			
0:33:00	1980			
0:34:00	2040			
0:35:00	2100			
0:36:00	2160			
0:37:00	2220			
0:38:00	2280			
0:39:00	2340			
0:40:00	2400	50		
0:44:00	2640			
0:45:00	2700			
0:50:00	3000	65		
0:55:00	3300			
1:00:00	3600	75		35
1:10:00	4200	90		42
1:11:00	4260			
1:20:00	4800	100		
1:30:00	5400	112		
1:40:00	6000			
1:41:00	6060	125		
1:45:00	6300			
1:50:00	6600			
1:51:00	6660	140		
2:00:00	7200	150		
2:10:00	7800	160		
2:15:00	8100			
2:20:00	8400	170		
2:30:00	9000	180		
2:35:00	9300			
2:45:00	9900	190		
3:00:00	10800	205		
3:15:00	11700			
14:30:00	52200			
14:58:00	53880			

FIGURE B6
DAMES & MOORE



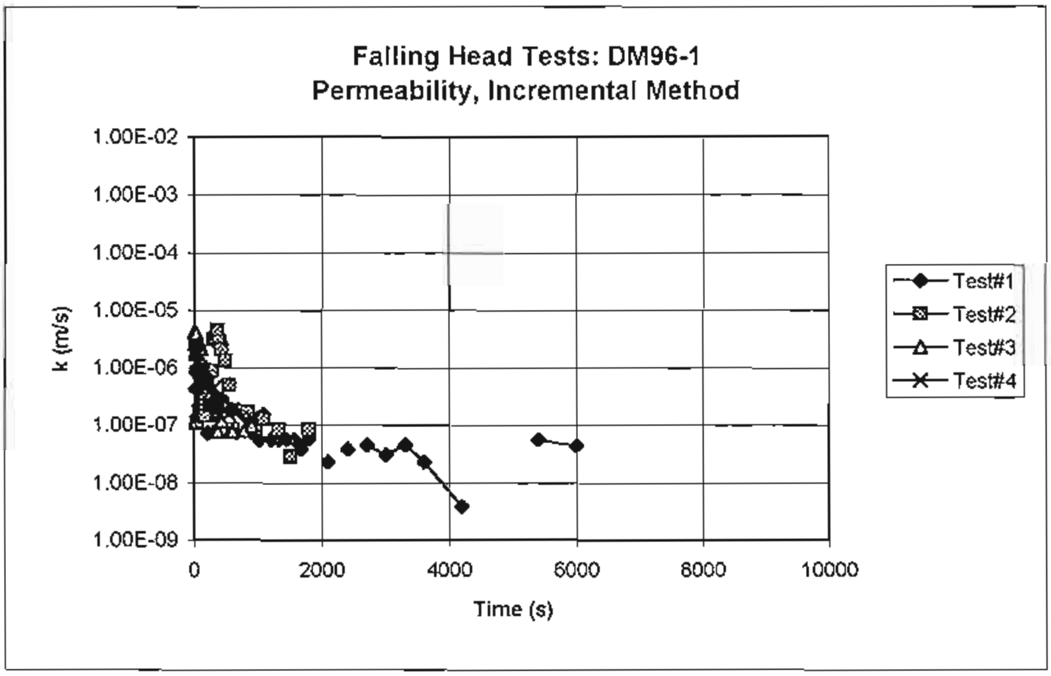
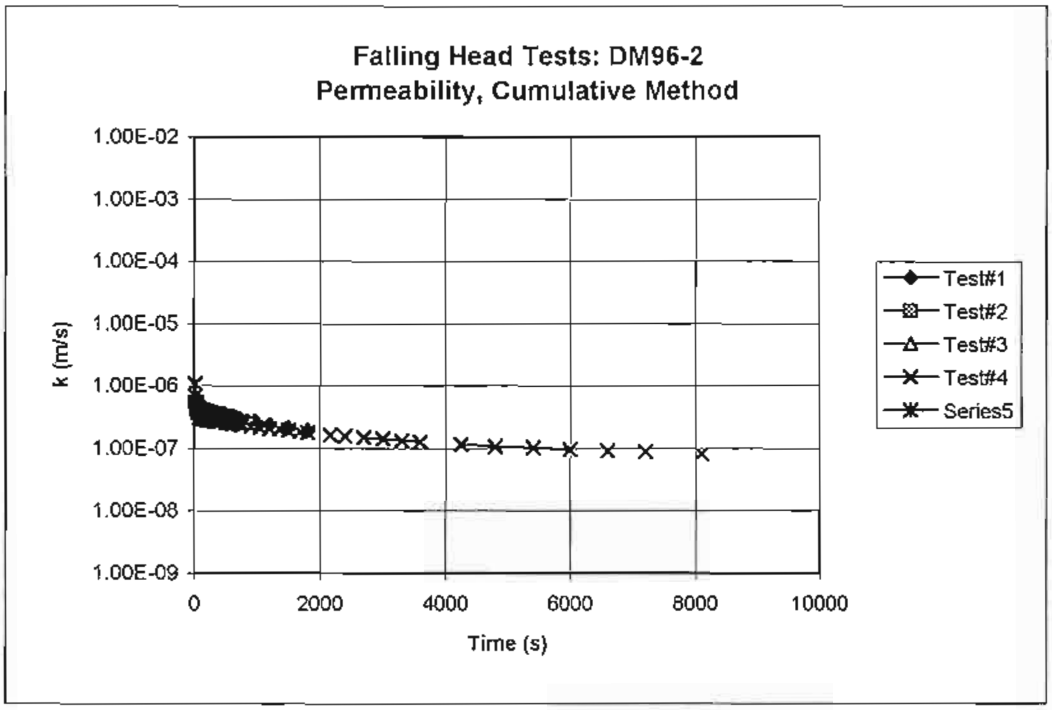


FIGURE B7
DAMES & MOORE



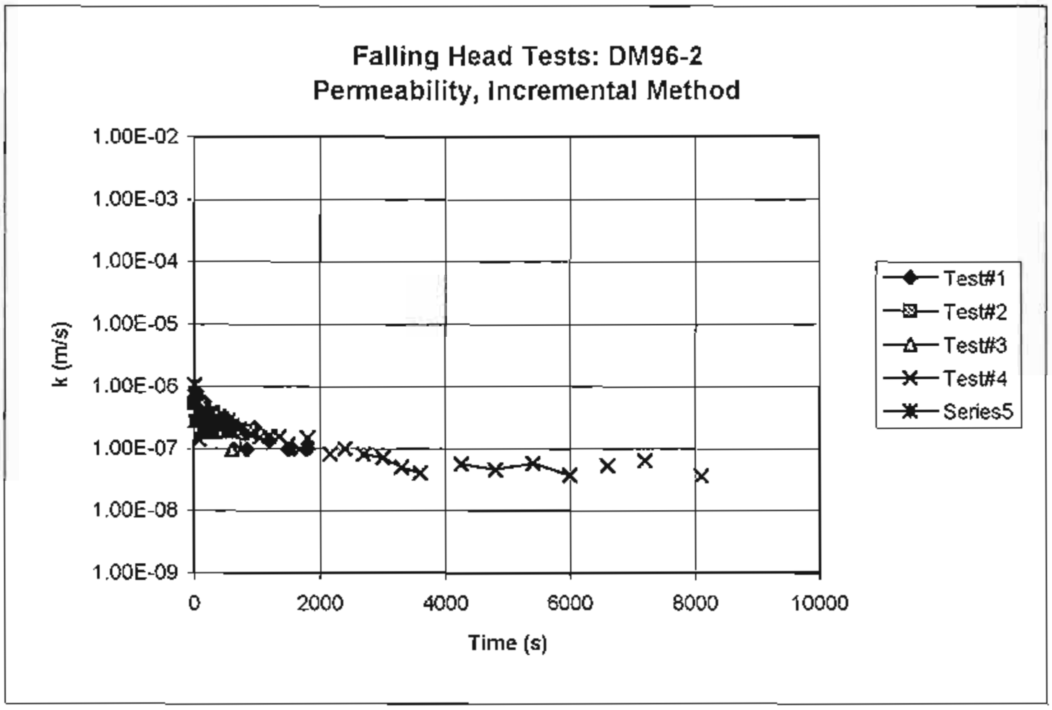
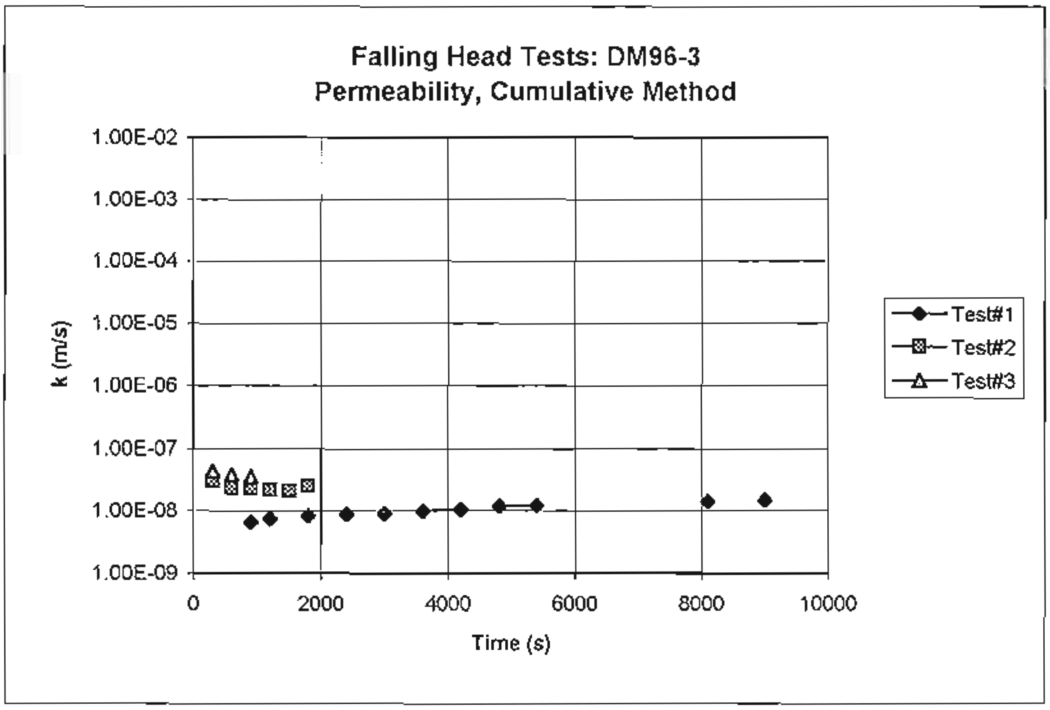


FIGURE B8
DAMES & MOORE



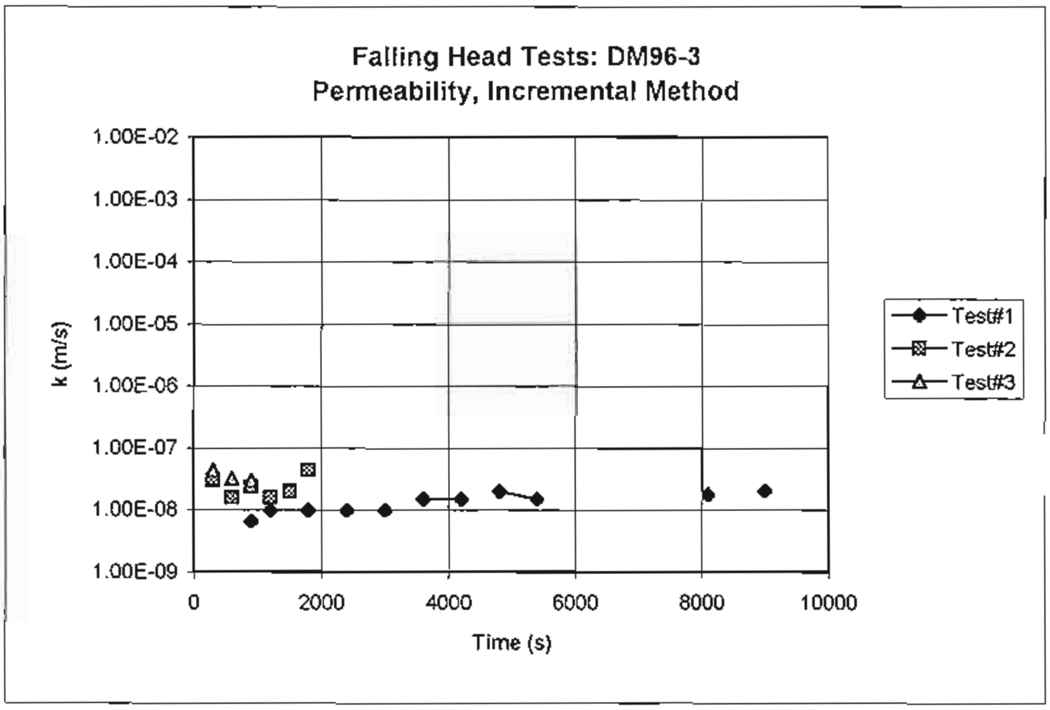
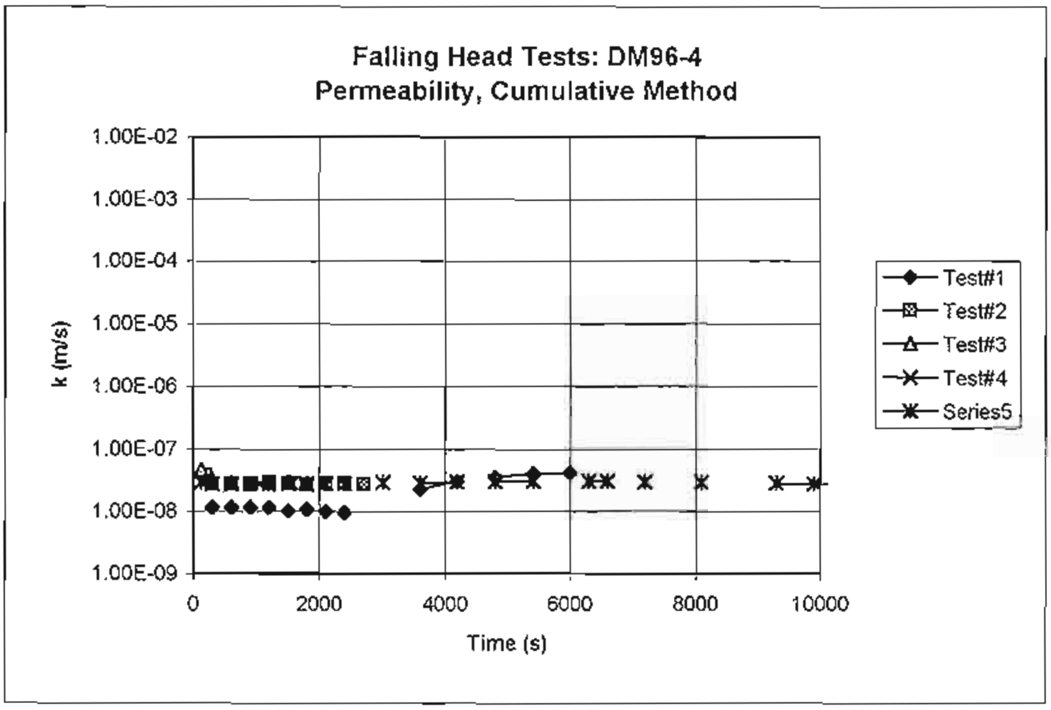


FIGURE B9
DAMES & MOORE



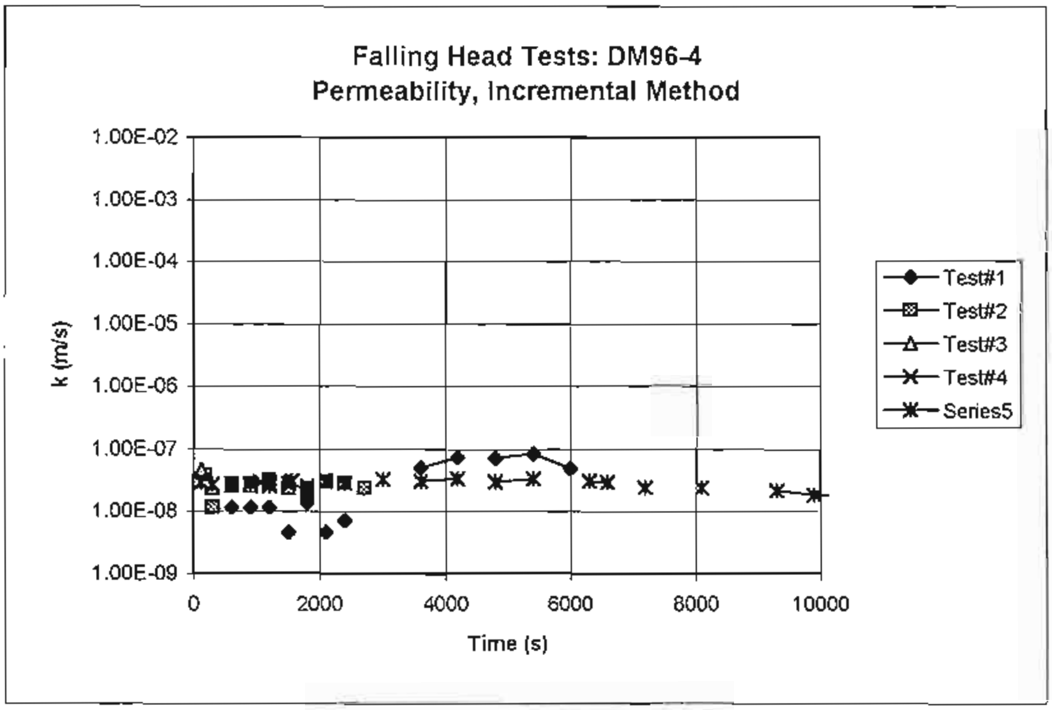
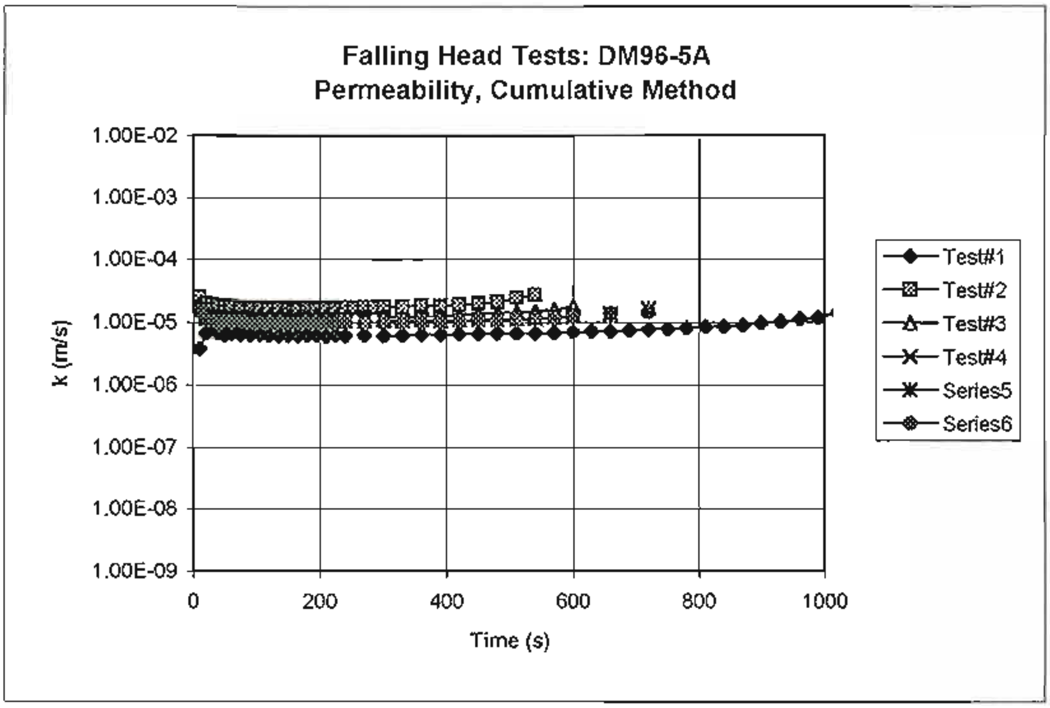


FIGURE B10
DAMES & MOORE



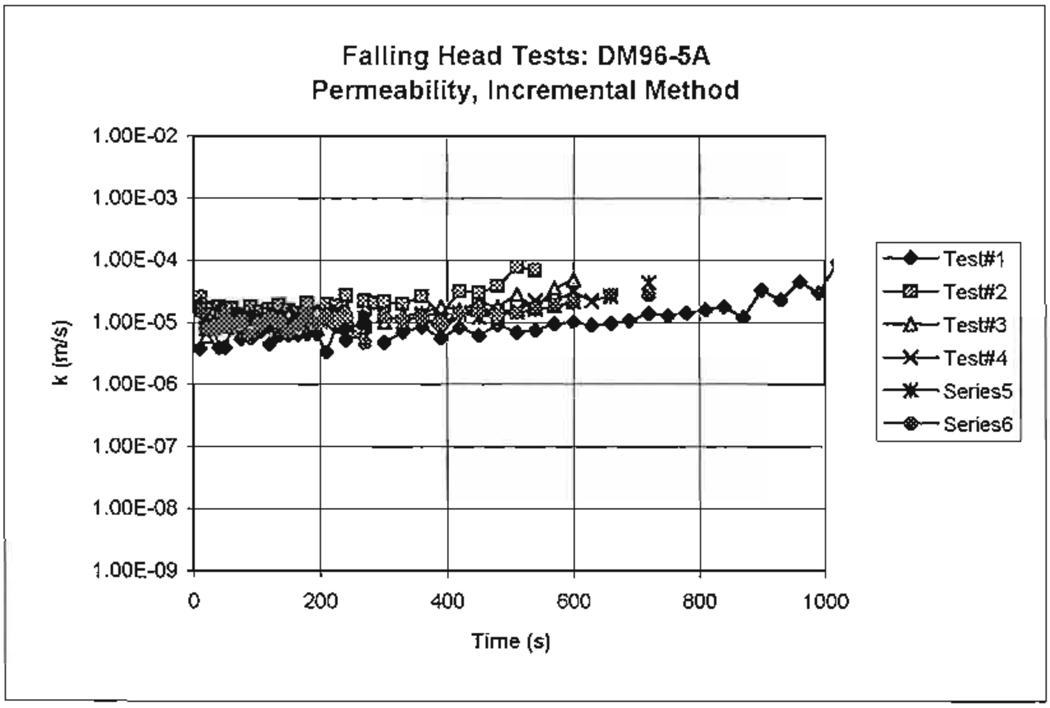
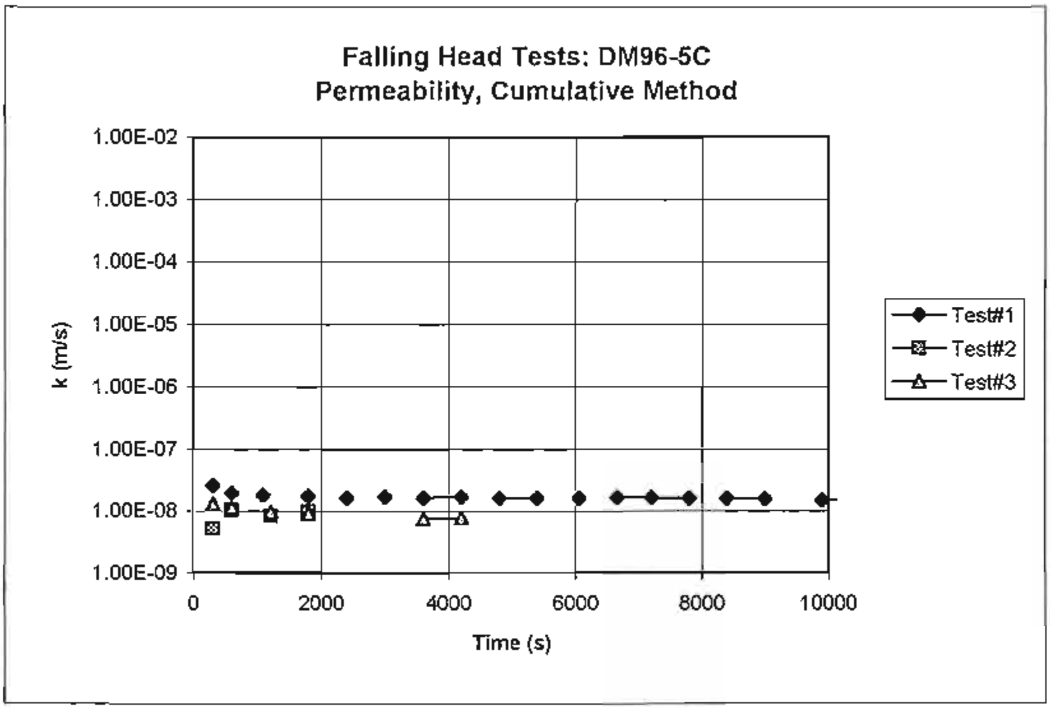


FIGURE B11
DAMES & MOORE



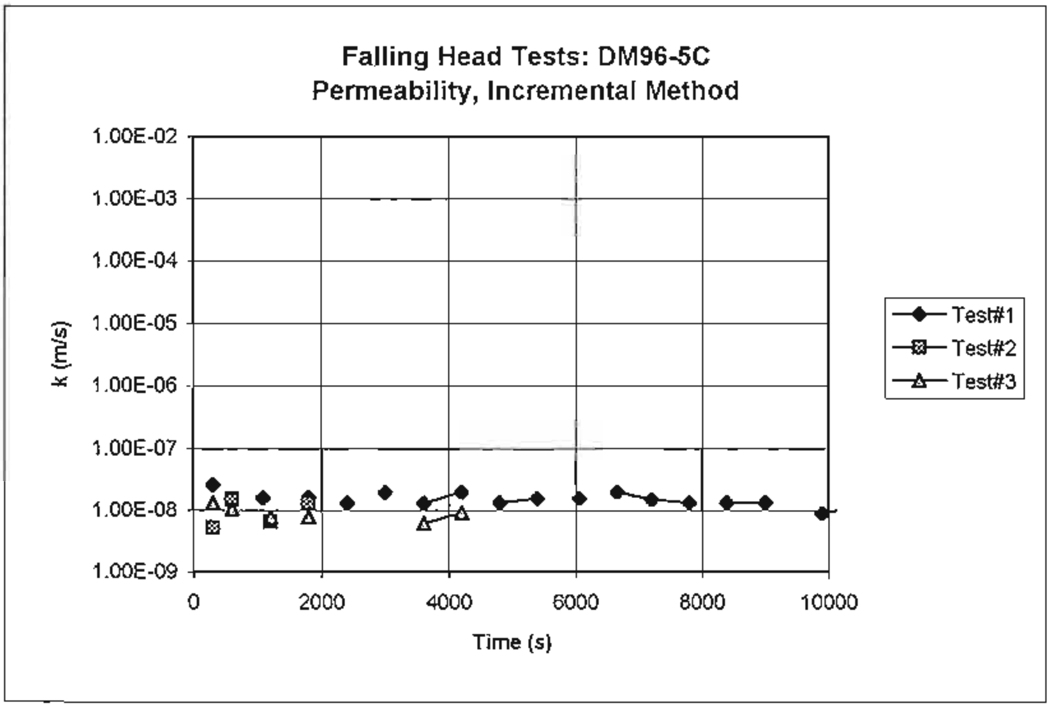


FIGURE B12
DAMES & MOORE

Appendix C

APPENDIX C

LABORATORY TEST RESULTS

APPENDIX C

LABORATORY TEST RESULTS

Test certificates for laboratory tests carried out as part of the geotechnical work are presented in this appendix.

* * *

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 1 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33888	WG 33893	WG 33895
Sample No:	BU1	BU2	B2
Test Pit:	TP96-7	TP96-11	TP96-12
Depth (m):	1.8-2.0	1.0	1.5-1.7
Date Sampled:	13.7.96	13.7.96	13.7.96

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	8.1	2.1	3.3

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : ____________ (P. Brittan) **Date :** 10-9-96

NATA

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WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 2 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33907	WG 33914	WG 33916	WG 33919	WG 33920
Sample No:	1	8	9	10B	11
Borehole No:	DM96-1	DM96-1	DM96-1	DM96-1	DM96-1
Depth (m):	1.5	7.5	9.0	10.6	12.0
Date Sampled:	14.7.96	14.7.96	14.7.96	15.7.96	15.7.96

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	9.6	13.0	13.4	11.6	12.6

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33922	WG 33924	WG 33925	WG 33928	WG 33929
Sample No:	13	15	16	3	4
Borehole No:	DM96-1	DM96-1	DM96-1	DM96-2	DM96-2
Depth (m):	15.0	18.0	19.5	4.5	6.0
Date Sampled:	15.7.96	15.7.96	15.7.96	15.7.96	15.7.96

DETERMINATION OF MOISTURE CONTENT
-according to AS 1289 2.1.1

Moisture Content (%):	9.9	12.1	18.0	13.4	13.3

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

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WESTERN GEOTECHNICS

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TEST CERTIFICATE

Page 4 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33931	WG 33933	WG 33935	WG 33936	WG 33938
Sample No:	5	7	9	10	12
Borehole No:	DM96-2	DM96-2	DM96-2	DM96-2	DM96-2
Depth (m):	7.5	10.5	13.5	15.0	18.0
Date Sampled:	16.7.96	16.7.96	16.7.96	16.7.96	16.7.96

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	17.4	12.9	22.0	21.0	21.0

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33941	WG 33943	WG 33944	WG 33947	WG 33948
Sample No:	15	2	3	5	6
Borehole No:	DM96-2	DM96-3	DM96-3	DM96-3	DM96-3
Depth (m):	22.5	3.0	4.5	7.5	9.0
Date Sampled:	16.7.96	17.7.96	17.7.96	17.7.96	17.7.96
Moisture Content (%):	22.0	9.6	12.9	10.4	13.1

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : ______ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

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TEST CERTIFICATE

Page 6 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33949	WG 33950	WG 33953	WG 33956	WG 33958
Sample No:	7	8	11	14	2
Borehole No:	DM96-3	DM96-3	DM96-3	DM96-3	DM96-4
Depth (m):	10.5	12.0	16.5	21.0	3.0
Date Sampled:	17.7.96	17.7.96	18.7.96	18.7.96	18.7.96

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	14.6	15.2	19.8	18.2	16.4

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : (P. Brittan) Date : 10-9-96

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Form No. AS 1289 2.1.1 94/1 R

WESTERN GEOTECHNICS

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ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 30.7/14.8.96

Lab Ref No:	WG 33960	WG 33962	WG 33963	WG 33971	WG 33973
Sample No:	4	6	7	6	7
Borehole No:	DM96-4	DM96-4	DM96-4	DM96-5B	DM96-5B
Depth (m):	6.0	9.0	10.5	7.5	9.0
Date Sampled:	18.7.96	19.7.96	19.7.96	20.7.96	20.7.96

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	18.6	21.2	25.2	16.6	14.3

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : ______________ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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TEST CERTIFICATE

Page 8 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	30.7/14.8.96

Lab Ref No:	WG 33977 / 33978	WG 33980	WG 33982	WG 33984
Sample No:	9 / 9B	11	13	1
Borehole No:	DM96-5B	DM96-5B	DM96-5B	DM96-5C
Depth (m):	12.0 / 12.1	15.0	18.6	3.0
Date Sampled:	20.7.96	20.7.96	20.7.96	21.7.96

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	14.0	20.2	13.2	17.5

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

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Form No. AS 1289 2.1.1 94/1 R

WESTERN GEOTECHNICS

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15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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TEST CERTIFICATE

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	13-21.8.96

Lab Ref No :	WG 33887	WG 33888	WG 33893	WG 33895
Sample No:	BU1	BU1	BU2	B2
Test Pit:	TP96-6	TP96-7	TP96-11	TP96-12
Depth (m):	0.5-0.7	1.8-2.0	1.0	1.5-1.7
Date Sampled:	13.7.96	13.7.96	13.7.96	13.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	18	26	21	24
Plastic Limit (%): (*3.2.1)	14	11	18	19
Plasticity Index (%): (*3.3.1)	4	15	3	5
Linear Shrinkage (%): (*3.4.1)	1.5	8.0	1.0	1.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	125	127
Nature of shrinkage:	Flat	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ______________ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 13-21.8.96

Lab Ref No :	WG 33898	WG 33900	WG 33904
Sample No:	BU1	BU1	BU1
Test Pit:	TP96-15	TP96-16	TP96-19
Depth (m):	0.5-0.7	0.4-0.6	0.5-0.7
Date Sampled:	13.7.96	13.7.96	13.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	26	25	25
Plastic Limit (%): (*3.2.1)	12	20	15
Plasticity Index (%): (*3.3.1)	14	5	10
Linear Shrinkage (%): (*3.4.1)	6.5	4.0	5.5

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	125	127	127
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ______________ (P. Brittan) Date : 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 13-21.8.96

Lab Ref No :	WG 33907	WG 33914 / 33915	WG 33916 / 33917
Sample No:	1	8 / 8B	9 / 9B
Borehole:	DM96-1	DM96-1	DM96-1
Depth (m):	1.5	7.5 / 7.6	9.0 / 9.1
Date Sampled:	14.7.96	14.7.96	14.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	18	54	48
Plastic Limit (%): (*3.2.1)	13	18	18
Plasticity Index (%): (*3.3.1)	5	36	30
Linear Shrinkage (%): (*3.4.1)	2.5	13.5	12.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	127
Nature of shrinkage:	Flat	Flat	Curling

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ____________ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

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TEST CERTIFICATE

Page 12 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	8-21.8.96

Lab Ref No :	WG 33919	WG 33920	WG 33922
Sample No:	10B	11	13
Borehole:	DM96-1	DM96-1	DM96-1
Depth (m):	10.6	12.0	15.0
Date Sampled:	15.7.96	15.7.96	15.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	52	49	49
Plastic Limit (%): (*3.2.1)	14	14	13
Plasticity Index (%): (*3.3.1)	38	35	36
Linear Shrinkage (%): (*3.4.1)	14.0	13.5	12.5

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	127
Nature of shrinkage:	Flat	Flat	Curling

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

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TEST CERTIFICATE

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	16/19.8.96

Lab Ref No :	WG 33924	WG 33925	WG 33928
Sample No:	15	16	3
Borehole:	DM96-1	DM96-1	DM96-2
Depth (m):	18.0	19.5	4.5
Date Sampled:	15.7.96	15.7.96	15.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	51	69	77
Plastic Limit (%): (*3.2.1)	17	20	33
Plasticity Index (%): (*3.3.1)	34	49	44
Linear Shrinkage (%): (*3.4.1)	13.5	16.0	16.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	127
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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TEST CERTIFICATE

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	19-28.8.96

Lab Ref No :	WG 33930	WG 33933	WG 33935
Sample No:	4B	7	9
Borehole:	DM96-2	DM96-2	DM96-2
Depth (m):	6.0	10.5	13.5
Date Sampled:	15.7.96	16.7.96	16.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	45	50	67
Plastic Limit (%): (*3.2.1)	16	18	28
Plasticity Index (%): (*3.3.1)	29	32	39
Linear Shrinkage (%): (*3.4.1)	12.0	13.5	15.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	125	127	126
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : <u>WG 33882-33984</u>

Approved Signatory : ______________ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

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TEST CERTIFICATE

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	19-28.8.96

Lab Ref No :	WG 33936	WG 33938	WG 33941
Sample No:	10	12	15
Borehole:	DM96-2	DM96-2	DM96-2
Depth (m):	15.0	18.0	22.5
Date Sampled:	16.7.96	16.7.96	16.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	69	68	69
Plastic Limit (%): (*3.2.1)	25	24	27
Plasticity Index (%): (*3.3.1)	44	44	42
Linear Shrinkage (%): (*3.4.1)	16.5	16.0	12.5

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	126	128
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ____________ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
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TEST CERTIFICATE

Page 16 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 7-28.8.96

Lab Ref No :	WG 33943	WG 33945 / 33944	WG 33947
Sample No:	2	3 / 3B	5
Borehole:	DM96-3	DM96-3	DM96-3
Depth (m):	3.0	4.5 / 4.6	7.5
Date Sampled:	17.7.96	17.7.96	17.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	23	65	44
Plastic Limit (%): (*3.2.1)	10	24	17
Plasticity Index (%): (*3.3.1)	13	41	27
Linear Shrinkage (%): (*3.4.1)	6.5	14.0	11.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	126
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ________________ (P. Brittan) Date : 10-9-96

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Form No. AS 1289 3.1.1/3.1.2, 3.2.1, 3.3.1, 3.4.1 95/2 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	16-23.8.96

Lab Ref No :	WG 33948	WG 33949	WG 33950
Sample No:	6	7	8
Borehole:	DM96-3	DM96-3	DM96-3
Depth (m):	9.0	10.5	12.0
Date Sampled:	17.7.96	17.7.96	17.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	38	45	43
Plastic Limit (%): (*3.2.1)	15	16	15
Plasticity Index (%): (*3.3.1)	23	29	28
Linear Shrinkage (%): (*3.4.1)	10.0	13.0	13.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	125	126
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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Form No. AS 1289 3.1.1/3.1.2, 3.2.1, 3.3.1, 3.4.1 95/2 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 18 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	16-20.8.96

Lab Ref No :	WG 33953	WG 33956	WG 33958
Sample No:	11	14	2
Borehole:	DM96-3	DM96-3	DM96-4
Depth (m):	16.5	21.0	3.0
Date Sampled:	18.7.96	18.7.96	18.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	42	61	81
Plastic Limit (%): (*3.2.1)	15	25	27
Plasticity Index (%): (*3.3.1)	27	36	54
Linear Shrinkage (%): (*3.4.1)	11.0	13.5	18.5

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	125
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

NATA

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Form No. AS 1289 3.1.1/3.1.2, 3.2.1, 3.3.1, 3.4.1 95/2 R

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 19 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 16-20.8.96

Lab Ref No :	WG 33960	WG 33962	WG 33963
Sample No:	4	6	7
Borehole:	DM96-4	DM96-4	DM96-4
Depth (m):	6.0	9.0	10.5
Date Sampled:	18.7.96	19.7.96	19.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	54	58	60
Plastic Limit (%): (*3.2.1)	22	25	24
Plasticity Index (%): (*3.3.1)	32	33	36
Linear Shrinkage (%): (*3.4.1)	13.5	13.0	12.5

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	125	124	127
Nature of shrinkage:	Flat	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ______ (P. Brittan) **Date :** 10-9-96

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Form No. AS 1289 3.1.1/3.1.2, 3.2.1, 3.3.1, 3.4.1 95/2 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 20 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	29/30.8.96

Lab Ref No :	WG 33971	WG 33973 / 33974	WG 33977 / 33978
Sample No:	6	7 / 7B	9 / 9B
Borehole:	DM96-5B	DM96-4	DM96-5B
Depth (m):	7.5	9.0 / 9.1	12.0 / 12.1
Date Sampled:	20.7.96	20.7.96	20.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	74	50	50
Plastic Limit (%): (*3.2.1)	19	19	18
Plasticity Index (%): (*3.3.1)	55	31	32
Linear Shrinkage (%): (*3.4.1)	18.0	14.0	8.0

NOTES:

Sample History:	Air Dried	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127	127
Nature of shrinkage:	Curling	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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Form No. AS 1289 3.1.1/3.1.2, 3.2.1, 3.3.1, 3.4.1 95/2 R

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 16.8.96

Lab Ref No :	WG 33980	WG 33982
Sample No:	11	13
Borehole:	DM96-5B	DM96-5B
Depth (m):	15.0	18.6
Date Sampled:	20.7.96	20.7.96

ATTERBERG LIMITS

-according to AS 1289*

Liquid Limit (%): (*3.1.2)	51	42
Plastic Limit (%): (*3.2.1)	19	16
Plasticity Index (%): (*3.3.1)	32	26
Linear Shrinkage (%): (*3.4.1)	13.5	11.0

NOTES:

Sample History:	Air Dried	Air Dried
Preparation Method:	Dry Sieved	Dry Sieved
Shrinkage Mould Length (mm):	127	127
Nature of shrinkage:	Flat	Flat

Sample supplied by client.

Certificate No. : WG 33882-33984

Approved Signatory : ______________ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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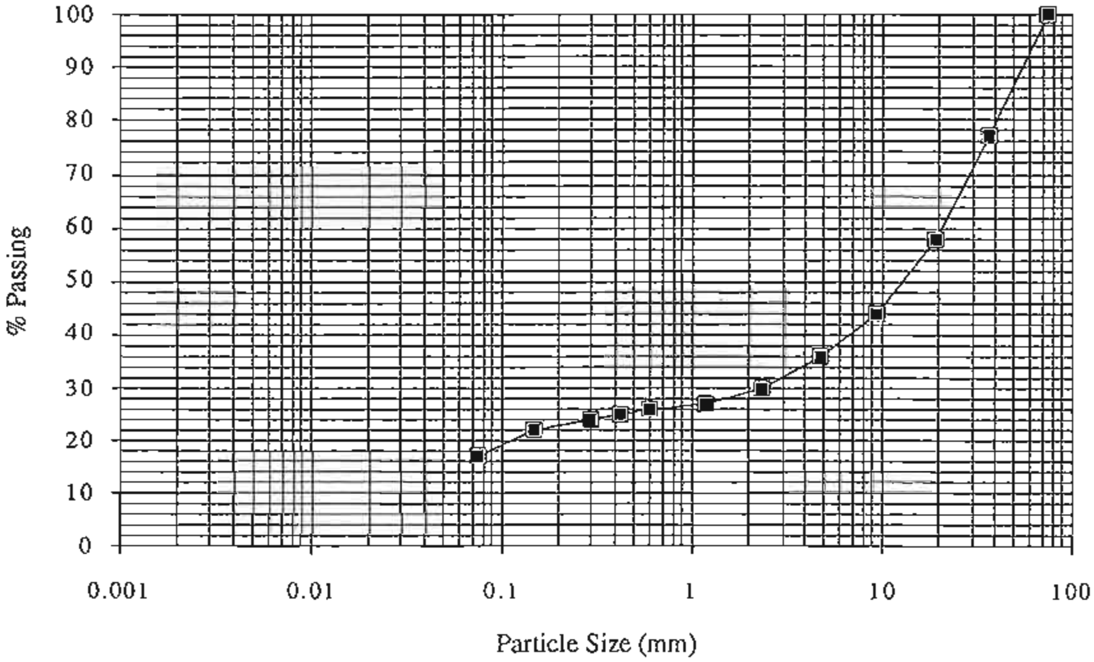
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 22 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: B1 **Test Pit:** TP96-1
Date Sampled: 12.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33882
Date Tested: 6.8.96
Depth (m): 1.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	77
19.0	58
9.5	44
4.75	36
2.36	30
1.18	27
0.600	26
0.425	25
0.300	24
0.150	22
0.075	17

Notes.

1. Sample size does not conform to minimum mass required as per AS 1289 1.4.7.
2. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

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ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

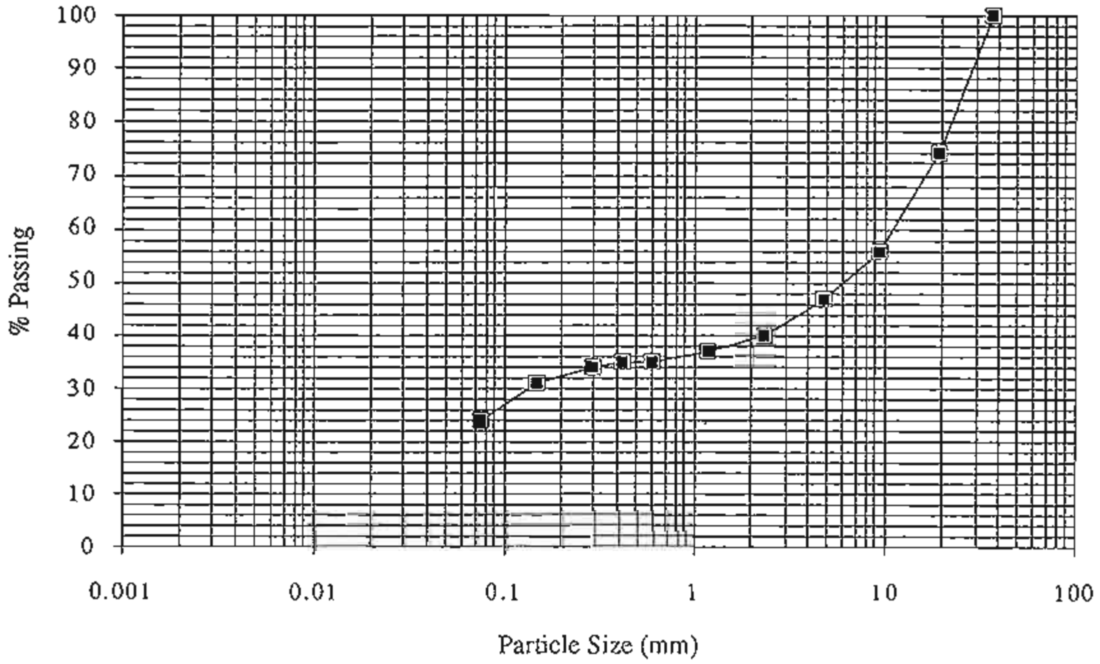
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 23 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: B1 **Test Pit:** TP96-3
Date Sampled: 12.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33884
Date Tested: 7.8.96
Depth (m): 0.8

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
37.5	100
19.0	74
9.5	56
4.75	47
2.36	40
1.18	37
0.600	35
0.425	35
0.300	34
0.150	31
0.075	24

Notes.
1. Sample size does not conform to minimum mass required as per AS 1289 1.4.7.
2. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

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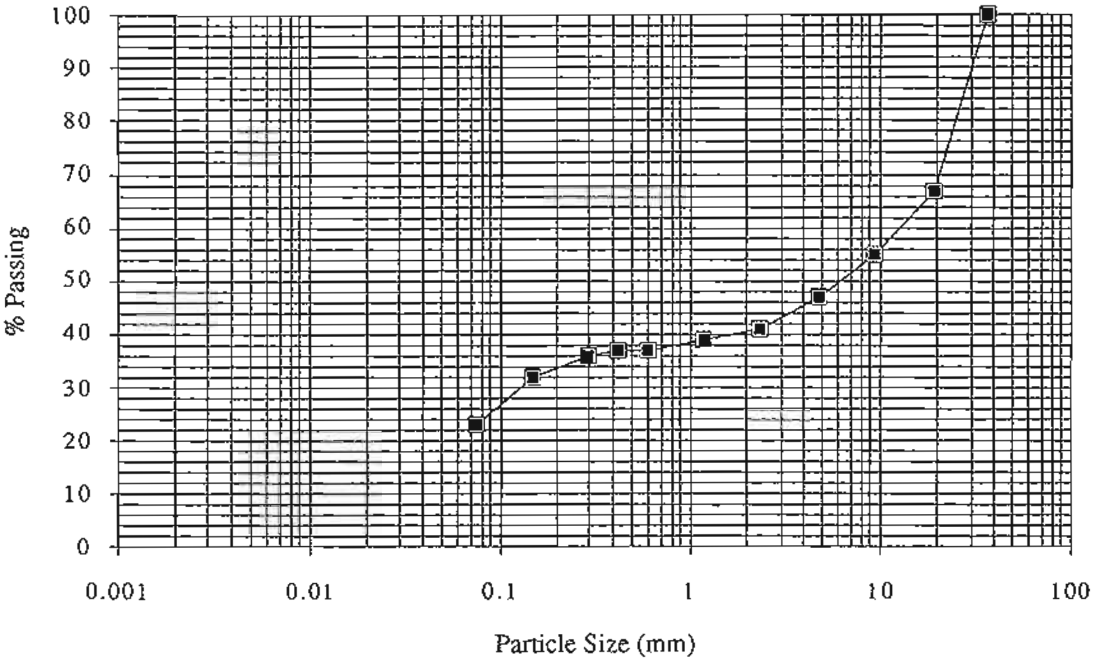
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 24 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: B1 **Test Pit:** TP96-5
Date Sampled: 12.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33886
Date Tested: 6.8.96
Depth (m): 0.4

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
37.5	100
19.0	67
9.5	55
4.75	47
2.36	41
1.18	39
0.600	37
0.425	37
0.300	36
0.150	32
0.075	23

Notes.
1. Sample size does not conform to minimum mass required as per AS 1289 1.4.7.
2. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

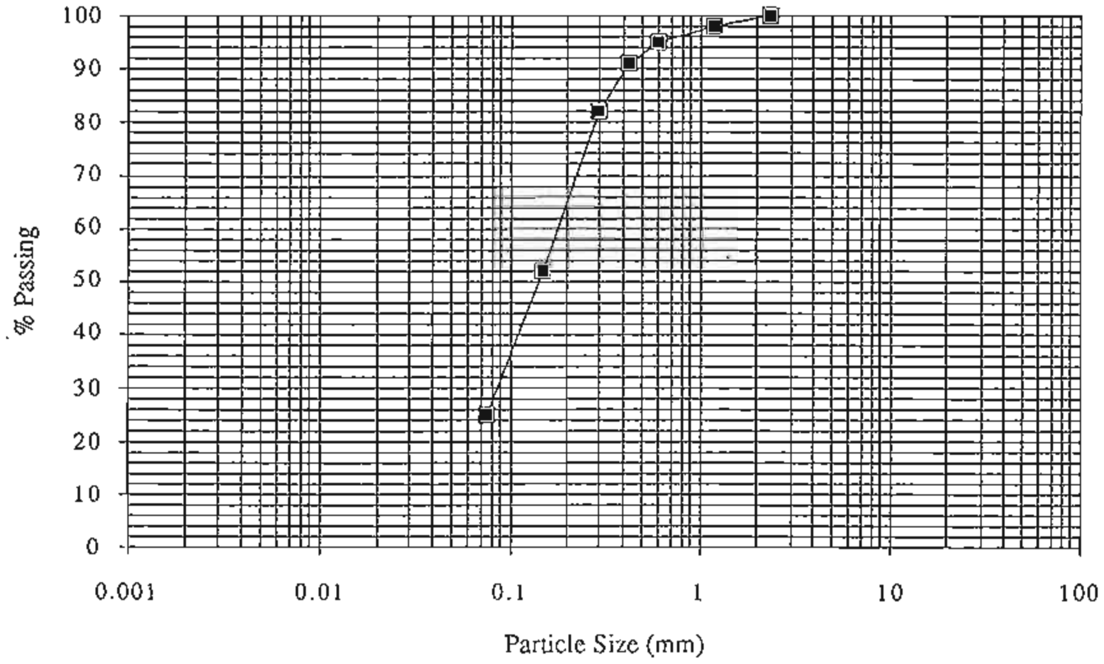
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 25 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-6
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33887
Date Tested: 12.8.96
Depth (m): 0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	98
0.600	95
0.425	91
0.300	82
0.150	52
0.075	25

Notes.
1. Sample supplied by Client.

Approved Signatory: (P. Brittan)

Certificate No: WG 33882-33984

Date: 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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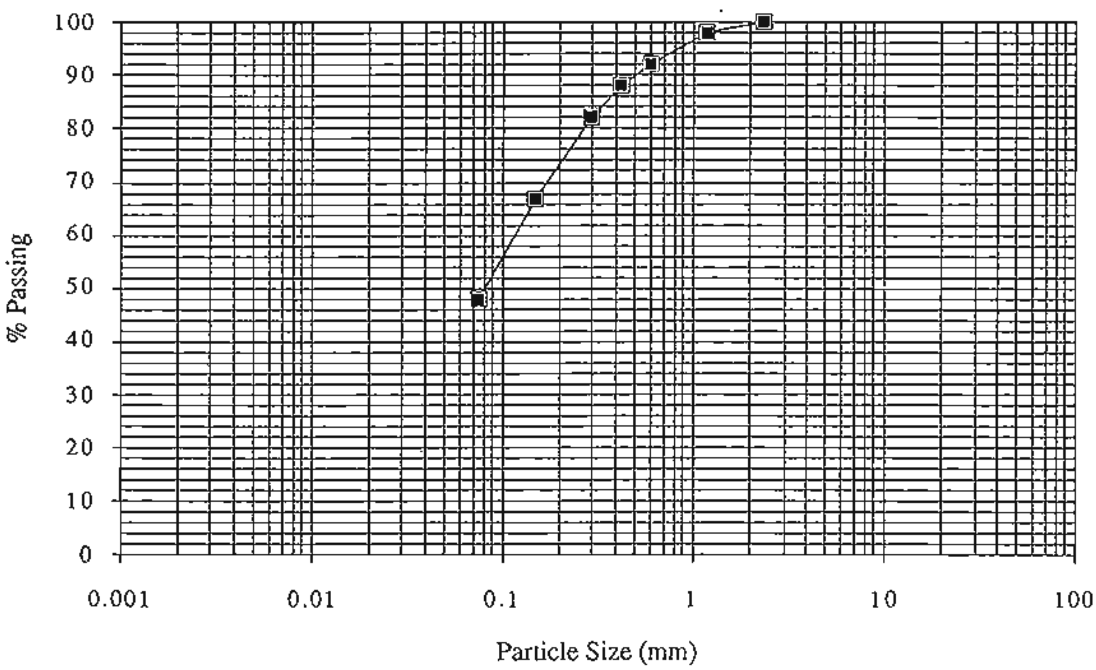
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 26 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-7
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG33888
Date Tested: 12.8.96
Depth (m): 1.8-2.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	98
0.600	92
0.425	88
0.300	82
0.150	67
0.075	48

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

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WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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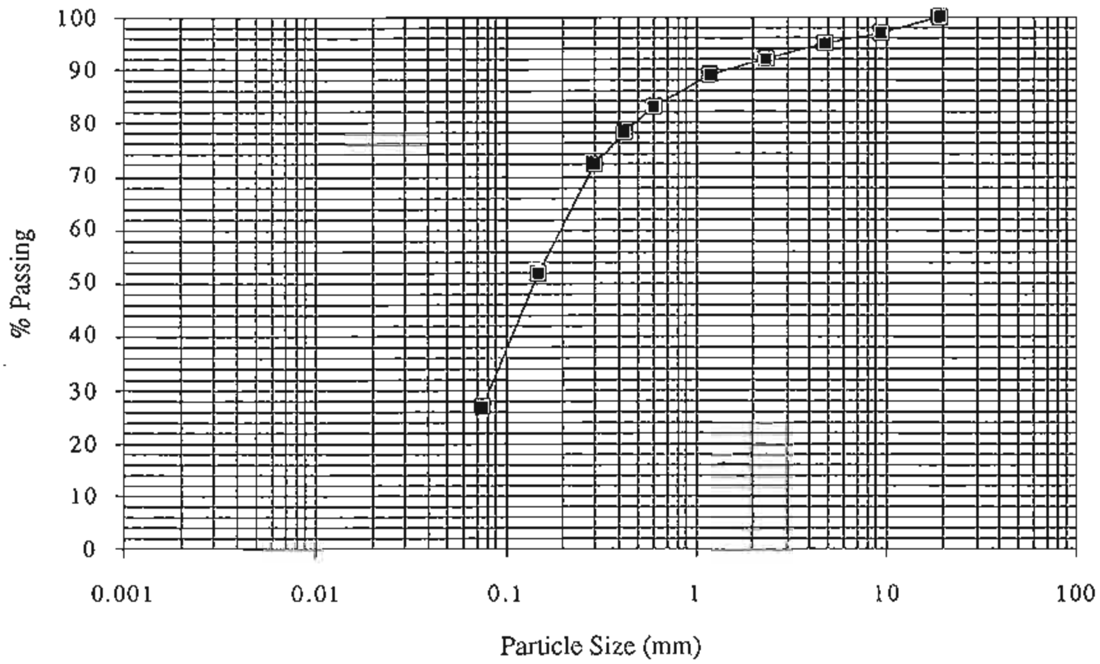
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: B1 **Test Pit:** TP96-8
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33889
Date Tested: 5.8.96
Depth (m): 0.8-1.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
19.0	100
9.5	97
4.75	95
2.36	92
1.18	89
0.600	83
0.425	78
0.300	72
0.150	52
0.075	27

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984
Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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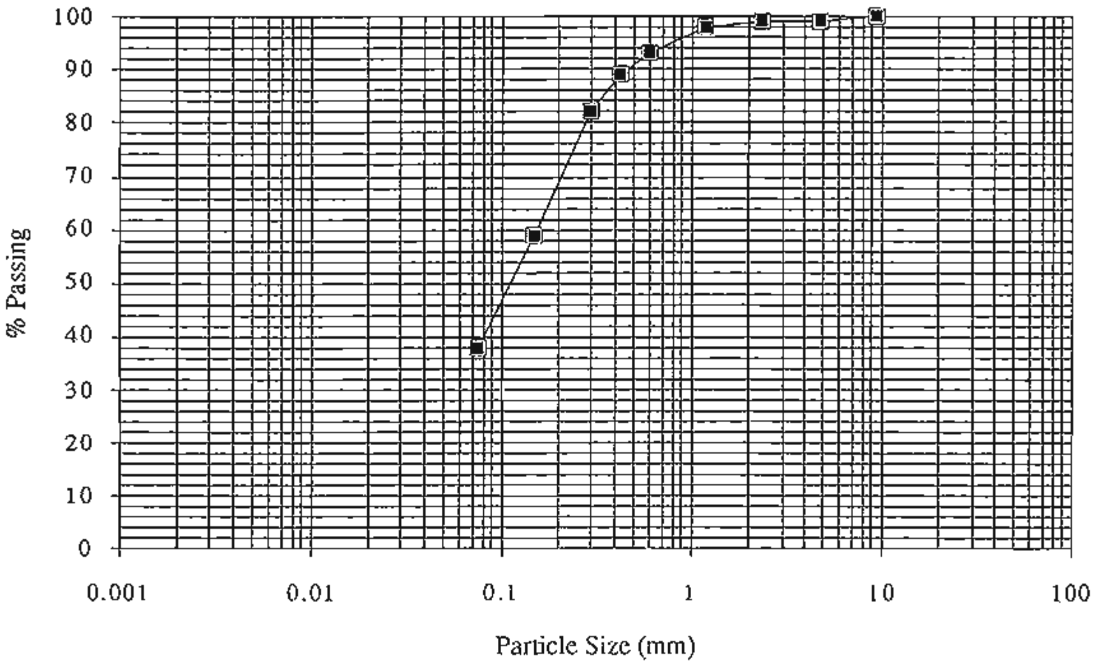
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 28 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: B1 **Test Pit:** TP96-9
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33890
Date Tested: 8.8.96
Depth (m): 1.0-1.2

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
9.5	100
4.75	99
2.36	99
1.18	98
0.600	93
0.425	89
0.300	82
0.150	58
0.075	38

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

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WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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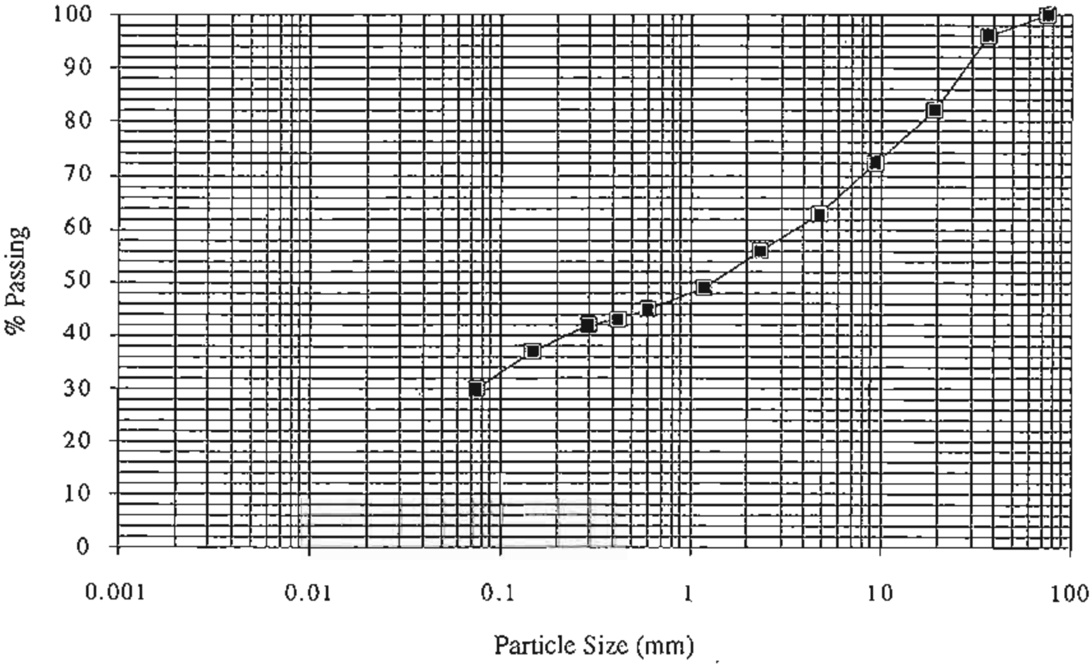
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 29 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU2 **Test Pit:** TP96-11
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33893
Date Tested: 2.8.96
Depth (m): 1.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	96
19.0	82
9.5	72
4.75	63
2.36	56
1.18	49
0.600	45
0.425	43
0.300	42
0.150	37
0.075	30

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

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Form No. AS 1289 3.6.1 94/1 R

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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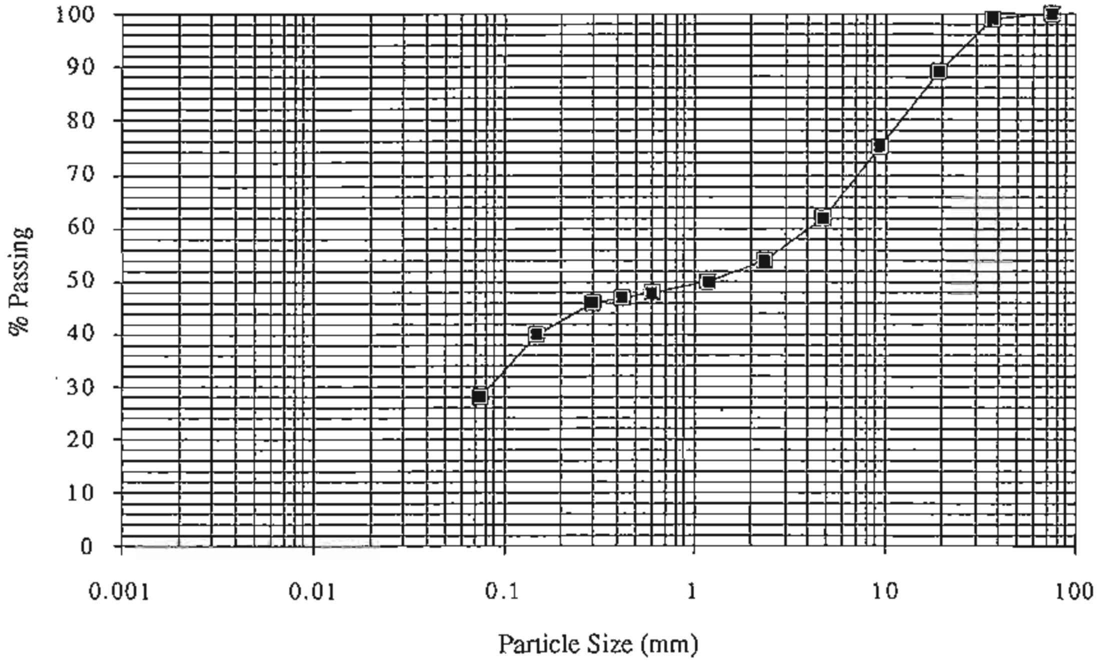
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 30 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-12
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG33894
Date Tested: 2.8.96
Depth (m): 0.3-0.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	99
19.0	89
9.5	74
4.75	62
2.36	54
1.18	50
0.600	48
0.425	47
0.300	46
0.150	40
0.075	28

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

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Form No. AS 1289 3.6.1 94/1 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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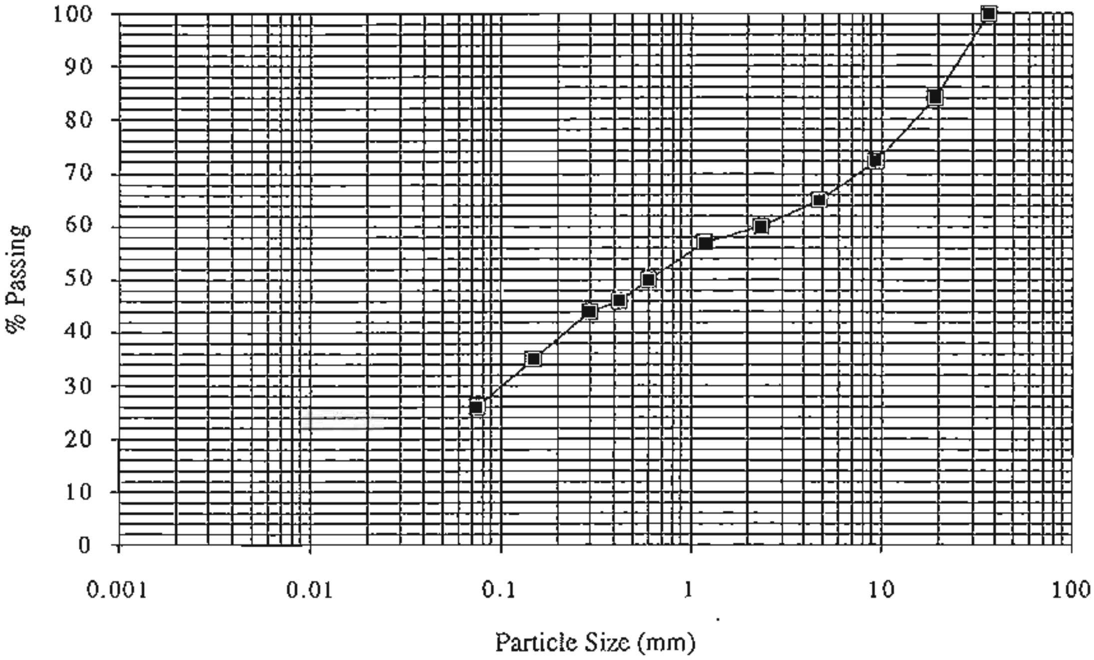
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 31 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: B2 **Test Pit:** TP96-12
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33895
Date Tested: 20.8.96
Depth (m): 1.5-1.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
37.5	100
19.0	84
9.5	72
4.75	65
2.36	60
1.18	57
0.600	50
0.425	46
0.300	44
0.150	35
0.075	26

Notes.

1. Sample size does not conform to minimum mass required as per AS 1289 1.4.7.
2. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

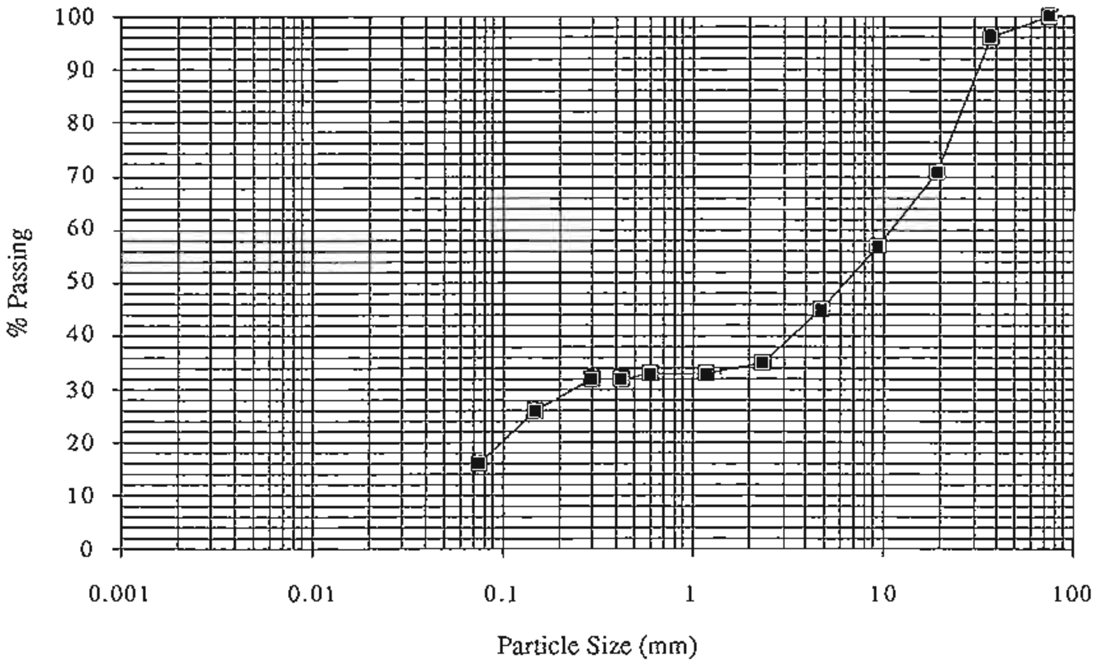
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 32 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-13
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33896
Date Tested: 2.8.96
Depth (m): 0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	96
19.0	71
9.5	57
4.75	45
2.36	35
1.18	33
0.600	33
0.425	32
0.300	32
0.150	26
0.075	16

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

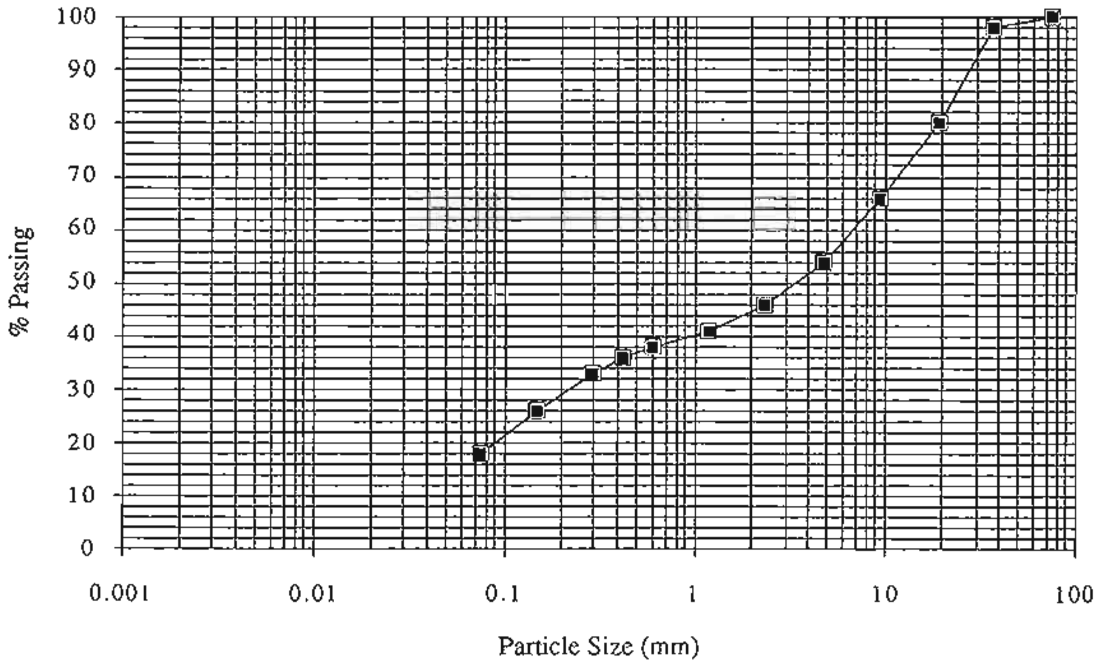
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-14
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33897
Date Tested: 2.8.96
Depth (m): 2.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	98
19.0	80
9.5	66
4.75	54
2.36	46
1.18	41
0.600	38
0.425	36
0.300	33
0.150	26
0.075	18

Notes.
1. Samle supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

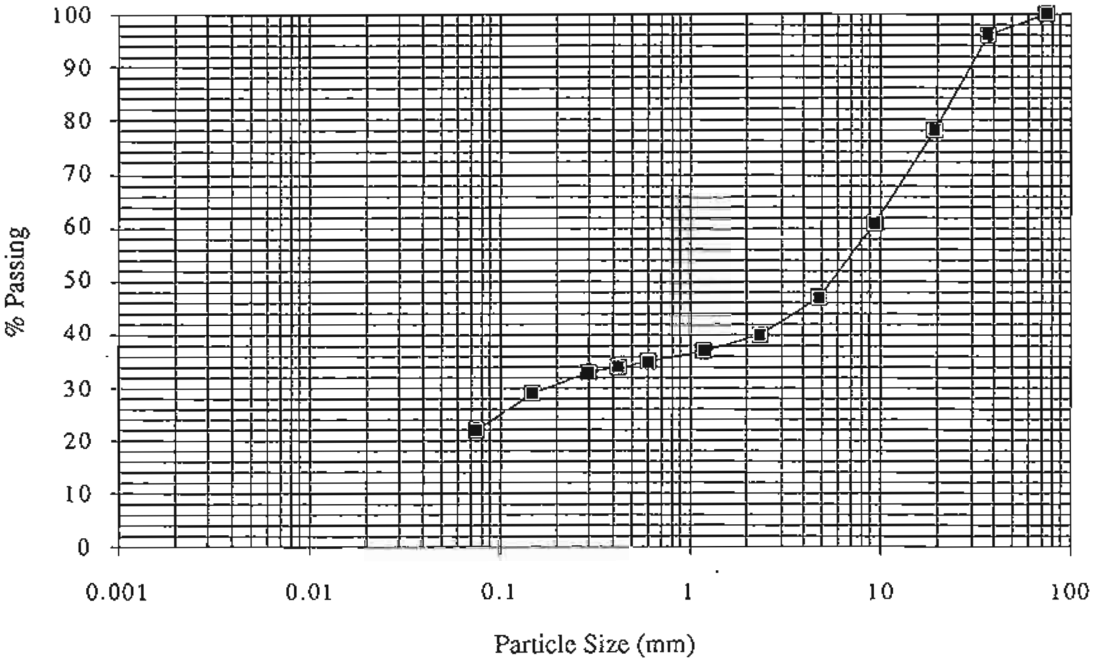
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 34 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-15
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33898
Date Tested: 2.8.96
Depth (m): 0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	96
19.0	78
9.5	61
4.75	47
2.36	40
1.18	37
0.600	35
0.425	34
0.300	33
0.150	29
0.075	22

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) Date: 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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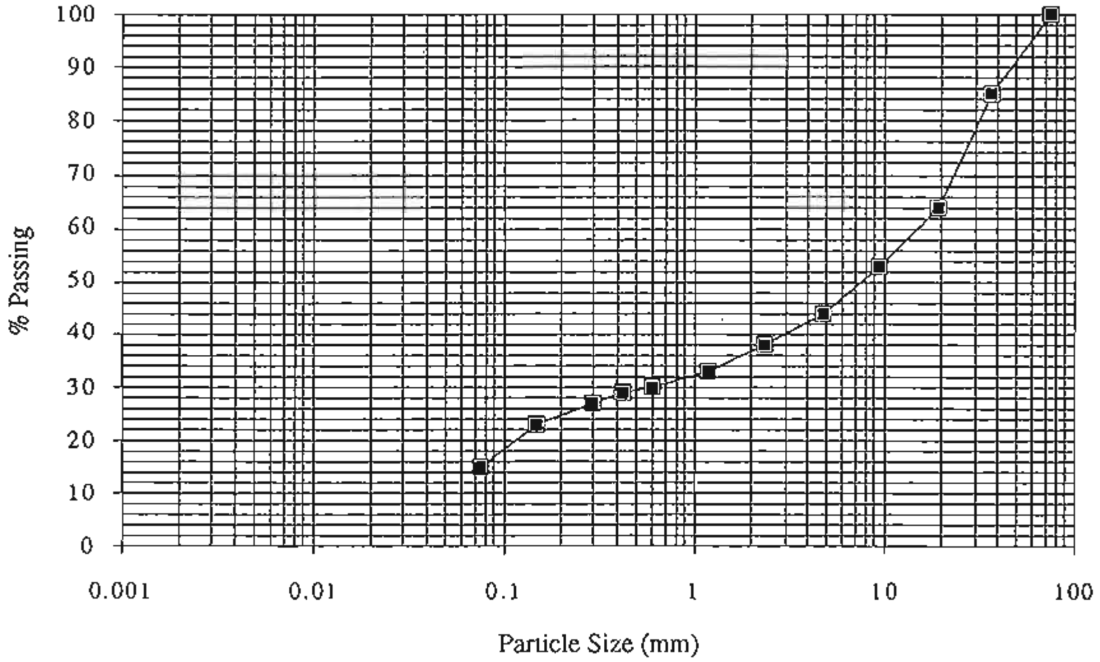
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 35 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-16
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33900
Date Tested: 7.8.96
Depth (m): 0.4-0.6

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	85
19.0	64
9.5	53
4.75	44
2.36	38
1.18	33
0.600	30
0.425	29
0.300	27
0.150	23
0.075	15

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______ (P. Brittan) **Date:** 10-9-96

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Form No. AS 1289 3.6.1 94/1 R

WESTERN GEOTECHNICS

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ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

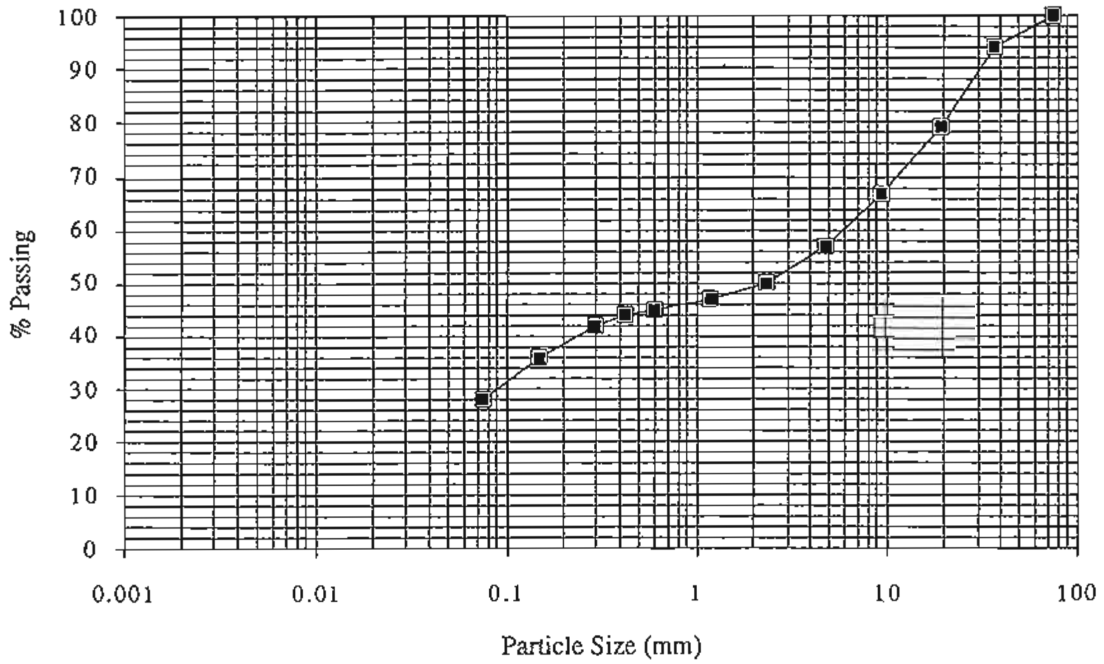
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 36 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-17
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33901
Date Tested: 12.8.96
Depth (m): 0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	94
19.0	79
9.5	67
4.75	57
2.36	50
1.18	47
0.600	45
0.425	44
0.300	42
0.150	36
0.075	28

Notes.

1. Sample size does not conform to minimum mass required as per AS 1289 1.4.7.
2. Sample supplied by Client.

Certificate No: WG 33882-33984

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Form No. AS 1289 3.6.1 94/1 R

WESTERN GEOTECHNICS
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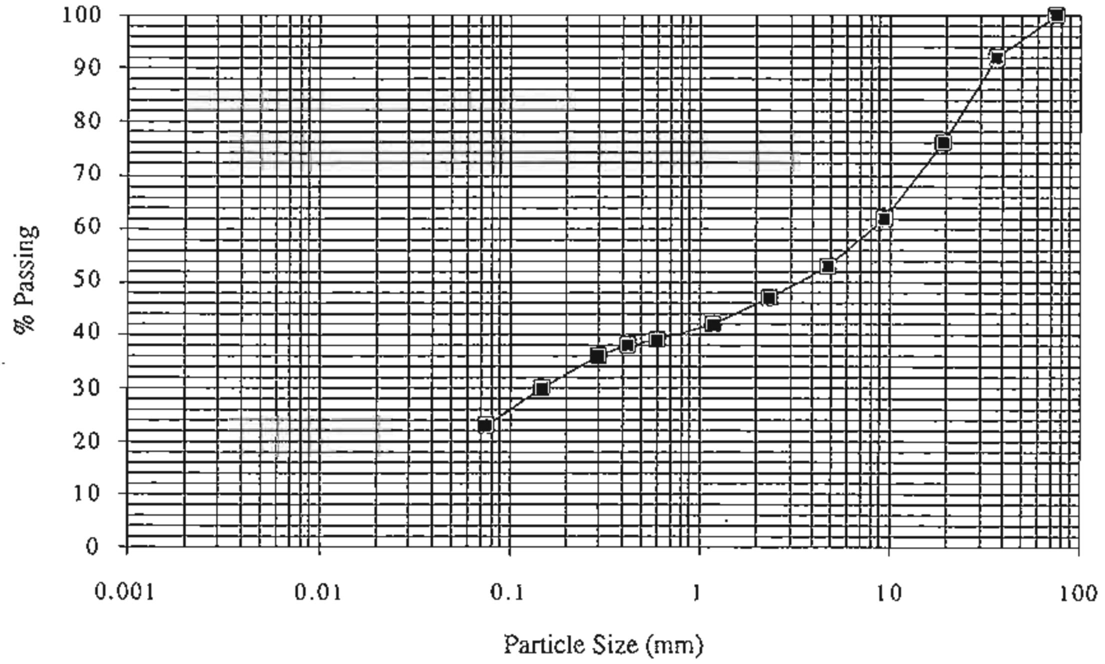
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 37 of 82

CLIENT:	Dames & Moore			**JOB No.:**	001-01-288
PROJECT:	-			**Client Job No:**	15780-018-361
LOCATION:	Kintyre			**Lab Ref No:**	WG 33902
Sample No:	BU1	**Test Pit:**	TP96-18	**Date Tested:**	12.8.96
Date Sampled:	13.7.96			**Depth (m):**	0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	92
19.0	76
9.5	62
4.75	53
2.36	47
1.18	42
0.600	39
0.425	38
0.300	36
0.150	30
0.075	23

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) Date: 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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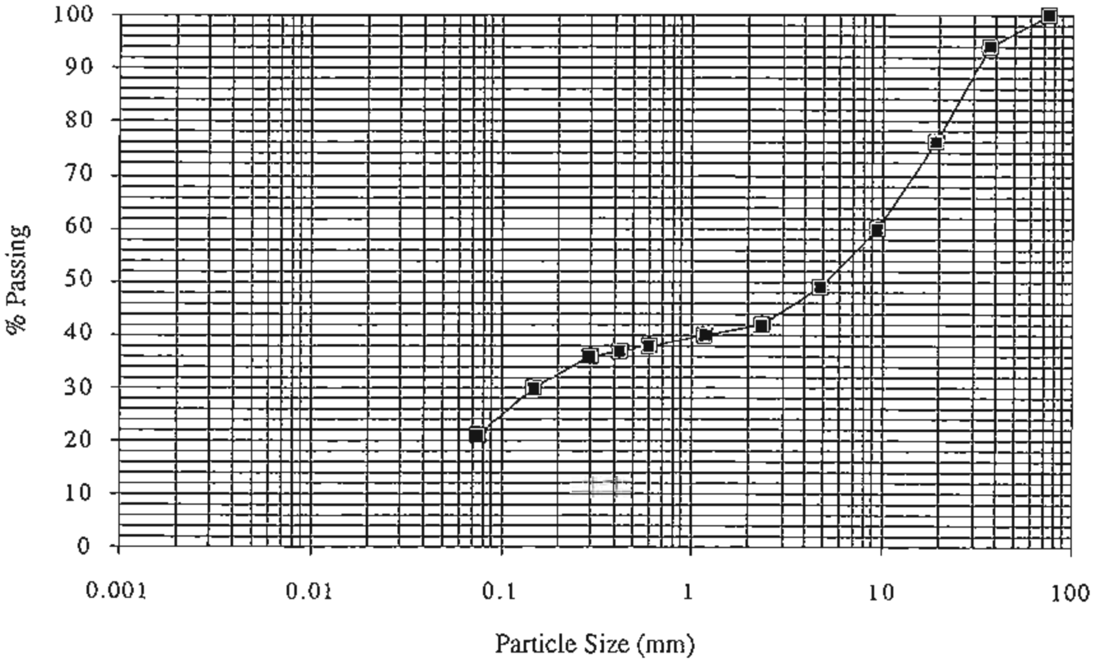
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 38 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-19
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33904
Date Tested: 5.8.96
Depth (m): 0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	94
19.0	76
9.5	60
4.75	49
2.36	42
1.18	40
0.600	38
0.425	37
0.300	36
0.150	30
0.075	21

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) Date: 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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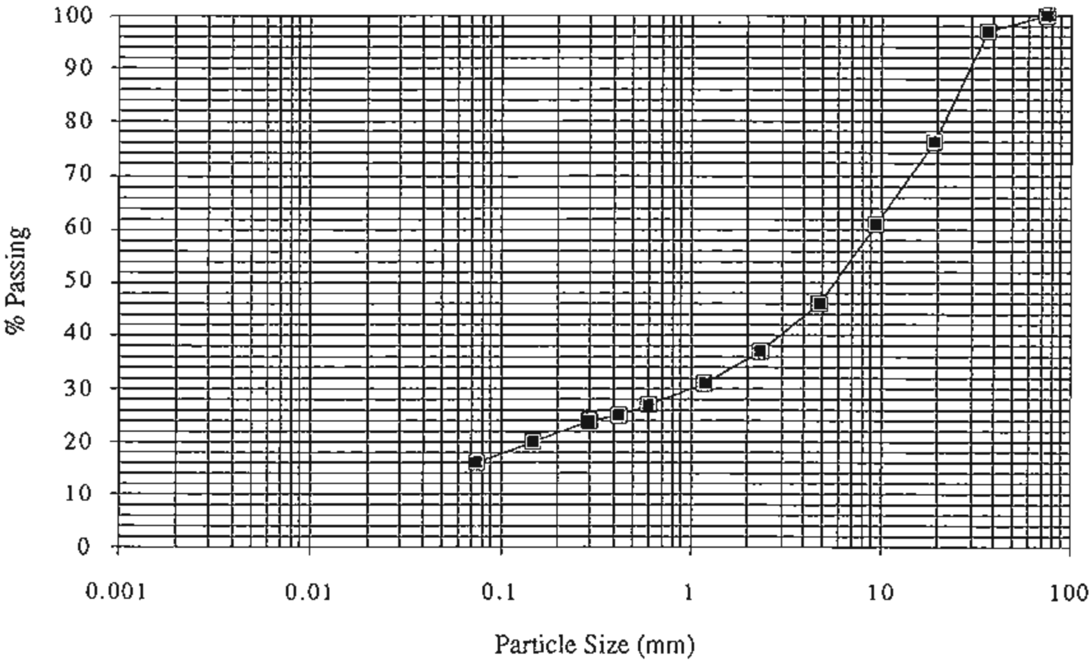
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 39 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: BU1 **Test Pit:** TP96-20
Date Sampled: 13.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33905
Date Tested: 12.8.96
Depth (m): 0.5-0.7

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
75.0	100
37.5	97
19.0	76
9.5	61
4.75	46
2.36	37
1.18	31
0.600	27
0.425	25
0.300	24
0.150	20
0.075	16

Notes.
1. Sample size does not conform to minimum mass required as per AS 1289 1.4.7.
2. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

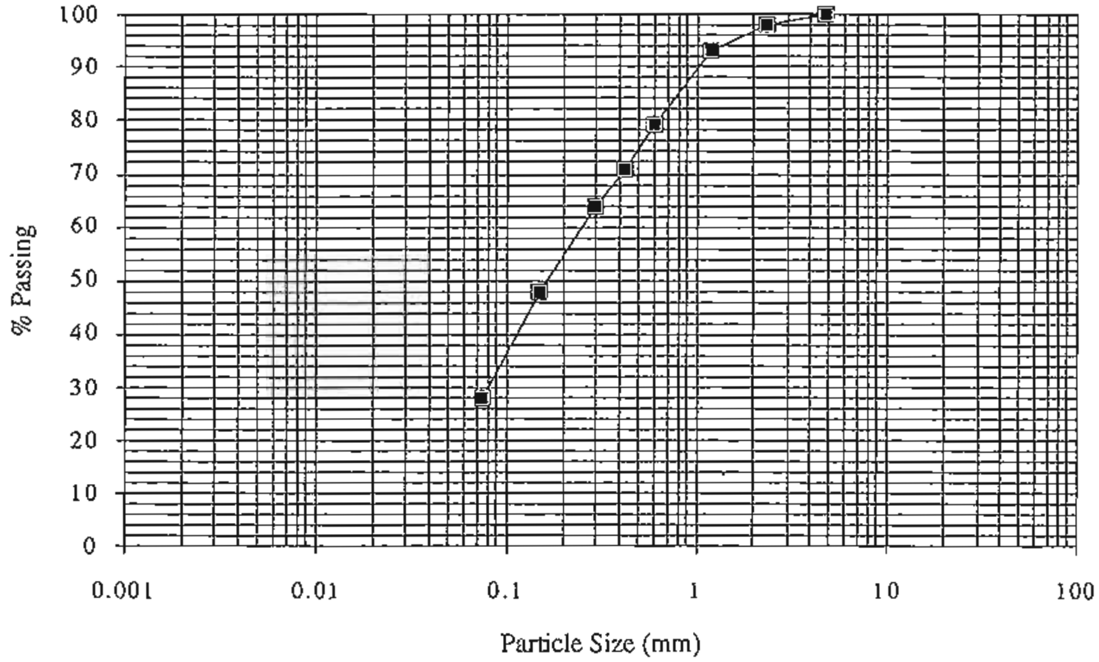
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 40 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 1 **Borehole:** DM96-1
Date Sampled: 14.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33907
Date Tested: 20.8.96
Depth (m): 1.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
4.75	100
2.36	98
1.18	93
0.600	79
0.425	71
0.300	64
0.150	48
0.075	28

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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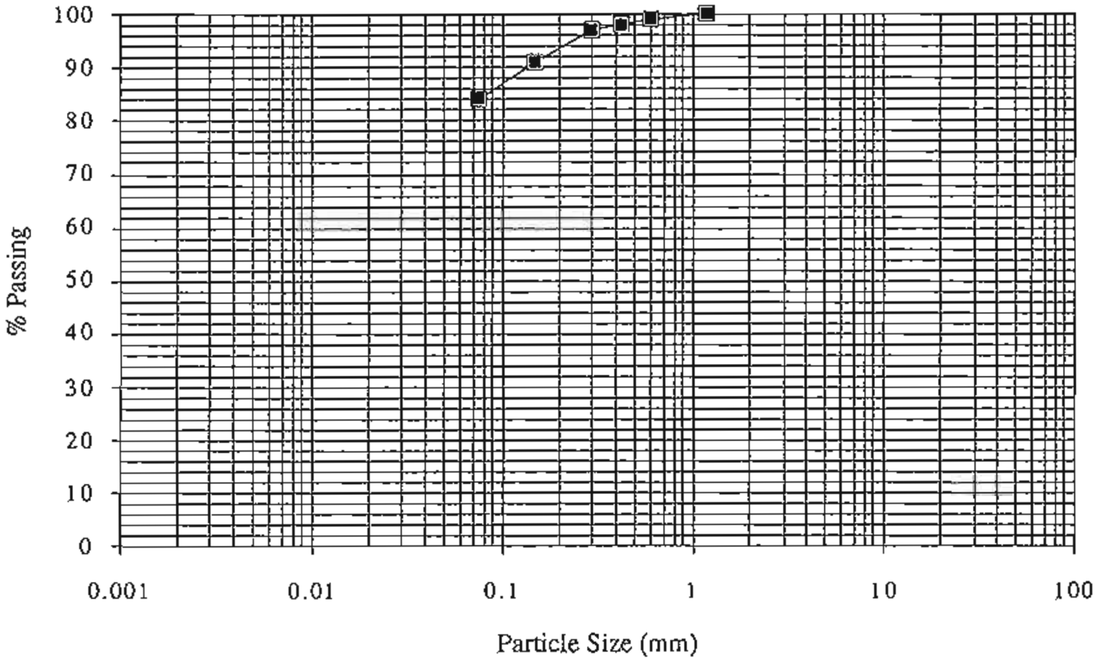
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 41 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 10B **Borehole:** DM96-1
Date Sampled: 15.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG33919
Date Tested: 20.8.96
Depth (m): 10.6

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
1.18	100
0.600	99
0.425	98
0.300	97
0.150	91
0.075	84

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

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WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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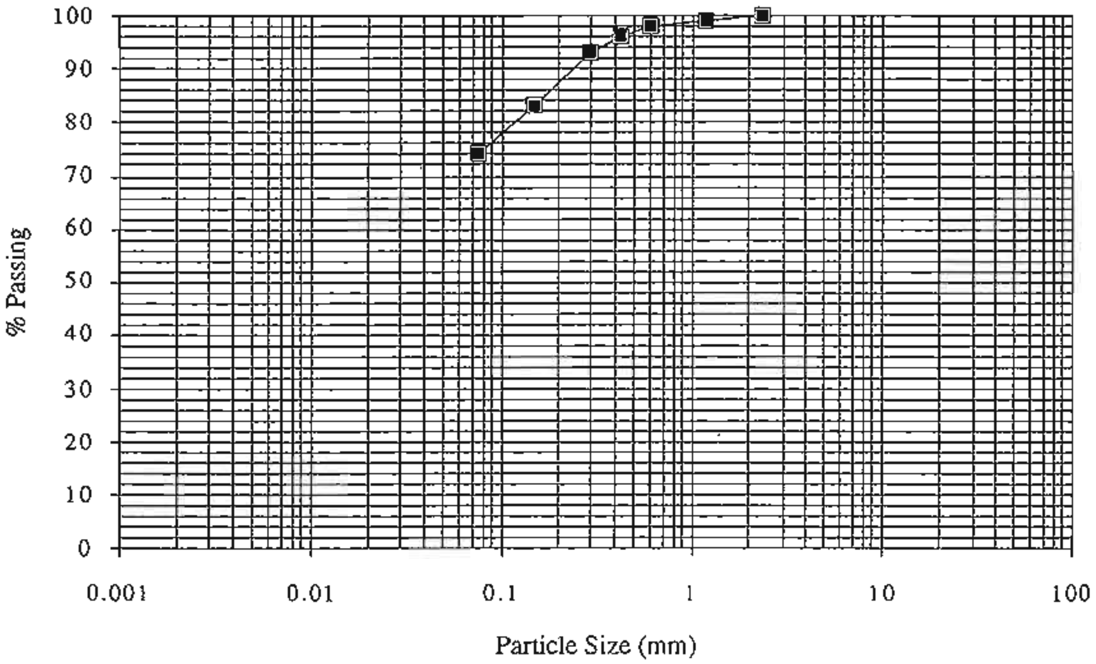
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 42 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 11 **Borehole:** DM96-1
Date Sampled: 15.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33920
Date Tested: 7.8.96
Depth (m): 12.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	98
0.425	96
0.300	93
0.150	83
0.075	74

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) Date: 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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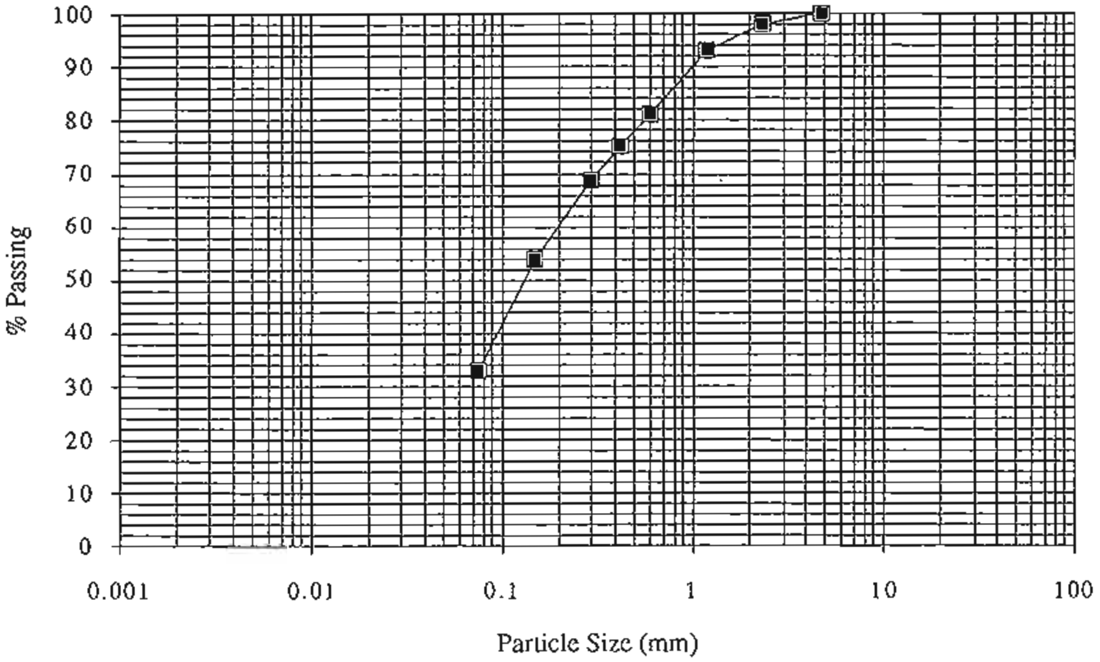
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 43 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 1 **Borehole:** DM96-2
Date Sampled: 15.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33926
Date Tested: 7.8.96
Depth (m): 1.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
4.75	100
2.36	98
1.18	93
0.600	81
0.425	75
0.300	69
0.150	54
0.075	33

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ____________ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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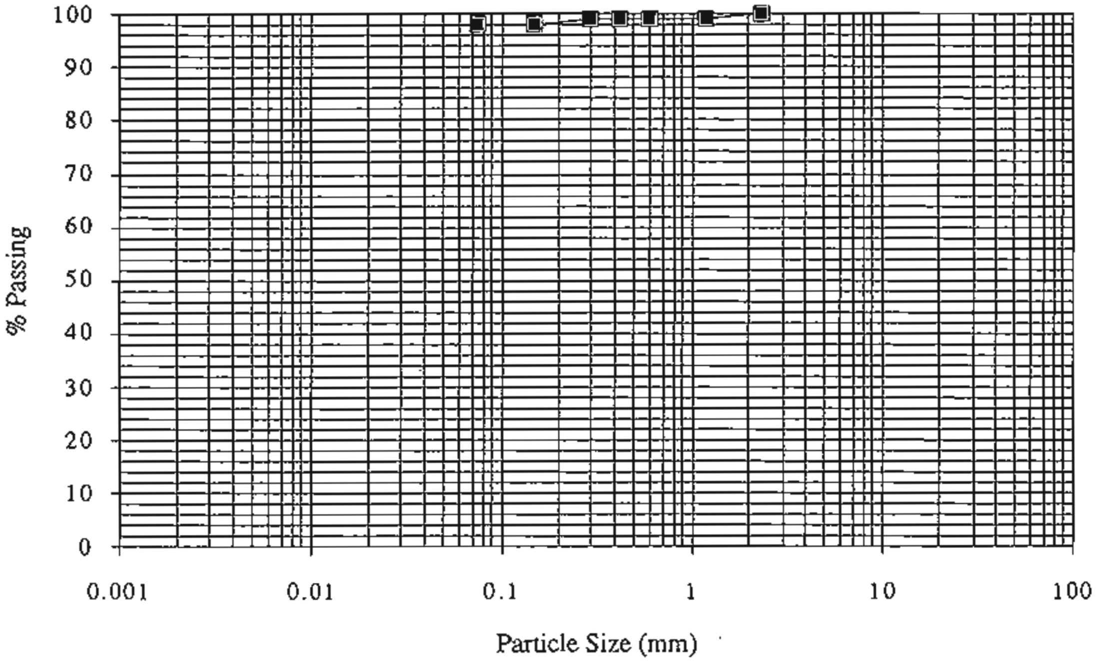
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 44 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 9 **Borehole:** DM96-2
Date Sampled: 16.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG33935
Date Tested: 15.8.96
Depth (m): 13.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	99
0.425	99
0.300	99
0.150	98
0.075	98

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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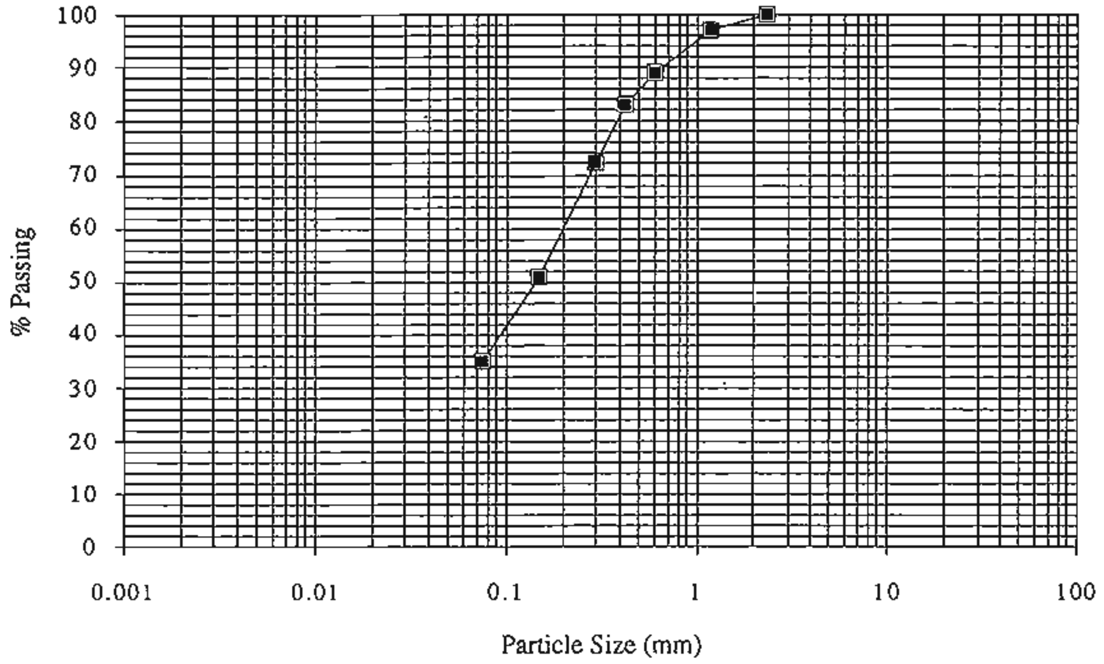
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 45 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 1 **Borehole:** DM96-3
Date Sampled: 17.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33942
Date Tested: 7.8.96
Depth (m): 1.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	97
0.600	89
0.425	83
0.300	72
0.150	51
0.075	35

Notes.
1. Sample supplied by Client.

Approved Signatory: ______________ (P. Brittan)

Certificate No: WG 33882-33984

Date: 10-9-96

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WESTERN GEOTECHNICS

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ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

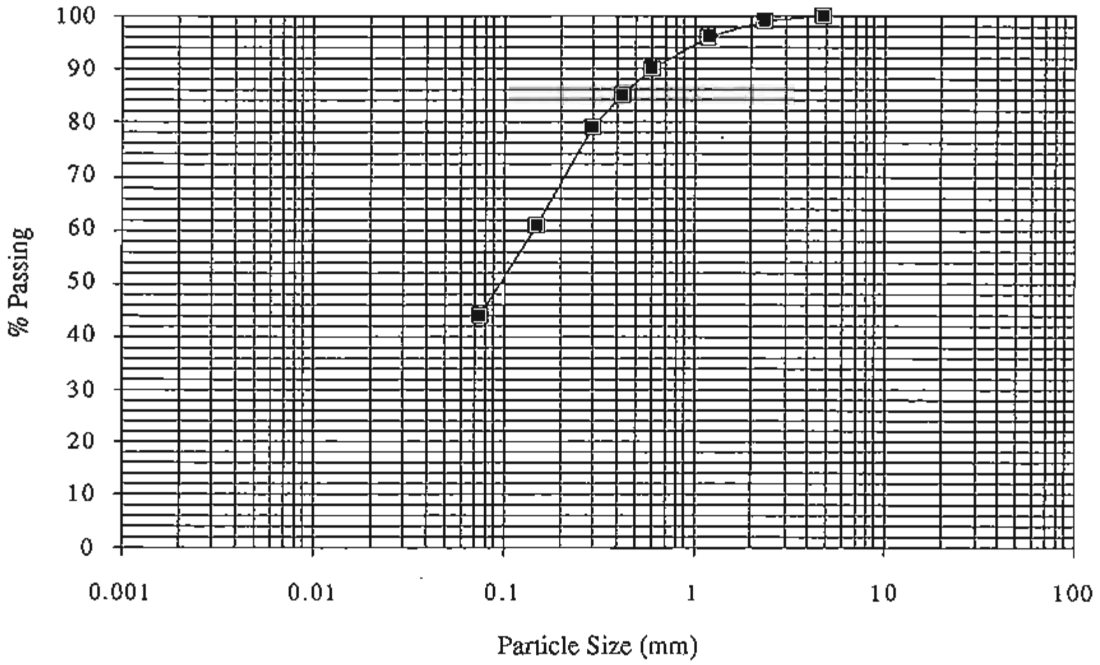
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 46 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 2 **Borehole:** DM96-3
Date Sampled: 17.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33943
Date Tested: 6.8.96
Depth (m): 3.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
4.75	100
2.36	99
1.18	96
0.600	90
0.425	85
0.300	79
0.150	61
0.075	44

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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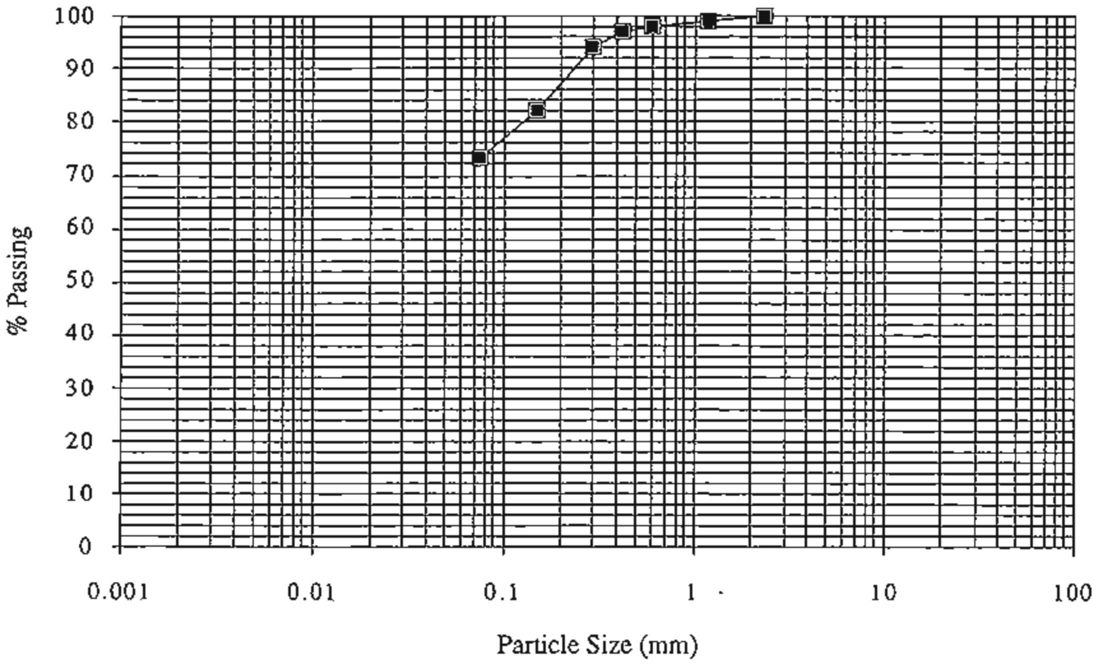
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 47 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 5 **Borehole:** DM96-3
Date Sampled: 17.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33947
Date Tested: 15.8.96
Depth (m): 7.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
2.36	100
1.18	99
0.600	98
0.425	96
0.300	94
0.150	82
0.075	73

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

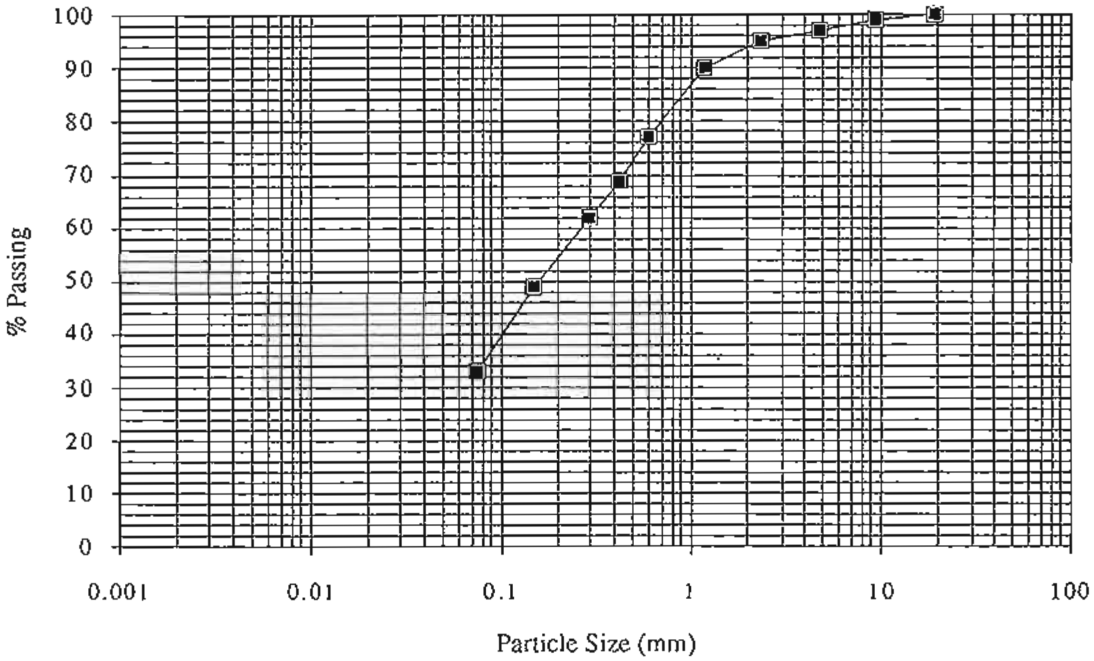
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 48 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 1 **Borehole:** DM96-4
Date Sampled: 18.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33957
Date Tested: 6.8.96
Depth (m): 1.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
19.0	100
9.5	99
4.75	97
2.36	94
1.18	90
0.600	77
0.425	69
0.300	62
0.150	49
0.075	33

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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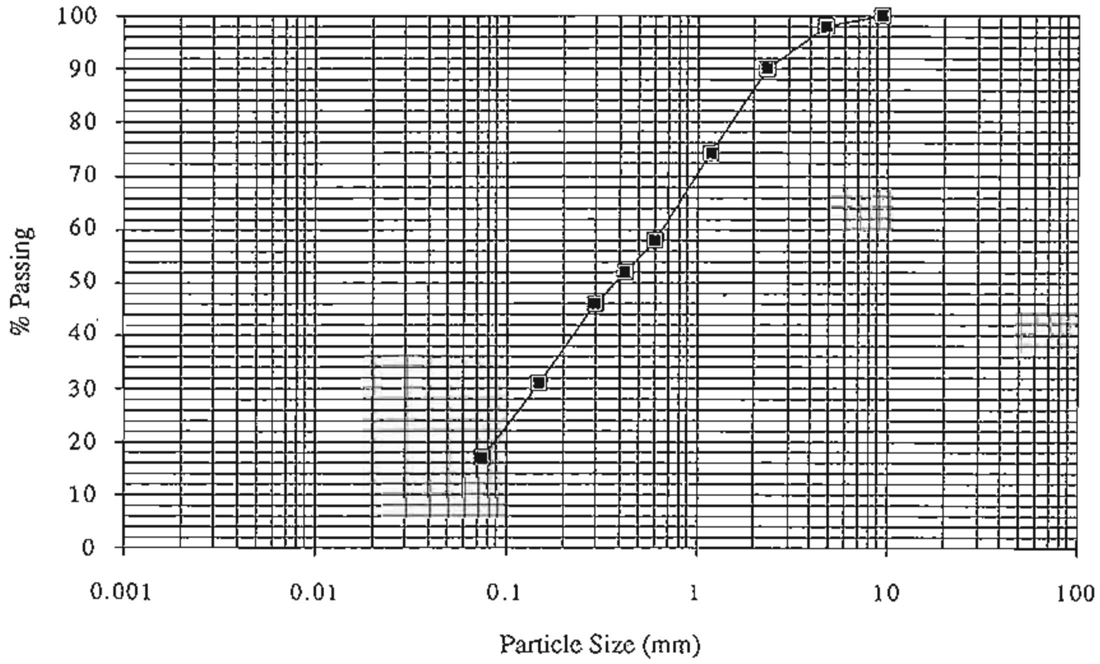
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 49 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 1 **Borehole:** DM96-5B
Date Sampled: 20.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33966
Date Tested: 8.5.96
Depth (m): 1.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
9.5	100
4.75	98
2.36	90
1.18	74
0.600	58
0.425	52
0.300	46
0.150	31
0.075	17

Notes.
1. Sample supplied by Client.

Approved Signatory: ______________ (P. Brittan)

Certificate No: WG 33882-33984
Date: 10-9-96

WESTERN GEOTECHNICS
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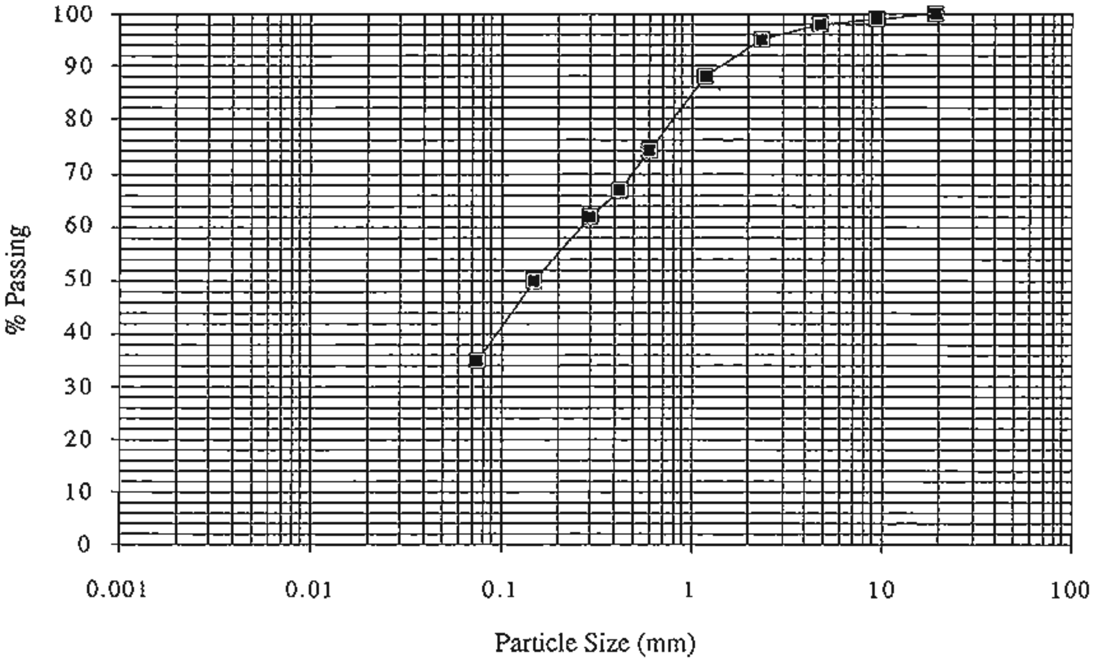
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 50 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre
Sample No: 2 **Borehole:** DM96-5B
Date Sampled: 20.7.96

JOB No.: 001-01-288
Client Job No: 15780-018-361
Lab Ref No: WG 33967
Date Tested: 15.8.96
Depth (m): 3.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS-according to AS 1289 3.6.1



Sieve Size (mm)	% Passing
19.0	100
9.5	99
4.75	98
2.36	95
1.18	88
0.600	74
0.425	67
0.300	62
0.150	50
0.075	35

Notes.
1. Sample supplied by Client.

Certificate No: WG 33882-33984
Approved Signatory: ______ (P. Brittan) **Date:** 10-9-96

WESTERN GEOTECHNICS

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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 15/27.8.96

Lab Ref No:	WG 33923	WG 33933	WG 33951	WG 33977 / 33978
Sample No:	14	7	9	9 / 9B
Borehole:	DM96-1	DM96-2	DM96-3	DM96-5B
Depth (m):	16.5	10.5	13.5	12.0 / 12.1
Date Sampled:	15.7.96	16.7.96	18.7.96	20.7.96

PERCENT FINES (% FINER THAN 75 μm)

-according to AS 1289 3.6.1*

Material Finer Than 75 μm (%):	46	70	77	69

Notes:

1. * The percentage fines or wash is only a part of the full sieve analysis test conducted in AS 1289 3.6.1.
2. Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : ______________ (P. Brittan)**Date :** 10-9-96

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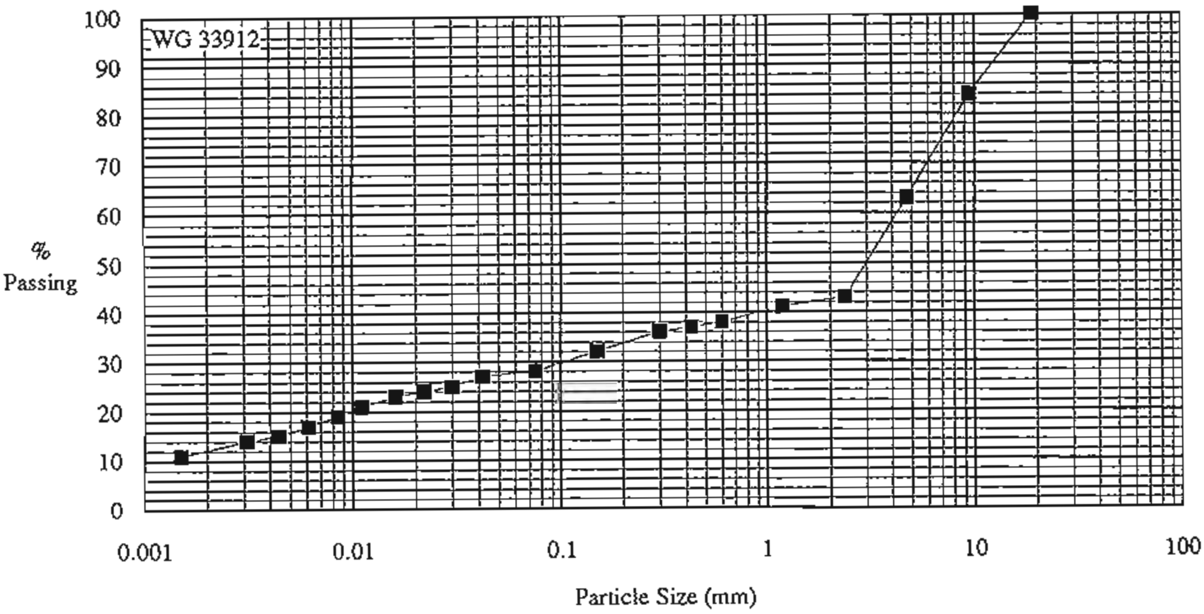
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33912
Sample No. :	6 **Borehole:** DM96-1	**Date Tested :**	19.8.96
Date Sampled:	14.7.96	**Depth (m):**	6.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING

Sieve Size (mm)	**% Passing**
19.0	100
9.50	84
4.75	63
2.36	43
1.18	41
0.600	38
0.425	37
0.300	36
0.150	32
0.075	28

HYDROMETER

Particle Diameter (mm)	**% Finer**
0.042	27
0.030	25
0.022	24
0.016	23
0.011	21
0.0085	19
0.0061	17
0.0044	15
0.0031	14
0.0015	11

Notes:

1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : ______ (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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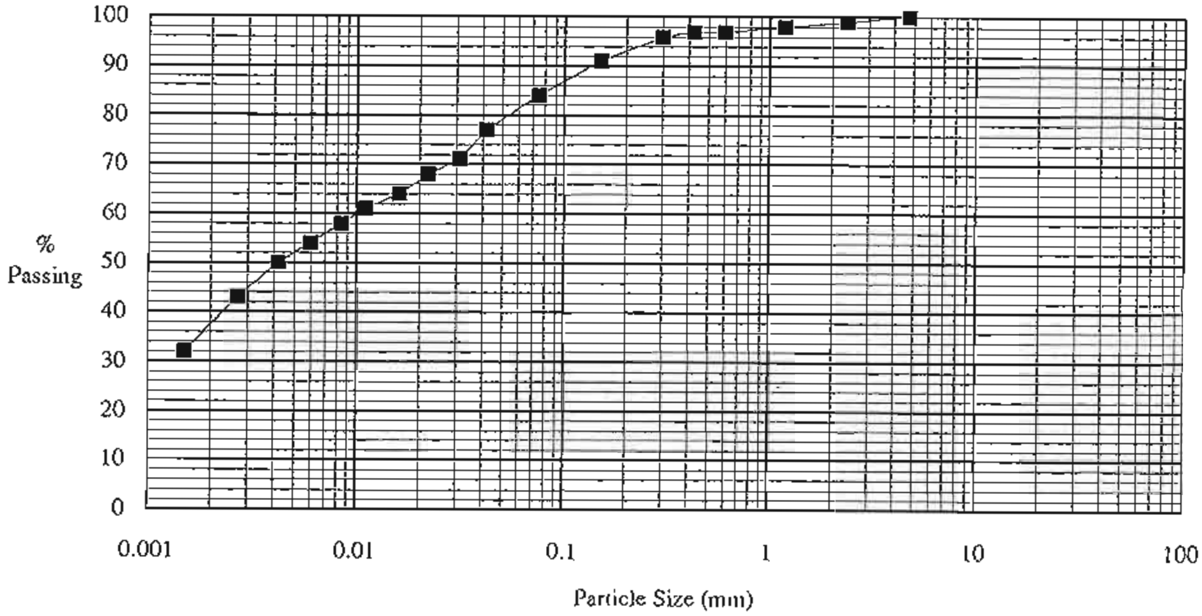
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 53 of 82

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : 8 / 8B **Borehole:** DM96-1
Date Sampled: 14.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33914 / 33915
Date Tested : 19.8.96
Depth (m): 7.5 / 7.6

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING

Sieve Size (mm)	% Passing
19.0	-
9.50	-
4.75	100
2.36	99
1.18	98
0.600	97
0.425	97
0.300	96
0.150	91
0.075	84

HYDROMETER

Particle Diameter (mm)	% Finer
0.042	77
0.031	71
0.022	68
0.016	64
0.011	61
0.0084	58
0.0060	54
0.0042	50
0.0027	43
0.0014	32

Notes:

1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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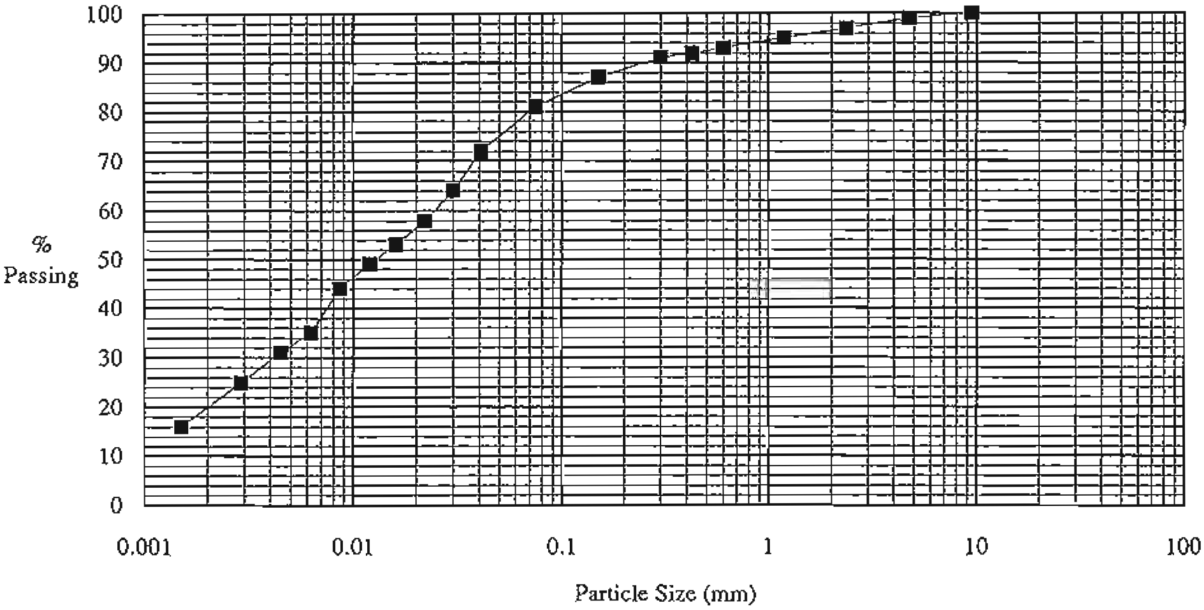
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33916 / 33917
Sample No. :	9 / 9B **Borehole:** DM96-1	**Date Tested :**	28.8.96
Date Sampled:	14.7.96	**Depth (m):**	9.0 / 9.1

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING		HYDROMETER	
Sieve Size (mm)	**% Passing**	**Particle Diameter** (mm)	**% Finer**
19.0	-	0.041	72
9.50	100	0.030	64
4.75	99	0.022	58
2.36	97	0.016	53
1.18	95	0.012	49
0.600	93	0.0086	44
0.425	93	0.0063	35
0.300	91	0.0045	31
0.150	87	0.0029	25
0.075	81	0.0015	16

Notes:

1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :<u>WG 33882-33984</u>

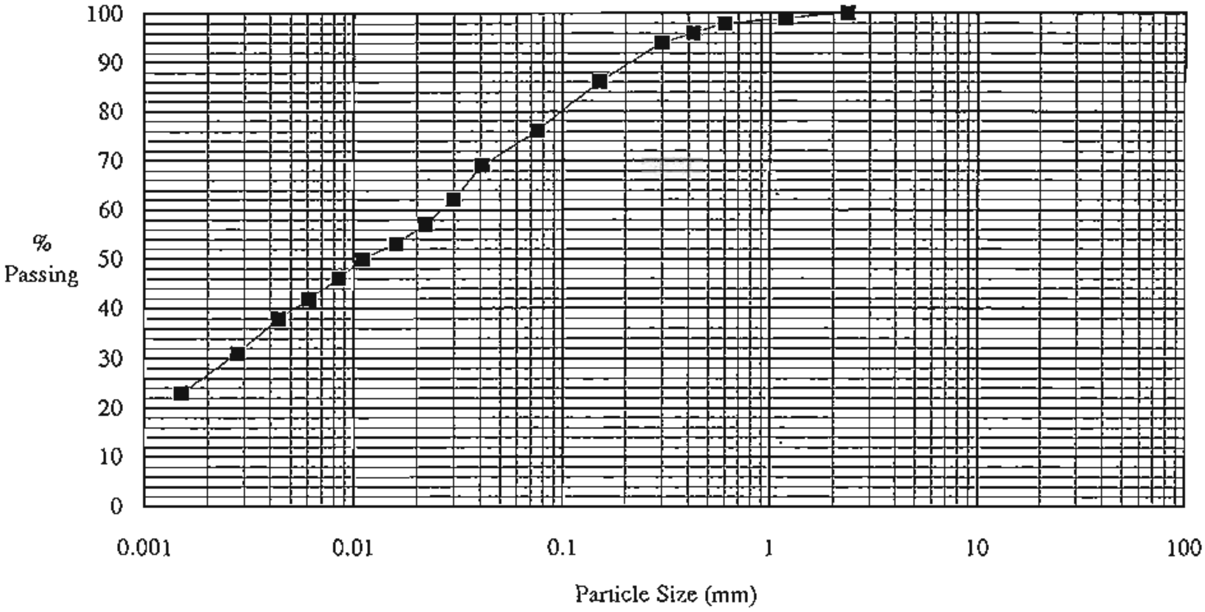
Approved Signatory : ______________(P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33930
Sample No. :	4B **Borehole:** DM96-2	**Date Tested :**	27.8.96
Date Sampled:	15.7.96	**Depth (m):**	6.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING		HYDROMETER	
Sieve Size (mm)	% Passing	Particle Diameter (mm)	% Finer
19.0	-	0.041	69
9.50	-	0.030	62
4.75	-	0.022	57
2.36	100	0.016	53
1.18	99	0.011	50
0.600	98	0.0085	46
0.425	97	0.0061	42
0.300	95	0.0044	38
0.150	87	0.0028	31
0.075	77	0.0015	23

Notes:

1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : ____________(P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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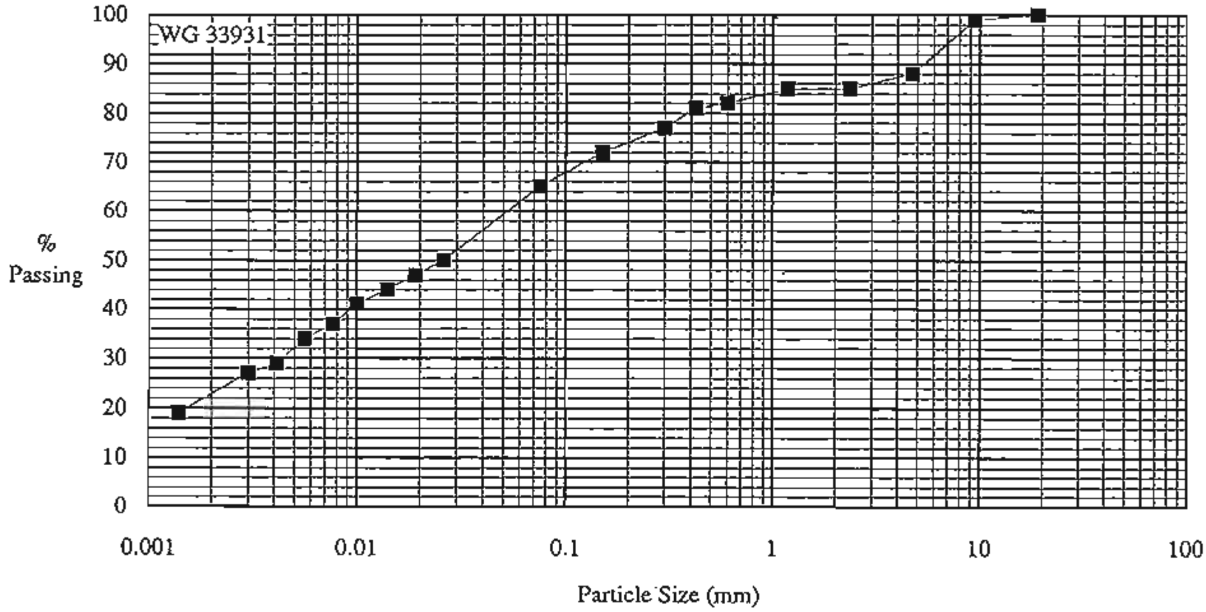
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 56 of 82

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33931
Sample No. :	5 **Borehole:** DM96-2	**Date Tested :**	19.8.96
Date Sampled:	16.7.96	**Depth (m):**	7.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING

Sieve Size (mm)	% Passing
19.0	100
9.50	99
4.75	88
2.36	85
1.18	85
0.600	82
0.425	81
0.300	78
0.150	72
0.075	66

HYDROMETER

Particle Diameter (mm)	% Finer
0.026	50
0.019	47
0.014	44
0.010	41
0.0077	37
0.0056	34
0.0041	29
0.0030	27
0.0015	19

Notes:
1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

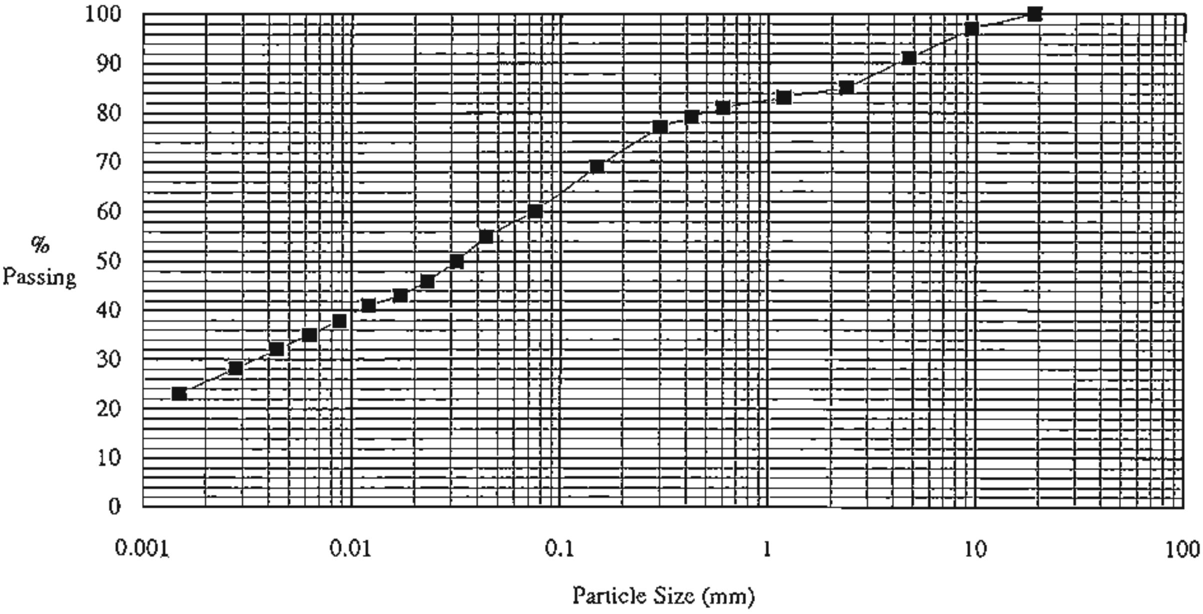
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 57 of 82

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33944 / 33945
Sample No. :	3 / 3B **Borehole:** DM96-3	**Date Tested :**	28.8.96
Date Sampled:	17.7.96	**Depth (m):**	4.5 / 4.6

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING		**HYDROMETER**	
Sieve Size (mm)	**% Passing**	**Particle Diameter** (mm)	**% Finer**
19.0	100	0.044	55
9.50	97	0.032	50
4.75	91	0.023	46
2.36	85	0.017	43
1.18	83	0.012	41
0.600	81	0.0088	38
0.425	79	0.0063	35
0.300	77	0.0044	32
0.150	69	0.0028	28
0.075	60	0.0015	23

Notes:

1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : ______________ (P. Brittan) **Date :** 10-9-96

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Form No. AS 1289 3.6.2 95/2 R

WESTERN GEOTECHNICS
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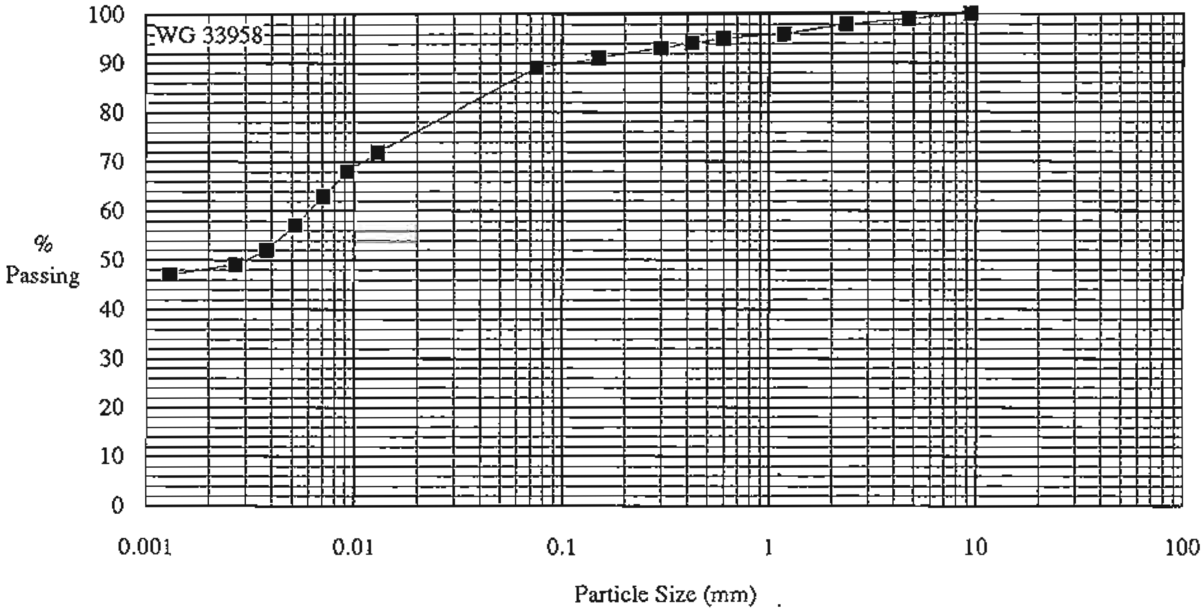
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : 2 **Borehole:** DM96-4
Date Sampled: 18.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33958
Date Tested : 19.8.96
Depth (m): 3.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING

Sieve Size (mm)	% Passing
19.0	-
9.50	100
4.75	99
2.36	98
1.18	96
0.600	95
0.425	94
0.300	93
0.150	91
0.075	89

HYDROMETER

Particle Diameter (mm)	% Finer
0.013	72
0.0093	68
0.0071	63
0.0052	57
0.0038	52
0.0027	49
0.0013	47

Notes:
1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : ____________ (P. Brittan) **Date :** 10-9-96

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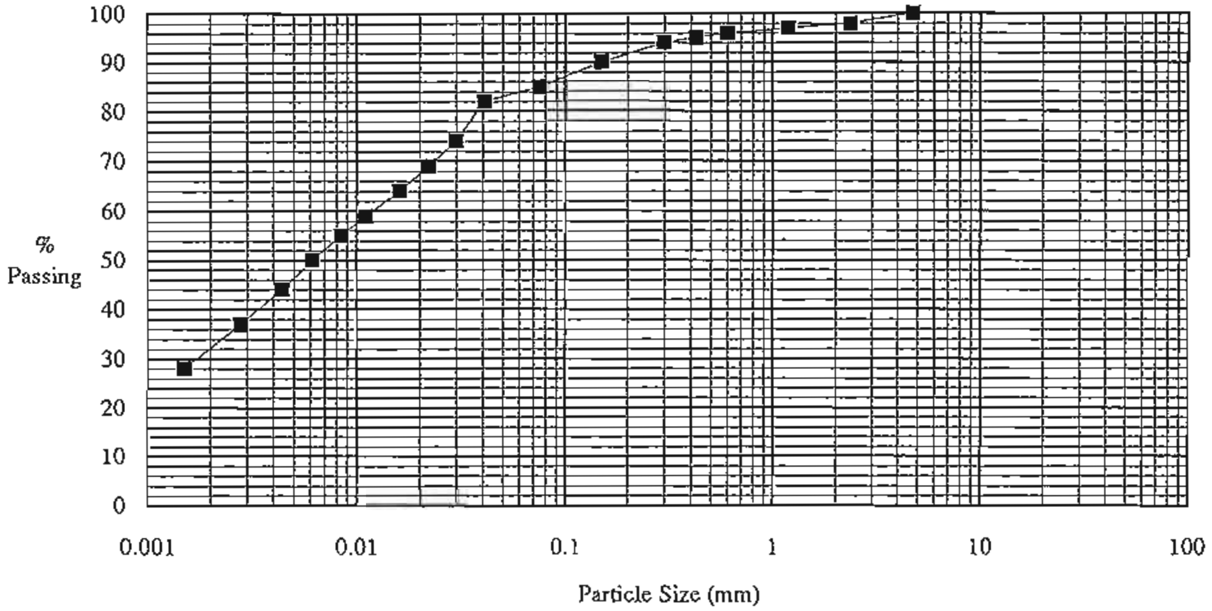
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : 6 **Borehole:** DM96-5B
Date Sampled: 20.7.96
JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33971
Date Tested : 28.8.96
Depth (m): 7.5

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING

Sieve Size (mm)	% Passing
19.0	-
9.50	-
4.75	100
2.36	98
1.18	97
0.600	96
0.425	95
0.300	94
0.150	90
0.075	85

HYDROMETER

Particle Diameter (mm)	% Finer
0.040	81
0.029	73
0.021	68
0.015	63
0.011	59
0.0083	54
0.0060	49
0.0043	44
0.0028	37
0.0014	27

Notes:
1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.
3. Due to insufficient sample size one stone retained 26.5mm passing 37.5mm was removed prior to test. 9% retained 26.5mm.

Certificate No. :WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

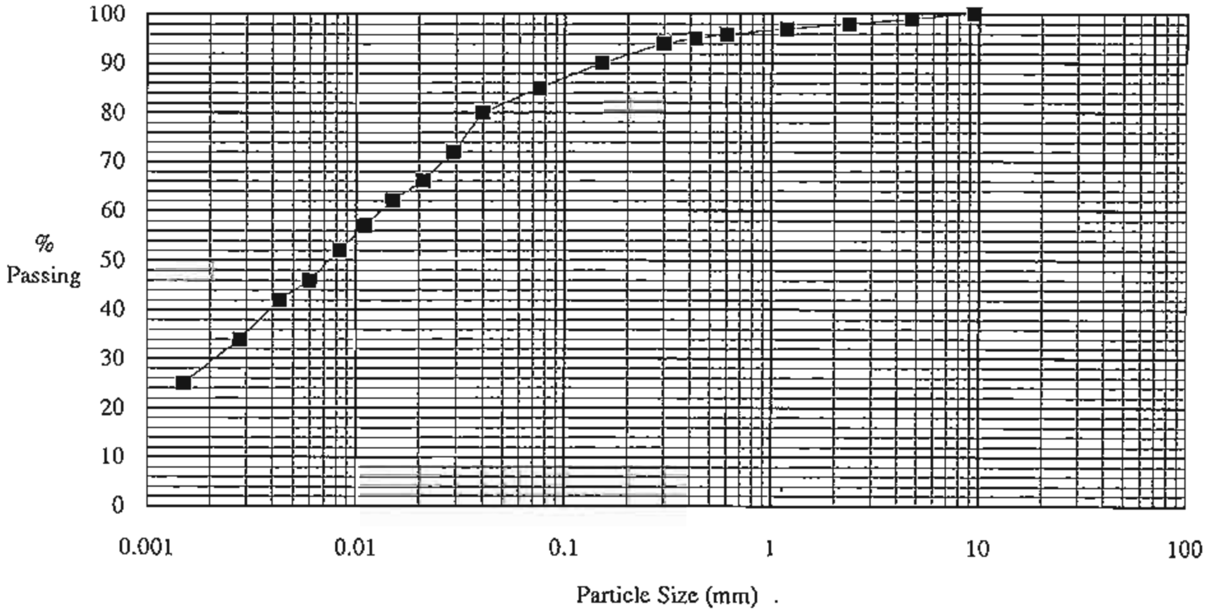
PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 60 of 82

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : 7 / 7B **Borehole:** DM96-5B
Date Sampled: 20.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33973 / 33974
Date Tested : 28.8.96
Depth (m): 9.0 / 9.1

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING

Sieve Size (mm)	% Passing
19.0	-
9.50	100
4.75	99
2.36	98
1.18	97
0.600	96
0.425	95
0.300	94
0.150	90
0.075	85

HYDROMETER

Particle Diameter (mm)	% Finer
0.040	80
0.029	72
0.021	66
0.015	62
0.011	57
0.0083	52
0.0060	46
0.0043	42
0.0028	34
0.0014	25

Notes:
1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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WESTERN GEOTECHNICS

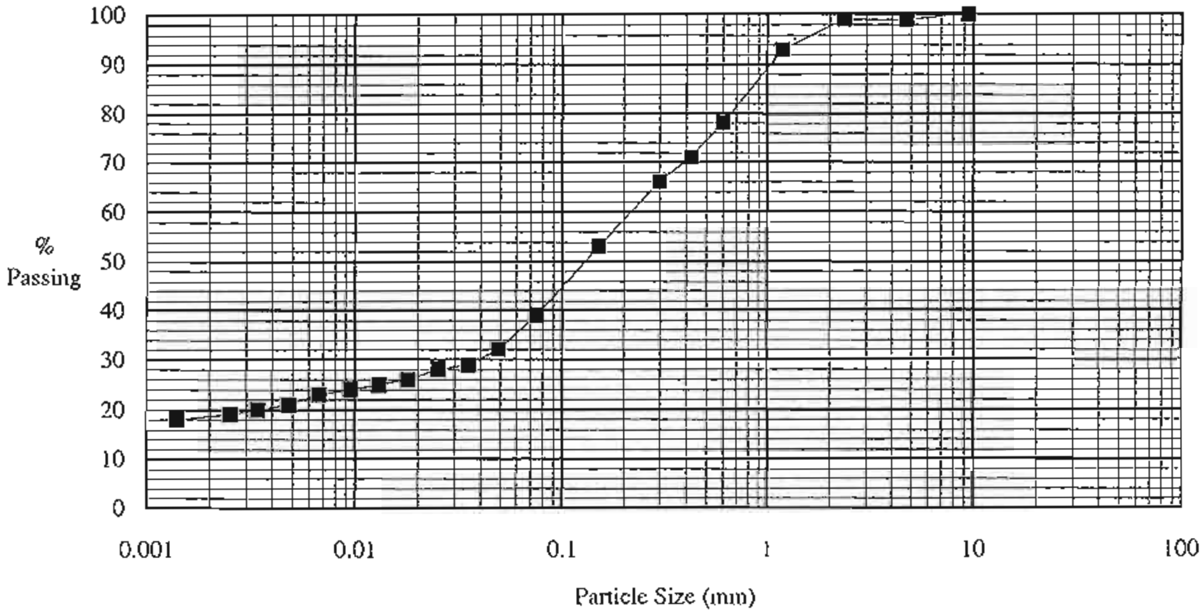
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

PARTICLE SIZE DISTRIBUTION TEST CERTIFICATE

Page 61 of 82

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33984
Sample No. :	1 **Borehole:** DM96-5C	**Date Tested :**	20.8.96
Date Sampled:	21.7.96	**Depth (m):**	3.0

PARTICLE SIZE DISTRIBUTION TEST RESULTS - according to AS 1289 3.6.2 - 1995



SIEVING		HYDROMETER	
Sieve Size (mm)	**% Passing**	**Particle Diameter (mm)**	**% Finer**
19.0	-	0.048	32
9.50	100	0.035	29
4.75	99	0.025	28
2.36	99	0.018	26
1.18	93	0.013	25
0.600	78	0.0094	24
0.425	71	0.0066	23
0.300	65	0.0047	21
0.150	53	0.0033	20
0.075	38	0.0025	19
		0.0014	18

Notes:

1. Where a Specific Gravity Test has not been conducted on individual test specimens, an assumed value of 2.70 has been used in the calculation of these results.
2. Sample supplied by Client.

Certificate No. :WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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TEST CERTIFICATE

Page 62 of 84

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB No: 15780-018-361
DATE TESTED: 27.8.96

Lab Ref No: WG 33916
Sample No: 9
Borehole: DM96-1
Depth (m): 9.0
Date Sampled: 14.7.96

PINHOLE DISPERSION CLASSIFICATION TEST RESULTS
- according to AS1289 C8.3

Natural Moisture Content (%)	13.4
Standard Maximum Dry Density (t/m^3):	Unknown
Optimum Moisture Content (%):	Unknown
Dry Density at test (t/m^3):	1.88
Moisture Content at test (%):	13.4
Percentage Compaction (%):	-
Head at Termination of Test (mm):	50
Test Time of Head (min):	10
Visibility of Colour of Flow (at end of test):	Cloudy
Final Flow Through Specimen (ml/s):	0.95
Ratio of Final to Initial Hole Diameter (after test to nearest 0.5):	2.0
Source of Water:	Tap Water

Classification Designation: D2
Description : Dispersive

Note. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ____________ (P. Brittan) Date: 10-9-96

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WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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TEST CERTIFICATE

Page 63 of 84

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB No:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	27.8.96

Lab Ref No: WG 33944
Sample No: 3
Borehole: DM96-3
Depth (m): 4.5
Date Sampled: 17.7.96

PINHOLE DISPERSION CLASSIFICATION TEST RESULTS

- according to AS1289 C8.3

Natural Moisture Content (%)	12.9
Standard Maximum Dry Density (t/m^3):	Unknown
Optimum Moisture Content (%):	Unknown
Dry Density at test (t/m^3):	1.82
Moisture Content at test (%):	12.9
Percentage Compaction (%):	-
Head at Termination of Test (mm):	1000
Test Time of Head (min):	5
Visibility of Colour of Flow (at end of test):	Clear
Final Flow Through Specimen (ml/s):	3.0
Ratio of Final to Initial Hole Diameter (after test to nearest 0.5):	1.0
Source of Water:	Tap Water

Classification Designation: ND1

Description : Erosion Resistant

Note. Sample supplied by Client.

Certificate No: WG 33882-33984

Approved Signatory: ______________ (P. Brittan) **Date:** 10-9-96

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Form No. AS 1289 C8.3 94/1 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB No: 15780-018-361
DATE TESTED: 20.8.96

Lab Ref No:	WG 33912	WG 33933	WG 33944 / 33945	WG 33958	WG 33971
Sample No:	6	7	3 / 3B	2	6
Borehole No:	DM96-1	DM96-2	DM96-3	DM96-4	DM96-5B
Depth (m):	6.0	10.5	4.5 / 4.6	3.0	7.5
Date Sampled:	14.7.96	16.7.96	17.7.96	18.7.96	20.7.96

DETERMINATION OF THE pH VALUE OF A SOIL ELECTROMETRIC METHOD

-according to AS 1289 D3.1

pH:	9.6	9.3	8.8	8.6	9.2

Note: Sample supplied by client.

Certificate No.: WG 33882-33984

Approved Signatory : Melby Castle (M. Castle)**Date :** 5/9/96

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WESTERN GEOTECHNICS
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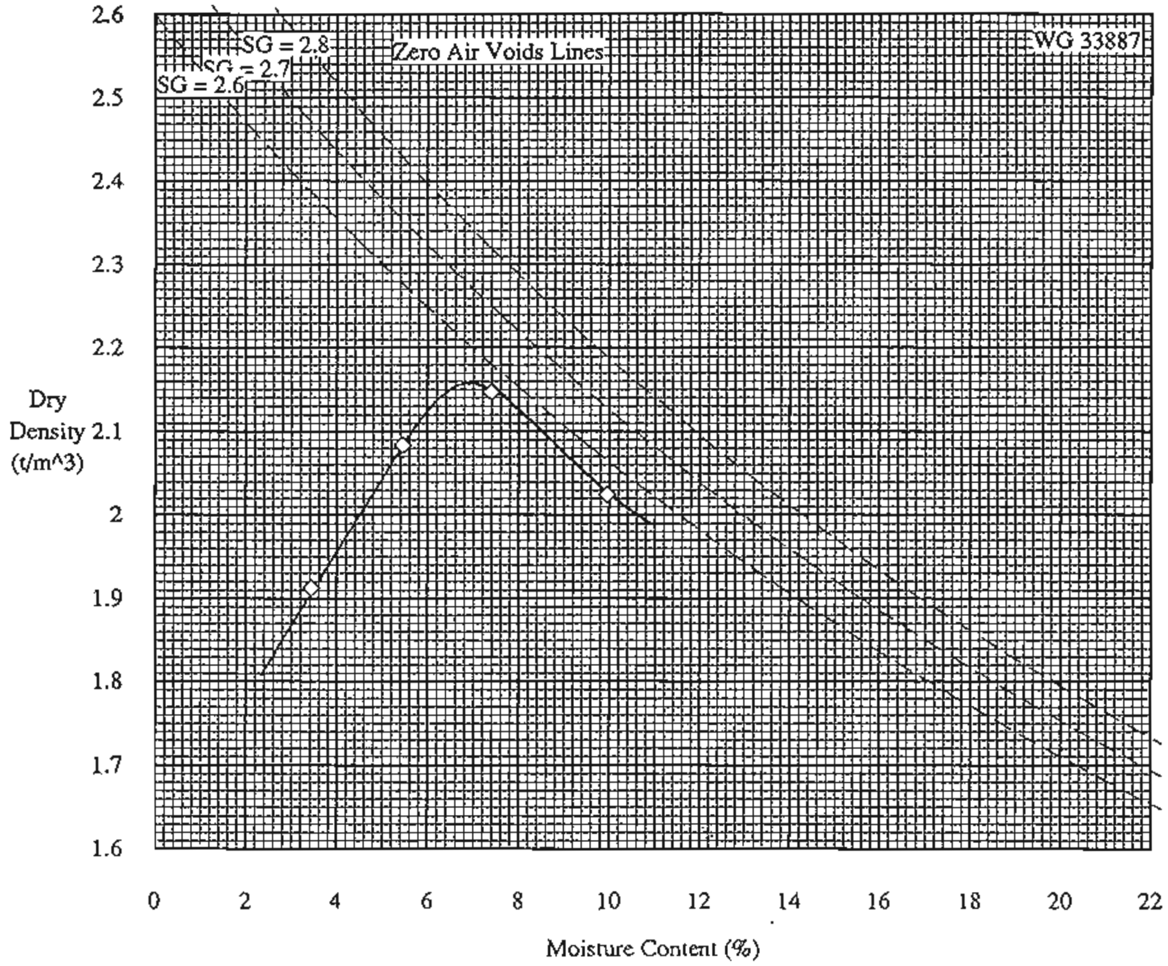
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

COMPACTION TEST CERTIFICATE

Page 65 of 82

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33887
Sample No. :	BU1 **Test Pit:** TP96-6	**Date Tested :**	1/2.8.96
Date Sampled:	13.7.96	**Depth (m):**	0.5-0.7

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.16 **Optimum M/C** (%) = 7.0 **Field M/C** (%) = -

Notes :
1. 0% plus 19.0mm.
2. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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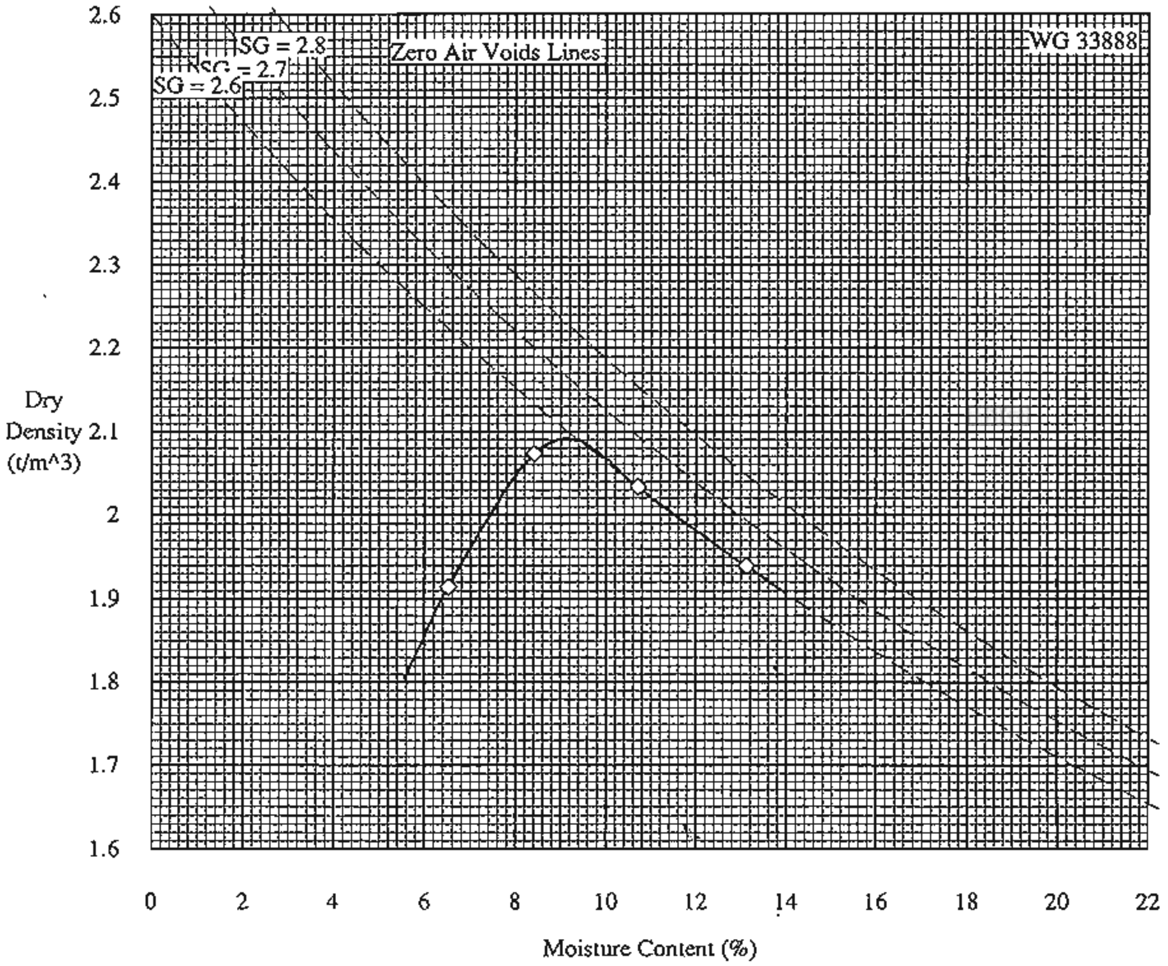
COMPACTION TEST CERTIFICATE

Page 66 of 82

CLIENT :	Dames & Moore	**JOB No. :**	001-01-288
PROJECT :	-	**Client Job No:**	15780-018-361
LOCATION :	Kintyre	**Lab No. :**	WG 33888
Sample No. :	BU1 **Test Pit:** TP96-7	**Date Tested :**	1/2.8.96
Date Sampled:	13.7.96	**Depth (m):**	1.8-2.0

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.09 **Optimum M/C** (%) = 9.5 **Field M/C** (%) = -

Notes :
1. 0% plus 19.0mm.
2. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) Date : 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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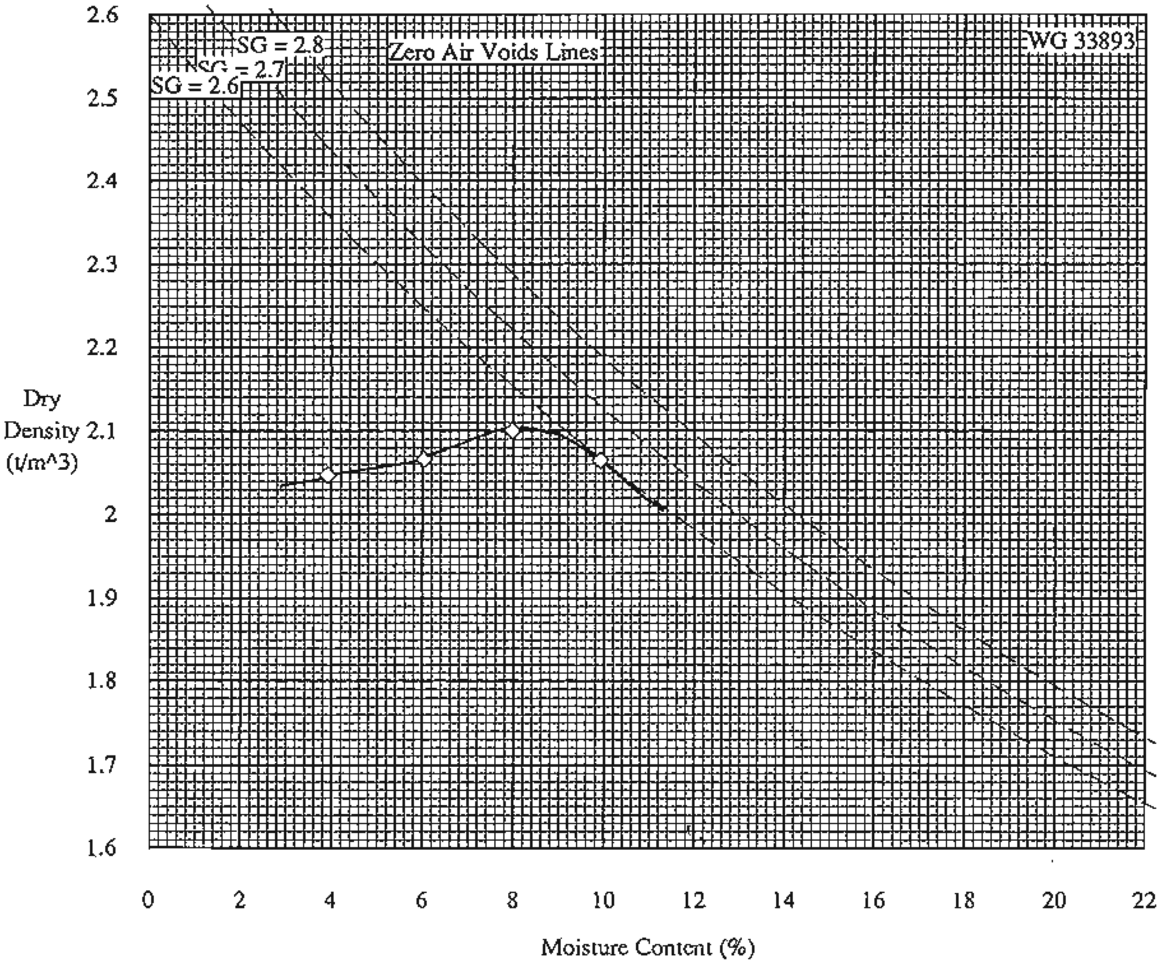
COMPACTION TEST CERTIFICATE

Page 67 of 82

CLIENT :	Dames & Moore		**JOB No. :**	001-01-288
PROJECT :	-		**Client Job No:**	15780-018-361
LOCATION :	Kintyre		**Lab No. :**	WG 33893
Sample No. :	BU2	**Test Pit:** TP96-11	**Date Tested :**	31.7/1.8.96
Date Sampled:	13.7.96		**Depth (m):**	1.0

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.10 **Optimum M/C** (%) = 8.5 **Field M/C** (%) = -

Notes :
1. 18% plus 19.0mm. Removed prior to testing.
2. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

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WESTERN GEOTECHNICS

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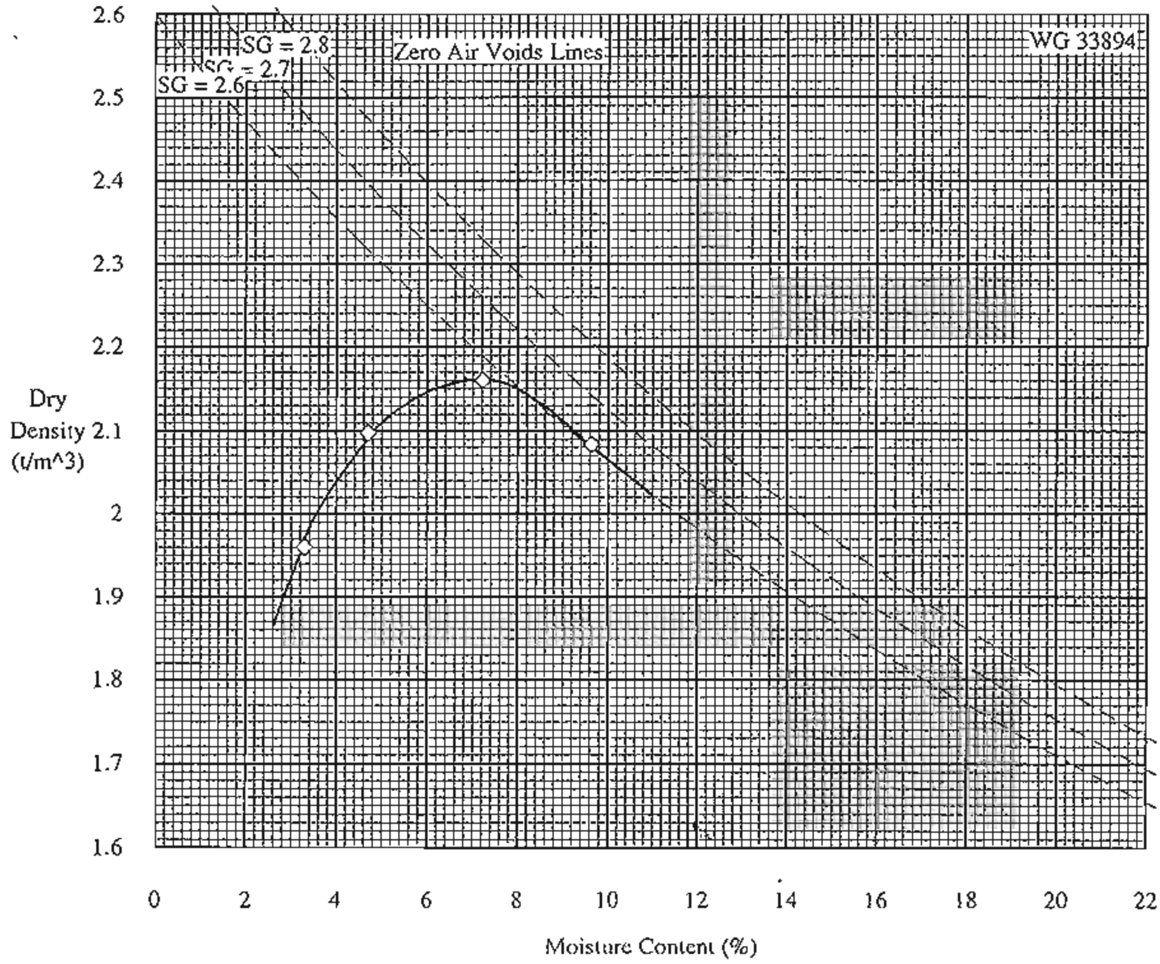
COMPACTION TEST CERTIFICATE

CLIENT :	Dames & Moore			**JOB No. :**	001-01-288
PROJECT :	-			**Client Job No:**	15780-018-361
LOCATION :	Kintyre			**Lab No. :**	WG 33894
Sample No. :	BU1	**Test Pit:**	TP96-12	**Date Tested :**	1/2.8.96
Date Sampled:	13.7.96			**Depth (m):**	0.3-0.5

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.16 **Optimum M/C** (%) = 7.0 **Field M/C** (%) = -

Notes :

1. 11% plus 19.0mm. Removed prior to testing.
2. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : ______________ (P. Brittan) **Date :** 10-9-96

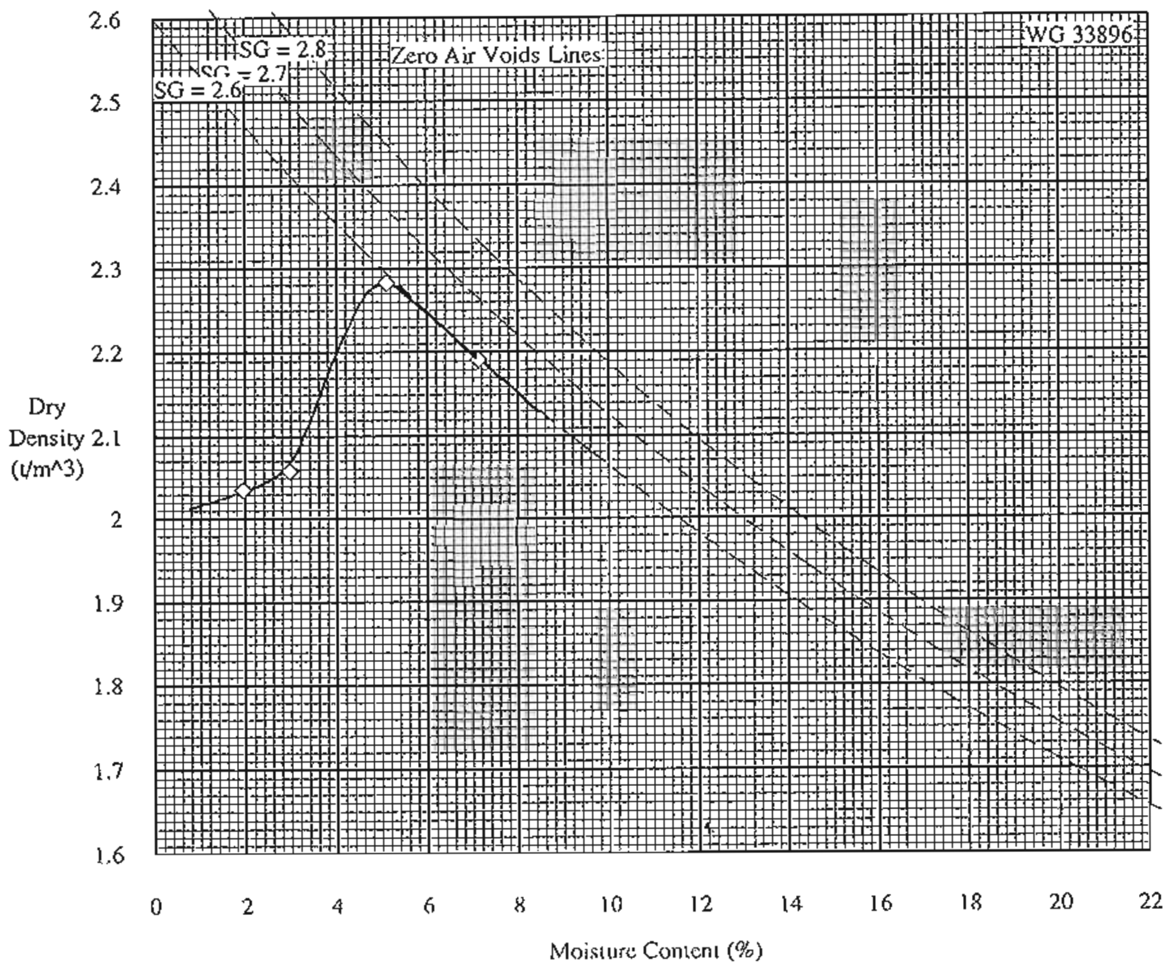
WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

COMPACTION TEST CERTIFICATE

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : BU1 **Test Pit:** TP96-13
Date Sampled: 13.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33896
Date Tested : 1/2.8.96
Depth (m): 0.5-0.7

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.28 **Optimum M/C** (%) = 5.0 **Field M/C** (%) = -

Notes :

1. 29% plus 19.0mm. Removed prior to testing.
2. Deviation from standard method. Greater than 20% retained on 19.0mm sieve. Removed prior to testing.
3. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : ____________ (P. Brittan) **Date :** 10-9-96

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WESTERN GEOTECHNICS

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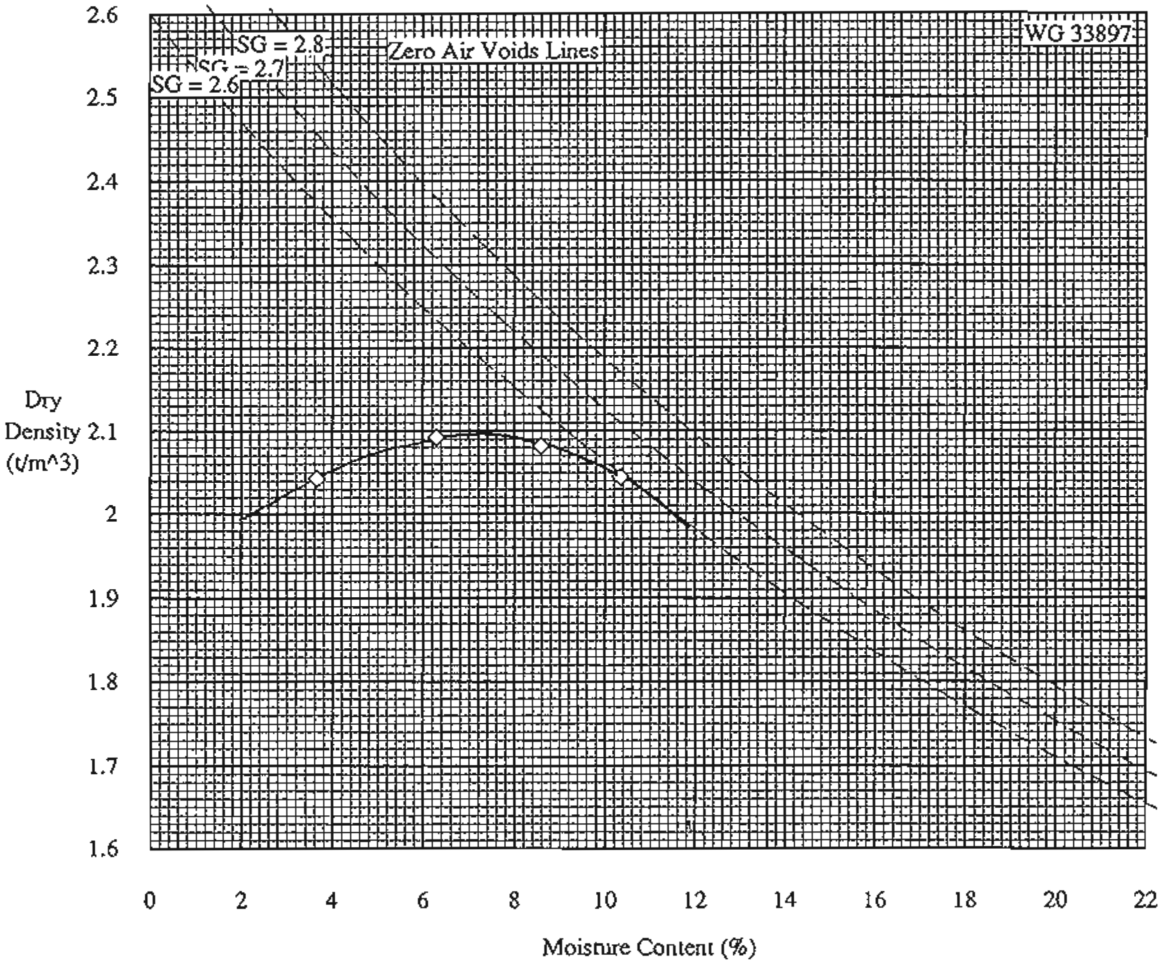
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

COMPACTION TEST CERTIFICATE

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : BU1 **Test Pit:** TP96-14
Date Sampled: 13.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33897
Date Tested : 31.7/1.8.96
Depth (m): 2.0

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.09 **Optimum M/C (%)** = 7.0 **Field M/C (%)** = -

Notes :
1. 20% plus 19.0mm. Removed prior to testing.
2. Sample supplied by Client.

Certificate No. : WG 33882-33984

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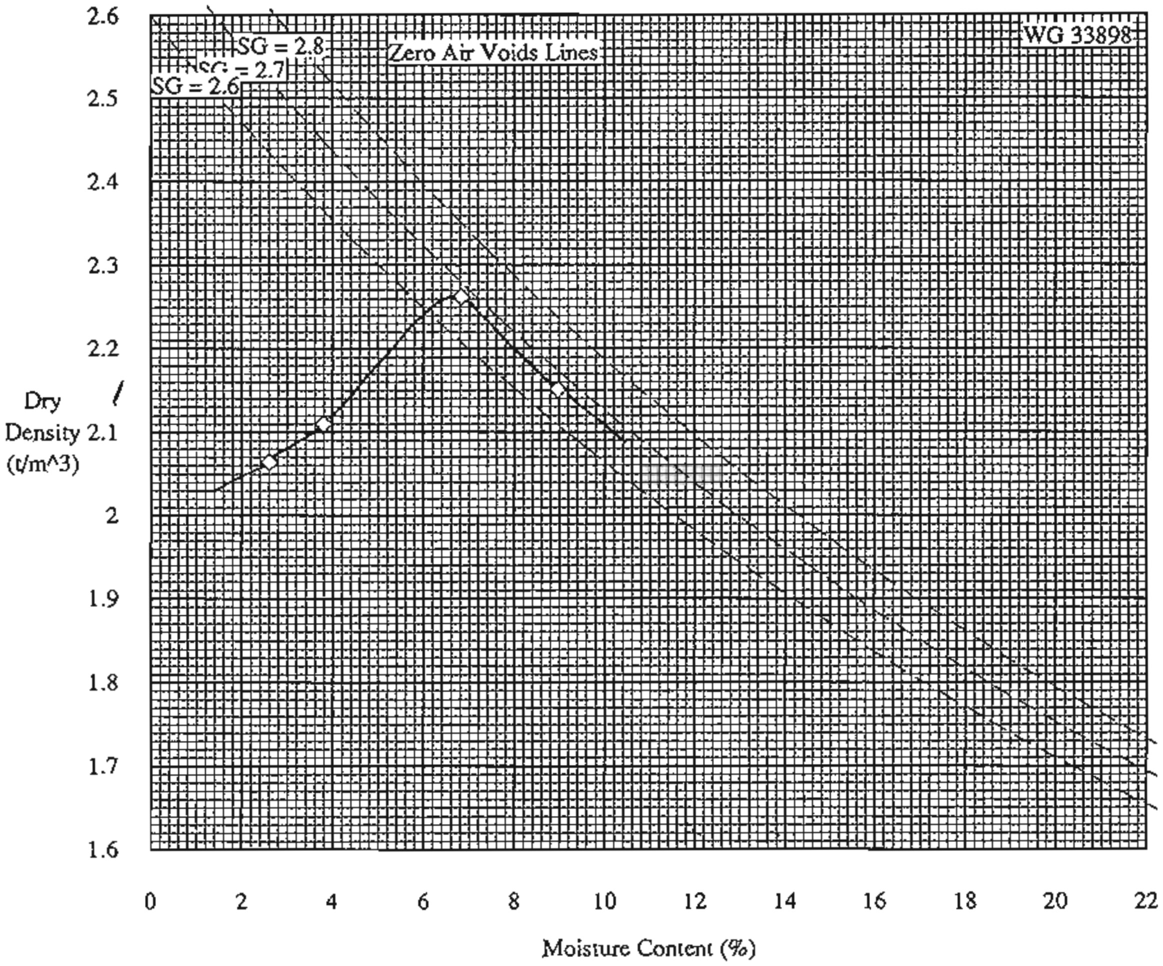
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

COMPACTION TEST CERTIFICATE

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : BU1 **Test Pit:** TP96-15
Date Sampled: 13.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33898
Date Tested : 1/2.8.96
Depth (m): 0.5-0.7

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = **2.26** **Optimum M/C** (%) = **6.5** **Field M/C** (%) = -

Notes :
1. 22% plus 19.0mm. Removed prior to testing.
2. Deviation from standard method. Greater than 20% retained on the 19.0mm sieve. Removed prior to testing.
3. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
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15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

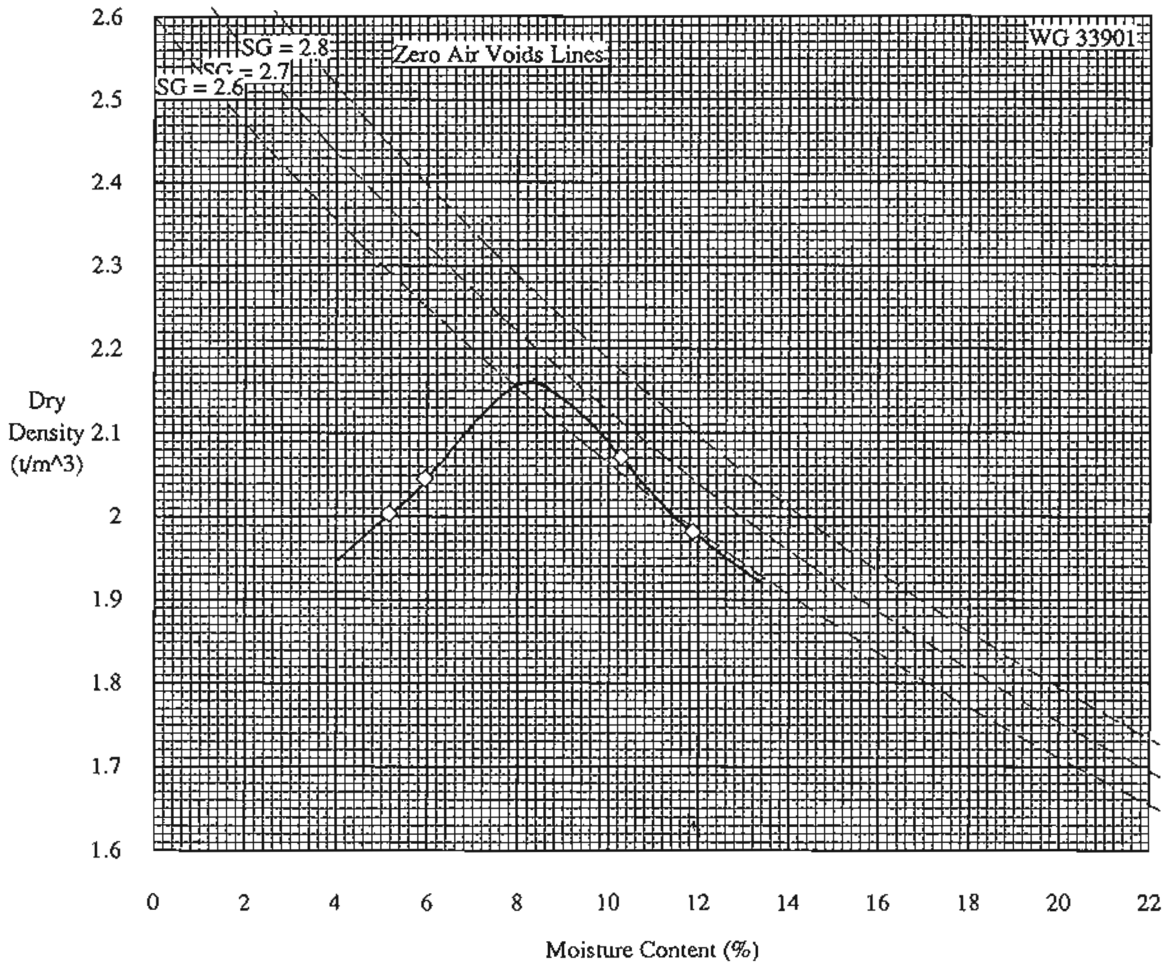
COMPACTION TEST CERTIFICATE

Page 72 of 82

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : BU1 **Test Pit:** TP96-17
Date Sampled: 13.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33901
Date Tested : 1/2.8.96
Depth (m): 0.5-0.7

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.17 **Optimum M/C** (%) = 8.5 **Field M/C** (%) = -

Notes :
1. 21% plus 19.0mm. Removed prior to testing.
2. Deviation from standard method. Greater than 20% retained on the 19.0mm sieve. Removed prior to testing.
3. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : _______ (P. Brittan) **Date :** 10-9-96

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Form No. AS 1289 5.2.1 94/1 R

WESTERN GEOTECHNICS

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15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

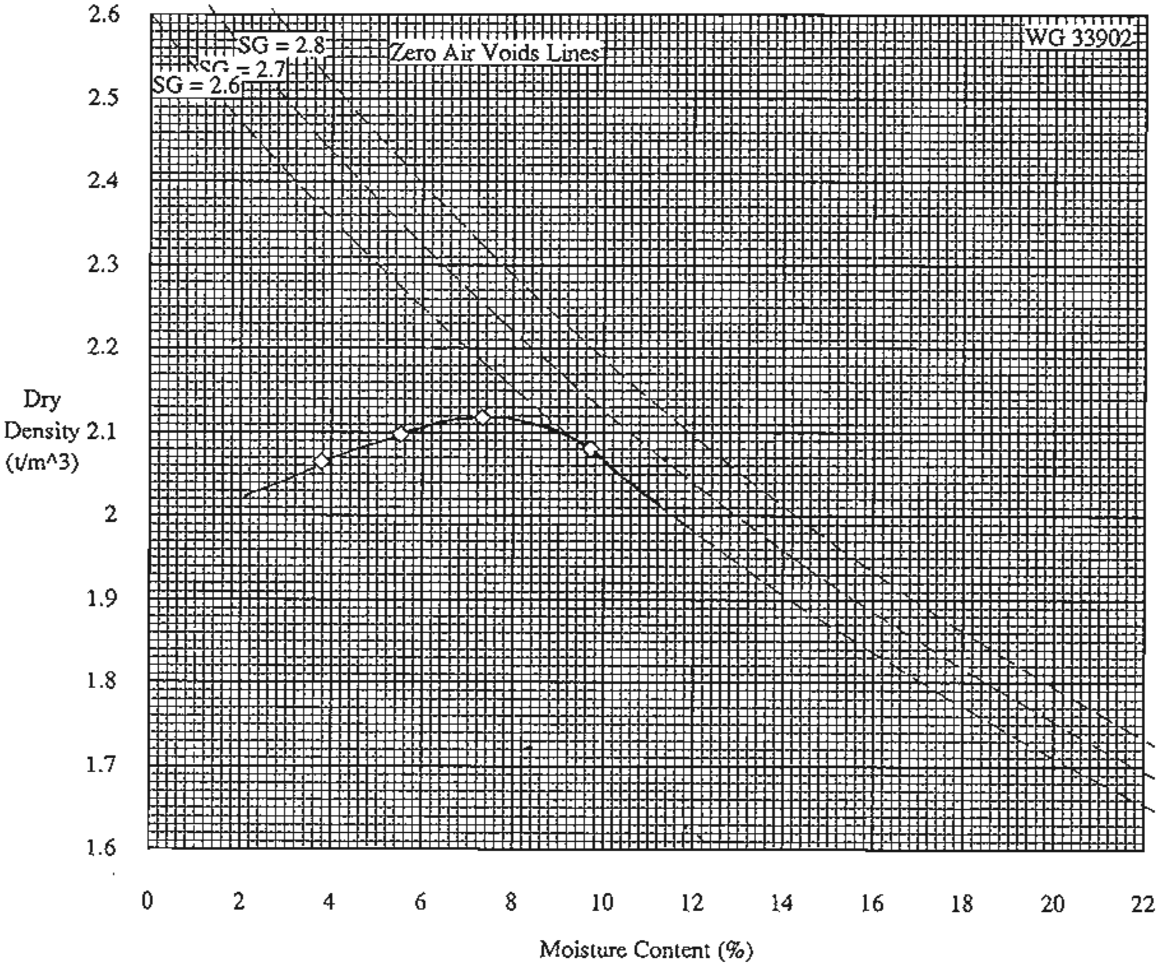
COMPACTION TEST CERTIFICATE

Page 73 of 82

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : BU1 **Test Pit:** TP96-18
Date Sampled: 13.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33902
Date Tested : 1/2.8.96
Depth (m): 0.5-0.7

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.12 **Optimum M/C** (%) = 7.5 **Field M/C** (%) = -

Notes :
1. 24% plus 19.0mm. Removed prior to testing.
2. Deviation from standard method. Greater than 20% retained on the 19.0mm sieve. Removed prior to testing.
3. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS
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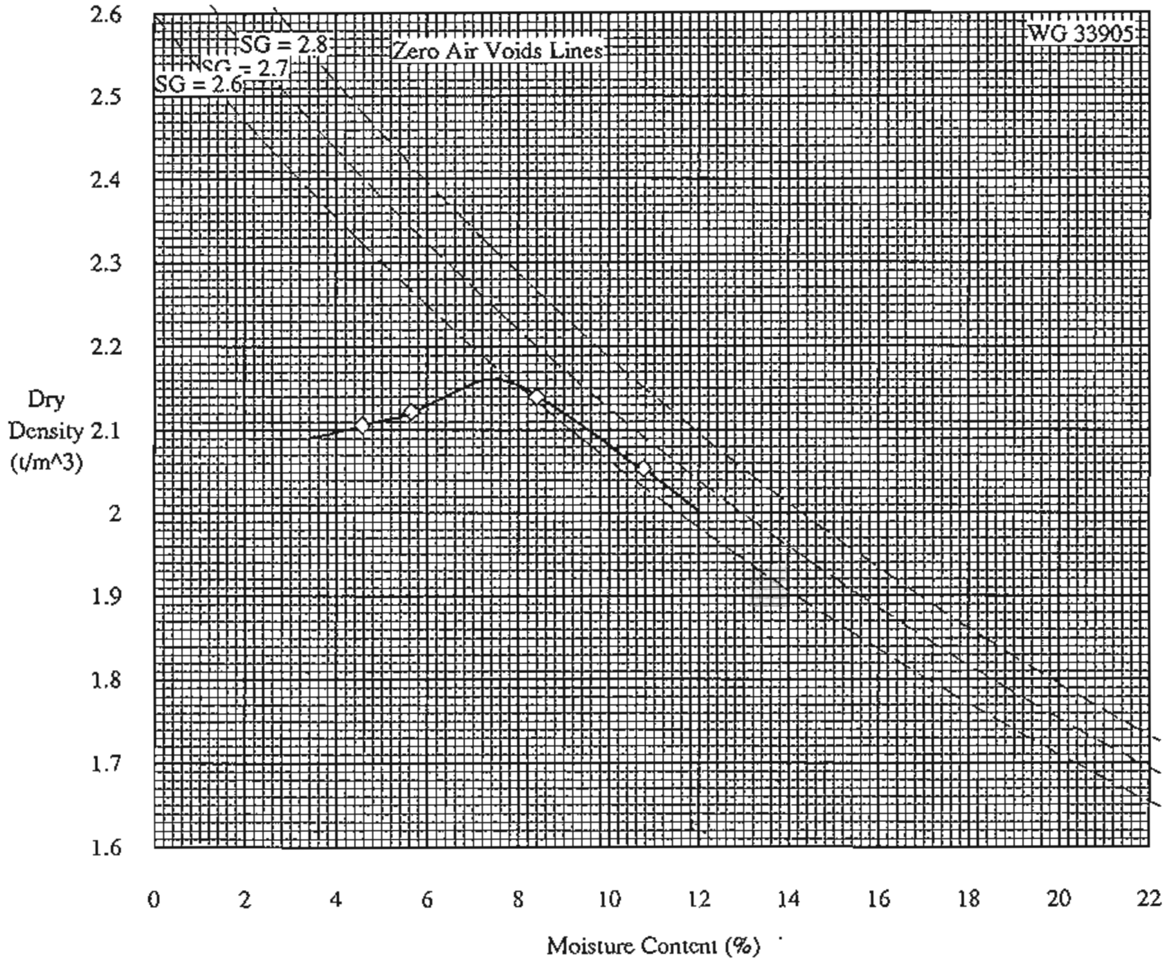
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

COMPACTION TEST CERTIFICATE

CLIENT : Dames & Moore
PROJECT : -
LOCATION : Kintyre
Sample No. : BU1 **Test Pit:** TP96-20
Date Sampled: 13.7.96

JOB No. : 001-01-288
Client Job No: 15780-018-361
Lab No. : WG 33905
Date Tested : 1/2.8.96
Depth (m): 0.5-0.7

COMPACTION TEST RESULTS - according to AS 1289 5.2.1



Max. Dry Density (t/m^3) = 2.16 **Optimum M/C (%)** = 7.5 **Field M/C (%)** = -

Notes :
1. 24% plus 19.0mm. Removed prior to testing.
2. Deviation from standard method. Greater than 20% retained on the 19.0mm sieve. Removed prior to testing.
3. Sample supplied by Client.

Certificate No. : WG 33882-33984

Approved Signatory : (P. Brittan) **Date :** 10-9-96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 75 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 8.8.96

Lab Ref No.: WG 33893
Sample No: BU2
Test Pit: TP96-11
Depth (m): 1.0
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO

- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	26
COMPACTION ACHIEVED, %:	94.8
MOISTURE CONTENTS, %	
at compaction:	8.9
after soaking:	12.7
top 30mm:	12.8
entire depth:	11.9
DRY DENSITY (t/m^3):	
before soaking:	1.99
after soaking:	1.97
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	1.0
OPTIMUM MOISTURE CONTENT (%):	8.5
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.10
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	45
at 5.0mm penetration:	45

Note. Sample supplied by Client.

Certificate No.: WG 33882-33984

Approved Signatory: (M. Castle) **Date:** 5/9/96

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Form No. AS 1289 F1.1 94/1 R

WESTERN GEOTECHNICS
WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Page 76 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	8.8.96

Lab Ref No.: WG 33894
Sample No: BU1
Test Pit: TP96-12
Depth (m): 0.3-0.5
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO

- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	25
COMPACTION ACHIEVED, %:	94.9
MOISTURE CONTENTS, %	
at compaction:	7.2
after soaking:	10.4
top 30mm:	9.4
entire depth:	9.3
DRY DENSITY (t/m^3):	
before soaking:	2.05
after soaking:	2.04
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	0.4
OPTIMUM MOISTURE CONTENT (%):	7.0
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.16
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	25
at 5.0mm penetration:	30

Note. Sample supplied by Client.

Certificate No.: WG 33882-33984

Approved Signatory: (M. Castle) **Date:** 5/9/96

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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TEST CERTIFICATE

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	8.8.96

Lab Ref No.: WG 33896
Sample No: BU1
Test Pit: TP96-13
Depth (m): 0.5-0.7
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO

- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	35
COMPACTION ACHIEVED, %:	95.4
MOISTURE CONTENTS, %	
at compaction:	4.6
after soaking:	7.7
top 30mm:	7.5
entire depth:	7.7
DRY DENSITY (t/m^3):	
before soaking:	2.17
after soaking:	2.16
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	0.7
OPTIMUM MOISTURE CONTENT (%):	5.0
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.28
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	30
at 5.0mm penetration:	30

Note. Sample supplied by Client.

Certificate No.: WG 33882-33984

Approved Signatory: (M. Castle)**Date:** 5/9/96

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ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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TEST CERTIFICATE

Page 78 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	8.8.96

Lab Ref No.: WG 33897
Sample No: BU1
Test Pit: TP96-14
Depth (m): 2.0
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO
- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	23
COMPACTION ACHIEVED, %:	95.1
MOISTURE CONTENTS, %	
at compaction:	6.9
after soaking:	13.0
top 30mm:	14.2
entire depth:	23.0
DRY DENSITY (t/m^3):	
before soaking:	1.99
after soaking:	1.94
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	2.4
OPTIMUM MOISTURE CONTENT (%):	7.0
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.09
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	19
at 5.0mm penetration:	23

Note. Sample supplied by Client.

Certificate No.: WG 33882-33984

Approved Signatory: ______ (M. Castle) **Date:** 5/9/96

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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 8.8.96

Lab Ref No.: WG 33898
Sample No: BU1
Test Pit: TP96-15
Depth (m): 0.5-0.7
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO

- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	25
COMPACTION ACHIEVED, %:	94.7
MOISTURE CONTENTS, %	
at compaction:	6.9
after soaking:	9.7
top 30mm:	10.4
entire depth:	8.9
DRY DENSITY (t/m^3):	
before soaking:	2.14
after soaking:	2.12
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	1.0
OPTIMUM MOISTURE CONTENT (%):	6.5
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.26
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	35
at 5.0mm penetration:	35

Note. Sample supplied by Client.

Certificate No.: WG 33882-33984

Approved Signatory: (M. Castle) **Date:** 5/9/96

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TEST CERTIFICATE

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 8.8.96

Lab Ref No.: WG 33901
Sample No: BU1
Test Pit: TP96-17
Depth (m): 0.5-0.7
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO
- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	20
COMPACTION ACHIEVED, %:	95.1
MOISTURE CONTENTS, %	
at compaction:	8.4
after soaking:	11.2
top 30mm:	12.3
entire depth:	10.8
DRY DENSITY (t/m^3):	
before soaking:	2.06
after soaking:	2.02
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	2.0
OPTIMUM MOISTURE CONTENT (%):	8.5
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.17
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	13
at 5.0mm penetration:	16

Note. Sample supplied by Client.

Approved Signatory: Meley Castle (M. Castle)

Certificate No.: WG 33882-33984
Date: 5/9/96

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TEST CERTIFICATE

Page 81 of 82

CLIENT: Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED: 8.8.96

Lab Ref No.: WG 33902
Sample No: BU1
Test Pit: TP96-18
Depth (m): 0.5-0.7
Date Sampled: 13.7.96

CALIFORNIA BEARING RATIO

- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	25
COMPACTION ACHIEVED, %:	94.9
MOISTURE CONTENTS, %	
at compaction:	7.6
after soaking:	12.6
top 30mm:	13.2
entire depth:	12.3
DRY DENSITY (t/m^3):	
before soaking:	2.01
after soaking:	1.98
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	1.4
OPTIMUM MOISTURE CONTENT (%):	7.5
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.12
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	16
at 5.0mm penetration:	20

Note. Sample supplied by Client.

Approved Signatory: ________________ (M. Castle)

Certificate No.: WG 33882-33984
Date: 5/9/96

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TEST CERTIFICATE

Page 82 of 82

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	8.8.96

Lab Ref No.:	WG 33905
Sample No:	BU1
Test Pit:	TP96-20
Depth (m):	0.5-0.7
Date Sampled:	13.7.96

CALIFORNIA BEARING RATIO

- according to AS 1289 F1.1

COMPACTIVE EFFORT USED:	Modified
rammer mass (kg):	4.9
drop height (mm):	450
no. of layers:	5
no. of blows/layer:	20
COMPACTION ACHIEVED, %:	94.8
MOISTURE CONTENTS, %	
at compaction:	7.8
after soaking:	12.4
top 30mm:	15.2
entire depth:	12.4
DRY DENSITY (t/m^3):	
before soaking:	2.05
after soaking:	2.00
SURCHARGE (kg):	4.5
CONDITION OF SPECIMEN:	Soaked (4 days)
SWELL (%):	2.5
OPTIMUM MOISTURE CONTENT (%):	7.5
MODIFIED MAXIMUM DRY DENSITY (t/m^3):	2.16
CALIFORNIA BEARING RATIO, %	
at 2.5mm penetration:	16
at 5.0mm penetration:	20

Note. Sample supplied by Client.

Certificate No.: WG 33882-33984

Approved Signatory: Melvy Castle (M. Castle)**Date:** 5/9/96

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ENGINEERING MATERIALS TESTING : SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
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REPORT CERTIFICATE
TRIAXIAL SHEAR TEST

TXL Attachment 1 of 5

CLIENT : Dames & Moore Pty Ltd (Job # 15780-018-361)
PROJECT : Kintyre
Sample Id. : BH # DM96-5B, Sa # 6 **Depth :** 7.5m
Test Type : CIU, Multi-Stage with P.W.P. Measurement

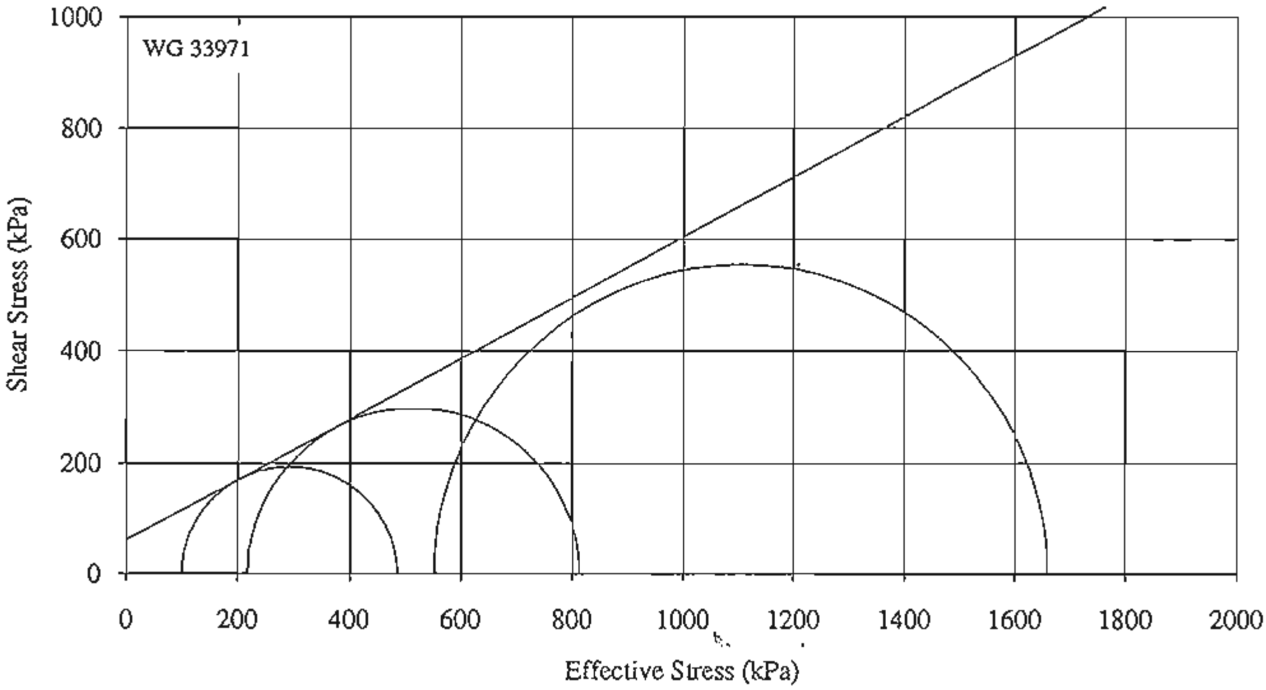
JOB No. : 001-01-288
LOCATION : -
Lab No: WG 33971
Date Tested : 3-14/8/96

Specimen Details :		**Placement**	**Final**
Length/Diameter (ratio)	=	2.05	-
Dry Density (t/m³)	=	1.841	1.873
Moisture Content (%)	=	16.7	19.2

Sampling Details : 61 mm Ø tube sample.

Sample Description :
Grey-Brown, Silty Clay trace Gravel
Saturation Stage Data :
Pore Pressure Coefficient, B = 0.97

EFFECTIVE STRESS MOHR CIRCLES



SHEAR STAGE DATA (Based on peak effective stress ratio, 3rd stage peak deviator stress)

Stage	**Strain Rate (mm/min)**	ε_f (%)	σ_3 (kPa)	u_o (kPa)	u_f (kPa)	σ'_1 (kPa)	$(\sigma_1 - \sigma_3)_f$ (kPa)
1	0.010	0.91	350	200	250	486	386
2	0.007	0.99	500	200	283	814	597
3	0.005	1.16	800	200	248	1660	1108

Cohesion, c' (kPa) = 60 **Friction Angle,** ø' (degrees) = 28.5

CONSOLIDATION TEST DATA (Specimen initially saturated with $\Delta\sigma'_3$ of 20 kPa)

Stage	$\Delta\sigma'_3$ (kPa)	c_v (m²/year)	M_v (m²/MN)	k (m/sec)	**Drainage Condition**
1	130	1.6×10^1	1.1×10^{-1}	5.7×10^{-10}	One End & Radial
2	150	4.6×10^0	3.3×10^{-2}	4.8×10^{-11}	One End & Radial
3	300	4.5×10^0	1.8×10^{-2}	2.6×10^{-11}	One End & Radial

Mode of Failure : Single shear @ 70° to core axis.

Authorised Signatory : ____________ (S. Brodie) **Date :** 20.8.96

Form No TXL/11/AA 94/1 R

WESTERN GEOTECHNICS

REPORT CERTIFICATE

TRIAXIAL SHEAR TEST

TXL Attachment 2 of 5

CLIENT : Dames & Moore Pty Ltd (Job # 15780-018-361)
PROJECT : Kintyre
Sample Id. : BH # DM96-5B, Sa # 6 **Depth :** 7.5m
Test Type : CIU, Multi-Stage with P.W.P. Measurement

JOB No. : 001-01-288
LOCATION : -
Lab No: WG 33971
Date Tested : 3-14/8/96

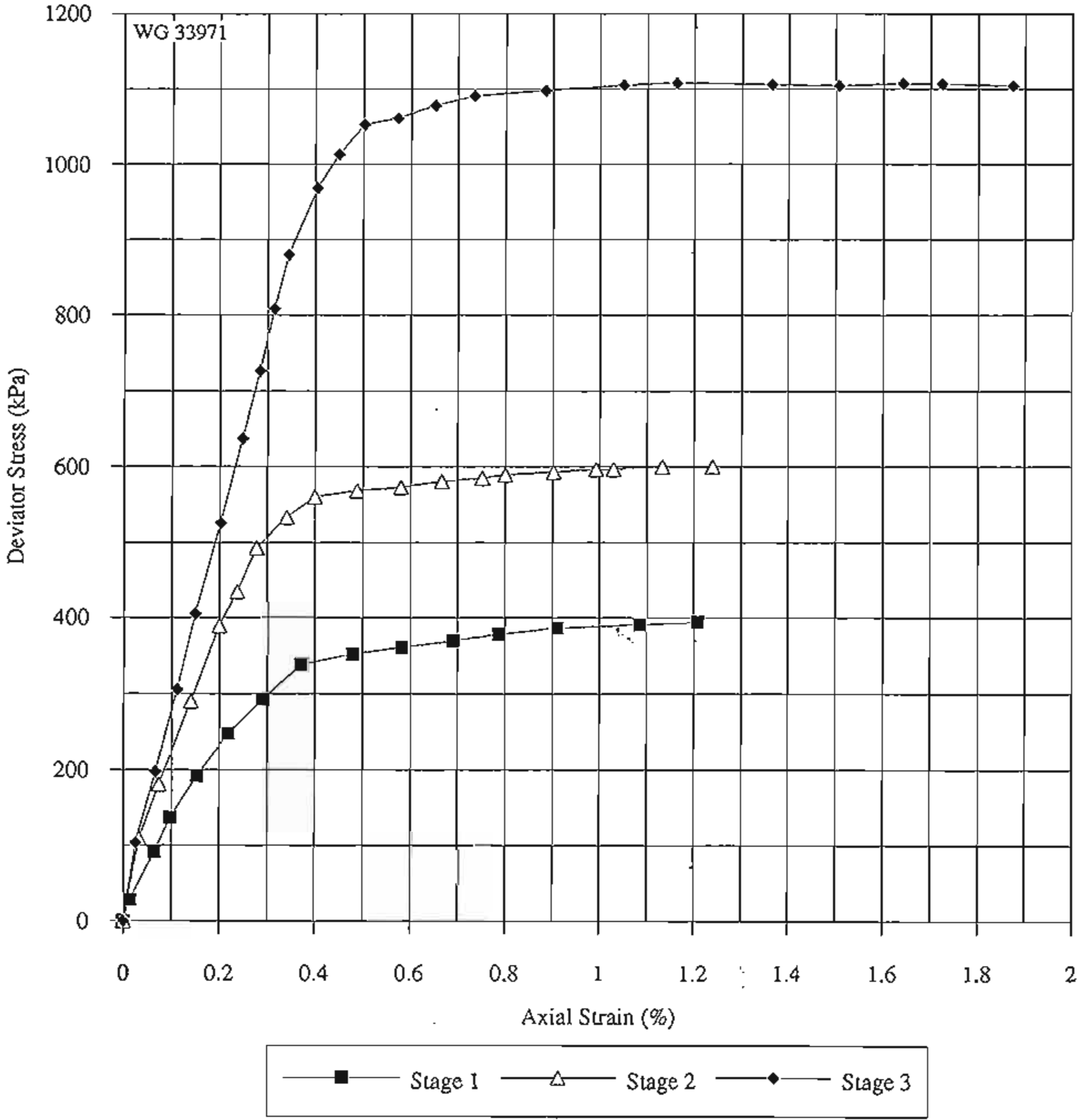
Specimen Details :		**Placement**	**Final**
Length/Diameter (ratio)	=	2.05	-
Dry Density (t/m³)	=	1.841	1.873
Moisture Content (%)	=	16.7	19.2

Sampling Details : 61 mm Ø tube sample.

Sample Description :
Grey-Brown, Silty Clay trace Gravel

Saturation Stage Data :
Pore Pressure Coefficient, B = 0.97

DEVIATOR STRESS Vs AXIAL STRAIN



Authorised Signatory : (S. Brodie) **Date :** 20-8-96

Form No TXL/11/AC 94/1 R

WESTERN GEOTECHNICS

REPORT CERTIFICATE

TRIAXIAL SHEAR TEST

TXL Attachment 3 of 5

CLIENT : Dames & Moore Pty Ltd (Job # 15780-018-361)
PROJECT : Kintyre
Sample Id. : BH # DM96-5B, Sa # 6 **Depth :** 7.5m
Test Type : CIU, Multi-Stage with P.W.P. Measurement

Specimen Details :		**Placement**	**Final**
Length/Diameter (ratio)	=	2.05	-
Dry Density (t/m³)	=	1.841	1.873
Moisture Content (%)	=	16.7	19.2

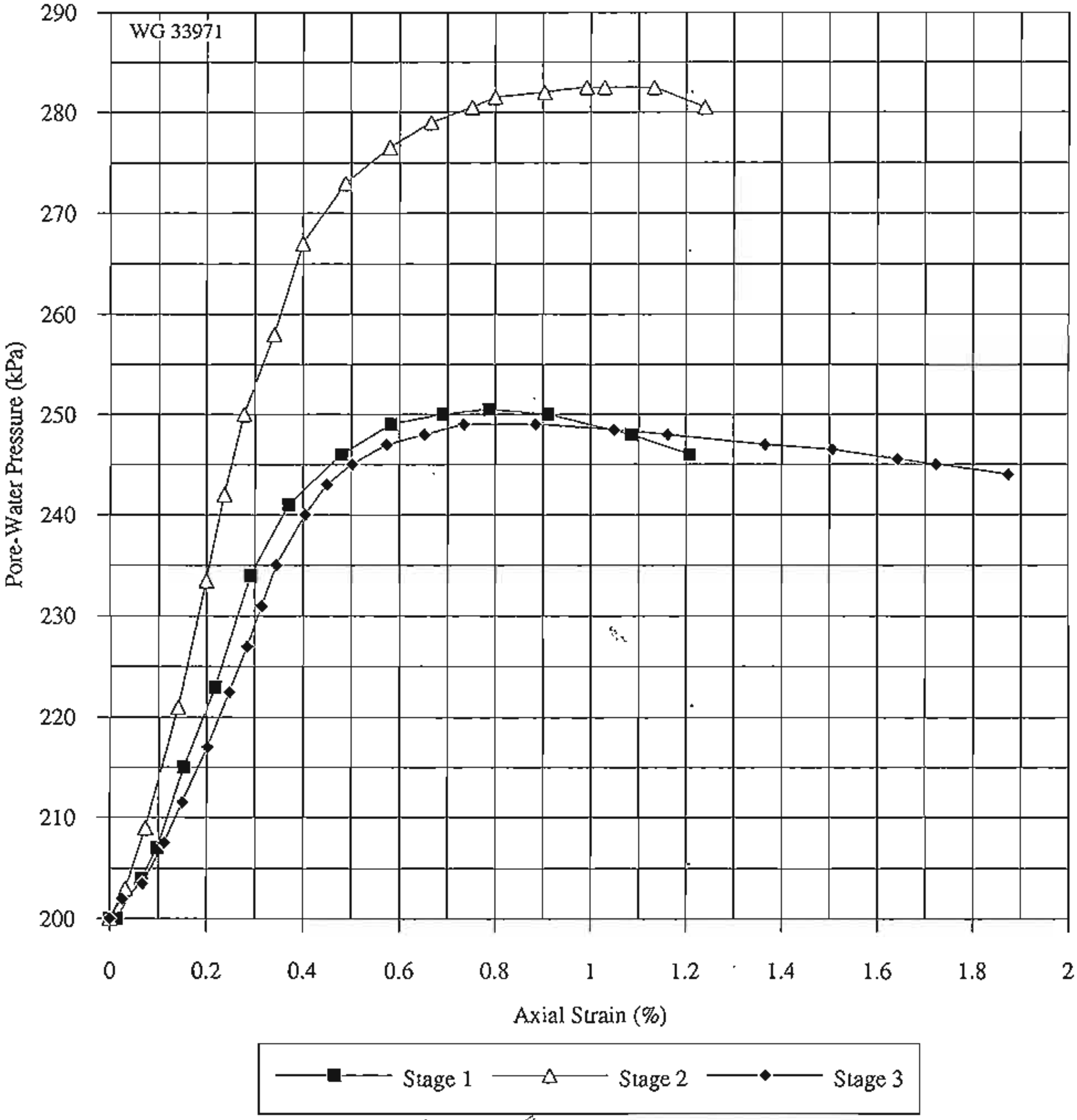
Sampling Details : 61 mm Ø tube sample.

JOB No. : 001-01-288
LOCATION : -
Lab No: WG 33971
Date Tested : 3-14/8/96

Sample Description :
Grey-Brown, Silty Clay trace Gravel

Saturation Stage Data :
Pore Pressure Coefficient, B = 0.97

PORE PRESSURE Vs AXIAL STRAIN



Authorised Signatory : (S. Brodie) **Date :** 20.8.96

Form No TXL/11/AD 94/1 R

WESTERN GEOTECHNICS

REPORT CERTIFICATE

TRIAXIAL SHEAR TEST

TXL Attachment 4 of 5

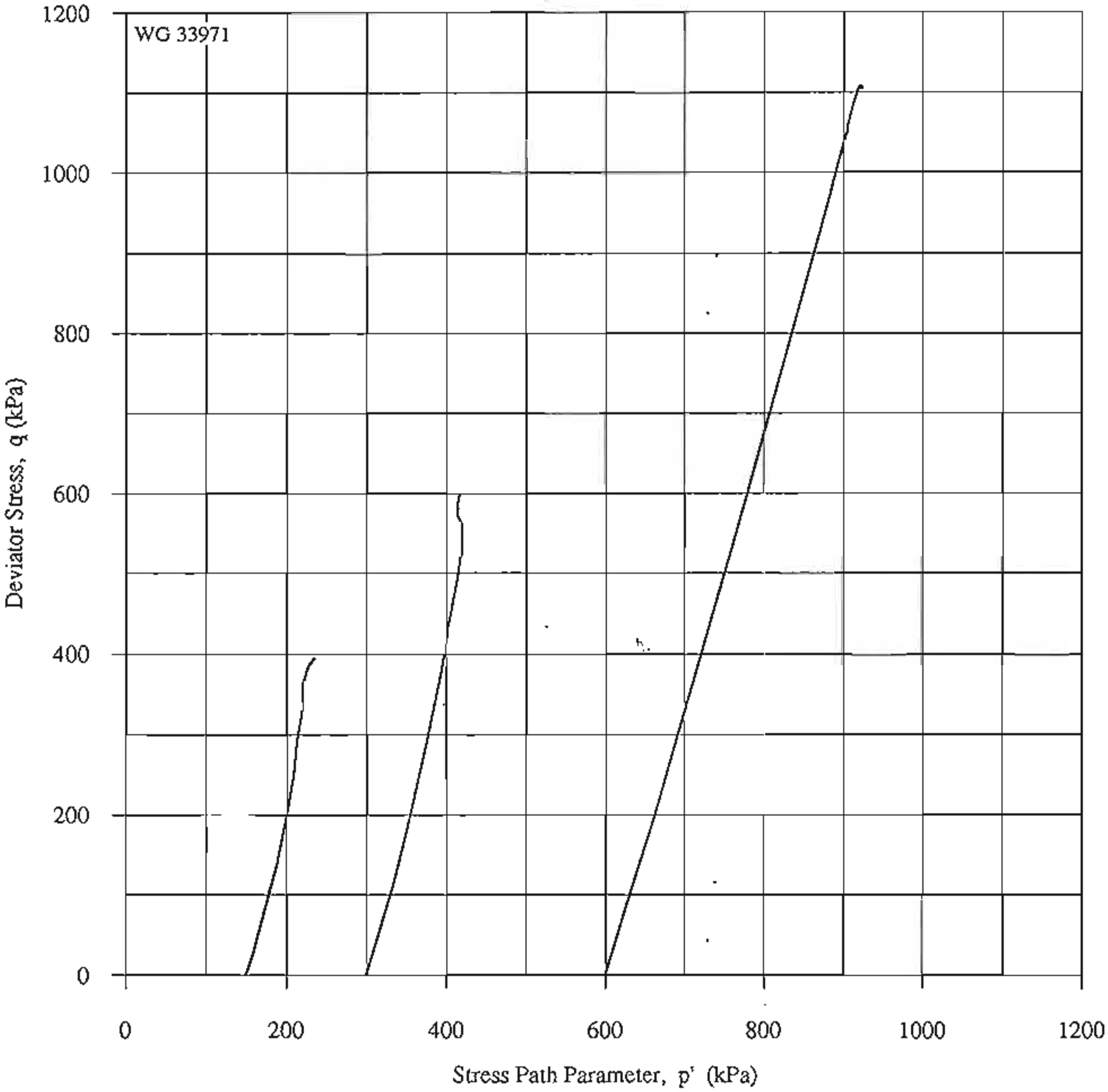
CLIENT : Dames & Moore Pty Ltd (Job # 15780-018-361)
PROJECT : Kintyre
Sample Id. : BH# DM96-5B, Sa # 6 **Depth :** 7.5m
Test Type : CIU, Multi-Stage with P.W.P. Measurement

Specimen Details :		**Placement**	**Final**
Length/Diameter (ratio)	=	2.05	-
Dry Density (t/m³)	=	1.841	1.873
Moisture Content (%)	=	16.7	19.2

Sampling Details : 61 mm Ø tube sample.

JOB No. : 001-01-288
LOCATION : -
Lab No: WG 33971
Date Tested : 3-14/8/96
Sample Description :
Grey-Brown, Silty Clay trace Gravel
Saturation Stage Data :
Pore Pressure Coefficient, B = 0.97

EFFECTIVE STRESS PATH (Cambridge)



Note : $p' = (\sigma_1' + 2\sigma_3')/3$ & $q' = q = \sigma_1' - \sigma_3'$

Authorised Signatory : ____________ (S. Brodie) **Date :** 20-8-96

Form No TXL/11/AE 94/1 R

WESTERN GEOTECHNICS

REPORT CERTIFICATE

TRIAXIAL SHEAR TEST

TXL Attachment 5 of 5

CLIENT : Dames & Moore Pty Ltd (Job # 15780-018-361)
PROJECT : Kintyre
Sample Id. : BH# DM96-5B, Sa# 6 **Depth :** 7.5m
Test Type : CIU, Multi-Stage with P.W.P. Measurement

JOB No. : 001-01-288
LOCATION : -
Lab No: WG 33971
Date Tested : 3-14/8/96

Specimen Details :

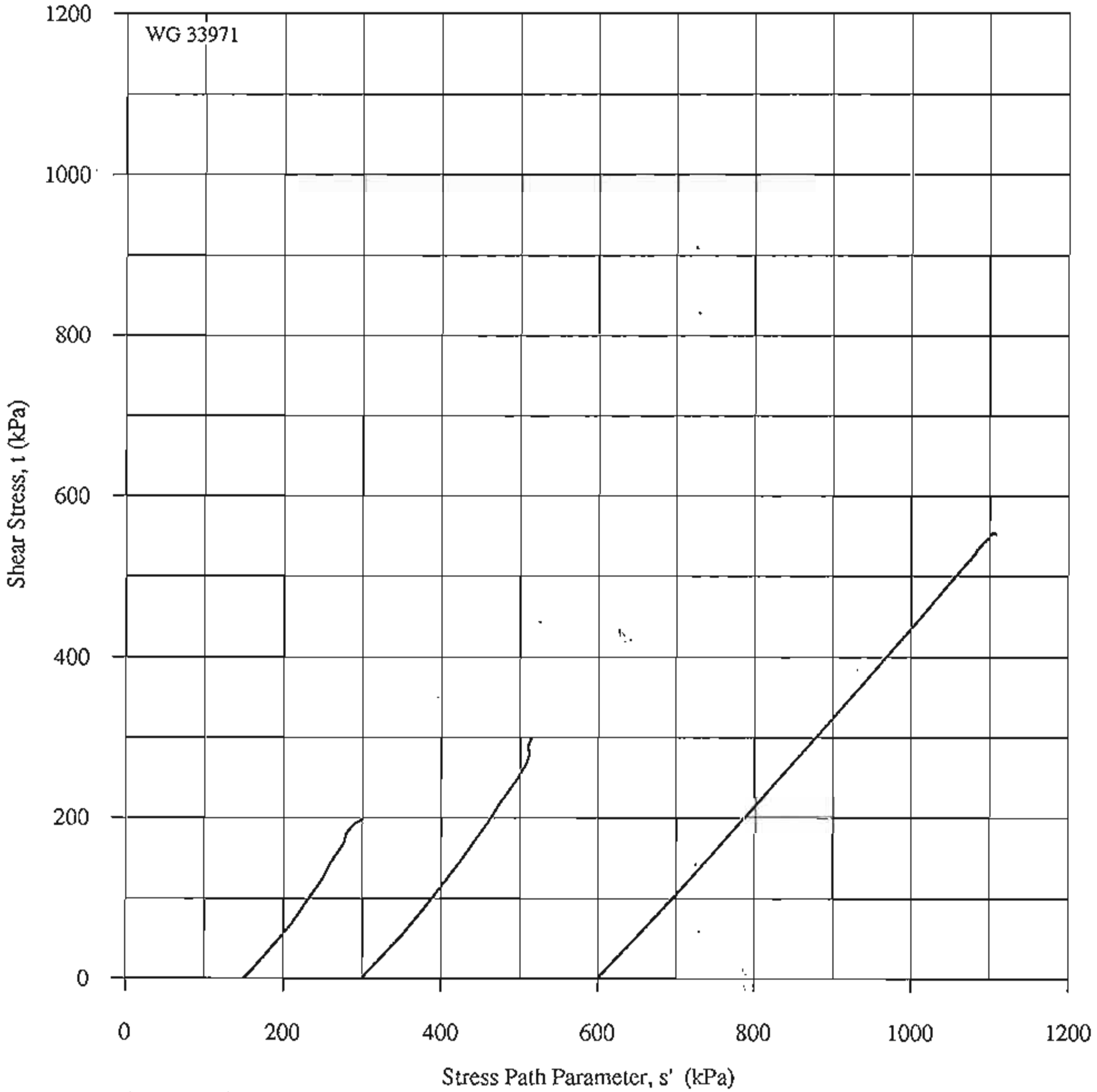
		Placement	Final
Length/Diameter (ratio)	=	2.05	-
Dry Density (t/m³)	=	1.841	1.873
Moisture Content (%)	=	16.7	19.2

Sampling Details : 61 mm Ø tube sample.

Sample Description :
Grey-Brown, Silty Clay trace Gravel

Saturation Stage Data :
Pore Pressure Coefficient, B = 0.97

EFFECTIVE STRESS PATH (M.I.T.)



Note : s' = (σ'1 + σ'3)/2 & t = t' = (σ1 - σ3)/2

Authorised Signatory : (S. Brodie) **Date :** 20-8-96

Form No TXL/11/AF 94/1 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Attachment 1 of 3

CLIENT:	Dames & Moore	**JOB NO:**	001-01-288
PROJECT:	-	**CLIENT JOB NO:**	15780-018-361
LOCATION:	Kintyre	**DATE TESTED:**	26.8.96

Lab Ref No:	WG 33914	WG 33916	WG 33929	WG 33944	WG 33973
Sample No:	8	9	4	3	7
Borehole:	DM96-1	DM96-1	DM96-2	DM96-3	DM96-5B
Depth (m):	7.5	9.0	6.0	4.5	9.0
Date Sampled:	14.7.96	14.7.96	15.7.96	17.7.96	20.7.96

DETERMINATION OF DENSITY

- by caliper method

Dry Density (t/m^3):	1.79	1.88	1.84	1.82	1.88

DETERMINATION OF MOISTURE CONTENT

-according to AS 1289 2.1.1

Moisture Content (%):	13.0	13.4	13.3	12.9	14.3

Authorised Signatory : ______________ (P. Brittan) **Date :** 10-9-96

Form No. SOIL #9 95/1 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
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MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Attachment 2 of 3

CLIENT : Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED : 28.8-17.9.96

PERMEABILITY TEST RESULTS
-by Falling Head Method

LAB REF NO.	SAMPLE ID.	DRY DENSITY (t/m³)	MOISTURE CONTENT Initial (%)	MOISTURE CONTENT Final (%)	PERMEABILITY, k (m/sec)
WG 33914	#8 @ 7.5m, BH: DM96-1 Date Sampled: 14.7.96	1.79	13.0	21.1	7.8×10^{-10}
WG 33929	#4 @ 6.0m, BH: DM96-2 Date Sampled: 15.7.96	1.84	13.3	19.2	1.2×10^{-9}
WG 33973	#7 @ 9.0m, BH: DM96-5B Date Sampled: 20.7.96	1.88	14.3	19.8	1.5×10^{-10}

NOTES:

1. The samples were remoulded to Insitu Density and Moisture.
2. Dimensions of permeameter tube specimen :
   diameter = 61 mm
   length = 50 mm
3. Initial saturation achieved by de-airing under vacuum.
4. The "Falling Head" Permeability tests were started at an initial head height of two metres.
5. Successive falling head readings were taken until steady state conditions were achieved, i.e. constant value for permeability.
6. Tap water was used as the permeant.
7. Sample supplied by client.

Authorised Signatory: ______________ (S. Brodie) Date: 15-10.96

Form No. PERM #2 94/1 R

WESTERN GEOTECHNICS

WESTERN GEOTECHNICS PTY LTD ACN 008 946 638 NATA REG No 2418
ENGINEERING MATERIALS TESTING: SOIL-AGGREGATE-CONCRETE-BRICK-ROCK
15 SEVENOAKS ST, BENTLEY, WA 6102 PHONE: 458-1700 FAX :458-3700
MAILING ADDRESS:- POST OFFICE BOX No. 219, BENTLEY, W.A. 6102

TEST CERTIFICATE

Attachment 3 of 3

CLIENT : Dames & Moore
PROJECT: -
LOCATION: Kintyre

JOB NO: 001-01-288
CLIENT JOB NO: 15780-018-361
DATE TESTED : 28.8-17.9.96

PERMEABILITY TEST RESULTS
-by Falling Head Method

LAB REF NO.	SAMPLE ID.	DRY DENSITY (t/m³)	MOISTURE CONTENT Initial (%)	MOISTURE CONTENT Final (%)	PERMEABILITY, k (m/sec)
WG 33967	#2 @ 3.0m, BH: DM96-5B Date Sampled: 20.7.96	1.80	8.3	14.7	2.5×10^{-10}

NOTES:

1. The sample was remoulded to a dense condition at Field Moisture.
2. Dimensions of permeameter tube specimen :
   diameter = 61 mm
   length = 50 mm
3. Initial saturation achieved by de-airing under vacuum.
4. The "Falling Head" Permeability tests were started at an initial head height of two metres.
5. Successive falling head readings were taken until steady state conditions were achieved, i.e. constant value for permeability.
6. Tap water was used as the permeant.
7. Sample supplied by client.

Authorised Signatory: ____________ (S. Brodie) **Date:** 15-10-96

Form No. PERM #2 94/1 R

ROGER TOWNEND AND ASSOCIATES
CONSULTING MINERALOGISTS
ACN 069 920 476

Principal: Dr. Roger Townend

PHONE: (09) 358 1138
A/H: (09) 453 2640
FAX: (09) 358 1139

With Compliments

Alex Gower,

Dames and Moore,

85 The Esplanade,

S Perth,

WA 6151

12-9-96

our ref. 96310

your ref. RO 2683

Quantitative analysis of two soils for clays.

R Townend

REG. NO. 16-96-3110

DATE 16-9-96

NAME	INFO	ACTION	Complete (Sign)	DATE
AG			ag	4/9/96

FILE NO.

103 - 105 Dowd Street, Welshpool, Western Australia 6106
Correspondence to Box 120 Bentley W.A. 6102
(PATALYN PTY LTD TRADING FOR THE TOWNEND FAMILY TRUST)

INTRODUCTION.

Two soils were submitted for analysis of their clays. The samples were analysed by separation of a fine silt clay fraction by screening, elutriation of a clay fraction and XRD and XRF analyses.

RESULTS.

XRF ANALYSIS -38 MICRON FRACTION.

	DM96.1(22%)	DM96-3(30.3%)
SIO2	64.3	64.9
AL2O3	15.5	15.1
FE2O3	5.49	5.35
CAO	0.87	0.88
MGO	2.83	2.87
NA2O	1.41	1.45
K2O	3.99	3.98
TIO2	0.64	0.66
MNO	0.06	0.05
P2O5	0.162	0.173
BAO	0.07	0.07
LOI	4.65	4.34
TOTAL	100.1	99.92

XRD ANALYSIS -38 MICRON FRACTION.

The chemistry and XRD patterns are almost identical for the two samples so that a combined result is given.

QUARTZ	15-25%
MICA	15-25%
K FELDSPAR	15-25%-
SMECTITE	10-20%
KAOLIN	7-15%
PLAGIOCLASE	10-15%
OXIDES ETC	<5%

The mica is mainly altered biotite.

The soils are characterised by a high content of fresh primary silicates , even in the finest sized fraction.

The CLAY content for the two soils is calculated as follows:

DM 96-1.	5%	SMECTITE 60%	KAOLIN 40%
DM 96-3	8%	SMECTITE 60%	KAOLIN 40%

Pre-Feasibility Study Report

Kintyre Project
Tailings Management Facility Design

Prepared for:

Cameco

Cameco Corporation

Cameco Australia Pty. Ltd.

Level 3, 1060 Hay Street
PO Box 1958
West Perth, Western Australia 6872

Prepared by:

TETRA TECH

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Fax (970) 241-3120

Tetra Tech Project No. 114-201066

August 2012

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF DRAWINGS

LIST OF COMMONLY USED ABBREVIATIONS

ABA:	Acid Base Accounting
AEP:	Annual Exceedance Probability
ALARA:	As Low As Reasonably Achievable
ALR:	Action Leakage Rates
ANCOLD:	Australian National Committee on Large Dams
ARD/ML:	Acid Rock Drainage and Metal Leaching
ASTM:	American Society for Testing Materials
BADCT:	Best Available Demonstrated Control Technology
BAT:	Best Available Technology
BMP:	Best Management Practice
CQA:	Construction Quality Assurance
DMP:	Department of Mines and Petroleum
FS:	Factor of Safety
GCL:	Geosynthetic Clay Layer
HDPE:	High Density Polyethylene
ICOLD:	International Committee on Large Dams
K:	Hydraulic Conductivity
LCRS:	Leak Collection and Removal System
LL:	Liquid Limit
LPS:	Low Permeability Soil
MCE:	Maximum Credible Earthquake
MDD:	Maximum Dry Density
MDE:	Maximum Design Earthquake
Mt:	Million tonnes
OBE:	Operating Basis Earthquake
OMC:	Optimum Moisture Content
OMS:	Operations, Maintenance, and Surveillance
PE:	Polyethylene
PFS:	Pre-Feasibility Study
PGA:	Peak Ground Acceleration
PI:	Plasticity Index
PMF:	Probable Maximum Flood
QA/QC:	Quality Assurance/Quality Control
RAECOM:	Radiation Attenuation Effectiveness and Cover Optimization with Moisture Effects
ROM:	Run-of-Mine
SHA:	Seismic Hazard Assessment
SPT:	Standard Penetration Test
TMF:	Tailings Management Facility
TPA:	Tonnes per Annum
USA:	United States of America
UV:	Ultraviolet
WA:	Western Australia

1.0 INTRODUCTION

Cameco Australia Pty. Ltd. (Cameco) is undertaking a pre-feasibility study (PFS) with the objective of commencing mining of the Kintyre uranium deposit, which is located in the Eastern Pilbara region of Western Australia.

Tetra Tech has been commissioned by Cameco to address the requirements in the PFS for the storage of the tailings generated by the processing operation. This report presents the PFS-level design for the Tailings Management Facility (TMF) at the Kintyre uranium mining project (Project).

The design was prepared based on the following primary criteria: 1) acid leaching of ore and acid stripping of uranium from solution; 2) lime-neutralized tailings with conventional slurry disposal; 3) above-ground facility with embankments constructed with waste rock and/or overburden material from the pit; 4) location of facility will be between the planned waste rock and plant facilities south of the pit; 5) maximum elevation of the facility will be 400 above mean sea level to limit visual impacts which corresponds to a maximum height above surrounding terrain of about 20.5 m; and 6) provision for 100 per cent evaporation of tailings supernatant water and direct precipitation. Additional engineering parameters and design criteria were developed for the Project and are presented in Section 4.3.

The TMF design has been prepared in accordance with generally accepted engineering practices and Best Available Technology (BAT) industry practice to provide a high level of environmental protection. It is expected that the TMF and associated facilities will function without any structural failures that may cause a discharge to the underlying aquifer.

Pertinent site information and technical direction from Cameco have been incorporated into this pre-feasibility design report and drawings.

This PFS design report has been prepared under the supervision of Mr. Troy Meyer, P.Eng., Tetra Tech Geotechnical Engineer, and reviewed by Mr. Brad Bijold, P.E., Tetra Tech Project Manager.

2.0 PROJECT DESCRIPTION

2.1 General

The location of the Project is approximately 95 km south of the Telfer mine in the Little Sandy Desert and is considered to be remote. The project currently envisions processing 5.25 Mt of ore at a production rate of 600,000 tonnes per annum (tpa). Tailings from the milling process will be delivered by slurry pipeline to the TMF disposal facility. The location of the facility is presented on Drawing 1 and the general facilities arrangement is presented on Drawing 2.

Open pit mining techniques will be used to mine and access the ore, move overburden (barren material) and other non-ore, or waste materials. Overburden and the waste materials will be transported by haul truck to the waste dumps with suitable waste material hauled to the tailings facility as needed. Uranium ores will be hauled to a crushing plant for crushing, and subsequently conveyed to a mill for further processing. The tailings thickener underflow slurry will be pumped to the TMF at a slurry solids content of about 50 per cent by weight.

2.2 Planned Tailings Management Facility

Including a 30 per cent contingency, the total tailings production for TMF design will be 6.9 Mt requiring a storage volume of approximately 4.6 million m^3, at an average in-situ tailings dry density of 1.5 t/m^3. Section 3.0 discusses tailings properties used for design.

The tailings cells are designed as permanent, zero-discharge, single-use facilities and are geomembrane-lined accordingly. The planned TMF consists of two above-grade fully lined impoundment cells constructed in stages with a compacted earth and rock fill tailings dam. The TMF has been designed with a central divider berm constructed between two disposal cells, each with independent leak collection and recovery systems and liner overdrain systems to contain process solutions, enhance solution collection, and protect the groundwater regime. The primary purpose for dividing the TMF into cells is to limit the active tailings disposal area in order to limit dust and radon emissions. Section 4.5 presents engineering analyses related to radiation protection.

The TMF design includes provision for diversion of upstream stormwater runoff around the facility and collection and containment of stormwater occurring on the facility itself. Excess tailings water and direct precipitation will be evaporated through dedicated external lined evaporation ponds to be constructed adjacent to the TMF. Section 4.6 presents the surface water management plan.

2.3 Planned Construction and Disposal Operations

In general, the plan will involve construction of a 53-hectare integrated system which is divided into a two separate storage cells of approximately equal size. The facility construction, operation, and decommissioning will occur in 5 phases:

- Phase 1 (Year 0) – Construct starter embankment for Cell A (elevation 383 m) and Cell B (elevation 387 m) to provide initial three years of tailings storage, and construct the Evaporation Ponds;

- Phase 2 (Years 1 through 3) – Complete construction of Stage 2 embankment for Cell A (elevation 389 m) and Cell B (elevation 393 m) to provide additional four years of storage;

- Phase 3 (Years 4 through 7) – Complete construction of Stage 3 (ultimate) embankment for Cell A (elevation 394 m) and Cell B (elevation 398 m) to provide additional storage up to the ultimate TMF capacity;
- Phase 4 (Years 8 through 11) – Continued operational deposition of tailings with periodic extension of reclaim system, as needed; and
- Phase 5 – Decommissioning and Closure.

The above operational sequence and configurations are presented herein for preliminary planning purposes only. Actual development of the TMF will be based on operational factors such as achieved tailings production rates and in-place density.

The ultimate TMF dam would have a nominal final height of around 20.5 m, and would be capable of storing 6.9 Mt of tailings material over the life of the operation, allowing for 1 m of freeboard (0.5 m storm depth plus 0.5 m residual freeboard) for the management of stormwater.

In Phase 1, starter embankments for both Cells A and B will be constructed during mine pre-production using pit overburden and/or waste rock materials as well as material excavated from the evaporation pond and TMF footprint areas. After milling operations commence, work will continue in phases to raise the embankments to their ultimate elevation using non-mineralized material from the open-pit.

Conventional tailings slurry will be deposited into the facility in a sub-aerial manner over the operational life, maximizing the deposited density resulting in lower tailings permeability. The tailings surface during operations will slope from deposition points along the perimeter to the central water pool at an average slope of approximately 1 per cent. The water pool will be located in the central portion of each cell throughout the operating life of the facility and tailings water will be removed via a central reclaim structure. Near the end of the facility life, tailings will be deposited from the central reclaim structure to fill in the pool area with tailings in order to facilitate closure.

Based on the concept of sub-aerial disposal, the slurry delivery pipeline will extend around each cell and deposition will be carried out using spigot pipes set at numerous points along the TMF cell perimeter. The perimeter deposition will allow the water pool to develop in the center of the impoundment away from the dam embankment.

Tailings deposited into the impoundment are expected to drain and consolidate over the operational life of the impoundment and for a short period following closure. Water expelled from the tailings mass as consolidation occurs will travel upwards to the tailings surface and downwards into the overdrain system.

Tailings will be deposited by switching back and forth between the cells during the operational lifetime of the facility, limiting the exposed tailings beach (compared to one large disposal cell). The surface of the cell that is not in active deposition will remain flooded or wetted, to the extent practicable, to serve the dual role of radon cover and evaporative surface. When the storage capacity of both cells has been reached, the tailings impoundment and evaporation ponds will be reclaimed for closure of the facility during Phase 5.

3.0 TAILINGS PROPERTIES

3.1 General

This section presents the testing program results compiled to date to characterize the tailings material geotechnical and geochemical properties. The acidic tailings slurry will be neutralized to a pH of about 8.0 at the plant and transported to the TMF at a target slurry density of about 50 to 55 per cent (by weight).

3.2 Physical Properties

Limited tailings geotechnical testing has been completed to date. Additional tailings laboratory test work is currently underway to provide parameters for design and operation of the tailings disposal facility. The testing program includes classification tests (particle size distribution, particle and liquor density, and Atterberg Limits, segregation threshold tests, settling and air drying tests, tests to determine soil-water characteristic curve (SWCC), shear strength, consolidation, permeability, as well as rheology tests. The objectives of the testing program were to provide input parameters for engineering analyses to include tailings deposition modelling, slope stability, seepage, and consolidation, as well as operational parameters for transport of the tailings.

Sieve and hydrometer testing on the tailings sample indicates a P80 (size with 80 per cent passing) of approximately 350 micron with 69 per cent passing the #200 mesh sieve (75 micron) and 4 per cent smaller than two micron. The results indicate a specific gravity of 2.75, a Liquid limit (LL) of 24 and a Plasticity Index (PI) of 0. The USCS classification for the tailings material is low plasticity silt (ML).

Based on published data, the in-place void ratio will vary from 0.6 to 0.9 for sand tailings and 0.7 to 1.3 for slime tailings (Vick 1983). Based on the measured Kintyre tailings particle specific gravity of 2.75, the resulting in-place dry density of the tailings may vary from 1.20 to 1.72 t/m^3. Empirical relationships developed for tailings based on specific gravity and liquid limit (Myint 2008) applied to the Kintyre tailings result in a void ratio of 0.64 at 10 kPa load, which equates to a dry density of 1.68 t/m^3. Taking these estimates into consideration, an average value of 1.5 t/m^3 was selected for the purposes of this preliminary study. This value will be confirmed during future studies based on results of the ongoing laboratory testing.

3.3 Geochemical Characterization

Geochemical characterization studies have been completed to develop an understanding of the potential for acid rock drainage and metal leaching (ARD/ML) associated with the Project.

Selection of the tailings samples were based on the geologic model and the available assay data provided by Cameco. A total of 273 drill holes with available multi-element assay data were considered during the selection process.

A variety of chemical tests were applied to the samples. All samples were subjected to static tests and a subset was analysed using kinetic testing. Static and kinetic results were compared to the Australian Drinking Water Guidelines. A detailed listing of the sampling and testing methods and all analytical results can be found in a separate report (Tetra Tech 2012).

Static test results are used to evaluate the potential for acid formation and short-term release of solutes whereas long-term kinetic test results are used to estimate rates of oxidation and dissolution and temporal variation of acid generation and leachate quality. Static tests performed on the Kintyre Project samples included Acid-base Accounting, Water Leach Tests, Elemental Analysis, Mineralogy, and Net Acid Generation Testing.

The geochemical assessment of historical assay data (1,624 samples) and a more detailed analysis of 15 selected samples from the Kintyre Uranium Project area suggest that ARD/ML should not be a significant issue. While several metals of concern were identified (Pb, Zn, U, and Al) that showed an increase in kinetic test effluents and/or exceeded Australian Drinking Water Standards, most metals were either present in quantities below the analytical detection limit, or were well below Australian Drinking Water Guidelines.

In light of the fact that humidity cell cycle week 25 showed a noticeable increase in certain metals for several samples starting in flush cycle 25 onward, these humidity cells should be continued for a few more cycles to ascertain if this is merely a spurious release from the breakdown of host minerals in the matrix, or represents a longer-term metal release. In all cases, no acid generation was noticed and overall the system appears to be neutral to basic in regards to pH. As development of the property continues, future actions recommended are to obtain additional samples, of waste rock from deeper portions of the proposed pit as well as samples in close proximity to the proposed ultimate pit surface. These samples will be submitted for analysis to assist in filling in areas with sparse data, including the use of humidity cell tests.

4.0 TAILINGS MANAGEMENT FACILITY DESIGN

4.1 General

The TMF design includes a staged development of the tailings impoundment to contain up to 6.9 Mt of tailings storage, which is sufficient for the currently delineated ore reserves plus a 20 per cent contingency.

The Kintyre TMF will receive slurry tailings from the processing plant at a nominal rate of 1,640 dry tonnes per day. Tailings slurry will be deposited into the impoundment sub-aerially with rotational spigotting resulting in thin layers to promote consolidation of the tailings mass. The containment dams will be constructed from non-mineralized waste rock. The storage area will be active from late pre-production through the end of the mine's life.

The limits of the tailings cells are equipped with a double layer liner system with an intervening leak collection and recovery system to contain process solutions, enhance solution collection, and protect the groundwater regime.

4.2 Facility Description

Two tailings cells (A and B) of approximately equal tailings storage volume have been designed to meet the total required capacity. The plan area of the lined portions of each tailings cell is approximately 17.5 hectares (ultimate configuration). The TMF has been designed with a central divider berm constructed between the two cells and two independent leak collection and recovery systems and tailings underdrain systems. The purpose for dividing the TMF into cells is to limit the lined area and exposed tailings surface for ALARA radiation protection.

The TMF perimeter embankment design incorporates internal slopes of 2.5H:1V, external slopes of 3H:1V and a nominal crest width of 14 m, comprising a 6.5 m width of structural fill and 7.5 m width of transition and filter zones. The design includes an access causeway that extends from the center of the divider embankment to the central reclaim tower. The causeway will have slopes of 1.5H:1V and a crest width of 6 m. A cross-section of the TMF is illustrated in Drawings 8 through 10 and liner system details are provided in Drawing 17.

The design developed for this study includes: a double geomembrane liner system with leak detection between the liners; a leachate collection system above the liner; and a series of lined evaporation ponds adjacent to the tailings facility for containment and evaporation of excess tailings and stormwater from the facility

The construction of both cells for startup will allow contingency storage in the early years of production in case the liner system within one of the sub-cells is not operating properly and requires inspection and/or repair. Expansion of the TMF will then be accomplished through progressive embankment raising using the downstream construction method.

Based on a production rate of 600,000 tpa, each tailings cell has a design life of approximately 5.7 years and capacity to accommodate storage of 3.45 Mt of tailings with one meter of freeboard. The design of the TMF starter embankment is based on providing a minimum of 3 years of initial tailings storage. Storage capacity estimates have been based on an average tailings dry density of 1.5 t/m^3 and a plant tailings output of 600,000 tpa. Stage–Area/Capacity curves, of crest elevation versus storage capacity (Mt), elevation versus storage volume (million m^3) and elevation versus tailings area (ha) are included as Figure 4.1 for tailings for combined tailings Cells A and B. Rate of rise curves are presented as Figure 4.2.

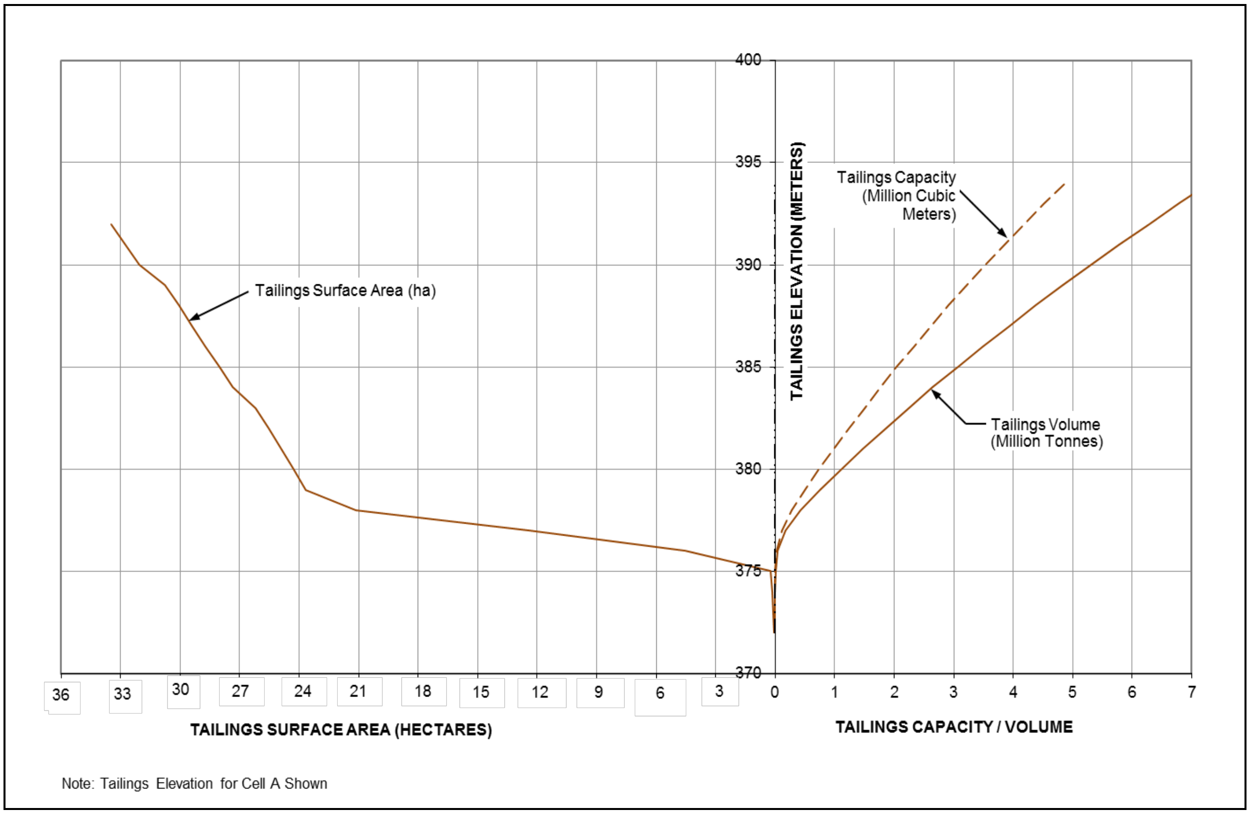

Figure 4.1. Stage – Area/Capacity Curves Combined Tailings Cells A & B

The initial rate of rise of tailings in the impoundment will be relatively rapid, with about 6 m occurring during startup operations in the first six months, rapidly decreasing to less than 2 m per year by the end of Stage 1 deposition and about 1.5 m per year by the end of Stage 3. The depositional sequence will be governed by the following objectives:

- The tailings beach will generally slope to the water pool area at an approximate 1 per cent grade.
- Sub-aerial deposition with rotational spigoting will be used to maximize densification of the tailings.
- A tailings beach will be developed from the tailings dam embankment and around the perimeter of the impoundment.
- The supernatant water pool will be directed to the central area of the impoundment, where the water reclaim system will be operated.
- The water pool in each cell will be maintained as necessary to minimize dust and radon emissions.

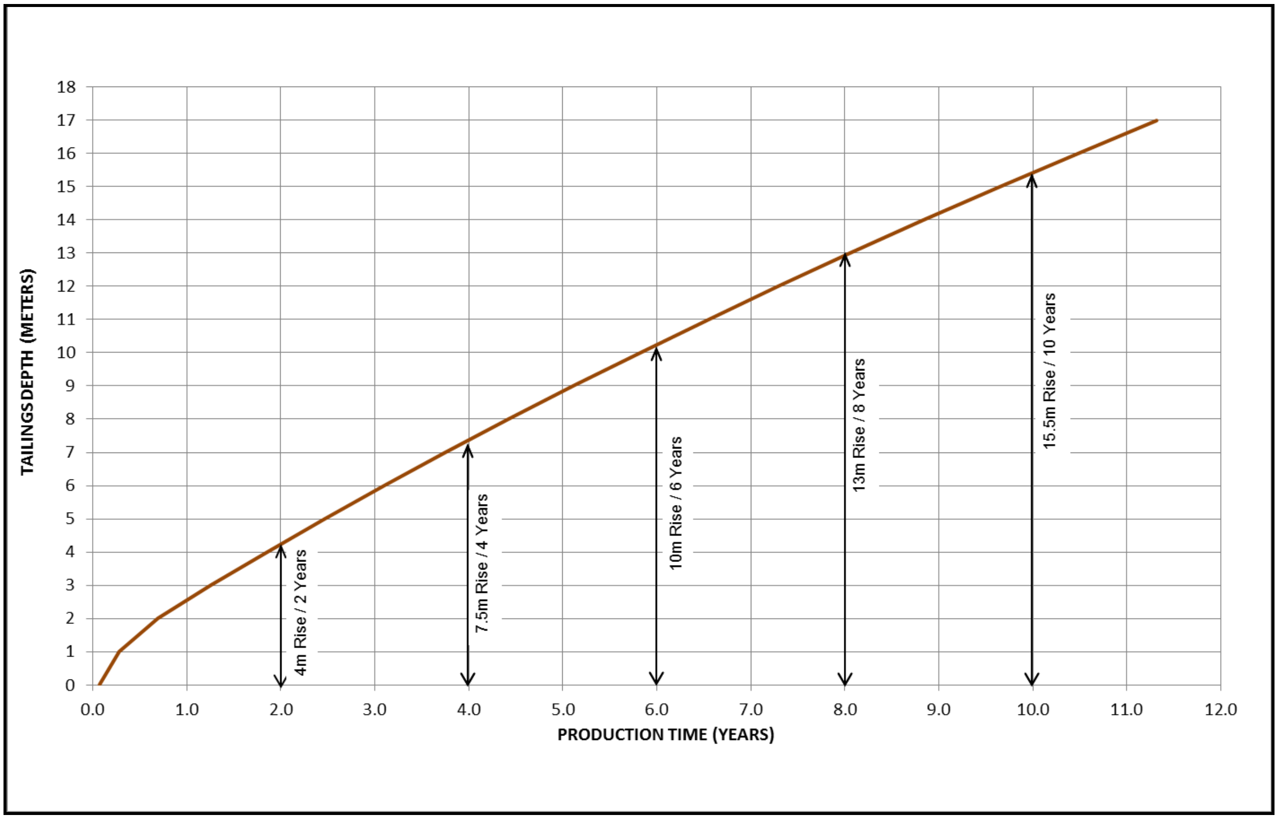

Figure 4.2. Tailings Rate of Rise Curve Concurrent Filling of Cells A & B (After Startup)

4.3 Design Criteria

Design criteria have been developed for the project based on permitting requirements in Australia. The PFS design criteria presented below is based on Cameco's standards for environmental performance and guidelines established by the relevant Australian and International Standards and Australian and West Australian Acts and Regulations.

The currently selected design criteria assume adoption of industry standard Best Available Technology (BAT), where applicable, with adherence to Australian and International standards and guidelines in the design, construction, operation, and closure of tailings storage facilities. Recognized industry standard design criteria commensurate with current technology and appropriate to site-specific considerations have been established for the Kintyre TMF as summarized below.

4.3.1 Regulatory Framework and Guidelines

The Radiological Council of Western Australia is the statutory authority appointed under the Radiation Safety Act in Western Australia to assist the Minister for Health to protect public health and to maintain safe practices in the use of radiation. The TMF will be designed and operated within the Radiation Management Plan and the Radioactive Waste Management Plan as required by the Code, as well as the requirements of the WA Department of Mines and Petroleum (DMP).

Australian Code requires projects to meet "As Low As Reasonably Achievable" (ALARA) radiation protection, however prescriptive requirements are not provided. A BAT approach has been adopted for tailings containment and closure designs which will provide appropriate environmental protection as well as ALARA radiation protection, economic and social factors being taken into account.

4.3.2 Cameco Standards

Cameco recognizes environmental protection as among its highest corporate priorities during all stages of our activities including exploration, development, operation, decommissioning and reclamation, and abandonment. Cameco's employees and stakeholders share in the responsibility of continually improving the safety of our workplace and the quality of our environment. The principals of Cameco's safety and environmental values are to:

- promote and support a strong safety culture
- strive to be a leader in safety and environmental practices and performance, which includes timely, accurate and transparent reporting
- manage risks to levels as low as reasonably achievable
- prevent pollution
- comply with and move beyond legal and other requirements
- continually improve the efficiency of our resource and energy use, management of wastes and tailings, and reduction of land disturbances, air emissions and discharges to water
- use science and innovation to drive our efforts at continual improvement.

Cameco standards integrate the relevant requirements and guidelines set forth by regulatory agencies with practices at Cameco's facilities. Cameco uses industry standard risk management processes to assess environmental risks and incorporate the mitigating strategies into the design, inspection, and maintenance of Tailings Management Facilities.

4.3.3 Dam Classification

The design of tailings dams in Western Australia follows the requirements of the WA Department of Mines and Petroleum (DMP) Safe Design and Operating Standards for Tailings Storage (1999). This document provides requirements and guidelines for the design, construction, management and decommissioning of tailings facilities in Western Australia. Other applicable documents include various Australian National Committee on Large Dams (ANCOLD) and International Committee on Large Dams (ICOLD) manuals.

Based on DMP criteria, a dam hazard rating of HIGH may be applied to a proposed TMF embankment containing conventionally disposed uranium tailings slurry or thickened tailings. This classification is based on the current estimation of potential impacts to population, environment, and infrastructure. The TMF design Category 1 is required for a HIGH hazard rating, which requires the TMF to be designed and managed to the highest standards.

4.3.4 Engineering Design Criteria

In addition to the general project criteria discussed in Section 1.0, the following engineering design criteria and objectives for the TMF have been developed:

- Compliance with all applicable Australian regulations and standards.

- Creation of a site-specific design that accounts for local factors including climate, geology, hydrogeology, seismicity, and vegetation.
- Provision of secure permanent storage for a minimum of 6.3 million tonnes (Mt) tailings material, which is sufficient for the ore to be mined and processed during about 13.5 years of project life at a projected rate of 1,640 tonnes per day (tpd).
- Control and containment of all waters associated (seepage and runoff) with the tailings facility.
- Sub-aerial deposition method using rotational slurry spigotting with the goal of achieving a consolidated and dewatered (as much as practicable) tailings mass at closure.
- Limiting the area of exposed tailings - ALARA radiation protection and prevention of airborne release of tailings solids to the environment by limiting the active disposal area (compared to one large disposal cell).
- Establishment of an effective and efficient reclamation program, with a focus on concurrent reclamation (progressive closure), where possible.
- Decommissioning in a way that does not pose unacceptable risk to public health and safety or the environment while limiting the need for ongoing maintenance and providing a sustainable land and water use that meets stakeholder and community objectives.

The tailings closure design will be based primarily on the following general objectives:

- The cover will be designed to be effective for 1,000 years to the extent reasonably achievable.
- Target limit for radon flux from the cover surface to <20 pCi/m^{2}s [0.74 Becquerel per square meter per second (Bq/m^{2}s)], or as required to meet applicable ALARA air quality limits.
- Limit infiltration of moisture into, and release of contaminated liquid from the tailings to mitigate environmental effects to downstream receptors.

Specific engineering design criteria are presented in Table 4.1 and set forth minimum safety standards acceptable for the Kintyre TMF. The engineering design will be developed using current state-of-the-industry technology and engineering practice to assure that the design strictly adheres to these criteria. Specific assumptions used in the engineering analysis and quantitative values derived for specific criteria will be presented in the PFS report.

Table 4.1. Summary of Engineering Design Criteria

1.0	**Basic Data**		
	1.1	Tailings produced at 600,000 tonnes per year.	
	1.2	Storage requirement is nominal 9 years of production tailings 6.3 Mt or 4.2 million cubic meters based on assumed tailings in-situ average dry density of 1.5 t/m^3 (TBC)	
2.0	**Slope Stability**		
	2.1	Static	
		2.1.1	Minimum factor of safety (FS) of 1.5 for operational and closure conditions.
	2.2	Dynamic (earthquake)	
		2.2.1	Use Maximum Design Earthquake (MDE) seismic coefficients as determined by site-specific Seismic Hazard Assessment (SHA): Maximum Design Earthquake Peak Ground Acceleration = 0.18 g Operating Basis Earthquake Peak Ground Acceleration = 0.14 g
		2.2.2	Minimum factor of safety (FS) of 1.0 for pseudo-static condition.
		2.2.3	Foundation must be checked for liquefaction potential under earthquake loading.
3.0	**Surface Water Management**		
	3.1	During operations, contain runoff resulting from the 100-year 72-hour design storm event. The TMF shall contain runoff from the extreme storm event that considers consecutive cyclone associated events, in addition to the normal operating level and required minimum 0.5 m residual freeboard.	
	3.2	Discharge, safely pass, or shed flows from the design storm at post-closure.	
4.0	**Seepage Control**		
	4.1	The TMF liner system and final cover systems will be designed, constructed, and installed to limit migration of wastes out of the impoundment to the adjacent subsurface soil, ground water, or surface water at any time during the active life of the impoundment.	
	4.2	Lining of the entire TMF area with a double composite liner with leak detection system and overdrain collection system to protect the liner and collect seepage flows at the base of the facility.	
	4.4	Design liner and overdrain system to minimize hydraulic head on the geomembrane.	
5.0	**Water Balance**		
	5.1	Use normal average conditions to evaluate monthly fluid levels throughout the life of the tailings impoundment and evaporation pond requirement.	
	5.2	The evaporation ponds were sized to handle the extreme storm event of 400mm in 72-hours during average climatic conditions.	
	5.3	Assume no water reclaim to plant.	
6.0	**Radiation Protection and Dust Control**		
	6.1	ALARA radiation protection and prevention of airborne release of tailings solids to the environment by limiting the active disposal area to meet air quality standards	
	6.2	Use Best Management Practice (BMP) to further control dusting including flooding of active and/or inactive disposal cells, as needed	
7.0	**Tailings Deposition**		
	7.1	Tailings slurry to be conveyed by pipeline to TMF at 50 per cent solids content by dry weight.	
	7.2	Sub-aerial deposition with rotational spigotting will be utilized. Deposition strategy will be designed to minimize beach angles to reduce segregation.	
8.0	**Closure**		
	8.1	Decommission so as to not pose an unacceptable risk to public health and safety or the environment while limiting the need for ongoing maintenance and providing a sustainable land and water use that meets stakeholder and community objectives.	
	8.2	Design final cover system to provide long-term radiation and wind and water erosion protection and to limit water infiltration into the tailings mass. The cover will be designed to be effective for 1,000 years, to the extent reasonably achievable. Target limit for radon flux from the cover surface to <20 pCi/m^2/s [0.74 Becquerel per square meter per second (Bq/m^2/s)], or as required to meet applicable ALARA air quality limits. Limit infiltration of moisture into, and release of contaminated liquid from the tailings to mitigate environmental effects to downstream receptors.	

4.4 Site Conditions

4.4.1 General

The Kintyre uranium deposit is located in the Eastern Pilbara region of Western Australia. The location is approximately 95 km south of the Telfer mine in the Little Sandy Desert and is considered to be remote.

4.4.2 Geologic Setting and Site Investigations

Near-surface deposits in the Kintyre area are generally composed of a few meters of red Aeolian sand or alluvial deposits underlain by glacial sediments of the Paterson Formation. In an area of the eastern Whale, the Paterson Formation glacial deposits are underlain by Coolbro Sandstone. An unconformity exists between the Coolbro Sandstone and the metamorphic rocks of the Rudall Complex, and elsewhere the Coolbro Sandstone appears to have weathered away such that glacial sediments are in direct contact with the Rudall Complex.

Geotechnical and hydrogeological site investigations were carried out by Dames and Moore (1996). The work included geotechnical borings and test pit excavations, in-situ permeability testing and laboratory testing. Drawing 4 presents the location of the boreholes on the current site plan. The findings of the study include the following:

- The upper sand layer in the proposed tailings disposal area is fine to medium grained with up to 35 per cent fines. This material is suitable for use as engineered fill.
- Compacted silty sand exhibits low permeability (2.5×10^{-6} cm/s) based on laboratory testing.
- A subsurface clay layer occurs below the sand layer.
- The clay exhibits high plasticity and low permeability (10^{-7} cm/s or lower) based on field permeability test results.
- The depth of the groundwater may vary from 23 m to 26 m.

In the area of the proposed TMF, the surficial layer (silty sand) is approximately 2.5 m to 4.5 m thick and overlays a thin sandy/clayey gravel layer in some areas. A clay layer occurs below this and is estimated to be at least 10 m thick transitioning to weathered claystone at depth. The geotechnical boreholes completed to date were not advanced to competent bedrock. Exploration borehole data indicates that the clay layer may be fairly continuous across the proposed waste disposal areas. This data suggests the depth to the top of the clay layer ranges from 3 m to 9 m with a thickness ranging from 10 m to 87 m.

To further the design to feasibility level, a comprehension field site investigation and testing program will be performed to determine engineering properties of foundation and borrow materials to supplement work previously completed. The field and laboratory program may include the following:

- Exploratory boreholes;
- Standard penetration testing;
- Test pits and trenches;
- Laboratory testing on samples of soil and rock material;

- In-situ testing including permeability and standard penetration tests;
- Borrow source investigation including material characterization and estimated available quantity; and
- Seismic refraction surveys.

4.4.3 Meteorology

Weather data collected at Telfer Aero Station (operated by the Bureau of Metrology, BoM station number 01303) located about 95km north of the Site from 1981 to 2010 indicate that January is the hottest month of the year with a mean maximum temperature of 40.5°C and extremes ranging from 17.2°C to 48.1°C. July is the coolest month of the year with daily temperature averaging 25.4°C and extremes ranging from 3.0°C to 33.4°C. Total annual evaporation (recorded as Class A pan evaporation at the Telfer station between 1981 and 1995) averages 4,124 mm. Total annual precipitation is 379 mm with over 77 per cent of the total precipitation associated with cyclones occurring in the four months from December to March.

The 100-year 72-hour event was estimated to be 266 mm. A review of the daily precipitation data for the Telfer station was performed in order to compare this value with historic values and is presented in Table 4.2. The records indicate that events associated with cyclones tend to generate 2 to 4 days of high precipitation and can produce significant back-to-back events which could be important to consider for site hydrology and water balance studies. Several events exceed the 100-year value of 266 mm; for example, cyclone Monty in 2004 generated 369 mm of precipitation over a 72-hour period. This suggests the design storm event value may need to be revised upward. For the purposes of pre-feasibility studies, a conservative design storm event precipitation value of 400 mm has been chosen.

The climate data presented in Table 4.2 is used in the water balance. Table 4.3 presents the summary statistics for the annual precipitation and evaporation data.

Table 4.2. Summary of Precipitation and Evaporation Data

Month	Average Year Precipitation (mm/month)	Wet Year Precipitation (mm/month)	Dry Year Precipitation (mm/month)	Pan Evaporation (mm/month)
January	46.8	60.5	27.9	443.3
February	100.1	194.0	24.7	361.2
March	79.7	140.9	38.3	381.3
April	20.4	24.4	11.9	321.0
May	19.0	28.3	9.3	241.8
June	12.5	19.9	17.9	192.0
July	13.5	14.3	12.0	213.9
August	5.7	11.6	1.8	260.4
September	2.6	0.9	0.2	336.0
October	2.2	3.5	0.0	440.2
November	14.9	13.8	3.5	465.0
December	48.3	85.1	30.7	468.1

Source: Bureau of Meteorology, Telfer Aero Station Number 01303, located 95 km north of Kintyre

Table 4.3. Kintyre Mine Site Precipitation and Evaporation Summary Statistics

Statistic	Average Year Precipitation (mm/month)	Wet Year Precipitation (mm/month)	Dry Year Precipitation (mm/month)	Pan Evaporation (mm/month)
Average	30.5	49.8	14.9	343.7
Minimum	2.2	0.9	0.0	192.0
Maximum	100.1	194.0	38.3	468.1
Total	365.7	597.2	178.2	4,124.2

Source: Bureau of Meteorology, Telfer Aero Station, Number 01303, located 95 km north of Kintyre

Table 4.4. Summary of Historical Storm Event Precipitation

Year	Date	Precipitation (mm)	Total Precipitation (mm)	Associated Storm Event
1976	Feb 1-3	35	104	
	Feb 7-9	69		
1980	Feb 15-17	74	182	Cyclone Enid
	Feb 18-20	109		
1981	Feb 14-16	95	200	
	Feb 18-20	105		
1982	Feb 26-28	102	102	
1993	Dec 17-19	287	287	
1995	Feb 12-15	104	231	Cyclone Bobby
	Feb 18-21	127		
1998	Feb 2-4	139	139	
1999	Feb 21-23	129	129	

Year	Date	Precipitation (mm)	Total Precipitation (mm)	Associated Storm Event
2000	Feb 18-21	113	197	
	Feb 26-27	84		
2003	Feb 28 - Mar 2	247	247	
2004	Feb 28-30	369	369	Cyclone Monty
2007	Feb 10-13	240	240	

Source: Australian Bureau of Meteorology

4.4.4 Seismicity

Based on guidance for dams in Australia (ANCOLD 1999) the Operating Basis Earthquake (OBE) should have an annual exceedance probability (AEP) as follows:

- a 1 in 50 AEP event for LOW Consequence dams;
- a 1 in 100 AEP event for SIGNIFICANT Consequence dams; and
- a 1 in 1,000 AEP event for HIGH and EXTREME Consequence dams.

The Maximum Design Earthquake (MDE) should be at least a 1:10,000 AEP event for HIGH and EXTREME Consequence Dams.

Tetra Tech has performed a site-specific Seismic Hazards Assessment (SHA) for Kintyre using both probabilistic and deterministic approaches. This seismic hazard analysis includes results from deterministic analyses and published results based on probabilistic methods. Deterministic analyses were performed using attenuation relationships from western North America, eastern North America, and Western Australia to evaluate seismic hazards for the property resulting from a maximum credible earthquake (MCE). A MCE, by definition, has no specific recurrence interval and is the largest reasonably conceivable earthquake that appears possible along a recognized fault or within a geographically defined tectonic province, under the presently known or presumed tectonic framework. Theoretically, no earthquake should occur which exceeds that of the MCE. A deterministic analysis therefore allows for a conservative approach to the determination of risks associated with identified seismic hazards.

Considering the requirements of the Australian National Committee on Large Dams (ANCOLD), Tetra Tech recommends a MDE peak ground acceleration (PGA) of 0.18g, and an OBE PGA of 0.14 g, based on an MCE of moment magnitude 5.3 generated by a background event within 10 km of the Kintyre site. These PGA estimates are anticipated to reflect the current tectonic environment with greater accuracy than a probabilistic value based on the very short historic seismic record available.

4.5 Engineering Analyses

4.5.1 General

The following sections present the engineering analyses conducted for the Kintyre tailings facility design which included trafficability, slope stability, liquefaction potential, and seepage analyses.

4.5.2 Liquefaction Potential

Liquefaction can be generally defined as the loss of shear strength in loose, saturated, and cohesionless soils due to the generation of excess pore pressures as a result of large shear strains induced by undrained cyclic loading. Liquefaction can be caused by seismic loading in which loose, saturated soils tend to contract and displace pore water. If the soil is unable to dissipate the increasing pore pressure generated from the pore water displacement, undrained loading results and a loss of effective shear strength occurs. Liquefaction is common in loose, saturated, and cohesionless sand but has also been noted to occur in material such as low plasticity clay and silt or cohesionless gravels.

4.5.2.1 TMF Foundation

The sandy soils underlying the TMF have an approximate average depth of 3 to 4 m. Geotechnical borings were advanced within or near the footprint of the TMF and were drilled to depths exceeding 20 m. Based on blow counts obtained from the SPT, the majority of native sandy surficial soils encountered were dense to very dense and consisted mainly of sand with varying amounts of silt and clay. Furthermore, groundwater encountered in geotechnical borings was below the sandy layer in a hard clay layer. Therefore, the native soils underlying the TMF are not susceptible to liquefaction.

4.5.2.2 Embankment

The compacted earth and rock embankment fill materials above the stripped and prepared foundation surfaces are not susceptible to liquefaction. The planned embankment earth fill materials will be compacted in thin lifts to a minimum 95 per cent of Standard Proctor maximum dry density (ASTM D-698). The compacted sandy gravel and gravelly sand filter materials will be placed in the embankment earth fill section and is anticipated to be dilative during shearing, thus not susceptible to liquefaction.

In addition, the embankment rock fill materials will be fully drained under normal conditions due to the tailings impoundment liner system and overlying low permeability drained tailings beach fill on the upstream dam slope, as well as the underlying liner overdrain system. The planned embankment rock fill materials will be placed in controlled lifts capable of being compacted by heavy loaded haul trucks or steel drum vibratory compactor rollers, as determined by the engineer in rock test fills during construction. The compacted and fully drained non-plastic rock fill materials will not be susceptible to liquefaction.

4.5.3 Slope Stability

4.5.3.1 General

The stability analyses for the TMF structures included both static and pseudo-static stability analyses at the maximum dam embankment section using the SLOPE/W component of the GeoStudio computer program (Geo-Slope, 2004). The analyses were conducted on the maximum section of the embankment for Stage 1 and Stage 3. Stability Analyses Methods and Parameters

The geotechnical and hydraulic parameters for the tailings facility stability analyses were developed from a site investigation of surface and subsurface conditions, laboratory-testing results of tailings material, literature review information, experience with similar materials and professional judgment.

The planned tailings facility was evaluated for both static and pseudo-static (earthquake) conditions using the MDE and a 66 per cent horizontal ground acceleration factor for the analyses.

4.5.3.2 Stability Analyses Results

Adequate factors of safety of 1.5 static and 1.0 pseudo-static (MDE earthquake) were obtained from the stability analyses based on the chosen parameters and proposed facility configuration.

The slope stability analyses indicate the TMF can be constructed and operated with stable 3H:1V outslopes to a total maximum height of approximately 20.5 m.

4.5.4 Seepage and Cover Analyses

4.5.4.1 General

The cover for the Tailings Management Facility (TMF) was designed to limit infiltration from entering the tailings and limit radon gas from exiting the tailings. The design of the TMF cover, the infiltration through the cover, and the seepage into the base liner system beneath the tailings were evaluated using the VADOSE/W program from the GeoStudio 2007 software package (GEO-SLOPE, 2007). The radon flux modelling was performed using RADON computer software (U.S. Nuclear Regulatory Commission [NRC], 1989).

These analyses and results should be considered preliminary as modelling is sensitive to material parameters, some of which have been assumed for the purposes of this study. Additional material characterization of tailings, waste, overburden, and site soils is required to confirm the performance of the TMF and for design of the closure cover.

4.5.4.2 Tailings Storage Facility Lining and Cover Design

The lining of the TMF was selected for operational containment of the tailings porewaters. Specifically, the liner was designed to prevent downward migration of contaminants that could impact groundwater.

The cover design for the TMF was based on the results of current geotechnical data for the on-site soils (Dames & Moore, 1996) and geotechnical data for the tailings (Golder, 2011). The proposed cover is shown on Drawings 26 and 27. The cover consists of three layers:

- Erosion barrier – provides protection against erosion
- Upper portion of cover – limits infiltration, provides a growth medium, provides the primary barrier to radon release from tailings
- Regrading layer – provides immediate protection against windborne release of tailings after operations and prior to the placement of the upper cover, serves as a base layer for construction operations when placing the upper cover, and allows grading of the cover to promote surface drainage to the perimeter of the TMF cells.

The final cover should be graded at a 0.5 per cent minimum slope to drain toward the perimeter of the TMF. This represents a post-settlement slope; actual construction slopes will be based on tailings deposition and long-term consolidation modelling to be completed during future studies.

The regrading layer will consist of a 1 m (minimum) thickness of waste rock. This minimum thickness was set to provide a stable surface for construction of the upper cover. The upper cover will consist of 2 m of native on-site fine-grained soils classified as silty sand, clayey silt, silty clay, and sandy silty gravel. On top of the upper cover will be an erosion barrier consisting of 100 mm (minimum) of crushed rock mulch for protection.

4.5.4.3 Infiltration and Seepage Modelling Methods

Modelling was performed to simulate the conditions during operations, as well as the closure of the facility. The operations model was constructed as a series of steady state simulations at the completion of each of the lifts before the placement of the regrading cover. This provides an estimate of the potential seepage from the tailings drain-down into the collection system below the facility for each of the three phases of operational tailings deposition. The final steady state operational model of the completed TMF with the two-layer closure cover is completed to provide initial conditions for the transient models. Transient modelling was used to simulate the closure and post-closure conditions and included the full facility with the cover placed over the tailings material.

The modelling was completed as a series of steady state models for each step of the facility construction, followed by transient models to simulate the four climate conditions being tested (average precipitation, wet year, dry year, and worst case year).

Steady state models served to provide initial moisture conditions based on stabilized flow conditions. The results of the steady state models were used as input values for the subsequent transient modelling scenarios and to evaluate the seepage rate to the drainage system during the closure phase of this facility.

Transient modelling provides a reasonable simulation of flow conditions within the tailings material. The top layer of the model is a surface region representing the recommended two or three-layer cover for the facility. It is in this part of the model that atmospheric conditions and soil come in contact, driving the water balance. The water within the facility then moves according to the rules of unsaturated flow physics through the tailings material.

4.5.4.4 Infiltration and Seepage Model Results

The results of the steady state models show that the saturation of the newly deposited tailings is at about 45 to 55 per cent and decreases over time. This analysis assumes that the tailings mass is fairly homogeneous. In practice, some degree of segregation will occur upon deposition with coarse tailings around the perimeter, fine tailings (slimes) mass in the central area of the impoundment, and an intermediate mixed (sand/slime) zone between. The degree of segregation will be mitigated by deposition of a high density tailings slurry (target range of 50 to 55 per cent solids). Future studies will endeavour to refine the seepage model based on results of tailings deposition modelling.

The cumulative flux through the cover, scaled for the entire facility, is presented for the average, dry, and wet precipitation years in Table 4.5. There is little difference between the average and dry precipitation years. The wet year almost doubles the amount of infiltration passing through the cover over the period of the year.

Table 4.5. Cumulative Flux through Cover into the TMF

Precipitation	Flux m^3/day	Per cent of Yearly Precipitation
Average Year	3.2	0.88
Dry Year	2.4	1.4
Wet Year	5.8	0.99

The results indicate that the seepage through the filter sand and into the TMF bottom drain reaches a peak within the first month of placement. After that time the seepage rate continues to decrease. The average seepage amount is 11,032 millimetres per year (mm/yr), 8,873 mm/yr, and 6,447 mm/yr, for the wet, average, and dry precipitation years, respectively, over the entire facility area. After 300 days, the seepage rate of 1,750 mm/yr is reached for the first year of post-closure for all three cases.

4.5.4.5 Radon Modelling

The radon flux modelling was performed using RADON computer software (NRC, 1989). The RADON model is a numerical model developed to model the flux through soil layers and is commonly used in applications such as this to design a reclamation cover over a TMF. For this model, the NRC Regulatory Guide 3.64 (NUREG 3.64) (NRC, 1989a) recommended value of an exit flux of less than 20 picocuries per square meter second (pCi/m^2-s) or 0.74 Bequerels per square meter second (Bq/m^2-s) was the limiting value.

The RADON model (NRC, 1989) requires several user inputs and provides default values to determine the exit flux through a designed cover. The inputs for each layer include thickness, density, porosity, radium activity, and moisture content. The input parameters are assigned to both the tailings and the cover.

The tailings are the only radon source and are located lowest in the subsurface profile. Radium concentration values were calculated based on the average ore grade of 0.4 per cent (WISE Uranium Project, 2012) using a formula presented in NUREG 3.64 (NRC, 1989a). This resulted in a radium activity concentration of 1,125 average picocuries per gram (pCi/g) (41.6 Bq/g) for use in the model.

The reclamation cover will be comprised of locally available borrow soils and run-of-mine waste rock. The establishment of the RADON model input parameter values for the cover soils is based on our understanding of the materials and their desired function. For instance, a 1-m thick layer of rock will be placed directly on the tailings to provide a more stable working surface for construction of the reclamation cover. Above that, a finer grained soil (silty sand) will be placed to simultaneously minimize infiltration, retain moisture, and provide a soil growth medium.

Regrading layer waste rock (waste rock) input parameters are based on Tetra Tech’s experience with similar materials, VADOSE/W model test results, and NUREG 3.64 (NRC, 1989a) guidelines. The specific values and the method used to assign them are discussed below. The thickness of the waste rock layer was set at 1-m thick to provide a stable surface needed for construction equipment operations.

Cover soil input parameters are based on NUREG 3.64 guidelines (NRC, 1989a) VADOSE/W model test results, and assumed material properties. The specific values and the method used to assign them are discussed below. The thickness of the cover soil layer was the optimized layer in the reclamation cover design.

The model was used to determine the thinnest cover. The results using the input parameters presented above are shown in this section. Table 4.6 contains the RADON model results.

Table 4.6. RADON Model Results

Soil Layer	Porosity	Density (g/cm^3)	Activity (pCi/g) - (Bq/g)	Gravimetric Moisture Content (%)	Thickness (m)
Cover soil	0.31	1.84	0	9.1	optimized
Waste rock	0.30	1.97	0	4.3	1.0
Tailings	0.46	1.53	1125 - 41.6	10.7	5.0

*Optimized layer in RADON model

RADON code modelling determined that a 1.6-m thick layer of cover soil is sufficient to limit radon attenuation to less than 20 pCi/m^2-s (0.74 Bq/m^2-s) when combined with a 1-m layer of waste rock. This represents the minimum cover thickness necessary to limit radon attenuation to less than 20 pCi/m^2-s (0.74 Bq/m^2-s). While this cover configuration does meet the NRC guidance limit, the proposed cover amount to be placed has a thickness of 2 m of cover soil combined with the 1 m of waste rock. The additional 40 cm is recommended to account for variability in materials due to assumptions presented in this analysis, laboratory testing results versus actual values, for ease of construction, to provide additional rooting depth for plants, and to further reduce infiltration into the tailings.

4.5.4.6 Erosional Stability

Erosional stability analysis was performed to determine a cover at closure that will not be prone to erode during extreme storm events. Based on the results of the erosional stability analysis, the following recommendations are suggested for the TMF reclamation cover. In order to have a consistent cover, rock mulch with a minimum D50 of 41 mm is recommended to be placed as the top surface of the TMF cover as well as the side slopes. The rock mulch layer should be placed with a thickness of 100 mm.

4.6 Surface Water Management

This section documents the design of surface water management, erosion protection features, and stormwater ponds for the mine site.

4.6.1 Design Basis

All operational surface water control features were sized for the 100-year 72-hour design storm event of 266mm (unless specified otherwise), computed using conservative assumptions of runoff coefficient and time of concentration.

4.6.2 Drainage System Features and Layout

During operations, potentially contaminated surface runoff from the mine site area will be routed to stormwater ponds (SWP), where it will be impounded and ultimately evaporated. Clean water (from outside the mine area) will be diverted around the site via surface water diversion channels, and discharged offsite. Surface water control features including diversion channels, collection drains, and stormwater ponds are discussed in detail below:

- Riprap-lined diversion channels located to the south and west of the mine area will divert offsite runoff around the TMF and WRL. Runoff will be discharged to the north and east into natural drainages. All the diversion channels will be trapezoid shaped with 3H:1V side slopes.

- Surface water collection drains will convey runoff that has contacted mine facilities such as the WRL or other facilities. These collection drains will terminate into stormwater ponds (SWP) which will contain and evaporate (or pump and treat for reuse) this contact stormwater. These surface water collection drains will be lined with HDPE. All the collection drains will have trapezoidal cross-sections with 3H:1V side slopes.

- Lined surface water collection drains will be located around the perimeter of the TMF to collect and convey runoff to SWP1.

- Culverts will be installed under service roads and parking/turnaround areas to convey flow from diversion channels and collection drains through the mine area.

Ongoing maintenance of minor flow controls will generally involve spot-fixes of observed minor erosion, and removal of rockfall and sediment from ditches. Failure of minor drainage controls is possible for rainfall events exceeding the 100-year recurrence interval. Failure could also occur due to sediment or rockfall restricting flow capacity of ditches. In the event of failure, the controls would need to be reconstructed and repaired.

Future studies will evaluate surface water runoff controls on the WRL.

4.7 Liner System Design

Australia does not have regulations specifically developed for containment design for tailings facilities, but instead relies on Best Available Technology approaches and precedence from other projects. The liner system has been designed, therefore, to ultimately achieve compliance with selected guidelines from industry. Development of the TMF and evaporation liner design for the Project included:

- Applicable regulatory requirements of Western Australia;

- Applicable Australian guidelines including ANCOLD Guidelines on Tailings Dams (2012)

- Containment system guidelines of the State of Arizona, USA (these are not regulatory requirements in Western Australia but are considered as standards for best practice); and

- Previous experience with design, construction, and performance of similar systems for mining projects.

ANCOLD (2012) guidance indicates TMF liner systems may consist of a number of materials including:

- Compacted clay;

- Natural soils mixed with bentonite or similar additives;

- Bitumen seal;

- Poly Vinyl Chloride (PVC) or similar liners;

- High Density Poly-Ethylene (HDPE),
- Linear Low Density Poly-Ethylene (LLDPE), butyl or similar geosynthetic liners; and
- Bentonite layers of patent design such as geocomposite liners (GCL).

ANCOLD recommends that single or double composite liner systems are deployed where the control of seepage is crucial. The single composite liner system should be comprised on two liner components (such as clay liner and geomembrane) placed in contact with each other. The probability of faults or defects occurring in each liner at the same location is very remote. In some situations an additional liner should be deployed over the single-composite liner system to form a double composite system with the two liners separated by a drainage medium such as sand which contains collector pipes which will collect any seepage through the first liner into a monitoring system. Since this drainage layer will almost invariably be at atmospheric pressure, the hydraulic gradient across the lower liner is then very low and can therefore be assumed to control seepage below the second liner to minimal levels.

4.7.1 Best Available Technology

Current industry BAT practice for containment of uranium mine tailings and process fluids was considered for the design of the Kintyre liner systems. For the purposes of this study, the TMF and Evaporation Ponds were considered to be equivalent to process solution ponds in terms of containment requirements. Prescriptive Best Available Demonstrated Control Technology (BADCT) design criteria for a process solution pond (ADEQ, 2004) include the following:

- A prepared subgrade consisting of a minimum of 150 mm of native or natural materials compacted to 95 per cent maximum dry density (ASTM D 698);
- An Low Permeability Soil (LPS) layer consisting of a minimum of 150 mm of 10 mm minus native or natural materials compacted to 95 per cent maximum dry density (ASTM D 698) with a maximum hydraulic conductivity of $1x10^{-6}$ cm/s;
- A secondary geomembrane liner of at least 30 mil thickness (60 mil if HDPE);
- A Leak Collection and Removal System (LCRS) layer consisting of a layer of sand, gravel, geonet, or other permeable material with a flow capacity equivalent to a 300 mm thick layer with a saturated hydraulic conductivity of 10^{-2} cm/sec or greater; and
- A primary geomembrane liner of at least 30 mil thickness (60 mil if HDPE).

The above prescriptive criteria were used as guidance for selection of the Kintyre TMF liner system components. It should be noted that these are only guidelines and modifications are allowed based on demonstration of equivalency to the prescriptive components.

4.7.2 Component Selection

Polyethylene geomembranes have been widely used as barrier to liquids for many different applications (Rowe 2005). Geomembrane materials considered for the Project included polyvinyl chloride (PVC), polypropylene (PP), Linear Low Density Poly-Ethylene (LLDPE), High Density Poly-Ethylene (HDPE) and bituminous geomembrane. HDPE was selected for the Project primarily for its resistance to UV degradation. The Evaporation Pond top liner will be exposed to UV for the duration of the Project and portions of the TMF liner will be exposed for up to 4 years prior to being covered by tailings. HDPE geomembranes are often selected for geomembranes in exposed applications (e.g., landfill and reservoir covers, pond and canal liners, etc.) and are well suited for this application.

The liner design incorporates sodium bentonite geosynthetic clay liners (GCL), due to the unknown availability of onsite LPS borrow materials. Geosynthetic Clay Liners are regularly used in Australia in solid and liquid waste containment applications (Phillips and Eberle, 2001). The GCL soil liner provides an equivalent 300 mm minimum thickness of $1x10^{-6}$ cm/sec or lower permeability soil layer. An equivalency evaluation of the liner system to the BAT criteria has been performed.

Geotechnical site investigations are recommended during future studies to identify and characterize potential onsite LPS borrow sources. If sufficient quantities of suitable and readily accessible LPS materials are found, a trade-off study can be performed comparing GCL and LPS approaches.

An Agru America, Inc. (Agru) Drain Liner™ (or similar approved product) was selected be installed along the TMF and Evaporation Pond slopes to form the LCRS. The Agru drain liner product consists of a combined HDPE liner plus drainage layer and eliminates the need for a separate drainage geonet layer which provides some advantages related to construction efficiency.

4.7.3 Liner System Details

The TMF and evaporation pond liner systems were designed based on state-of-industry BAT practice and previous experience. The proposed Kintyre TMF and evaporation pond liner systems consist of a 60 mil (1.5 mm) HDPE secondary (bottom) liner and a 60 mil (1.5 mm) HDPE primary (top) liner with a LCRS installed between the liners. The LCRS design ensures sufficient flow capacity to allow evacuation of fluids between the geomembranes. Leaks through the primary liner flow to the leak collection sump through the drainliner and geonet drainage layers.

The Kintyre liner system design utilizes Geosynthetic Clay Liner (GCL) will be used in lieu of a 150 mm thick layer of LPS material due to the unknown availability of onsite LPS borrow materials. The GCL soil liner provides an equivalent 300 mm minimum thickness of $1x10^{-6}$ cm/sec or lower permeability soil layer. Subgrade preparation for the GCL placement will involve compaction to 95 per cent of the maximum dry density based on ASTM D 698. Rocks larger than 38 mm in diameter will first be removed from the upper 150 mm of the subgrade prior to compaction.

In summary, the proposed TMF and Evaporation Pond liner systems will consist of the following components, from bottom to top:

- A minimum 150 mm-thick layer of properly compacted Liner Bedding Fill (prepared subgrade);
- A needle-punched reinforced GCL which is equivalent to having a 300 mm-thick layer of compacted soil having a permeability no greater than 10^{-6} cm/s;
- A 60 mil (1.5 mm) HDPE secondary (bottom) liner (drain liner on side slopes);
- An HDPE geonet drainage layer (pond floor); and
- A 60 mil (1.5 mm) HDPE primary (top) liner.

Any leakage through the primary liner will flow to the leak collection sump through the geonet or drain liner. The sump will be equipped with an automatic, fluid-level activated pump. The pump has been sized to remove fluids such that the head on the secondary liner is minimized.

Additionally, the TMF liner system will include the following liner overdrain system layers above the top liner:

- A 28-g non-woven geotextile cushioning layer;
- A 450 mm-thick drainage gravel layer;
- A network of corrugated, perforated polyethylene leachate collection pipes; and
- A 150 mm-thick sand filter layer to separate the tailings from the drainage layer.

Preparation of the TMF liner system construction is outlined in detail in the Section 5 of this report. Liner system details for the TMF and Evaporation Ponds are presented on Drawings 17 and 21, respectively.

4.7.4 Leak Collection and Removal System

The LCRS is designed to intercept seepage that passes through defects in the primary liner (if present). The LCRS consists of a geonet drain on the base of the facilities and drain liner on the side slopes of the facilities, overlying the secondary composite liner of HDPE geomembrane and GCL. The combination HDPE geonet (cell and pond floors) and drain liner (cell and pond sideslopes) will be used for leak detection through the primary HDPE geomembrane. The specifications for the geonet and drain liner will be provided in the Technical Specifications. Specifically, the geonet and drain liner will require a minimum transmissivity of 3.0 x 10-3 m^2/s. The leak detection system is designed to handle flow significantly greater than the established Action Leakage Rate (ALR).

The LCRS will carry fluid to a sump within each TMF Cell and Evaporation Pond. For the TMF cells, each sump is constructed as a dual sump with separate collection areas for the leak detection (LCRS) discharge and the leachate collection (overdrain system) discharge.

Within the TMF composite sumps, there is one 450 mm diameter access pipe for pump installation and instrumentation within the LCRS sump and two 600 mm diameter access pipes for pump installation and instrumentation within the overdrain sump. The instrumentation access pipes will be used for installation of water level monitoring equipment.

The details of the LCRS and sumps for the TMF and Evaporation Ponds are shown in Drawings 16 and 21, respectively.

4.7.5 Action Leakage Rates

4.7.5.1 Tailings Management Facility

The U.S. EPA (1992) present a method for estimating leakage through the primary liner for a properly installed and functioning liner system using Bernoulli's equation. Although there is a minute rate of leakage through HDPE due to permeation or diffusion, the permeation rate is insignificant when contrasted with the leakage through small punctures or defects in the installed liner. Assuming a small hole diameter of 2 mm, a total head of 0.3 m, and a hole density of 2-3 holes per hectare results in an ALR of 1,469 L/day/ha for the TMF Cells. The U.S. EPA (1992) also presents a method for estimating horizontal flow through the primary liner based on LCRS material properties, and TMF Cell geometry. This method calculates the ALR as a maximum flow rate per unit width through the LCRS layer using Darcy's Law. The TMF Cells have a drainliner LCRS on their sideslopes and a geoweb LCRS on their base. Because of the different material properties and gradients, flow was calculated separately for the sideslopes and bases. They were then factored together as functions of their respective width along the sump perimeter; the sideslopes being a function of the perimeter width with 40 per cent gradient, and the bases a function of the perimeter width with 1 per cent gradient; to determine the ALR. From Darcy's method for calculating the ALR as the maximum flow rate through the LCRS, the TMF Cell calculations resulted in an ALR of 11,571 L/day/ha.

Table 4.7 present the maximum leakage capture area for each sump and the ALR for each sump.

Table 4.7. Summary of Leakage Analysis for TMF

Parameter	TMF Cells	Evaporation Ponds	Unit
Liner Surface Area	179,312	9,430	(m^2)
ALR (Bernoulli)	1,469	973	(L/d/ha)
ALR (Darcy)	11,571	78,591	(L/d/ha)

If the ALR is exceeded for any sump, a series of steps will be taken to reduce the rate of discharge from the leak detection system. If the change in rate of discharge from the leak detection system is fairly abrupt, it may indicate a new contact with a liner puncture. In an area of recent tailings placement or tailings solution ponding, the liner will be examined for damage. This may include excavating through recently placed tailings or evacuating ponded tailings solution to try to expose the area of the liner where the leak is likely to be located. If a damaged section of liner is located, the liner will be repaired and tested. During this process, the location of tailings placement will be changed or the tailings placement will be suspended. If the contributing punctures in the primary liner cannot be located, all ponded tailings solution will be pumped from the suspect area to an adjacent cell or to the most distant practical location within the cell. If the rate of discharge to the leak detection subsequently declines to acceptable levels, restrictions will be placed on the moisture content of tailings that can be placed with the area of the cell where the leak occurred. Only reduced moisture tailings will be allowed to be placed in the section of the cell contributing to the sump where the allowable leak detection rate was exceeded. No ponding of solution will be allowed within the section of the cell contributing to the leak detection sump.

The required pump capacity was calculated based on Bernoulli's method for leakage calculation through an HDPE liner, as was used to calculate the ALR above, assuming 2-3 holes per hectare of liner material. This calculation differed from U.S. EPA guidelines with the assumption that the headwater depth used would be that of the tailings water depth on the liner. Because the base of the TMF Cells has an overdrain layer that limits headwater to 0.6m, the headwater on the base was set at 0.6 m. The TMF Cell sideslopes do not have an overdrain and the headwater was set at one-half of the ultimate tailings depth (19.5 m), 9.75 m. These calculations resulted in a pump capacity of 1753 L/min for the TMF Cells. The pumped discharge from the leakage detection sump will be metered with a combination totalizing/instantaneous meter and discharged to the TMF Cell surface for disposal through evaporation. The preliminary frequency of sump evacuation for active tailings areas will be once per day with a daily record of evacuated volume. The frequency may be reduced to a weekly evacuation and recording if the total evacuated volume is less than the daily ALR for the sump. Fluid-level monitoring equipment will be installed in the leak detection sump prior to operation of the corresponding tailings cell area. The fluid-level monitoring equipment will, at a minimum, provide a measurement of the depth of fluid in the sump and an adjustable alarm level to activate a light or siren type alarm. The fluid level monitoring equipment may also incorporate features to allow pump control. Acceptable fluid-level monitoring equipment may include suitable pressure transducers or transmitters. After a period of record for evacuation is established, level controls within the sump access pipes may be installed or existing controls adjusted to automate the pump operation and evacuation process provided an alarm system remains in place to clearly indicate excessive fluid levels. The leakage detection fluid evacuation equipment will be inspected daily after a sump is activated and this will continue as long as there is measurable discharge to the leakage detection sump.

4.7.5.2 Evaporation Ponds

The ALR for the Evaporation Ponds using Bernoulli's method was calculated using the same procedures, hole diameter, and hole density as for the TMF cells. The ALR is highly dependent on the depth of fluid in the Evaporation Ponds and was assumed to be the ultimate depth of the water, 4.9 m. The maximum ALR of each Evaporation Pond is 973 L/day/ha. The ALR for the Evaporation Ponds using Darcy's method was 78,591 L/day/ha. The required pump rate for the Evaporation Pond LCRS sumps was also calculated using Bernoulli's method as described in the pumping capacity calculations for the TMF Cells. These resulted in a required pump rate of 125 L/min.

4.7.6 TMF Liner Overdrain System

4.7.6.1 General

In order to limit the amount of head on the TMF primary liner and to decrease time to consolidate and dewater the tailings, a liner overdrain system has been designed. The overdrain consists of 100mm diameter secondary and 200mm diameter primary perforated HDPE collection pipes encased in 450mm of drainage gravel. 150mm of filter sand will be placed over the gravel to prevent piping of tailings into the drainage gravel. The overdrain system will only be placed on the floors of the TMF cells. Due to the steepness of the side slopes (2.5H:1V), side slope leachate accumulation is expected to be relatively low, thus the overdrain would not be required on the side slopes of the cells. The liner overdrain system will collect and convey downward seepage from the tailings as it is deposited and will promote consolidation of the tailings mass. The pipe network will drain by gravity to a sump which will be equipped with an automatic, fluid-level activated pump. The pump has been sized to remove fluids such that the head on the primary liner is minimized.

The minimum spacing between pipes has been designed to limit the head on the primary liner to 0.6m or less (thickness of the gravel drain). The size of the pipe has been designed to carry all of the predicted leachate at half the pipe capacity. Additional pipe capacity and flow through the drainage gravel add redundancy in the overdrain design.

The primary leachate collection pipes will carry leachate to the overdrain sump. The layout and details of the overdrain are shown in Drawing 16 and the overdrain sump on Drawing 18. The maximum drainage distance to a collection pipe along the base of the cell(s) is limited to 12m or less. The gravel drain around the pipes will also provide substantial conveyance capacity to supplement that in the pipes.

4.7.6.2 Overdrain Gravel

The drainage gravel serves the following functions: (1) providing a continuous drainage layer at the base of the tailings to prevent build-up of head on the primary liner, (2) adding drainage capacity to overdrain system, (3) preventing intrusion of tailings into the 6.35-mm slots in the perforated drainage pipe, (4) guarding the HDPE liner against penetration of stones or other objects, and (5) protecting the HDPE liner against damage from construction equipment. The drainage gravel will have a maximum particle size (D100) of 2.54 cm, in order to protect the integrity of the primary HDPE liner. The minimum particle size is designed to meet filter criteria with the pipe perforations of 6.35 mm, according to guidance given in the National Engineering Handbook, Part 633, Chapter 26 “Gradation Design of Sand and Gravel Filters” (USDA, 1994). The drainage gravel will be placed on the floor of the lined cells and not on the side slopes of the lined cells.

4.7.6.3 Overdrain Sand Filter

The sand filter is designed to prevent migration of tailings material into the pore spaces of the drainage gravel. As the tailings are discharged, tailings will segregate with the coarser fraction settling out close to the discharge point, and the finer fraction settling out at further locations. Therefore, it is likely that a finer gradation will exist at discrete locations. In order to estimate this finer fraction, the gradation was adjusted to represent the finest 50 per cent of the whole gradation (i.e. the smallest 50 per cent of the tailings settle out at a location far from discharge point). From this adjusted gradation, a gradation envelope for filter sand meeting filter criteria with both the fine tailings and the drainage gravel was developed using criteria presented in USDA (1994).

4.7.7 Collection Piping Fluid Capacity

The expected discharge rates from the mill to the TMF are approximately 93 m^3/hr of slurry, at a solids content of 50 per cent. The net result is approximately 69 m^3/hr of fluid. A large portion of this fluid (estimated to be about 70 per cent of the total tailings fluid) will be available for reclaim as supernatant. A portion of the fluid entrained in the tailings pore spaces will be squeezed out of the tailings mass during consolidation under self-weight loading and report either to the supernatant pool (upward seepage) or the overdrain system (downward seepage).

The proposed overdrain system consists of 200 mm diameter perforated primary pipes and 100mm diameter perforated secondary pipes placed on a 12 m around the TMF Cell floor. The capacity of the 100mm diameter secondary collection pipes placed at a minimum 1 per cent grade is approximately 167 L/min. The capacity of the 200 mm diameter primary collection pipes is approximately 1,435 L/min.

During initial tailings disposal operations, the liquid portion of the slurry will flow across the upper surface of the leachate collection system gravel. As it travels downgradient, it will percolate into the drainage gravel. It will travel a maximum distance of 12m (depending on discharge location) before the majority of the flow is intercepted by a perforated pipe and carried to the sump. The amount of flow above the capacity of a single 100mm secondary pipe will continue to travel downgradient until it is intercepted by another pipe. Between any two pipes of the leachate collection system, there is adequate capacity to convey the maximum expected flow of 69 m^3/hr of fluid.

Once the floor of the TMF has been covered by tailings, the maximum leachate flow rate will be a function of the maximum anticipated gradient within the tailings, and the saturated hydraulic conductivity of the tailings. Under the highest anticipated gradient within the tailings (conservatively estimate to be 2 under ponded conditions), and estimated hydraulic conductivity of the tailings of approximately 5×10^{-6} cm/s, the highest leachate flow rate under saturated conditions is expected to be approximately 3×10^{-5} L/min per square meter of placed tailings. The leachate collection system consists of 100 mm perforated collection pipes placed at 12 m spacing’s. Leachate within the 100 mm diameter secondary pipes will flow downgradient to a 200 mm diameter primary collection pipe. Required pipe diameters were calculated using Manning’s equation, considering anticipated flows from tributary areas, a roughness coefficient of 0.012 for HDPE pipe. Table 4.8 below summarizes the leachate collection pipe sizes.

Table 4.8. Overdrain Collection Pipe Sizes

Parameter	TMF Cells	Unit
Header Collection Pipes	300	(mm)
Primary Collection Pipes	200	(mm)
Secondary Collection Pipes	100	(mm)

4.7.8 Limiting Head on Primary Liner

During initial discharge of tailings, the maximum fluid levels will essentially be the height of the drainage gravel and filter sand, or 0.6 m, above the primary liner. As the fluid runs across the surface of the filter sand, it will percolate down into the gravel, and then be intercepted by the perforated overdrain pipes and carried to the sump.

After the floor of the TMF is covered by tailings, fluid pressure on the primary liner will be minimized by controlling the spacing of the collection pipes. Pipe spacing was determined using the McWhorter-Sunada equation (Strachan and Dorey, 1988). The maximum allowable head on the primary liner was limited to 0.6 m, in order to contain the saturated zone within the drainage gravel and to limit leakage rates through the primary liner.

The hydraulic conductivity of tailings was estimated from literature values for hydraulically placed uranium tailings (Keshian and Rager, 1988). As the tailings are discharged into the tailings storage facility, the coarser tailings will settle out near the discharge location, and the finer slimes will settle out at further locations. Therefore, the hydraulic conductivity at discrete locations will vary significantly. However, as the discharge locations are moved within the facility, a typical column of tailings above the primary liner is expected to have a composite vertical hydraulic conductivity comparable to typical values for fine sands to a combination of sand/slime. From Keshian and Rager (1988), the vertical hydraulic conductivity is estimated to vary from between 2 x 10^{-5} cm/s to 1 x 10^{-4} cm/s.

Tailings discharge procedures will result in ponding of tailings fluid upon the tailings. Water balance results indicate that the ratio of ponded fluid to consolidating tailings may approach a value of 0.3 to 1.0 during the initial portions of tailings discharge. This ratio results in a maximum gradient in the tailings of 1.3. Calculations for the overdrain conservatively assumed the gradient could be as high as two. The pipe spacing calculation results in a required pipe spacing of 12 m.

4.7.9 Liner Anchorage

Liner anchorage for all of the tops of slopes for both the TMF and Evaporation Ponds will be provided by anchor trenches. The most conservative parameters were used for the analysis with a slope of 2.5H:1V with no cover soil over the liner runout. The minimum trench depth is 1 m. This is sufficient for anchorage on the perimeter of the TMF and Evaporation Ponds. Typical details for the anchor trenches for the TMF and Evaporation Ponds is shown on Drawing 21.

4.7.10 Compatibility of HDPE Materials to Leachate

The liners, geonet, and piping will be comprised of HDPE. In addition to the structural and strength related parameters, specifications related to UV and environmental stability, as well as chemical resistance of the HDPE will be included technical specifications. The acidification of the process stream is considered the primary chemical alteration that has the potential to affect the liner. The acidic tailings slurry (and various other waste streams) are neutralised to a pH of 8.0. Based on the review of available data, no measurable chemical degradation of the HDPE materials is expected.

4.8 TMF Water Management and Evaporation Pond Design

This section discusses the water balance calculations, pond layout and containment system design for the TMF and external evaporation ponds.

4.8.1 Design Basis

The TMF was designed based on the assumption that none of the available tailings water would be reclaimed for reuse at the mill due to concerns related to treatment requirements of reclaimed tailings water prior to reuse. Therefore external lined ponds were designed to evaporate this excess water during operations. Climate data used for the water balance and design of the evaporation pond is presented in Section 4.4.3.

The TMF was sized to contain runoff from the extreme storm event of 400 mm in 72 hours with 1 m of freeboard. The extreme 72-hour design storm event is a conservative estimate of the Probable Maximum Flood (PMF) and considers historic cyclone-associated storm events. Free water from the TMF will be pumped to evaporation ponds. The evaporation ponds were sized to contain the volume of runoff from the extreme storm event from the TMF with one meter of freeboard during average climatic conditions.

4.8.2 Water Balance Assumptions

The water balance components include precipitation and evaporation parameters presented in Section 4.4.3. Four conditions were evaluated in the water balance. These four conditions present a spectrum of climatic conditions that may occur at the Kintyre site:

- Average Conditions
- Dry Conditions
- Wet Conditions
- Average Conditions plus an extreme storm event

The water balance inflow and outflow components are provided in Table 4.9. There are two tailings cells that will be used concurrently for deposition of tailings during the operation of the mine, with normal operations involving filling one cell with tailings while the other cell is kept in a flooded condition to maximize evaporation and minimize radon and dust emissions. This water balance allows for both cells to be flooded out during extreme events. The inflows include direct precipitation on the operating pool, and runoff from the tailings area. The outflows include evaporation from the exposed surface area of the operation pool, and evaporation from the wet tailings surface. Seepage losses were neglected for the purposes of this study.

Table 4.9. Water Balance Inflow and Outflow Components

Inflows	Outflows
Direct precipitation over TMF pond surface	Evaporation from the pond surface
Runoff from tailings	Evaporation from the wet tailings surface

The purpose of this water balance is to determine the amount of excess water that will be reclaimed from the TMF and to estimate water make-up requirements. The primary water balance assumptions are as follows:

- A seven year simulation period was used for this evaluation. Anything longer was not necessary because the maximum amount of excess water was produced from the TMF in the 2nd or 3rd year of operations.
- For wet conditions, a wet year was simulated during the second year of operation.
- For dry conditions, a dry year was simulated during the second year of operation.
- For the storm event scenario, average conditions were evaluated with the 400 mm extreme storm event occurring during February of the second year.
- An average in-place tailings dry density of 1.5 tonnes/m^3.
- A dry tailings deposition rate of 1650 tonnes/day.
- A slurry solids content by weight of 50 per cent.
- A slurry water inflow rate of 1650 tonnes/day.
- A catchment area of 292,617 m^2
- 100 per cent of precipitation entering the TMF area is assumed to become runoff that, in turn becomes reclaim water that will need to be pumped to the evaporation ponds.
- The TMF has a constant operating pool 7854 m^2.
- A wetted tailings beach of 22,212 m^2.
- An active tailings beach slope of 1 per cent and submerged tailings beach slope of 5 per cent.
- The volume of water entering the evaporation ponds by pumping reclaim water from the TMF is assumed to accumulate instantaneously.
- Evaporation from the evaporation ponds occurs over the estimated exposed surface area; this surface area is dynamically calculated in the water balance and is based on the relationship between volume and surface area for the event pond.

These assumptions form the design basis for the evaporation ponds. Enhanced evaporation using sprayers was not evaluated but may be considered in future studies assuming the salt content of the water is compatible with effective use of sprayers.

4.8.3 Sizing of the Evaporation Ponds and TMF Water Balance

The maximum amount of reclaim water that can be pumped from the TMF is 1650 m^3/day. This evaluation assumed that 100 per cent of the reclaim water will be sent to the evaporation ponds. Future studies may evaluate the potential for sending excess water to the water treatment plant. The maximum evaporation pond volume occurs during the average climate conditions with the extreme storm event. If 100 per cent of the reclaim water is sent to the evaporation ponds, the maximum amount of excess water is 150,500 m^3 which would require eight ponds with a maximum depth of around 3 m including a 0.5m of freeboard. The extreme storm event produces approximately 144,000 m^3 of water which takes roughly 87 days to pump out of the TMF at a rate of 1650 m^3/day.

The evaporation pond plan is provided in Drawing 20. Each pond will be 150 m long and 60 m wide with 3H:1V side slopes. They will be connected with internal spillways (openings in the divider berms) so that water from one pond can spill into the adjacent pond. The evaporation ponds will incorporate double-composite liner systems with a leak collection and removal system (LCRS). Details of the liner system are provided in Drawing 21.

4.8.4 Reclaim System Design

The reclaim system is designed to control the amount of the water in the TMF by collecting “free” water from the impoundment and pumping it to the evaporation ponds. A reclaim structure will be constructed from slotted concrete rings in the middle of the TMF in order to collect free water and discharge it to the evaporation ponds. Three well screens will be placed inside the concrete tower, and the void space between the well screens will be filled with sand filter material. Two of the well screens will be equipped with 70 m^3/hr vertical turbine pumps that discharge water into a header and then into dual contained HDPE pipes for conveyance to the evaporation ponds, the third well screen will serve as a spare. The reclaim structure will be accessible by an access causeway that will be used to service the pumps. A plan view of the reclaim system and details of the reclaim structure are provided in Drawing 19.

5.0 TMF DEVELOPMENT

The following sections provide a summary of the construction activities and requirements including preliminary technical specifications in summary form.

The construction and closure considerations for the TMF staged embankments and lined impoundment include the construction of each impoundment stage in advance of the minimum required tailings and storm storage levels to closure in the most efficient manner meeting the design criteria conditions for a fully lined facility. This requires planned construction schedules for staged development and closure work with the TMF performance monitored by instrumentation of the dams. The monitoring information will be reviewed by the engineer throughout the life of the operating facilities to closure. The general preliminary construction, monitoring and closure plan is discussed herein. Future studies will include development of detailed and comprehensive construction plan, monitoring and instrumentation plan and closure and reclamation plan.

5.1 Summary of TMF Development

5.1.1 Phase 1: Construct TMF Starter Facility and Evaporation Ponds (Year 0)

The first phase of the project will involve constructing the initial storage cells and Stage 1 embankments for tailings to accommodate approximately three years of tailings production. The first phase will also include construction of the Evaporation Ponds. The plan view for the Stage 1 TMF is shown on Drawing 5 and the Evaporation Pond plan in show on Drawing 20. Phase I generally involves five main steps as follows:

1. Grade the cell floors and construct the Stage 1 embankments for TMF Cells A and B,
2. Install liner system to elevation 383 m (Cell A) and 387 m (Cell B), including the liner Leak Collection and Removal System (LCRS) and the liner overdrain system,
3. Construct the initial central reclaim structures and access causeways,
4. Construct pipeline corridor for slurry delivery and reclaim systems and install pipework and pumps, and
5. Construct the Evaporation Pond cells including grading, embankment construction, and liner system.

Construction of the Phase I facility will allow tailings storage to an elevation of 382m in Cell A and 386m in Cell B with provision for 1 m of freeboard in each cell. The impoundment floor and side slopes will have grades of 1 per cent and 2.5H:1V, respectively. The floor will slope generally toward the northeast to facilitate drainage toward the sump.

An earthen berm (causeway) will be constructed to the reclaim structure for access and to provide a reclaim pipeline corridor. The causeway and reclaim pipeline will be raised in phases coinciding with embankment stages to maintain at least 1m of freeboard above the tailings surface. A reclaim tower will be constructed at the center of each cell and will comprise a reinforced concrete base cast above the liner system and a superimposed tower constructed of slotted reinforced concrete sections. The tower will be surrounded by an annulus of selected coarse and competent waste rock to retard the inflow of tailings fines into the tower. The tower will be equipped with a submersible pump, power, and lighting equipment. A reclaim water pipeline will be constructed from the return water pump, along the pipeline corridor to the plant or process water pond.

The inner 7.5 m of the TMF embankment side slopes (width chosen for constructability) will comprise transition and seal zones. The double-composite liner systems will meet the requirements of best available technology (BAT) engineering design options as discussed in the Section 4.3. Liner details for the TMF and Evaporation Ponds are shown on Drawings 17 and 21, respectively.

A pipeline/utility corridor will be constructed in Phase 1 to provide secondary containment for the slurry delivery and reclaim pipelines. A conceptual layout of the corridor and piping for Phase I is shown on Drawing 5. A tailings distribution system will be installed around the embankment crest to provide for rotational spigoting of tailings into the impoundment from the crest. The tailings delivery pipelines will have isolation valves to allow alternating tailings deposition. Ramps will be required to provide access to the top of the embankments but has not been included in this conceptual design.

5.1.2 Phase 2: Construct Stage 2 Embankments (Years 1 through 3)

Once milling and tailings deposition have commenced, construction of the TMF embankments to Stage 2 elevation will continue. As shown on Drawing 6 construction will entail bringing both embankments to crest elevations of 389 m (Cell A) and 393 m (Cell B) and extending the liner systems. Stage 2 configuration will provide approximately 4 years of additional tailings storage with provision for a minimum of 1m of freeboard.

5.1.3 Phase 3: Construct Stage 3 Embankments (Years 4 through 7)

Construction of the TMF embankments to Stage 3 elevation must be completed by end of Year 4 (or Year 5 if at least one cell is expanded by Year 4). As shown on Drawing 7 construction will entail bringing both embankments to crest elevations of 394 m (Cell A) and 398 m (Cell B) and extending the liner systems. Stage 3 configuration will provide additional tailings storage up to the ultimate TMF capacity.

5.1.4 Phase 4: Continued Operational Tailings Deposition (Years 8 through 11)

The TMF will be filled to final capacity with provision for a minimum of 1 m of freeboard through rotational spigoting in each cell and alternating deposition between cells. To the extent operationally practicable, the inactive cell will remain flooded (or the tailings beach wetted) while deposition is occurring in the other cell. Key advantages of an alternating deposition sequence include radon and dust mitigation and evaporative capacity. Maintaining a flooded or wetted surface in the inactive cell will prevent radon emanation to ALARA at the same time as providing additional evaporative area.

5.1.5 Phase 5: Decommissioning and Closure

Following the final deposition sequence of Phase 4 at the end of Year 11 (or at the end of milling operations), preparations will begin for decommissioning of the tailings impoundment. Decommissioning will involve draining and contouring the tailings surface, constructing the tailings cover, and construction of final surface water control structures. Tailings deposition may occur from the reclaim causeway in order to facilitate tailings surface contouring. The Evaporation Pond will remain operational during the closure period to manage long term leachate pumped from the overdrain and LCRS systems. The tailings cells have been designed considering closure requirements with integrated design for compatibility with the following concepts:

- Minimize the need for long-term active site care and maintenance during the post-closure period;

- Provide for long-term stability (physical and erosional) of perimeter embankments;
- Placement of an cover system over the tailings as deposition is complete within the tailings cell;
- Dewatering of the tailings as feasible prior to placement of closure cover materials;
- Provide additional capacity within the tailings cells to accommodate future closure considerations, such as disposal of the liner systems removed from the process/evaporation ponds and ore pads, etc., during site closure activities; and
- Construction of a final closure cover which meets the stated design criteria.

A conceptual post-closure plan is presented on Drawing 26. A minimum 0.5 per cent (post-settlement) reclamation slope is shown on the drawings for the final cover with outfall structures to safely convey water down the embankment outer slope to drainage swales. Future studies will model the tailings mass long-term settlement to provide pre-settlement grades for the TMF closure cover. Section 7 provides detailed information related to decommissioning of the facility.

5.2 Foundation and Subgrade Preparation

Foundation preparation includes removing or relocating existing structures, removing vegetation and unsuitable materials, and site grading. All ground surfaces will be rolled and inspected prior to GCL installation. The geomembrane will be properly anchored and covered with overliner materials in a timely manner to protect against wind uplift. A QA/QC program will be implemented as part of the detailed design and construction for this facility and will meet current industry guidance standards for liner installation, operation, and maintenance.

Table 5.1 presents a summary of the material and construction requirements for foundation and subgrade preparation.

Table 5.1. Foundation Preparation

Component	Description
Structures	Remove any existing structures. Plug condemnation boreholes and wells in top 30m depth with concrete grout or bentonite.
Vegetation	Clear and grub vegetation
Organic Surface Soils	Strip organic soil cover to minimum 3m beyond the construction limits and place in temporary topsoil stockpiles for final reclamation. Locate stockpiles as shown on drawings or at the direction of the Owner.
Site Grading	Excavate to lines and grades on the Drawings. Remove loose or unsuitable materials within construction limits as directed by the Engineer. Site Grading Fill material shall consist of soil with 150 mm maximum particle size and less than 30 per cent particles larger than 19mm. Place fill in maximum 0.3 m loose lifts and compact each lift to a minimum 95 per cent of the maximum dry density (ASTM D-698) within ±2 per cent of the optimum moisture content.

Component	Description
Subgrade	After clearing, grubbing, stripping, and excavating, the exposed subgrade surface shall be inspected and evaluated by the Engineer for the presence of loose or soft areas or unsuitable material prior to fill placement or geomembrane installation. Soil subgrade surface receiving site grading fill or geomembrane shall be scarified to a minimum depth of 150mm, moisture conditioned if necessary to within plus or minus two (±2) per cent of the optimum moisture content as determined by the Standard Proctor test (ASTM D-698), and recompacted to a minimum of 95 per cent of the maximum dry density (ASTM D-698). Soil subgrade surface receiving geosynthetics shall be prepared such that it is smooth and free of protruding rocks, vegetation, or any other materials, or objects deemed unsuitable by the Engineer.

5.3 Dam Configuration and Zoning

The TMF embankment dam is designed as an earthfill/rockfill structure with a geomembrane lined upstream dam face and appropriate filter and transition zones to ensure containment integrity. The planned fill placement for the TMF structures includes the use of conventional earth moving equipment, water wagons, roller compactors for earth fills, and vibratory compactors for rock fills. Suitable fill materials will be produced from required excavations for the TMF structures, impoundment borrow areas and offsite mine pit excavations. Moisture conditioning will be performed as needed in the embankment fills for compaction. The various fill types with material, lift thickness, moisture and compaction requirements are summarized on Drawing 11.

The fill types include compacted rockfill material taken from selective mine pit and other required excavations for placement in the central and downstream section of the tailings dam. The rockfill specifications will require selection of competent waste rock with strength rating of R3 or harder as determined by International Society of Rock Mechanics (ISRM) procedures. The rock fill materials are planned to be hauled by haul trucks to the tailings dam in stages, as needed. Dozers will spread the dumped rock piles in controlled lifts for compaction by the loaded trucks or by large vibratory steel drum compactor rollers. The lift thickness and compactive effort for rock fill placement will be determined by the Engineer in test fills at the tailings dam site during startup of embankment construction and as required during construction or when material differing from the initial test materials is encountered.

The compacted earth and rock fill dam section will be constructed in stages in the downstream direction using high strength compacted rock fill materials in the compacted rock fill zone for dam slope stability. A fine-grained subgrade earth fill section will be placed in the upstream section for a suitable surface for GCL placement with filter zones to provide transition from the upstream seal zone fill to the downstream rock fill section. The dam configuration and fill descriptions are provided in Table 5.2.

Table 5.2. Dam Configuration and Zoning

Component	Description
Dam Configuration	Constructed in three stages with crest with of 14 m (minimum) for each stage Upstream slope 2.5H:1V, downstream slope 3H:1V Stage 1 to El. 383 m (Cell A) and 387 m (Cell B) Stage 2 to El. 389 m (Cell A) and 393 m (Cell B) Stage 3 to El. 394 m (Cell A) and 398 m (Cell B)
Zoning	Upstream seal zone with varying 2.5 m horizontal thickness Filter and transition zones of 2.5 m horizontal thickness Downstream compacted rock fill zone with 3H:1V downstream slopes.
Subgrade Fill	Soil subgrade surface receiving site grading fill or geomembrane shall be scarified to a minimum depth of 150 mm, moisture conditioned if necessary to within plus or minus two (±2) per cent of the optimum moisture content as determined by the Standard Proctor test (ASTM D-698), and recompacted to a minimum of 95 per cent of the maximum dry density (ASTM D-698). Soil subgrade surface receiving geosynthetics shall be prepared such that it is smooth and free of protruding rocks, vegetation, or any other materials, or objects deemed unsuitable by the Engineer.
Fine Filter Zone	Derived from screened alluvial or site soil borrow sources. 10-mm maximum particle size with minimum 70 per cent passing the No. 4 ASTM sieve size (4.75-mm) and maximum 5 per cent non-plastic fines passing the No. 200 ASTM sieve size (0.075-mm). Coefficient of uniformity (C_u) shall be less than 6.
Coarse Filter Zone	Derived from crushed and screened alluvial or competent rock sources. 75-mm maximum particle size with minimum 40 per cent passing the No. 4 ASTM sieve size (4.75-mm) and maximum 5 per cent non-plastic fines passing the No. 200 ASTM sieve size (0.075-mm). Coefficient of uniformity (C_u) shall be less than 6.
Compacted Rock Fill	Competent rockfill with compaction effort based on large-scale test fill results. Fill materials to consist mainly of rockfill excavated from mine pre-stripping operations that will generate a high strength, durable and relatively clean marbleized limestone. Rockfill shall be competent material with a strength rating of R3 (medium strong rock) or harder as determine by ISRM procedures. Rockfill material will have more than 30 per cent particles larger than 19 mm, and the maximum rock particle size to be no more than two thirds the fill loose lift thickness Place rockfill in maximum loose lifts and compact each lift according to specifications derived from the results of a test fill.

5.4 Liner System

A double-composite liner system will be constructed within the TMF and Evaporation Pond limits. In conjunction with the geomembranes, a GCL will be used in place of a LPS layer.

The selected composite liner system consists of a primary geomembrane liner barrier in direct contact with a low permeability bentonite GCL barrier for containment of any impoundment seepage from the tailings in the TMF area and to contain fluids pumped to the Evaporation Pond. A 60-mil HDPE geomembrane was chosen for the primary and secondary liners.

The TMF liner system design includes an overdrain system above the liner with pumping from the overdrain wells at the tailings dam embankment to reduce hydraulic heads on the geomembrane liner surface. The overlying tailings material will also be drained by the reclaim pumping operations and act as an additional low-permeability layer over time from load consolidation and drainage.

Table 5.3. Liner System

Component	Description
GCL	CETCO Bentomat DN, or equivalent, installed in entire TMF and Evaporation Pond areas
Secondary Geomembrane	60-mil (1.5 mm) Single Textured HDPE
LCRS	200-mil geonet 8 oz/sq yd nonwoven geotextile heat laminated both sides
Primary Geomembrane	60-mil (1.5 mm) Smooth HDPE

5.5 Liner Overdrain System

The TMF liner overdrain design includes a minimum 450 mm loose lift thickness of crushed minus 25 mm clean gravel supplemented by drain pipes above the primary liner for gravity drainage to the overdrain sump. A 150 mm-thick sand filter layer will be installed over the gravel layer.

Primary collector pipes convey any fluid reporting to the overdrain gravel layer to collection pipes which drain by gravity to the overdrain sump. The corrugated and perforated drain pipe system includes four dual wall 200 mm diameter N-12 PE drain pipes and a network of 100 mm diameter PE primary pipes at a maximum pipe spacing of 15 m.

The quarry crushing circuit will require commissioning prior to stockpiling or direct placement of the drain fill cover over the liner and drain pipes in advance of the tailings deposition operations. The TMF liner system requires complete overdrain fill coverage as soon as practical to avoid any potential wind movement damage.

Table 5.4. Overliner Drain System

Component	Description
Pipework	Perforated and solid corrugated PE primary collection pipes to be ADS N-12 dual wall smooth interior Type SP, or approved equivalent.
Overdrain Fill	High strength, durable, non-reactive rock crushed to produce minus 25mm maximum particle size and a maximum of 5 per cent fines. Operational permeability of $1x10^{-4}$ m/s or higher.
Sand Filter	Minus 10 mm clean sand with maximum of 5 per cent fines.

6.0 TMF OPERATION

6.1 General

Tailings generated from plant site milling operations will be transported in double contained slurry pipelines and deposited in the lined tailings impoundment located to the west of the plant site, as shown on Drawing 2. The tailings generated from the milling operations will have a target slurry density range of 50-55 per cent (by weight) prior to deposition.

The tailings disposal operations will involve sub-aerial deposition of tailings slurry at a rate of about 1,600 tonnes per day (tpd) throughout the life of the facility. A reclaim water system will collect tailings supernatant flows from the top surface for pumping to the Evaporation Pond. Tailings seepage flows from the base (impoundment overdrain sumps) will be pumped back to the TMF surface pool for evaporation or to the mill for reuse.

The tailings impoundment capacity will be expanded in 3 discrete stages for the current mine reserves. The tailings impoundment has a total planned storage capacity of 6.3 Mt. Tailings disposal operations will include perimeter rotational deposition to maintain the water pool away from the tailings dam embankment, improve dust control on the tailings surface, and maximize the densification of the tailings surface layers.

Startup operations will include constructed rock outfall protection of the overdrain and liner system at each of the tailings slurry discharge points, until the overdrain is covered by tailings beach materials in the fully lined basin.

6.2 Tailings Slurry Delivery and Reclaim Water

The Stage 1 tailings discharge points are located along the dam crest and at 75 m intervals around each cell perimeter where liner protection revetments will be constructed. The discharge points are spaced to establish peripheral deposition and tailings beach development to the water pool in the central cell area. The startup Stage 1 discharge points from the tailings delivery line are shown on Drawing 7. The tailings line discharge points are designed to convey 100 per cent of the tailings flow distributed at several spigot locations around the cell perimeter with valve control.

A reclaim system located at the center of each cell has been designed for pumping reclaim water from the tailings water pool to the Evaporation Pond. The tailings delivery and reclaim pipelines will include double containment as shown on Drawing 19.

Stormwater input to the TMF will be limited to precipitation directly onto the TMF impoundment cells. Stormwater runoff and erosional sediments from the TMF outside slopes will be captured in the stormwater control system as discussed in Section 4.6. Stormwater from the top of the TMF will be captured and conveyed to the Evaporation Pond via the dedicated reclaim system as discussed in Section 4.7.

6.3 Tailings Beach Development

The tailings are predicted to form a beach at a slope of approximately 0.5 to 1 per cent based on published data and previous experience. The 1 per cent beach slope was used for water balance calculations to estimate the supernatant pool size.

A water pool will be formed on the surface of the tailings impoundment at the low point of the tailings beach toward the center of each impoundment cell. This water pool will contain precipitation (direct precipitation), excess process water, and consolidation water from the tailings mass. The water pool size will fluctuate seasonally with precipitation volumes and evaporation rates. Water in the pool will be allowed to build to a sufficient depth to operate the reclaim water return system and provide sufficient retention time to settle the fine tailings material. If retention times are found to become excessive, mitigative measures such as installation of a floating filter curtain around the reclaim tower will be implemented.

The reclaim water return system will not operate during the initial few months of tailings deposition, allowing a beach to form. Therefore, the impoundment will contain an excess solution balance after pumping system activation. The water management system and Evaporation Pond sizing accounts for late start up and subsequent initial imbalance.

Similarly, the pumps for the overdrain system will not be activated, until the overdrain system is fully covered with tailings. This delay will minimize short-circuiting of water from the surface pool. Activation of this pumping system will be undertaken as soon as practical in order to minimize the inventory buildup in the overdrain system.

7.0 PRELIMINARY CLOSURE PLAN

7.1 TMF Closure Concept

At this stage it is assumed that the post-closure approach involves the primary goals of returning the land to pre-mining conditions to the extent practicable and protection of environment and local inhabitants. Potential impacts on groundwater during the operational, closure, and post-closure periods of the facility will be limited by construction of low permeability liners to contain all tailings, pore fluids, and stormwater runoff coming in contact with tailings. Therefore, the focus of the closure/post-closure strategy is to cover the tailings mass with an appropriate capping system, minimize erosion and promote landform stability. Closure of the TMF tailings facility is envisioned to be comprised of two main elements: a cover system for the tailings deposited in the TMF facility, and a surface water management system. The cover system will be designed to limit surface water infiltration into the tailings mass, radon emissions from the tailings mass, and to be sufficiently durable to withstand the climate, including extreme precipitation events. The post-closure surface water management system will be designed to prevent ponded water on the surface of the TMF and safely pass peak flows from the extreme design rainfall event.

A tailings closure cover will be required to provide a durable surface and for re-vegetation, if desired. Upon final closure, a series of down-chutes and channels will provide safe passage of runoff from the design storm event.

The preliminary cover design (see Section 4.5.4) consists of a regrading layer of waste rock over the tailings surface to create a minimum 0.5 per cent grade (post-settlement) to the TMF perimeter for positive drainage. The regrading layer will consist of a minimum 1 m layer of waste rock. The thickness of this layer was set at 1 m to provide a stable surface for construction of the upper portion of the cover. The actual constructed thickness will vary to account for long-term settlement of the tailings and to form the minimum desired surface grades to the TMF perimeter for positive drainage of surface water. The cover will consist of 2 m of fine-grained native on-site soils. The top portion of the cover will be an erosion control layer consisting of 100 mm of crushed rock mulch for protection.

7.2 Evaporation Pond Closure

The Evaporation Pond will be closed using the following procedures:

- Any residual contained fluid will be allowed to evaporate;
- Any solid residues remaining on the top HDPE liner will be collected and placed on the lined TMF area;
- The top HDPE liner and geonet between the top HDPE liner and the bottom HDPE liner will be removed, including the Leak Collection and Removal System (LCRS). The top HDPE liner and geonet will either be sent to an approved off-site recycler or will be placed on the lined TMF area. Drain rock from the LRCS sump will be placed on the lined TMF area;
- The bottom HDPE liner will be inspected for visual signs of liner damage, liner defects, or impact by leakage through the liner system;
- If there is no evidence of past leakage, the HDPE liner and the GCL will be removed for appropriate disposal;

- Where inspection reveals presence of one (1) or more holes or tears or defective seams, the HDPE liner and GCL will be removed and the underlying surface inspected for visual signs of impact. Sampling and analysis of the underlying material will be performed as required, to determine whether the potential impact poses a threat to groundwater quality. If required, soil remediation will be conducted to minimize groundwater impact;

- The HDPE liner will either be sent to an approved off-site recycler or it will be placed in the Waste Management Area. If the liner cannot be recycled, it will also be placed in the lined TMF area; and

- The former Evaporation Pond will be filled with waste rock or stockpiled soils and graded to pre-mining conditions to promote surface runoff.

8.0 ENVIRONMENTAL MANAGEMENT

8.1 Groundwater and Surface Water

Potential impacts on groundwater will be limited by construction of low permeability liners to contain all tailings, pore fluids, and affected stormwater runoff. A double composite liner has been selected for the TMF and Evaporation Pond. Both liner systems will be constructed to industry best practices. The TMF is designed as a zero discharge facility with all surface water reporting to the TMF pool to be pumped to the Evaporation Pond. The Evaporation Pond is sized to store the entire runoff volume from the extreme storm event, which considers back-to-back cyclone-associated events.

A program of monitoring will be designed to give advance warning of unexpected amounts of groundwater seepage so that proactive measures can be implemented. The program will include:

- A network of monitoring wells located down-gradient of the TMF and Evaporation Pond. Perimeter wells will be located within 100 m of the facility to facilitate early warning of leakage. Monitoring wells would be recorded and sampled monthly.

- The TMF embankments will be instrumented appropriately to allow monitoring of the dam performance (see Section 8.3). Future studies will include development of an Emergency Response Plan (ERP) and Operation Surveillance and Monitoring (OSM) plan for the TMF.

- Routine facility inspections, by qualified people, of the TMF and Evaporation Pond will be instituted at the time of construction and will proceed quarterly with additional inspections in the event of a process upset or a major storm/surface water flow or seismic event. Inspections of the LCRS sump liquid level in the TMF and Evaporation Pond will be performed weekly. All inspections will take the form of a visual assessment of integrity along with a physical appraisal of pond design capacity. Inspection records will remain onsite for a period deemed necessary by the authorities.

- Preliminary leakage alert levels have been established for each sump of the TMF and Evaporation pond LCRS. Contingency actions will be followed in the event of a leakage alert level exceedance or accidental facility discharge. Section 4.7.5 presents the calculated alert levels and contingency procedures.

- Development of a facility surveillance program, to be carried out by mine personnel, with the intent of making ongoing observations relating to the conditions and performance of the tailings structure and associated facilities, upstream diversion structures, as well as tailings disposal and Evaporation Pond management operations, so that any changes to conditions or performance, or a hazardous condition can be identified and promptly addressed.

8.2 Dust Control

- The potential for exposure to tailings dust due to wind erosion will be limited in time because the operation of the TMF is intended to minimize the exposed tailings surface area. To the extent operationally practicable, the inactive tailings cell will be flooded and the tailings beaches in the active cell will be wetted.

- Best Management Plans (BMPs) for dust control will be implemented and include the following best practice procedures:

- Rotational tailings spigotting to promote thin layer desiccation and crusting;
- Flooding the inactive tailings disposal cell;
- Wetting the inactive tailings beaches; and
- Establishment of site-specific best work practice operational guidelines for tailings disposal to minimize dust generation.

Air emissions from the TMF will be monitored during the initial stages of construction by visual observations and air emission monitoring stations around the TMF. If necessary as deposition progresses, additional preventive measures such as installation of wind fences will be evaluated.

8.3 Preliminary Instrumentation Plan

The construction and closure considerations for the TMF embankments and lined impoundment include the construction of each impoundment stage in advance of the minimum required tailings and storm storage levels to closure in the most efficient manner meeting the design criteria conditions for a fully lined facility. This requires planned construction schedules for staged development and closure work with the TMF performance monitored by instrumentation of the dams for settlement and ground water level conditions, as well as monitoring surface and seepage water quality in the downstream drainages, underdrains and surrounding water well system. The monitoring information will be reviewed by the engineer throughout the life of the operating facilities to closure. Proposed instruments include piezometers and survey monuments, and flow meters.

- Piezometers will be used to measure the phreatic levels in the TMF embankments. Vibrating wire (VW) piezometers will be installed during construction and connected to a datalogger via signal cables. Signal cables will run from the instruments through a specially designed and protected trench to datalogger stations, which will be manhole-type structures.
- Survey monuments will be used to monitor settlement and potential horizontal or vertical movements of the embankments. They will be installed at the completion of each stage of the TMF.
- Flow meters will be installed at the LCRS and Overdrain collection systems to measure flow volumes over time.

Instrumentation locations and details are shown on Drawing 22. A more detailed instrumentation plan will be developed in future studies and will include a facility monitoring program.

8.4 Post-Closure Monitoring

Post-closure monitoring will be carried out until stabilized conditions are acceptably achieved. Monitoring will include:

- Continuation of seepage, groundwater, air emission and instrumentation monitoring programs developed during design and operating period;
- Visual inspections to assess the physical condition of the sites with emphasis on evidence of wind and water erosion; and

- Supplementary visual inspections following significant precipitation or seismic events.

The frequency and duration of post-closure monitoring will be re-evaluated at the time of closure to reflect the performance experience during facility operation and the observed post-closure behavior.

9.0 ESTIMATE OF CONSTRUCTION QUANTITIES

A preliminary schedule of quantities has been prepared, which provides for the construction of a TMF and associated facilities as presented herein using ROM waste and crushed and/or screened materials from the mining operation to construct embankments and sand/clay material borrowed from the site or required excavations for construction of the final closure cover.

Provision has been included in the estimates for the installation of a combined GCL/geosynthetic liner and an overliner system. Future studies may consider substituting with a LPS to meet the design requirements for seepage control, depending on confirmation of suitable and economic borrow sources.

Quantities for facility expansion after the initial disposal of tailings into the expanded TMF and for closure have been tabulated separately as they will likely be considered operating costs. Site grading cut and fill calculations were estimated using an AutoCAD Civil 3D computer program and existing topography at 1m contour intervals. No bulk or shrink factors were applied to the cut and fill estimates. Design plans, sections and details for the feasibility quantity estimate are shown on Drawings.

The quantity estimate includes construction of the lined TMF pad, diversion and collection ditches, Evaporation Pond, and sediment and retention ponds associated with the site water management systems. The lined TMF pad, collection ditches and Evaporation Pond foundation preparation and site grading cut and fill quantities are included as a general construction work item that will be constructed concurrently. Other quantity items including the pad liner, overliner drain fill, pond liners and pipelines are separated into individual work items.

10.0 GENERAL INFORMATION

This report was prepared by Tetra Tech on behalf of Cameco Corporation for purposes of assessing the scope, feasibility and cost of tailings disposal for the Project. The design, construction methodologies and operating procedures described in the report are also intended to assist others in assessing environmental impacts of the project and to serve as supporting documentation for permitting by regulatory agencies.

The material in the report reflects Tetra Tech's best judgment in the light of information available to us at the time of preparation. Our services were performed in a prudent and diligent manner using reasonable skill, care, modern techniques, and sound professional practice and standards.

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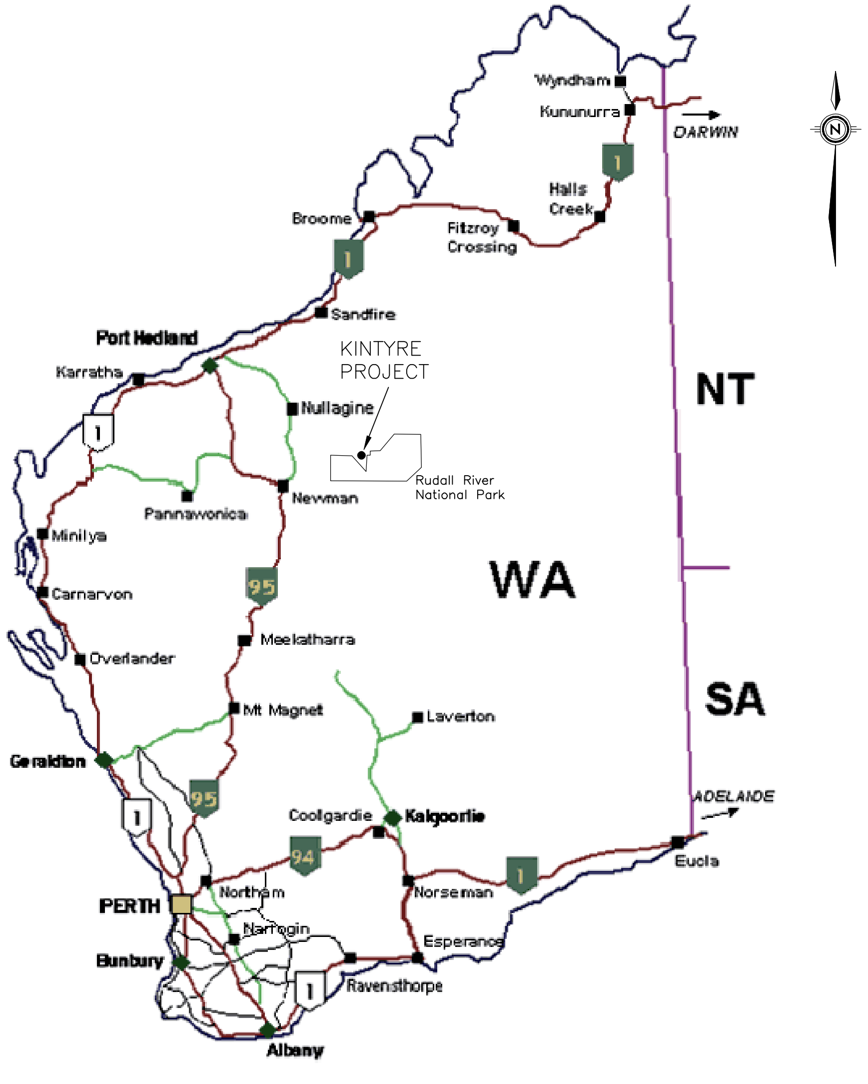
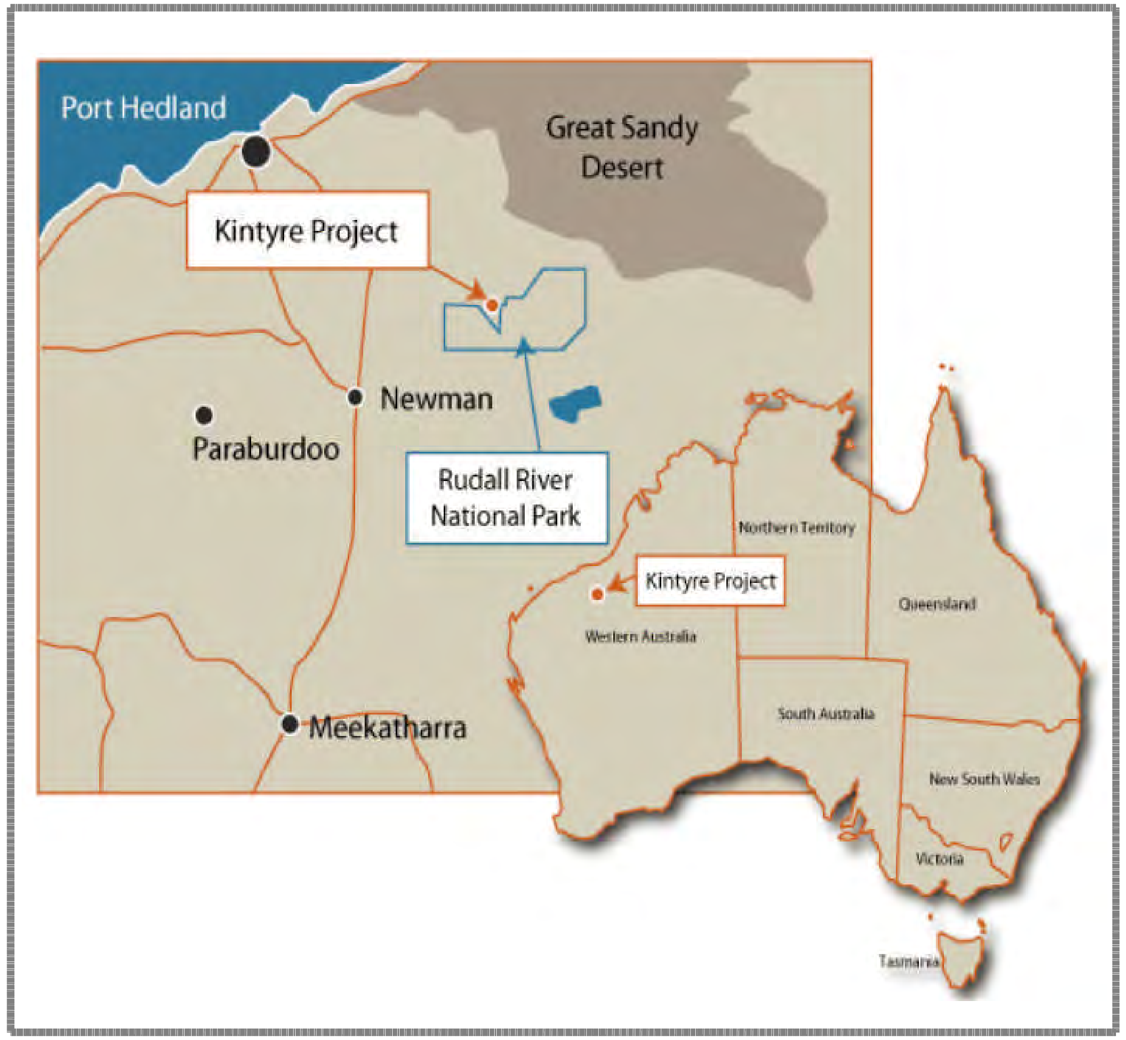
DRAWINGS

CAMECO - KINTYRE PROJECT
TAILINGS MANAGEMENT FACILITY
WESTERN AUSTRALIA, AUSTRALIA



REGIONAL LOCATION MAP
N.T.S.



PROJECT LOCATION MAP
N.T.S.

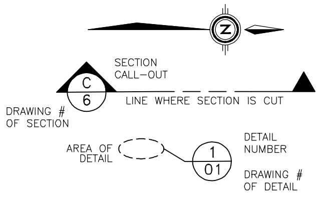
DRAWING INDEX

DWG #	DRAWING NAME
1	LOCATION MAP & DRAWING INDEX
2	GENERAL FACILITIES ARRANGEMENT
3	TAILINGS FACILITY SITE PLAN
4	SITE INVESTIGATION PLAN
5	TAILINGS FACILITY PLAN – STAGE 1 WITH STORAGE TABLES
6	TAILINGS FACILITY PLAN – STAGE 2 WITH STORAGE TABLES
7	TAILINGS FACILITY PLAN – ULTIMATE CONFIGURATION WITH STORAGE TABLES
8	TAILINGS FACILITY SECTIONS – STAGE 1
9	TAILINGS FACILITY SECTIONS – STAGE 2
10	TAILINGS FACILITY SECTIONS –ULTIMATE CONFIGURATION
11	TAILINGS EMBANKMENT DETAILS
12	TAILINGS STAGE 1 PLAN & GRADING DETAILS
13	TAILING STAGE 2 PLAN & GRADING DETAILS
14	ULTIMATE CONFIGURATION GRADING PLAN & DETAILS
15	HAUL ROADS AND RAMPS TYPICAL SECTIONS
16	LINER OVERDRAIN PLAN & DETAILS
17	LINER SYSTEM PLAN & DETAILS
18	TMF SUMP PLAN AND TAILINGS DISTRIBUTION SYSTEM DETAILS
19	RECLAIM SYSTEM PLAN & DETAILS
20	EVAPORATION PONDS PLAN
21	EVAPORATION PONDS SECTION AND DETAILS
22	TAILINGS EMBANKMENT INSRUMENTATION PLAN AND DETAILS
23	SURFACE WATER MANAGEMENT PLAN
24	SEDIMENT AND RETENTION POND SECTIONS AND DETAILS
25	SEDIMENT AND RETENTION POND SECTIONS AND DETAILS
26	IMPOUNDMENT PLAN AT CLOSURE
27	IMPOUNDMENT PLAN – SECTIONS AND DETAILS

GENERAL LEGEND

═	EXISTING CONTOURS
═	PROPOSED CONTOURS
═	EXISTING ROADS
═	PROPOSED ROADS
═	HAUL ROADS
– · –	DRAIN
– · –	RIVER/WASH

GENERAL SYMBOLS



NORTH ARROW

CROSS SECTION LOCATION

DETAIL CALL–OUT

PRELIMINARY - NOT FOR CONSTRUCTION

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REFERENCE

DWG No.	DESCRIPTION

REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
A	00/00/00	ISSUE FOR REVIEW AND APPROVAL	--		

REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

Cameco

MANAGEMENT RELEASE:

SCALE (A1): 1:AS-SHOWN		DATE
DESIGNED:	T. MEYER	21/06/12
DRAWN:	L. STANSBURY	21/06/12
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE
PFS DESIGN
LOCATION MAP & DRAWING INDEX

DWG No. 1

REV A

GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. ALL FACILITIES SHOWN ARE PROPOSED UNLESS OTHERWISE NOTED.

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REFERENCE

DWG No.	DESCRIPTION

REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
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REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

Cameco
MANAGEMENT RELEASE:

		DATE
SCALE (A1): **1:10000**		
DESIGNED:	T. MEYER	21/06/12
DRAWN:	L. STANSBURY	21/06/12
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
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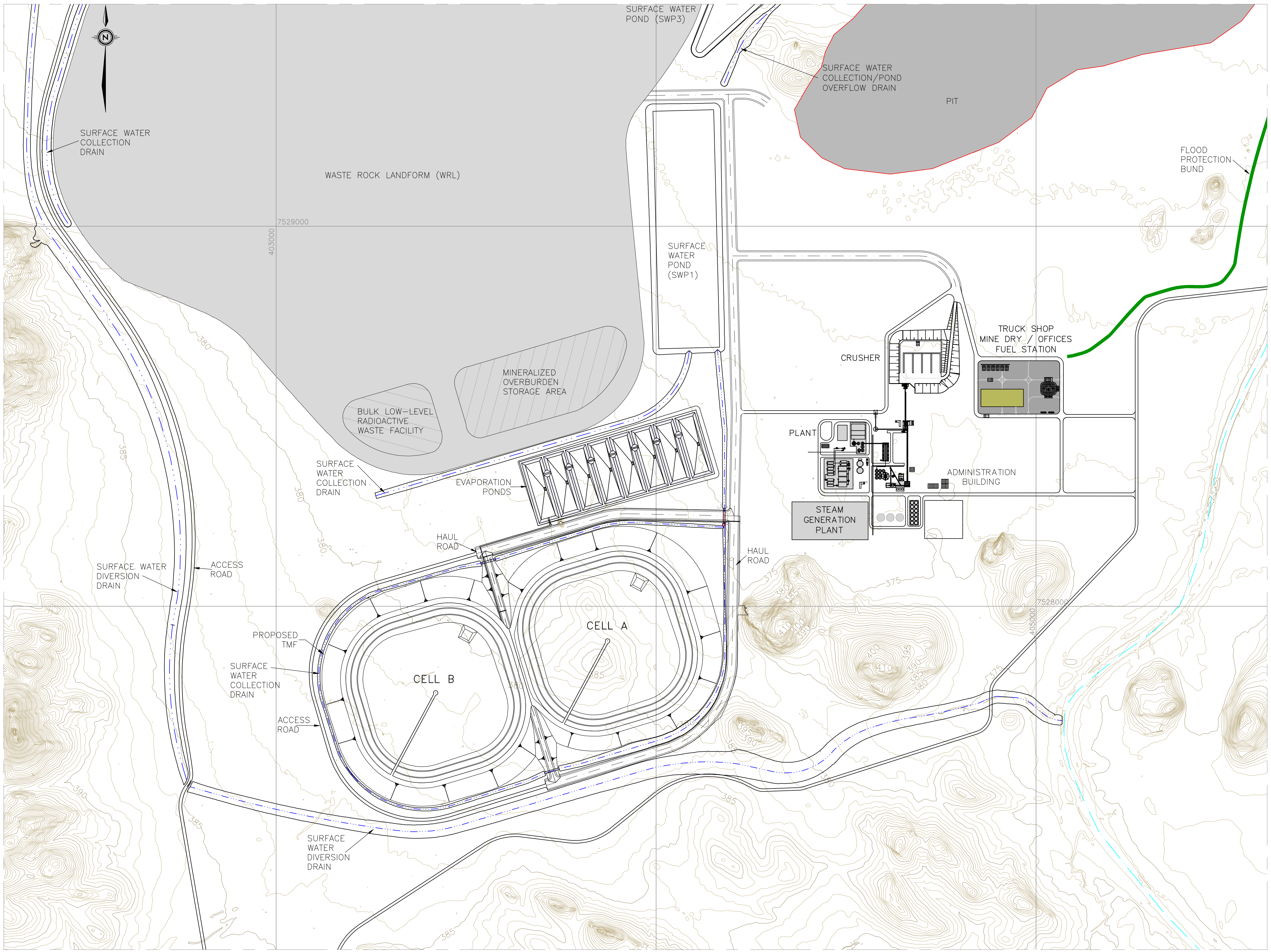
GENERAL FACILITIES ARRANGEMENT
DWG No. **2**
REV A



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. ALL FACILITIES SHOWN ARE PROPOSED UNLESS OTHERWISE NOTED.

PRELIMINARY - NOT FOR CONSTRUCTION

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\GENERAL FACILITIES.dwg – 7/31/2012 3:28 PM

REFERENCE

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DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
TAILINGS FACILITY SITE PLAN

DWG No. 3

REV A

GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. ALL FACILITIES SHOWN ARE PROPOSED UNLESS OTHERWISE NOTED.

KEY:

⌖ DM96–4 – 1996 BOREHOLE BY DAMES AND MOORE

⌖ TTA1–2 – 1997 TEST PIT BY DAMES AND MOORE

PRELIMINARY - NOT FOR CONSTRUCTION

100 0 100 200 300
METRES 1:5000

REFERENCE

DWG No.	DESCRIPTION

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LOC. KINTYRE

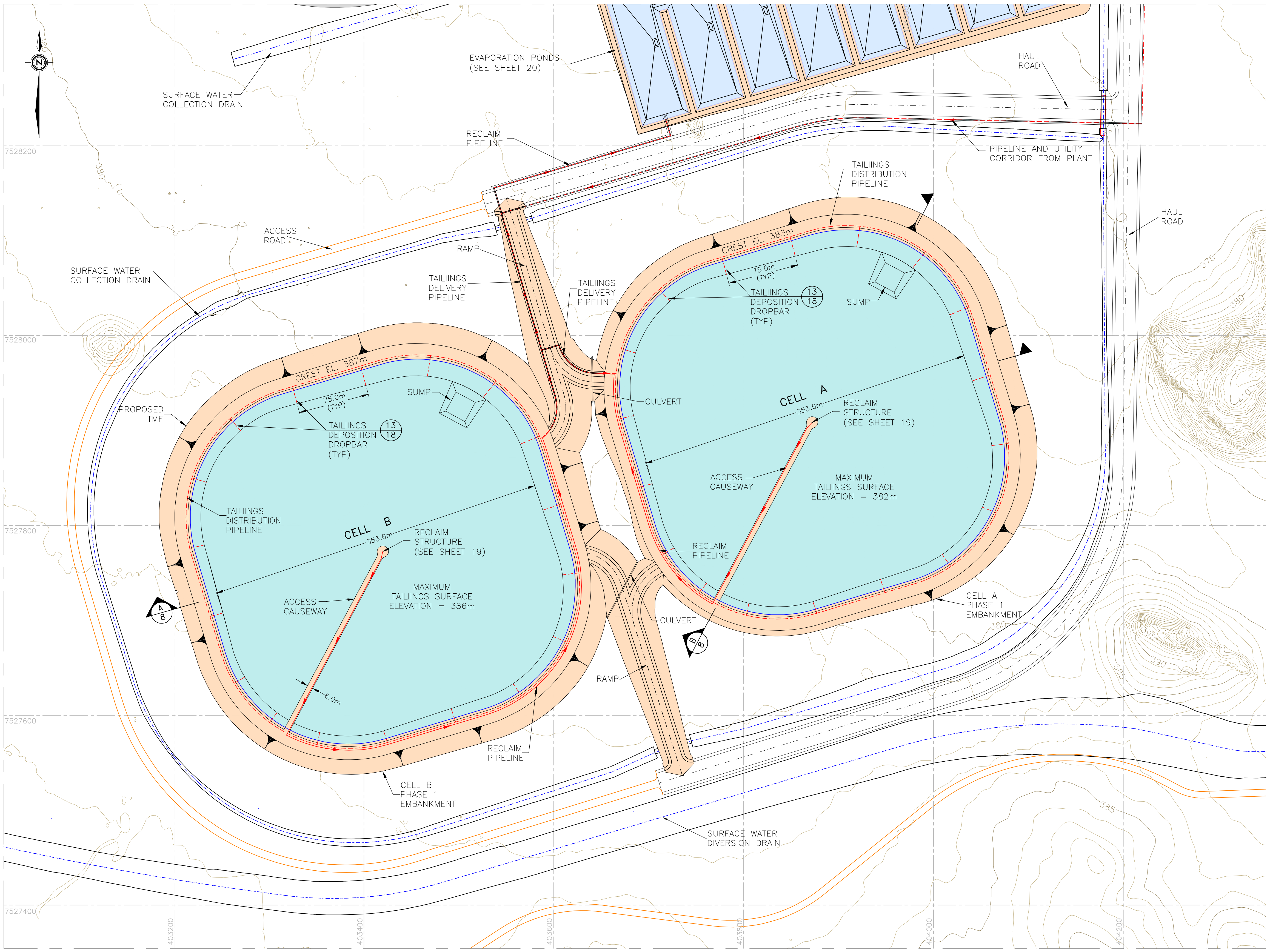
AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
SITE INVESTIGATION PLAN

DWG No. **4** REV A

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\GENERAL FACILITIES.dwg – 7/31/2012 3:28 PM



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

STAGE 1

CELL	TAILINGS million m³	TAILINGS ELEV.	EMBANKMENT million m³	CREST ELEV.
A	0.62	382	0.16	383
B	0.62	386	0.28	387

CELL A - TAILINGS VOLUME

Contour Elev.	Contour Area (sq. m)	Incremental Vol. (cu. m)	Cumulative Vol. (cu. m)
372	284	0	0
373	482	378	378
374	750	611	990
375	1,089	914	1,904
376	22,596	9,548	11,453
377	61,886	40,625	52,078
378	105,642	82,795	134,873
379	118,239	111,881	246,754
380	121,361	119,797	366,550
381	124,514	122,934	489,485
382	127,697	126,102	615,587

CELL B - TAILINGS VOLUME

Contour Elev.	Contour Area (sq. m)	Incremental Vol. (cu. m)	Cumulative Vol. (cu. m)
376	284	0	0
377	482	378	378
378	750	611	990
379	1,089	914	1,904
380	22,608	9,553	11,457
381	61,903	40,640	52,098
382	105,646	82,806	134,904
383	118,240	111,884	246,788
384	121,363	119,798	366,586
385	124,516	122,936	489,522
386	127,699	126,104	615,626

GENERAL LEGEND

🟧	EMBANKMENTS AND RAMPS
🟦	TMF LINER EXTENTS
🟦	EVAPORATION POND LINER EXTENTS

PRELIMINARY - NOT FOR CONSTRUCTION

50 0 50 100 150
METRES 1:2000

REFERENCE	
DWG No.	DESCRIPTION

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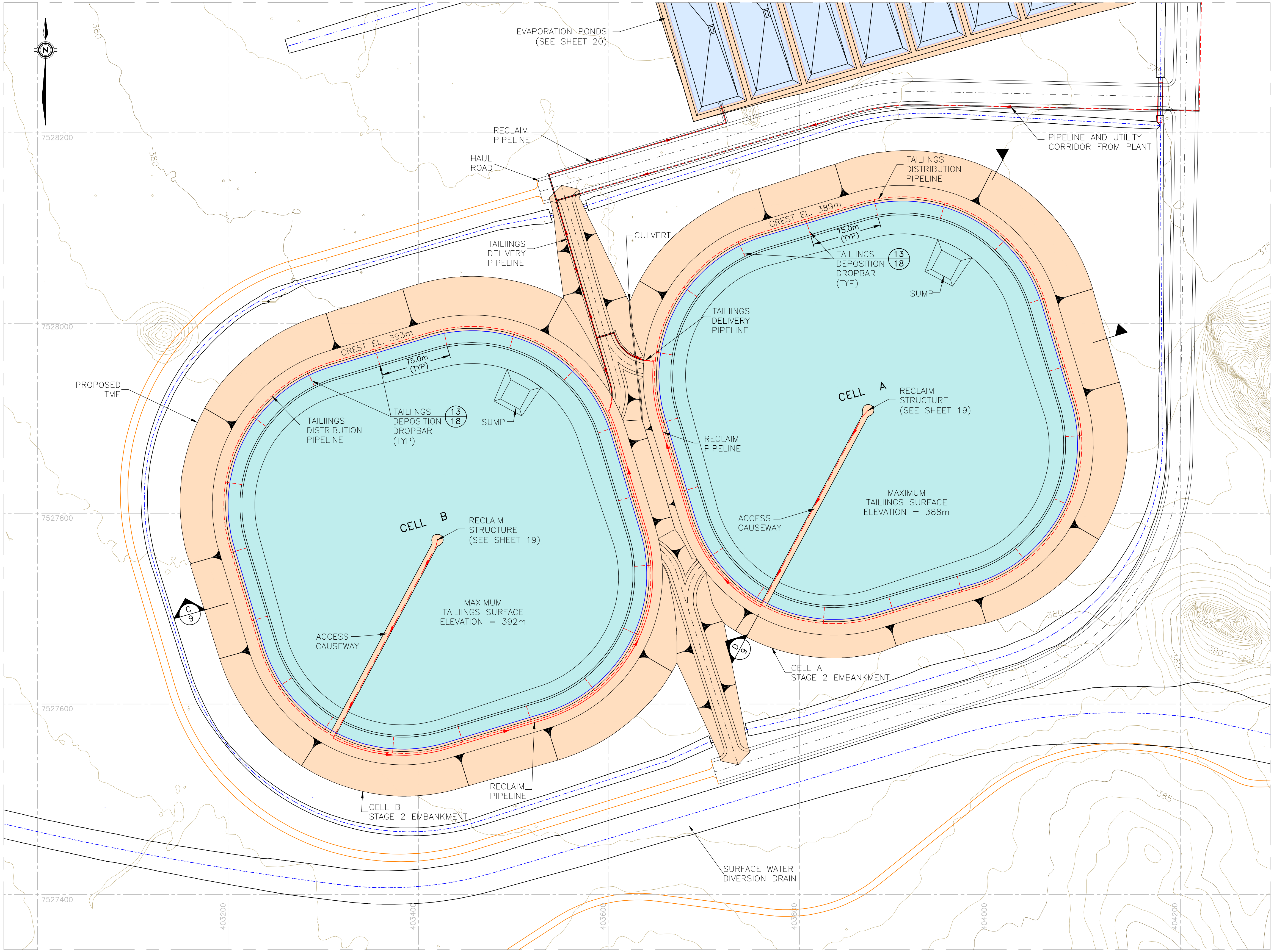
LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE
PFS DESIGN
TAILINGS FACILITY PLAN
STAGE 1 WITH STORAGE TABLES

DWG No. **5** REV A

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY PLAN & SECTIONS.dwg – 8/1/2012 4:17 PM



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

STAGE 2

CELL	TAILINGS million m³	TAILINGS ELEV.	EMBANKMENT million m³	CREST ELEV.
A	1.45	388	0.49	389
B	1.45	392	0.59	393

CELL A - TAILINGS VOLUME

Contour Elev.	Contour Area (sq. m)	Incremental Vol. (cu. m)	Cumulative Vol. (cu. m)
372	284	0	0
373	482	378	378
374	750	611	990
375	1,089	914	1,904
376	22,596	9,548	11,453
377	61,886	40,625	52,078
378	105,642	82,795	134,873
379	118,239	111,881	246,754
380	121,361	119,797	366,550
381	124,514	122,934	489,485
382	127,697	126,102	615,587
383	133,515	130,596	746,182
383	130,911	0	746,182
384	136,807	133,848	880,030
385	140,137	138,469	1,018,499
386	143,507	141,819	1,160,318
387	146,916	145,208	1,305,526
388	150,364	148,637	1,454,163
389	156,669	153,506	1,607,668

CELL B - TAILINGS VOLUME

Contour Elev.	Contour Area (sq. m)	Incremental Vol. (cu. m)	Cumulative Vol. (cu. M)
376	284	0	0
377	482	378	378
378	750	611	990
379	1,089	914	1,904
380	22,608	9,553	11,457
381	61,903	40,640	52,098
382	105,646	82,806	134,904
383	118,240	111,884	246,788
384	121,363	119,798	366,586
385	124,516	122,936	489,522
386	127,699	126,104	615,626
387	133,515	130,596	746,223
387	130,911	0	746,223
388	136,807	133,848	880,071
389	140,137	138,469	1,018,539
390	143,507	141,819	1,160,358
391	146,916	145,208	1,305,566
392	150,364	148,637	1,454,203
393	156,669	153,506	1,607,709

GENERAL LEGEND

🟧	EMBANKMENTS AND RAMPS
🟦	TMF LINER EXTENTS
🟦	EVAPORATION POND LINER EXTENTS

50 0 50 100 150
METRES 1:2000

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY PLAN & SECTIONS.dwg – 7/31/2012 5:01 PM

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DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

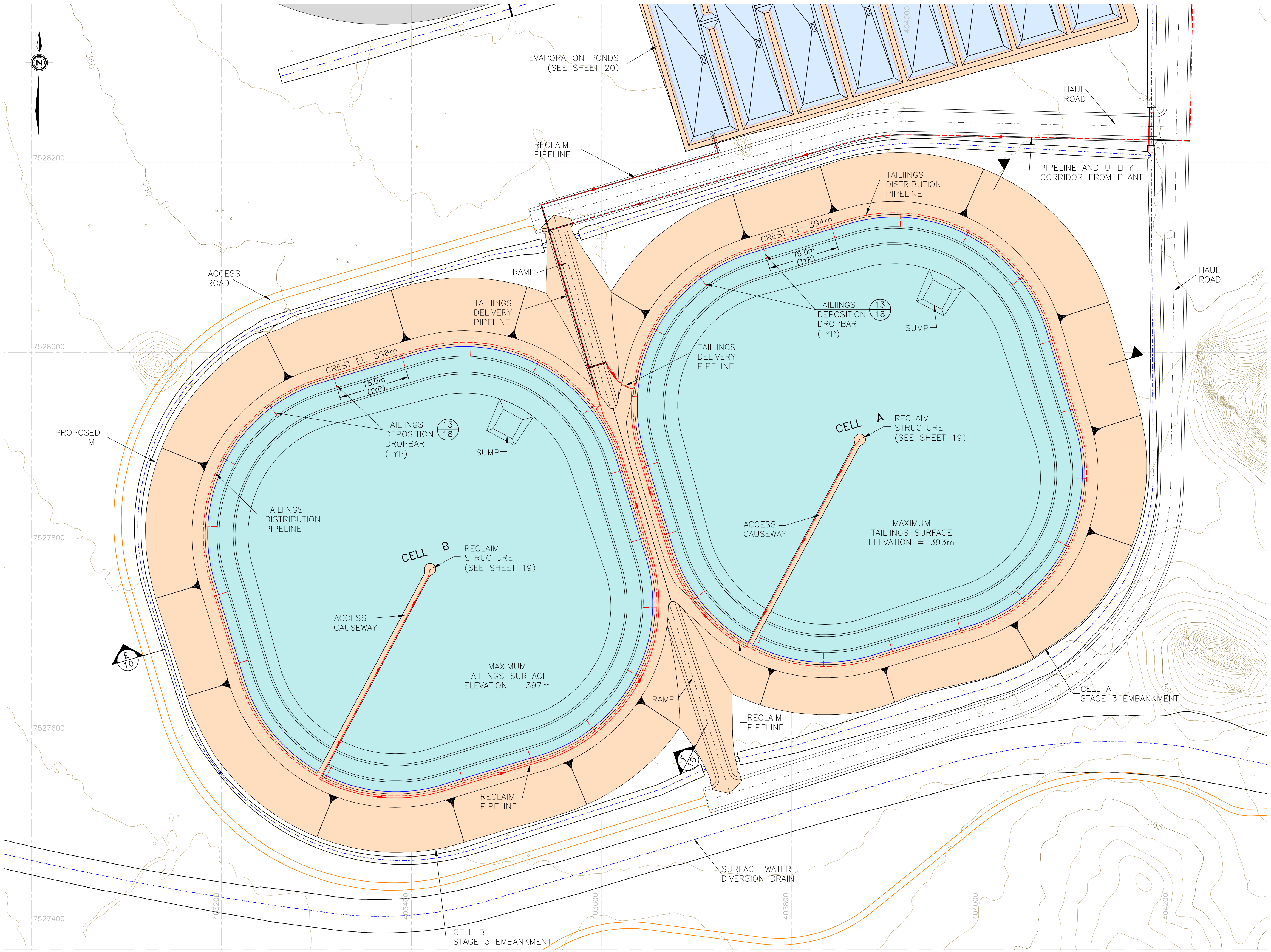
AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
TAILINGS FACILITY PLAN
STAGE 2 WITH STORAGE TABLES

DWG No. **6**

REV A



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

STAGE 3

CELL	TAILINGS million m³	TAILINGS ELEV.	EMBANKMENT million m³	CREST ELEV.
A	2.26	393	0.68	394
B	2.26	397	0.69	398

CELL A - TAILINGS VOLUME

Contour Elev.	Contour Area (sq. m)	Incremental Vol. (cu. m)	Cumulative Vol. (cu. m)
372	284	0	0
373	482	378	378
374	750	611	990
375	1,089	914	1,904
376	22,596	9,548	11,453
377	61,886	40,625	52,078
378	105,642	82,795	134,873
379	118,239	111,881	246,754
380	121,361	119,797	366,550
381	124,514	122,934	489,485
382	127,697	126,102	615,587
383	133,515	130,596	746,182
383	130,911	0	746,182
384	136,807	133,848	880,030
385	140,137	138,469	1,018,499
386	143,507	141,819	1,160,318
387	146,916	145,208	1,305,526
388	150,364	148,637	1,454,163
389	156,669	153,506	1,607,668
389	153,851	0	1,607,668
390	160,228	157,029	1,764,697
391	163,826	162,024	1,926,721
392	167,463	165,641	2,092,362
393	171,138	169,297	2,261,659
394	174,853	172,992	2,434,651

CELL B - TAILINGS VOLUME

Contour Elev.	Contour Area (sq. m)	Incremental Vol. (cu. m)	Cumulative Vol. (cu. M)
376	284	0	0
377	482	378	378
378	750	611	990
379	1,089	914	1,904
380	22,608	9,553	11,457
381	61,903	40,640	52,098
382	105,646	82,806	134,904
383	118,240	111,884	246,788
384	121,363	119,798	366,586
385	124,516	122,936	489,522
386	127,699	126,104	615,626
387	133,515	130,596	746,223
387	130,911	0	746,223
388	136,807	133,848	880,071
389	140,137	138,469	1,018,539
390	143,507	141,819	1,160,358
391	146,916	145,208	1,305,566
392	150,364	148,637	1,454,203
393	156,669	153,506	1,607,709
393	153,851	0	1,607,709
394	160,226	157,028	1,764,737
395	163,823	162,021	1,926,758
396	167,459	165,638	2,092,396
397	171,134	169,293	2,261,689
398	174,848	172,988	2,434,677

GENERAL LEGEND

🟧	EMBANKMENTS AND RAMPS
🟦	TMF LINER EXTENTS
🟦	EVAPORATION POND LINER EXTENTS

50 0 50 100 150
METRES 1:2000

REFERENCE	
DWG No.	DESCRIPTION

REVISIONS No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
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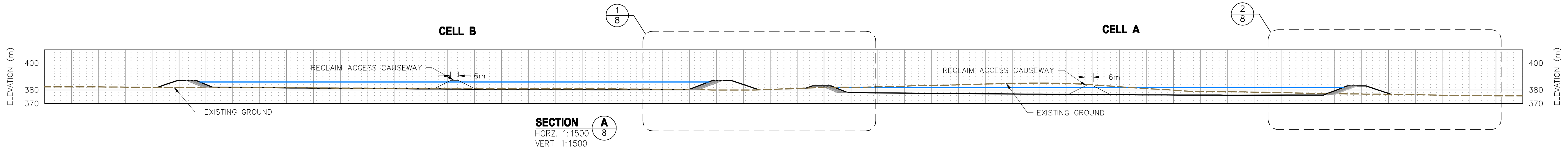
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE

PFS DESIGN
TAILINGS FACILITY PLAN - ULTIMATE
CONFIGURATION WITH STORAGE TABLES

DWG No. 7 REV A

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY PLAN & SECTIONS.dwg – 7/31/2012 5:01 PM



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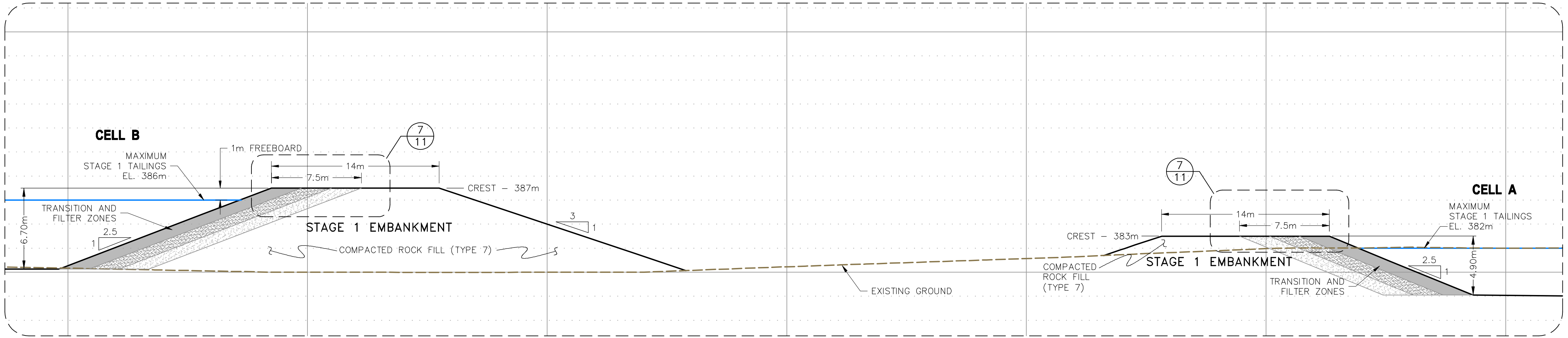

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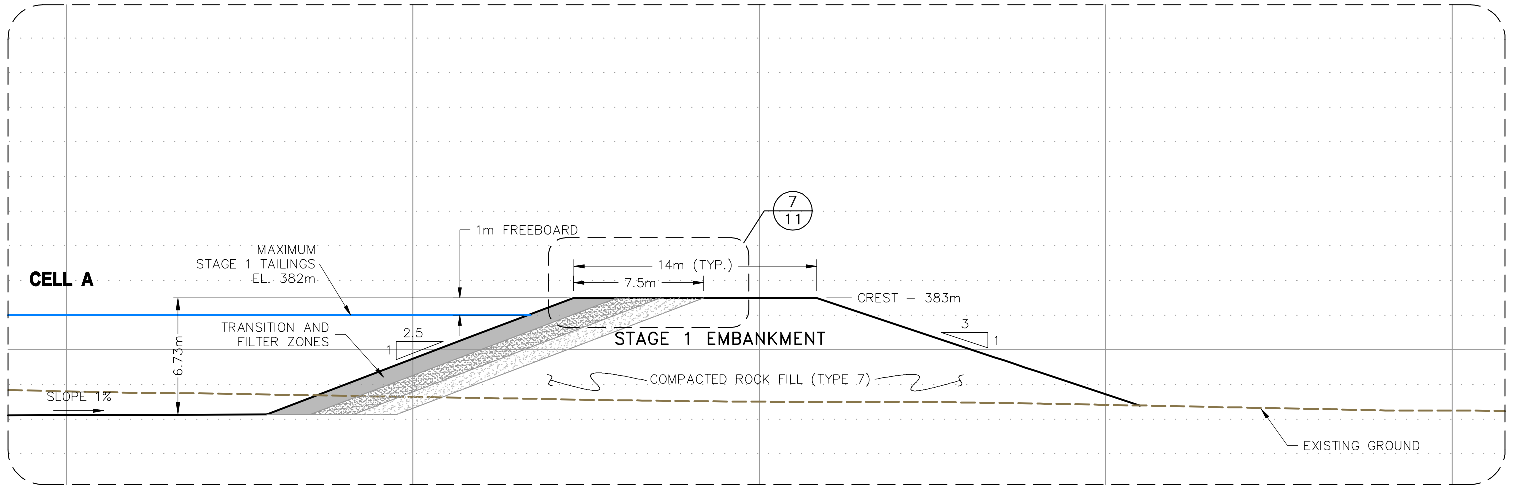

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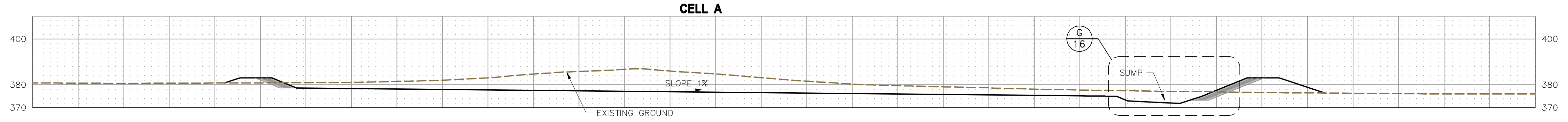
VERT. 1:200



SECTION B 8
HORZ. 1:1000
VERT. 1:1000

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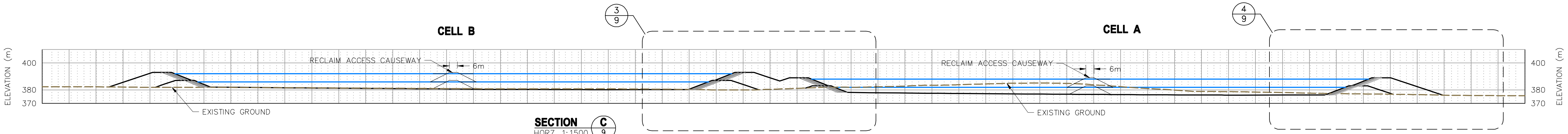
LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
TAILINGS FACILITY SECTIONS
STAGE 1
DWG No. **8**
REV A



SECTION C/9
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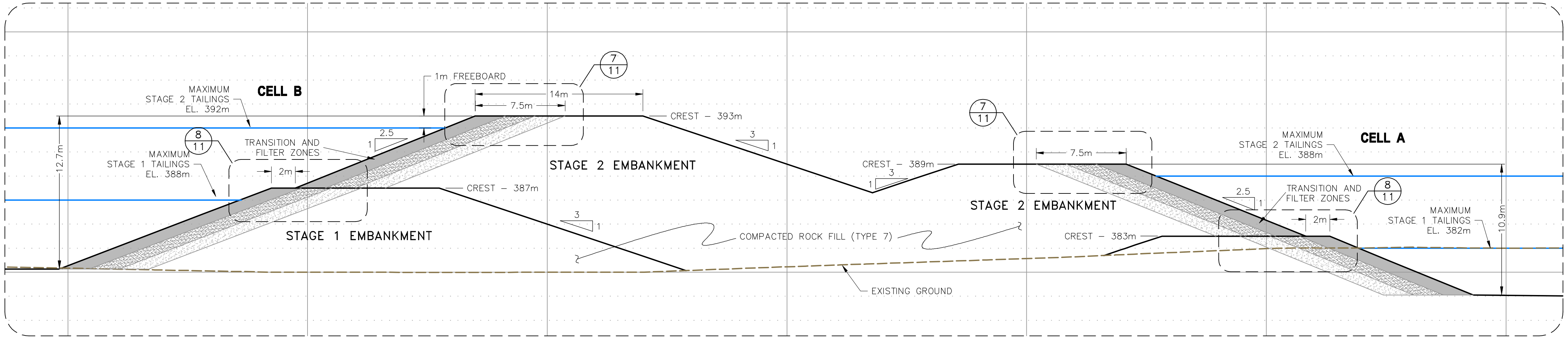

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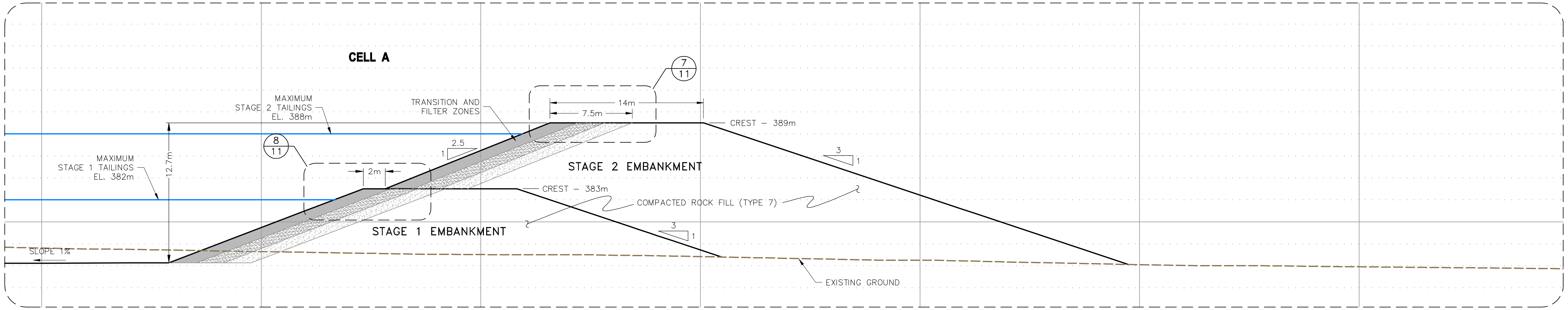

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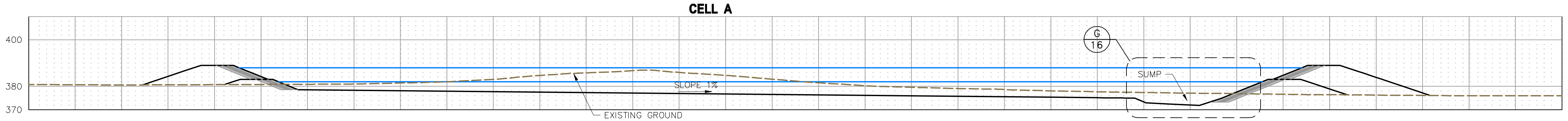

SECTION D/9
HORZ. 1:1000
VERT. 1:1000

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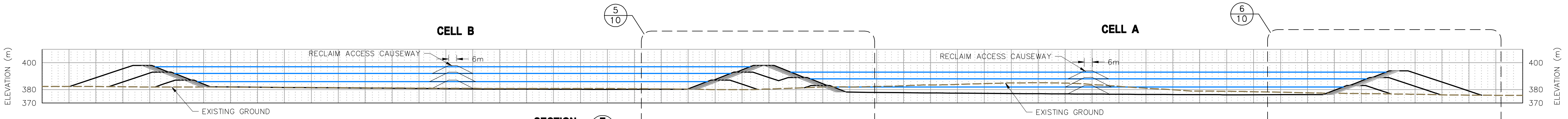
LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
TAILINGS FACILITY SECTIONS
STAGE 2
DWG No. 9
REV A



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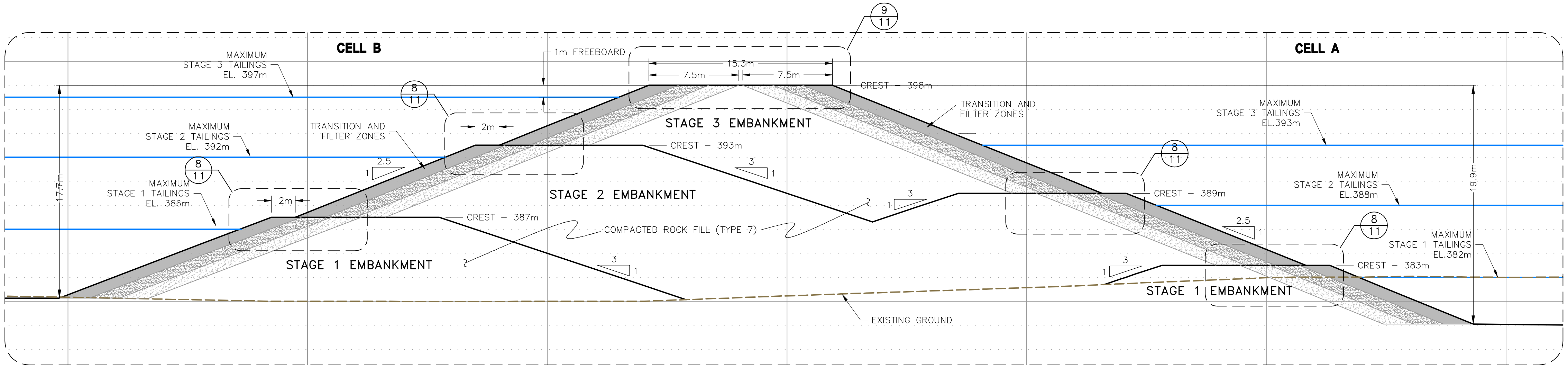

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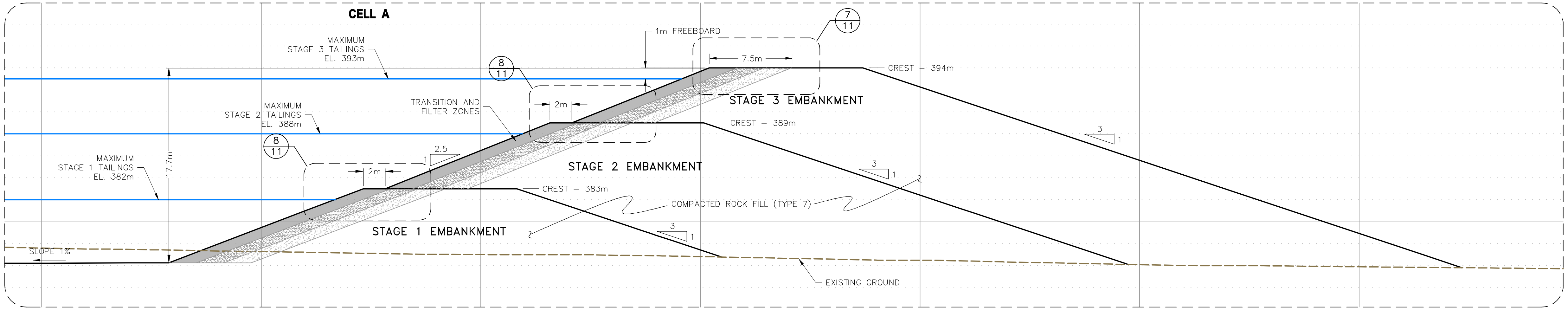

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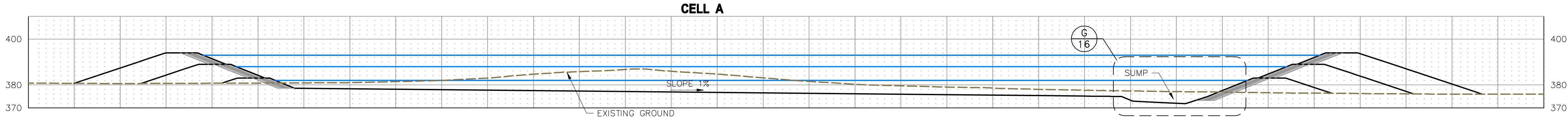

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LOC. KINTYRE

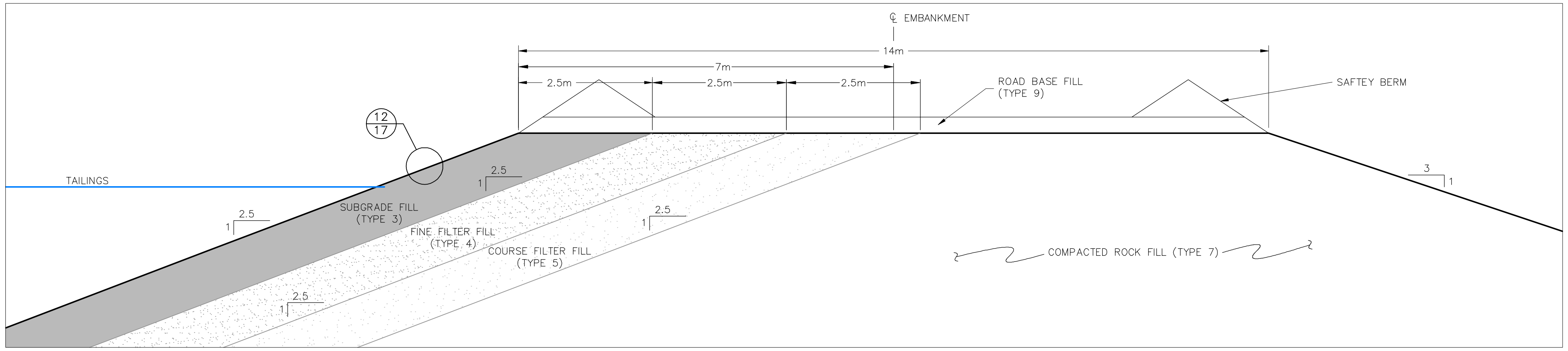
AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
TAILINGS FACILITY SECTIONS
ULTIMATE CONFIGURATION

DWG No. **10**

REV A



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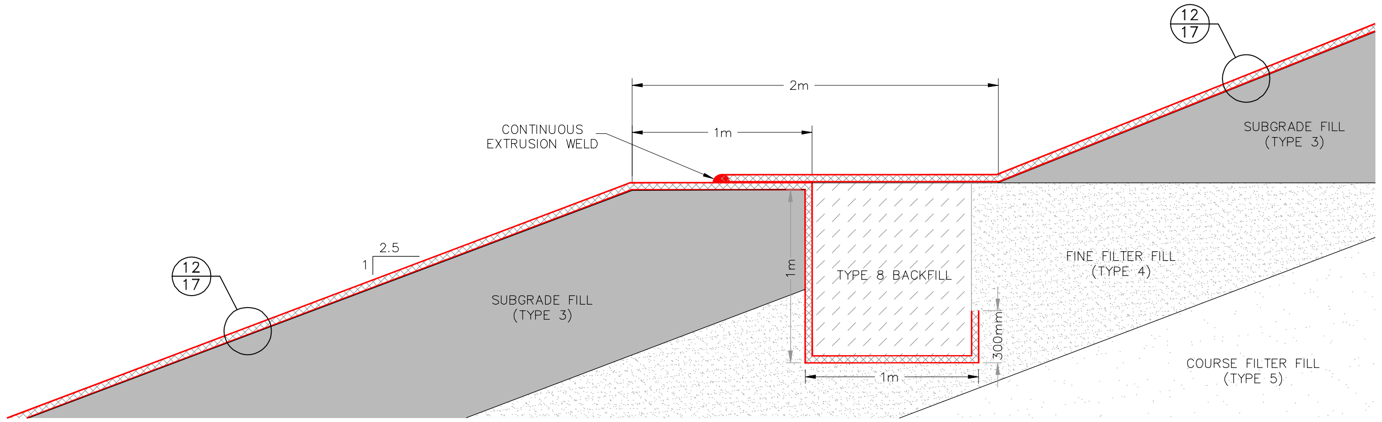

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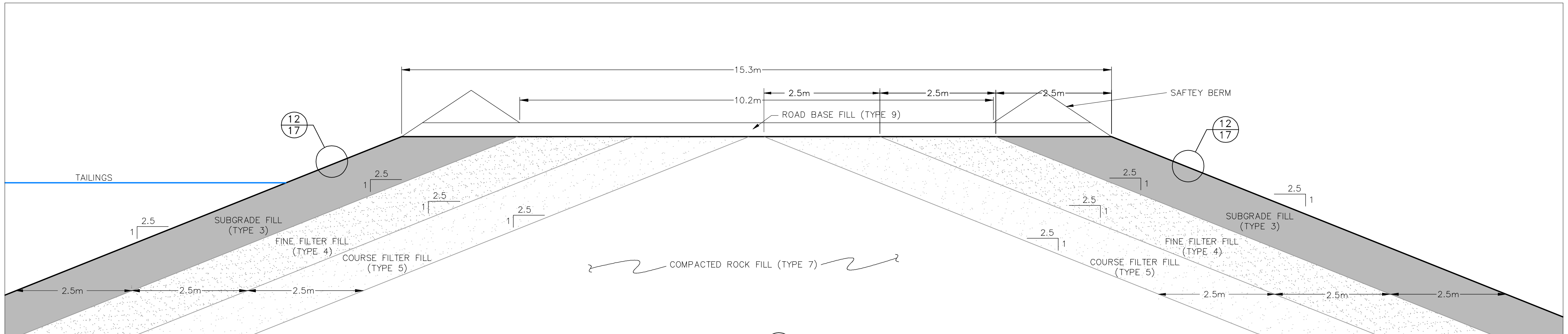

DETAIL 9/11
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DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

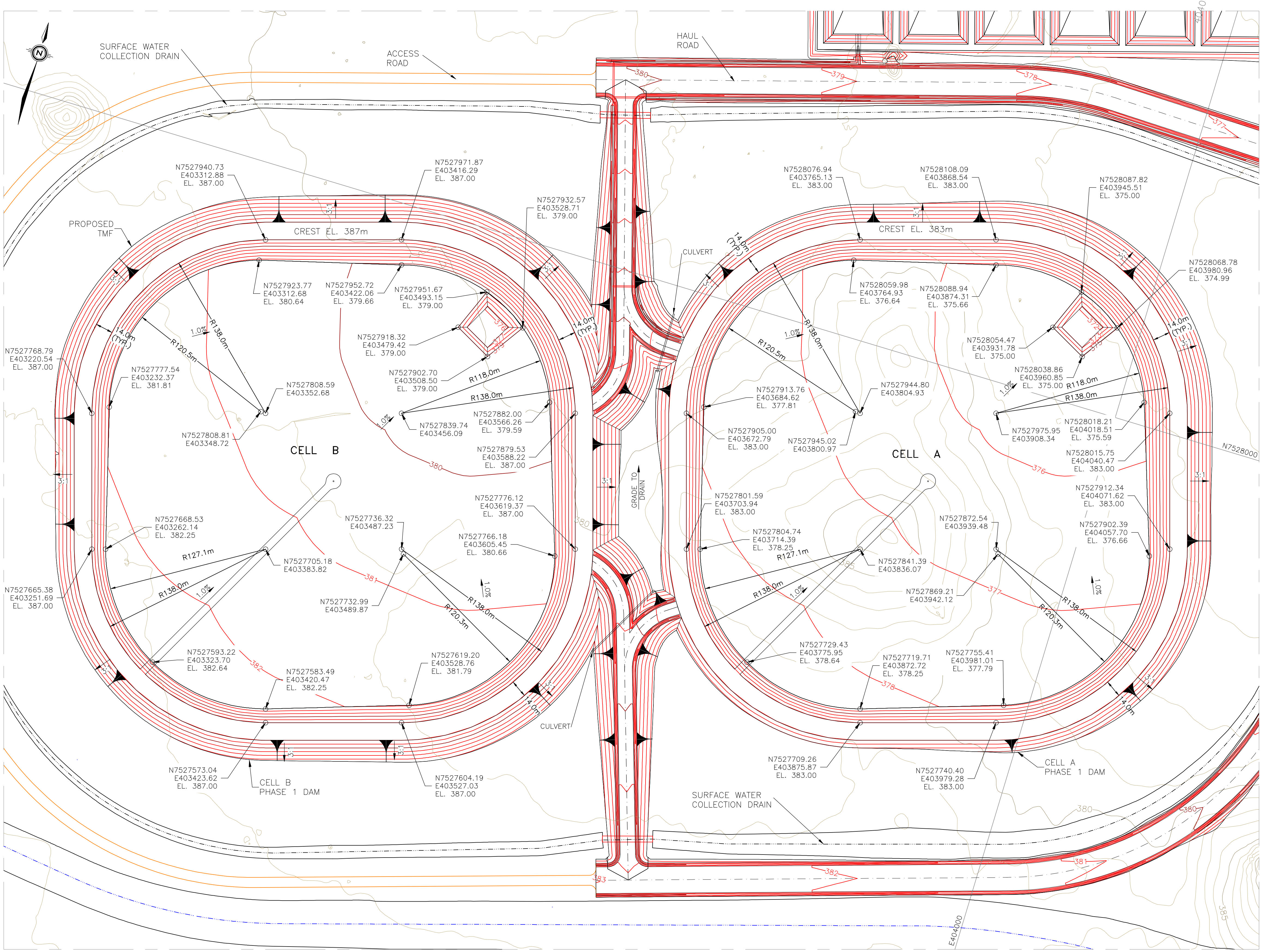
AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
TAILINGS EMBANKMENT DETAILS

DWG No. **11** REV A

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY PLAN & SECTIONS.dwg – 8/1/2012 2:44 PM



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

30 0 30 60 90
METRES
1:1500

Stansbury, Lisa - K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D - Kintyre\Pre-Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY GRADING PLAN.dwg - 7/31/2012 3:54 PM

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DESIGN AUTH. APPROVAL:		

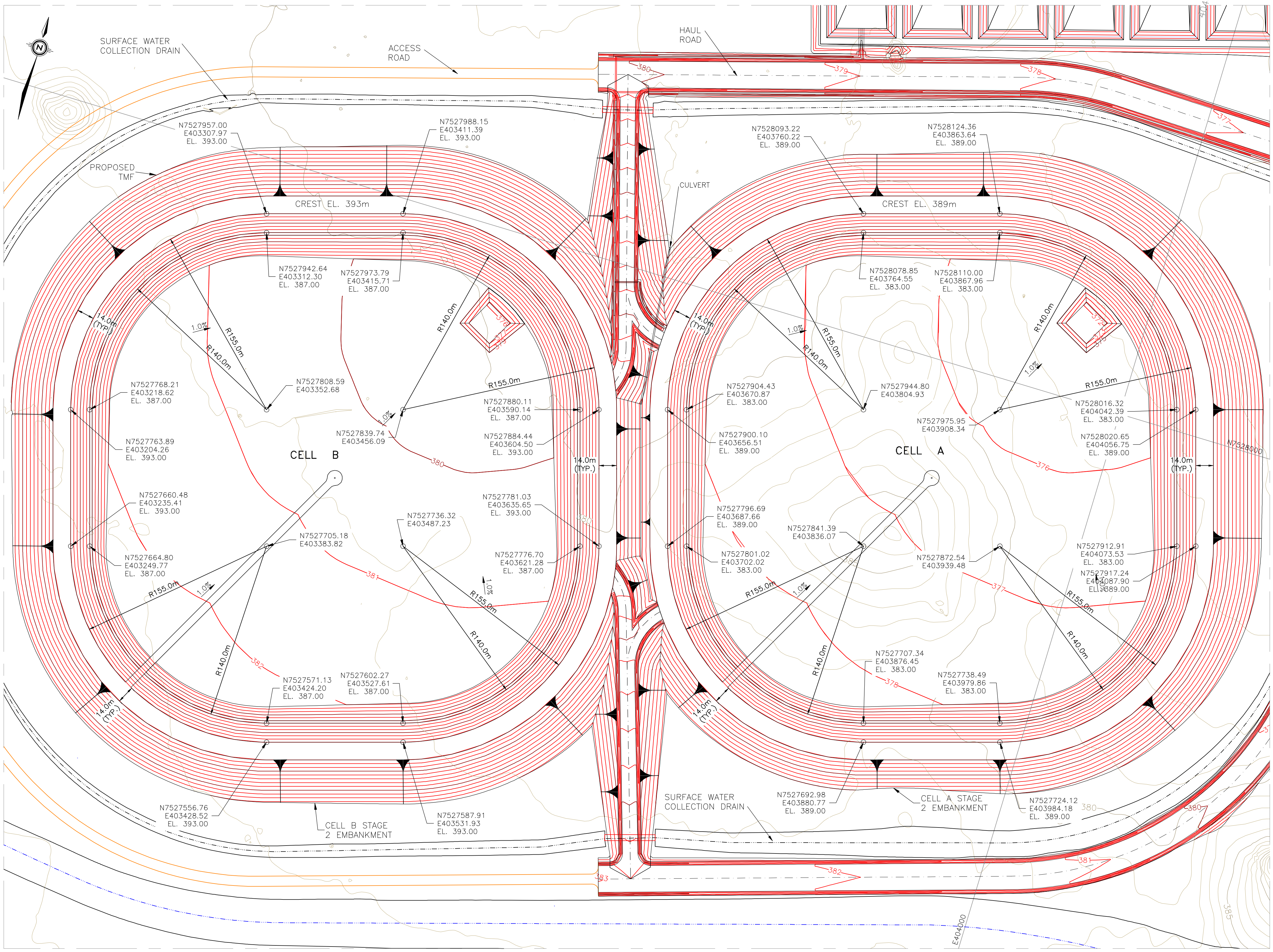
LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE
PFS DESIGN
TAILINGS STAGE 1 PLAN &
GRADING DETAILS

DWG No. 12

REV A



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

PRELIMINARY - NOT FOR CONSTRUCTION

30 0 30 60 90
METRES 1:1500

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY GRADING PLAN.dwg – 7/27/2012 11:05 AM

REFERENCE

DWG No.	DESCRIPTION

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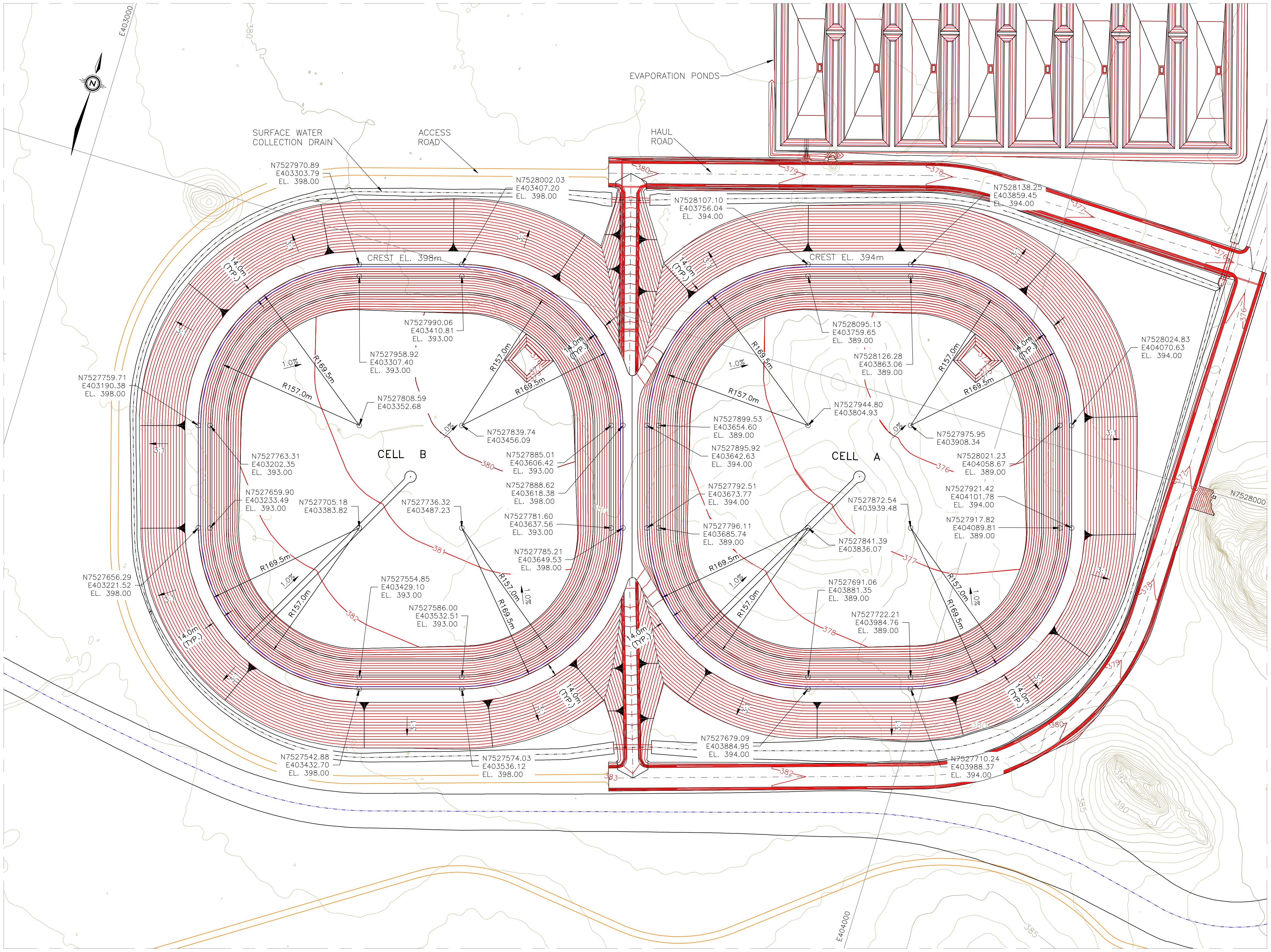
LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
TAILING STAGE 2 PLAN &
GRADING DETAILS

DWG No. **13** REV A



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

40 0 40 80 120
METRES 1:2000

REFERENCE	
DWG No.	DESCRIPTION

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LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
ULTIMATE CONFIGURATION
GRADING PLAN & DETAILS

DWG No. **14**

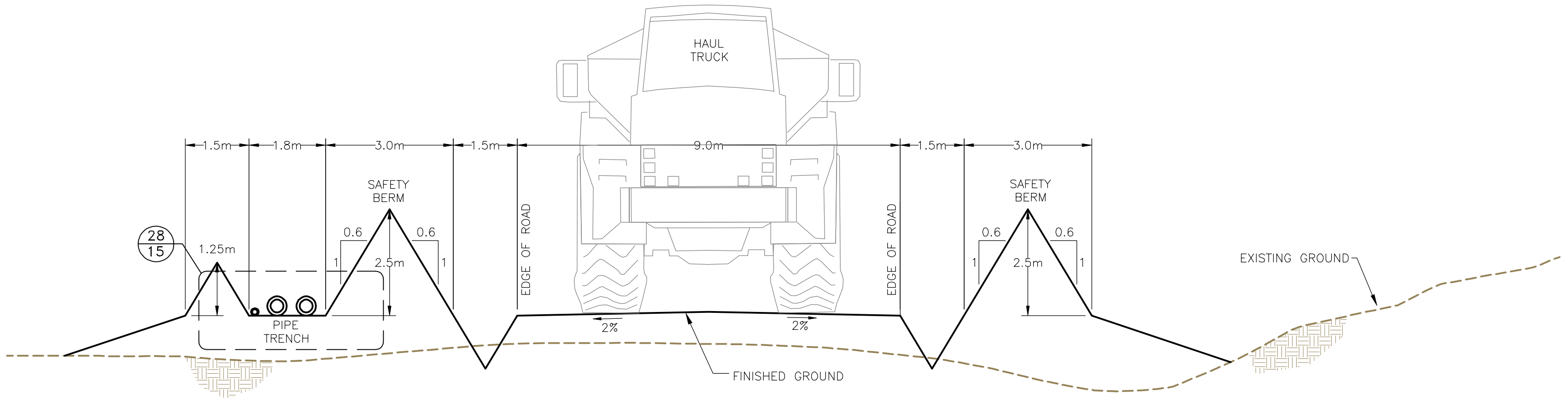
REV A

Stansbury, Lisa - K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D - Kintyre\Pre-Feasibility\Dwgs\Working Drawings\TAILINGS FACILITY GRADING PLAN.dwg - 7/27/2012 11:05 AM

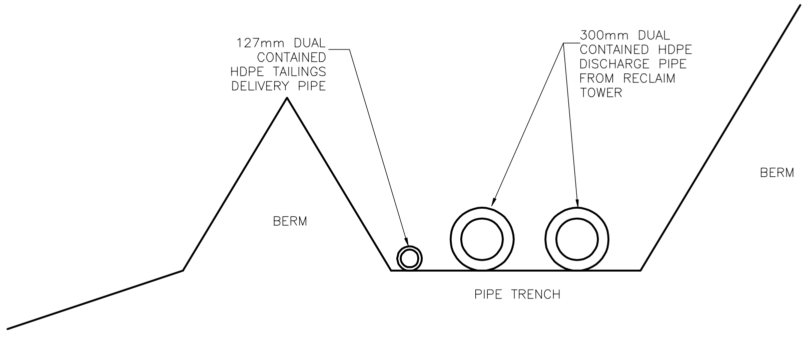
Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\HAUL ROAD & RAMP DETAILS.dwg – 7/31/2012 3:29 PM

NOTES:

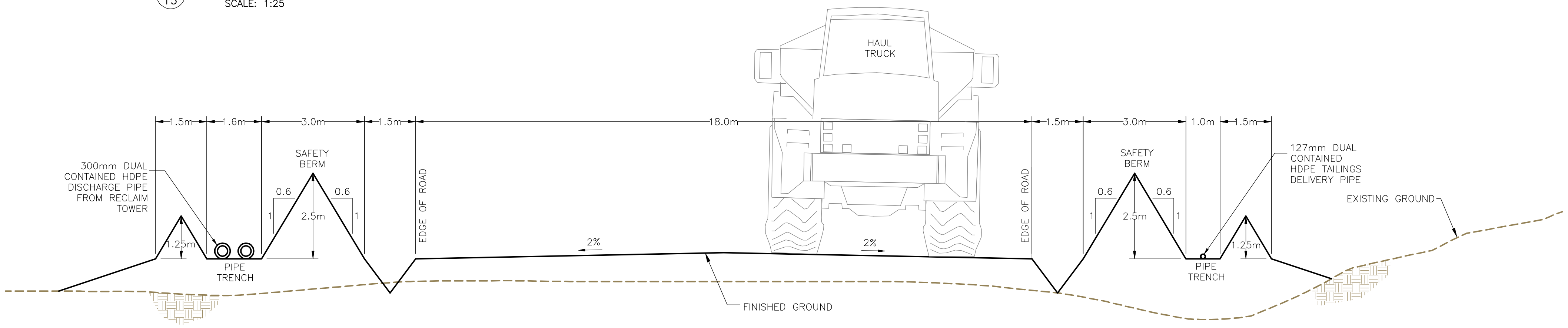
1. A SAFETY BERM IS REQUIRED.
2. ALL ROADS TO BE CROWNED OR SIDE–SLOPED MIN. 2% TO DIRECT STORMWATER OFF ROAD TRAVEL SURFACE AND TOWARD STORMWATER MANAGEMENT STRUCTURES AS NEEDED.
3. HAUL ROAD FILL DESIGN BY OTHERS



TYPICAL ONE WAY RAMP SECTION WITH PIPE TRENCH



(28/15) RECLAIM PIPE TRENCH TO EVAPORATION PONDS
SCALE: 1:25



TYPICAL HAUL ROAD SECTION WITH PIPE TRENCH BOTH SIDES

PRELIMINARY - NOT FOR CONSTRUCTION

REFERENCE

DWG No.	DESCRIPTION

REVISIONS

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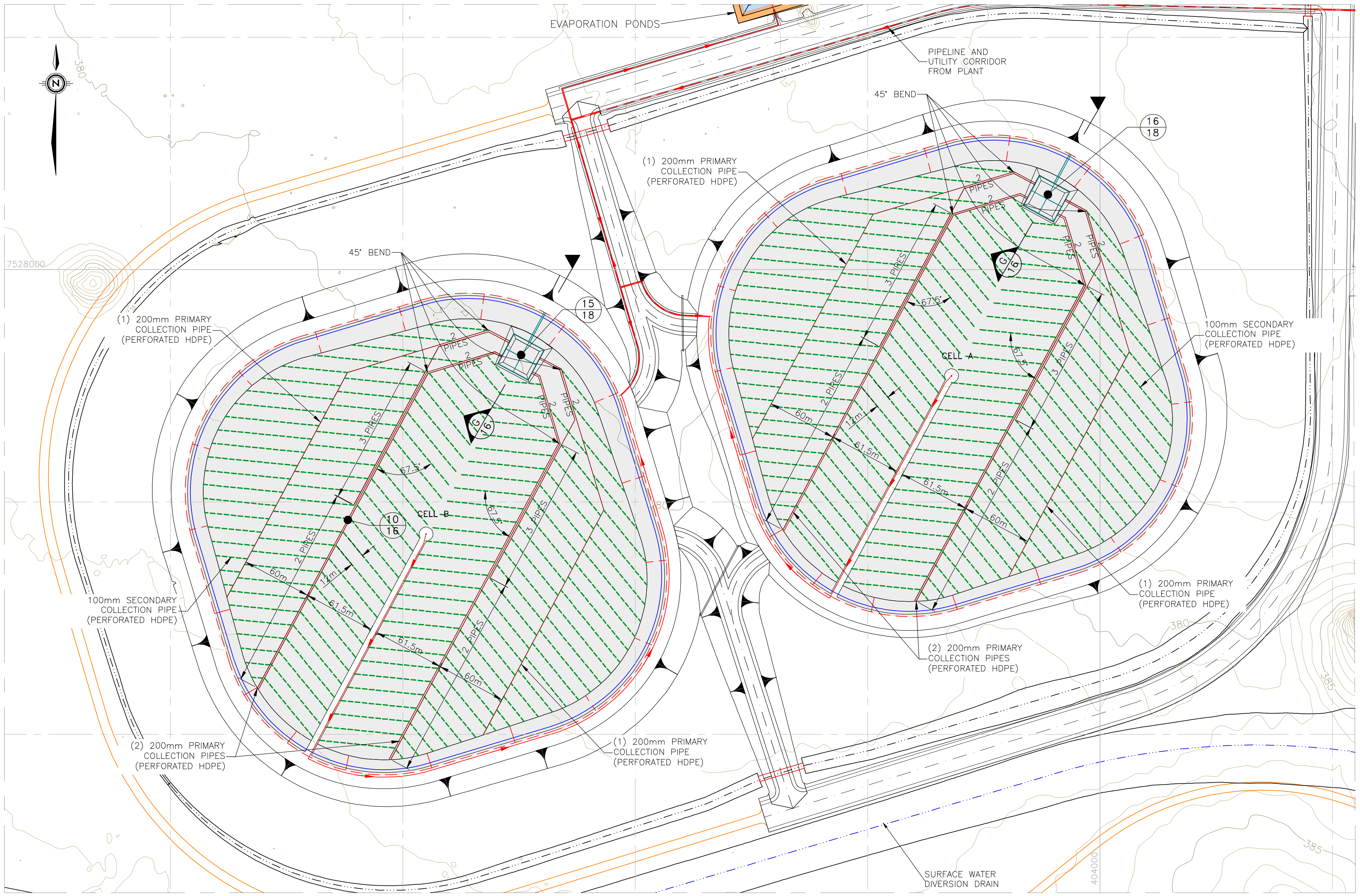
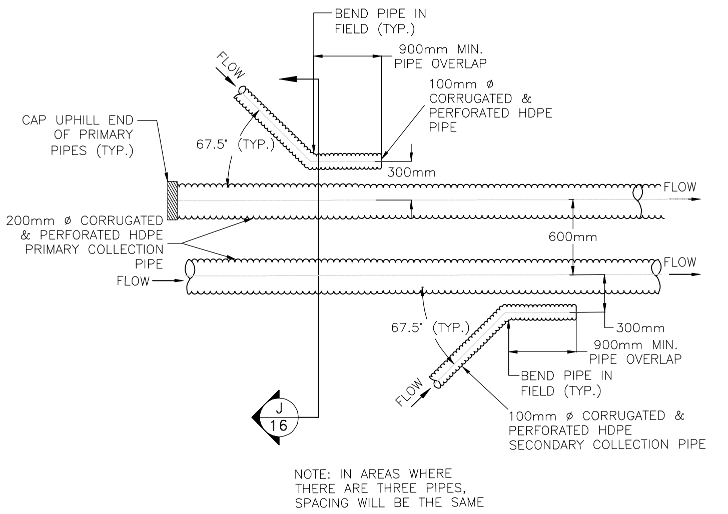
LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
HAUL ROADS AND RAMPS TYPICAL SECTIONS
DWG No. **15**
REV A

Herranz, Marco – K:\Clients\Cameco\Kintyre\tailings pfs design\CAD\c3d – kintyre\pre-feasibility\Dwgs\working drawings\LINER & SEEPAGE COLLECTION PLANS & DETAILS.dwg – 8/1/2012 3:44 PM



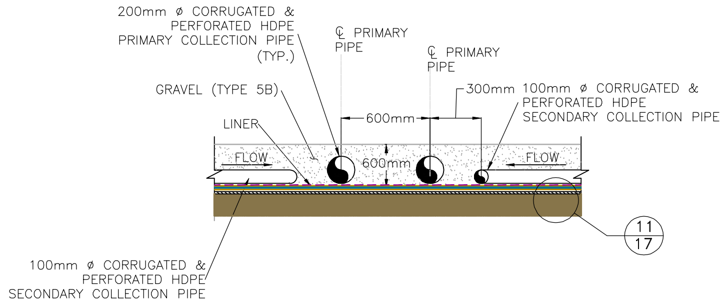
GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.



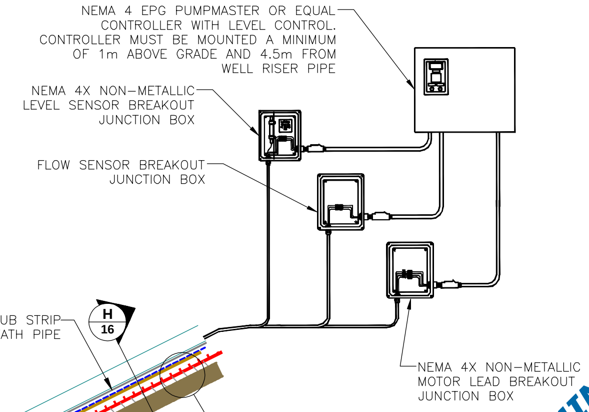
10 / 16 MULTIPLE DRAIN PIPE DETAIL

N.T.S.



J / 16 MULTIPLE DRAIN PIPE CROSS SECTION

N.T.S.



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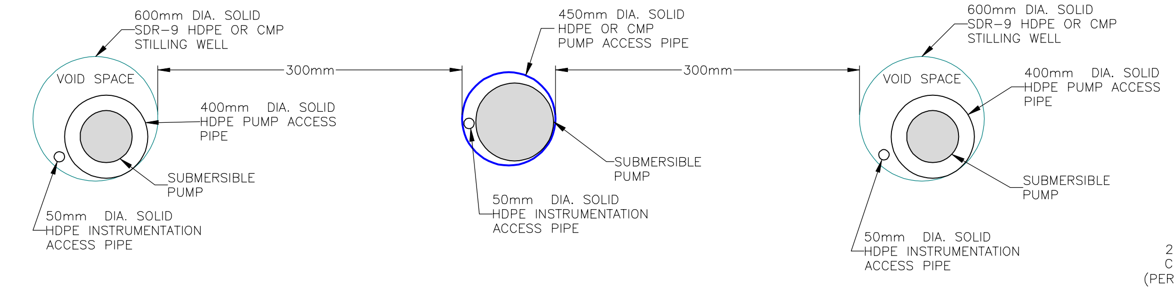


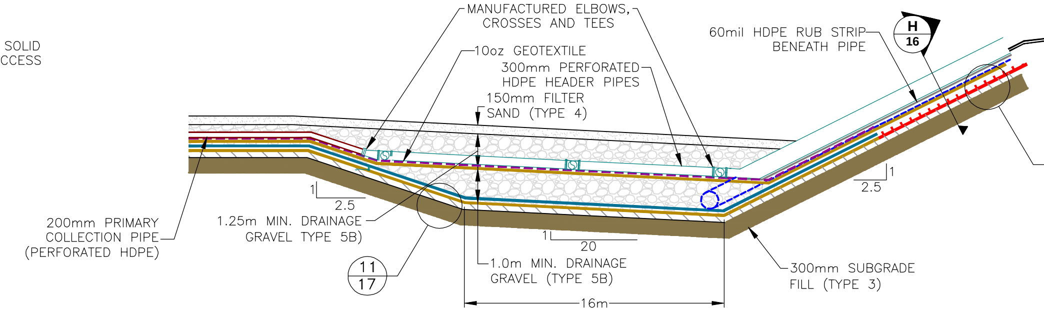
OVERDRAIN SYSTEM ACCESS PIPE

LCRS ACCESS PIPE

OVERDRAIN SYSTEM ACCESS PIPE

H / 16 SUMP AND PUMP ACCESS PIPES

N.T.S.



G / 16 OVERDRAIN COLLECTION SYSTEM SUMP

N.T.S.

50 0 50 100 150

METRES 1:2000

REFERENCE	
DWG No.	DESCRIPTION

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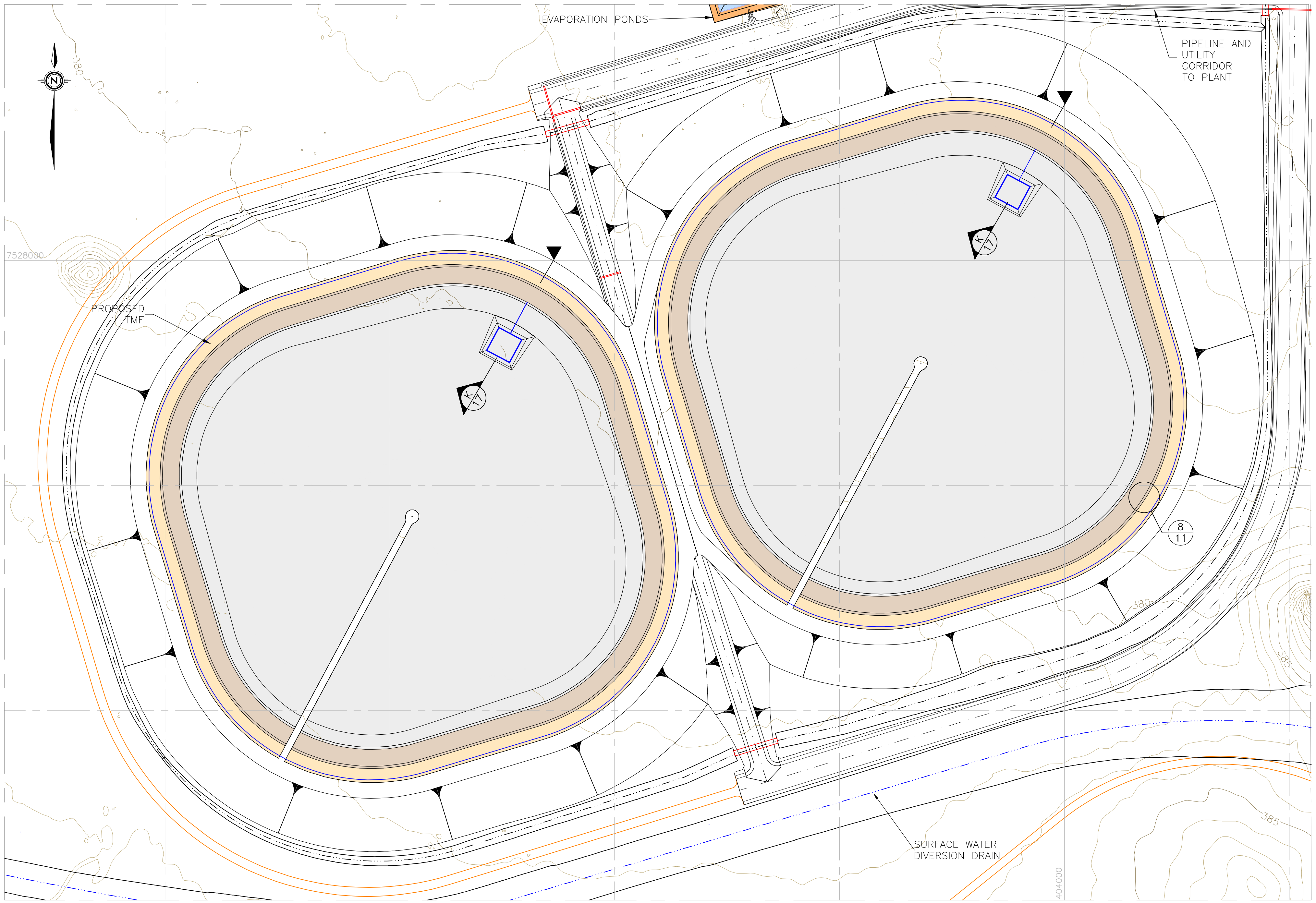
LOC. KINTYRE

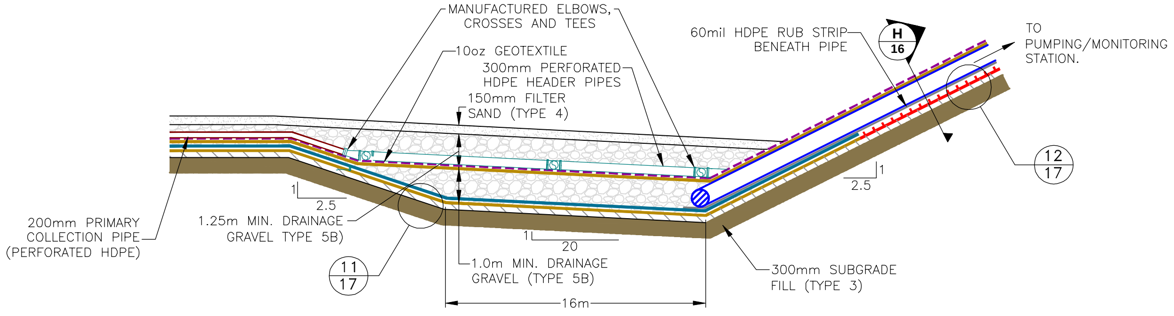
AREA TAILINGS MANAGEMENT FACILITY

TITLE

PFS DESIGN
LINER OVERDRAIN PLAN & DETAILS

DWG No. **16** REV A





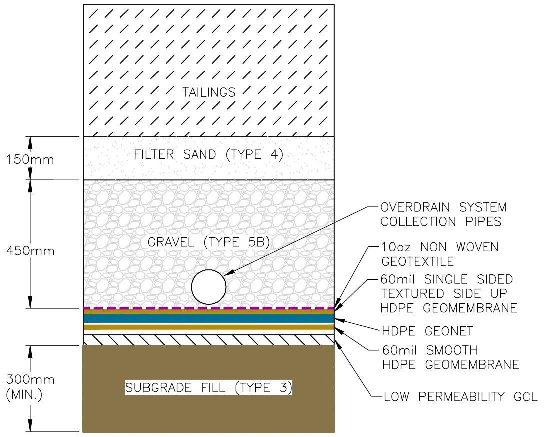
K/17 DUAL SUMP FOR LCRS & OVERDRAIN SYSTEM
N.T.S.

GENERAL NOTES:

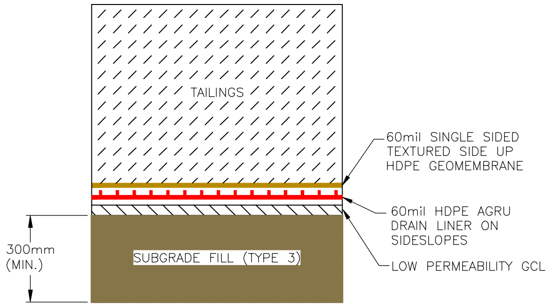
1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

GENERAL LEGEND

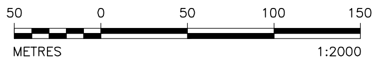
⬜	STAGE 1 LINER
🟫	STAGE 2 LINER EXTENSION
🟨	STAGE 3 LINER EXTENSION



11/17 TYPICAL LINER AND DRAINAGE SYSTEM FOR FLOOR
N.T.S.



12/17 TYPICAL LINER AND DRAINAGE SYSTEM FOR SIDE SLOPES
N.T.S.



Herranz, Marco – K:\Clients\Cameco\Kintyre\tailings pfs design\CAD\c3d – kintyre\pre-feasibility\Dwgs\working drawings\LINER & SEEPAGE COLLECTION PLANS & DETAILS.dwg – 8/1/2012 6:45 PM

REFERENCE

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LOC. KINTYRE

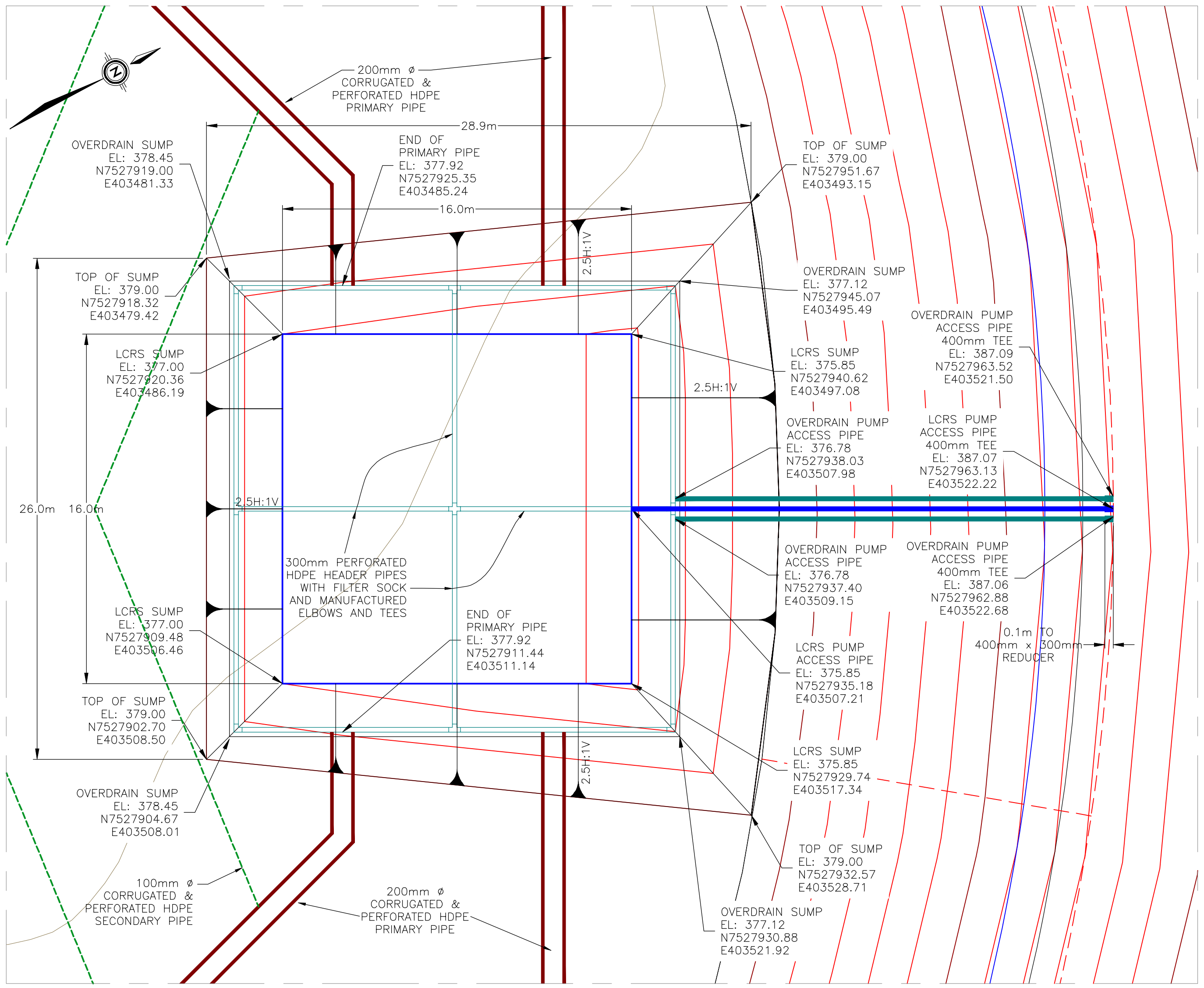
AREA TAILINGS MANAGEMENT FACILITY

TITLE

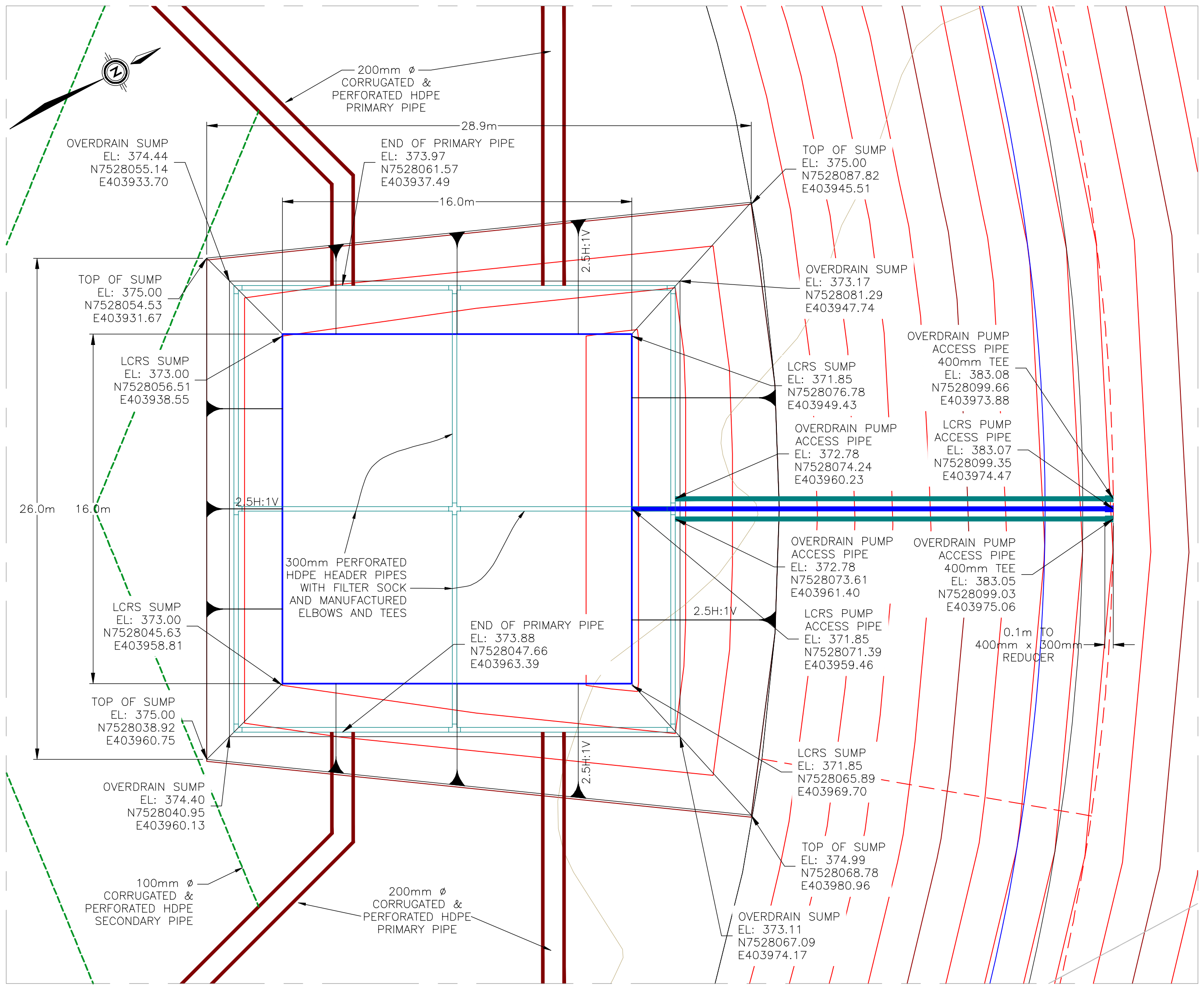
PFS DESIGN
LINER SYSTEM PLAN & DETAILS

DWG No. **17**

REV A



15/16 CELL B SUMP PLAN
N.T.S.



16/16 CELL A SUMP PLAN
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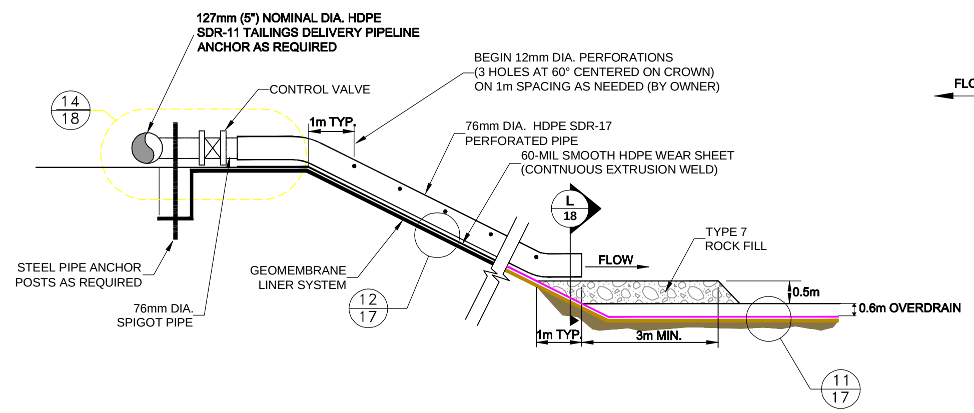
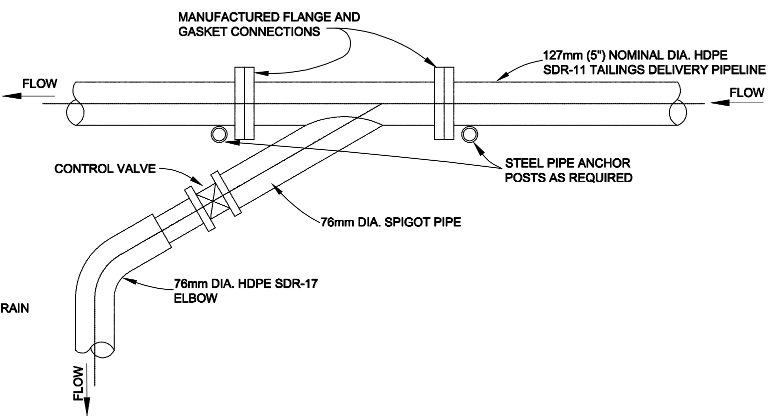


13/18 SCHEMATIC OF TAILINGS PIPE DISCHARGE SECTION DETAIL
N.T.S.



14/18 SCHEMATIC OF TAILINGS SPIGOT PLAN DETAIL
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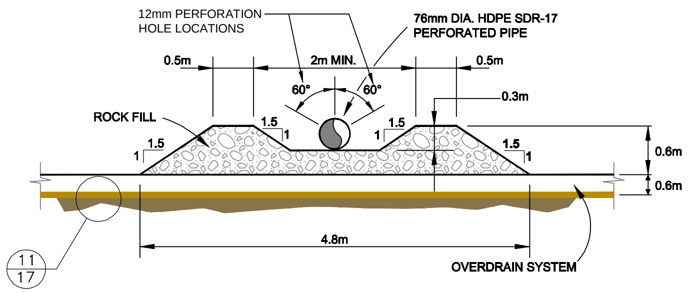

L/18 OVERDRAIN PROTECTION DETAIL
N.T.S.

REFERENCE	
DWG No.	DESCRIPTION

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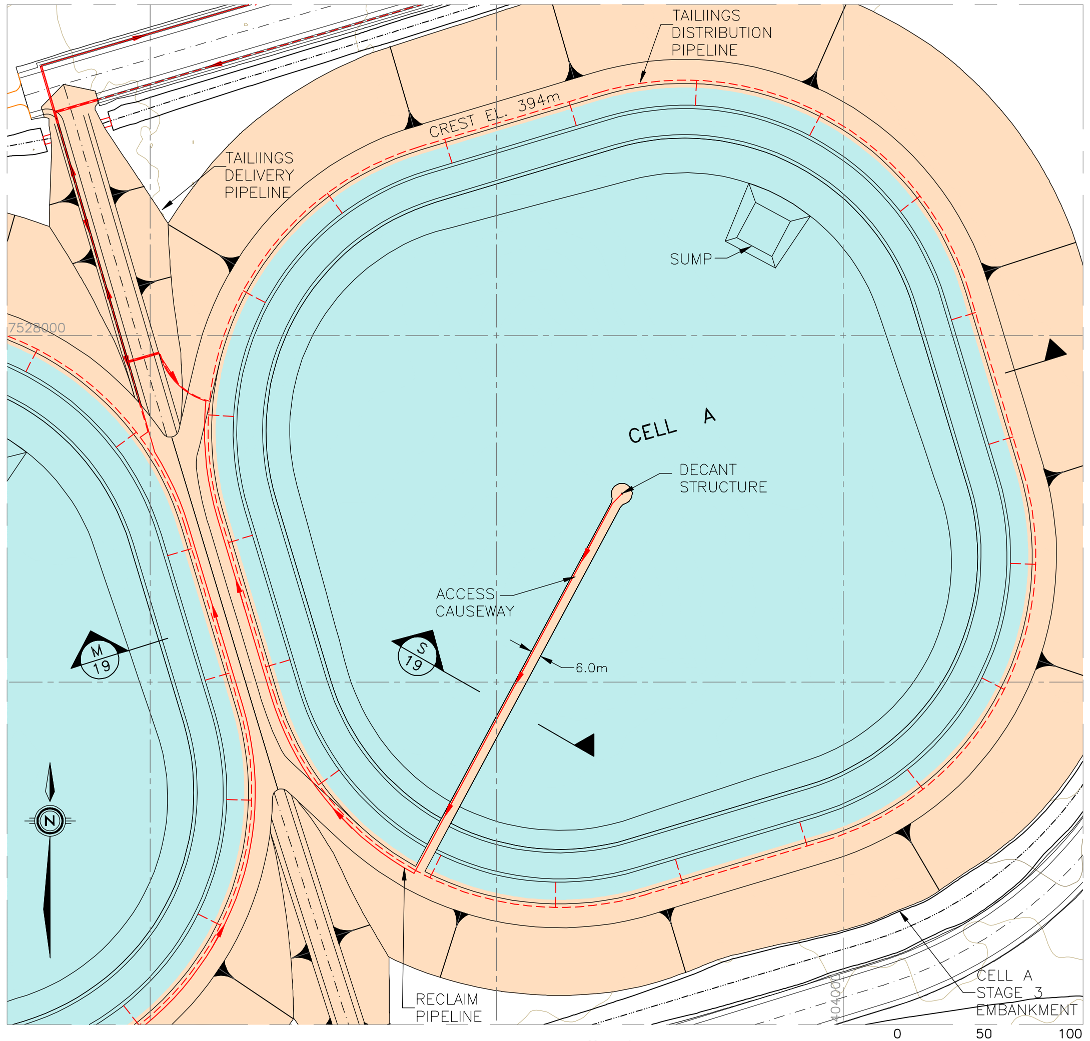
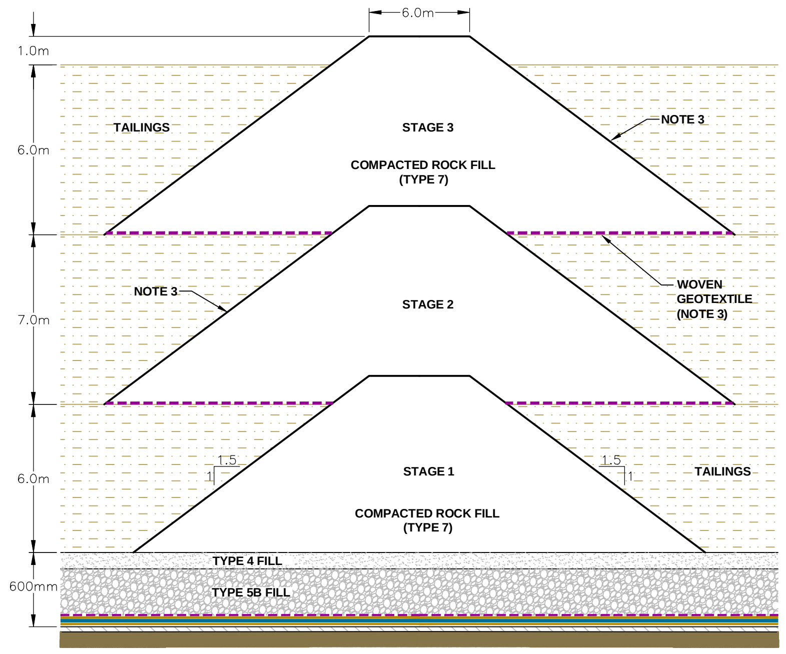
LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
TMF SUMP PLAN AND TAILINGS
DISTRIBUTION SYSTEM DETAILS
DWG No. 18
REV A

Herranz, Marco - K:\Clients\Cameco\Kintyre\tailings pfs design\CAD\c3d - kintyre\pre-feasibility\Dwgs\working drawings\LINER & SEEPAGE COLLECTION PLANS & DETAILS.dwg - 8/1/2012 3:44 PM



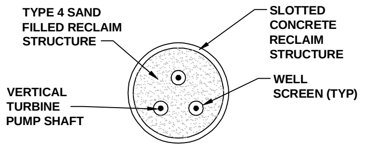


S 19 ACCESS CAUSEWAY SECTION

NOT TO SCALE

GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. FILL SLOPES AND WOVEN GEOTEXTILE REQUIREMENTS FOR STAGES 2 & 3 TO BE DETERMINED BASED ON FIELD INVESTIGATIONS TO DETERMINE TAILINGS INSITU GEOMECHANICAL PROPERTIES AT TIME OF CONSTRUCTION.



N 19 RECLAIM STRUCTURE SECTION

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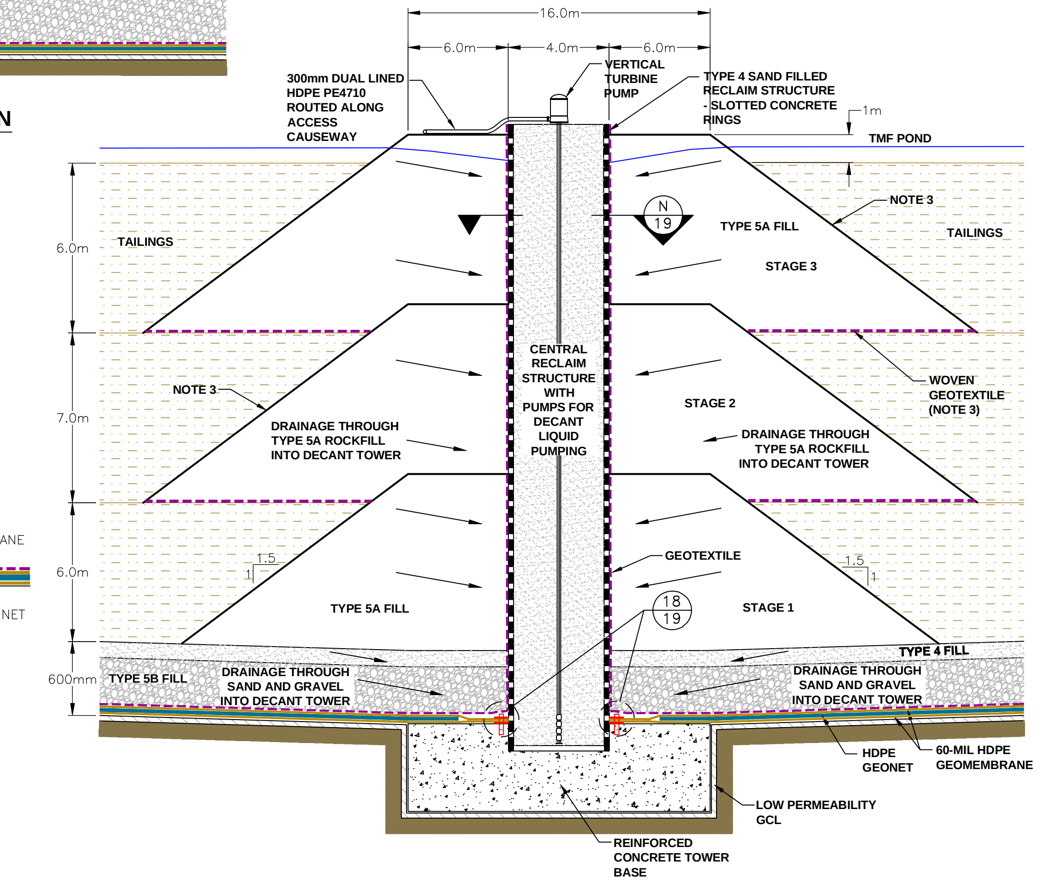
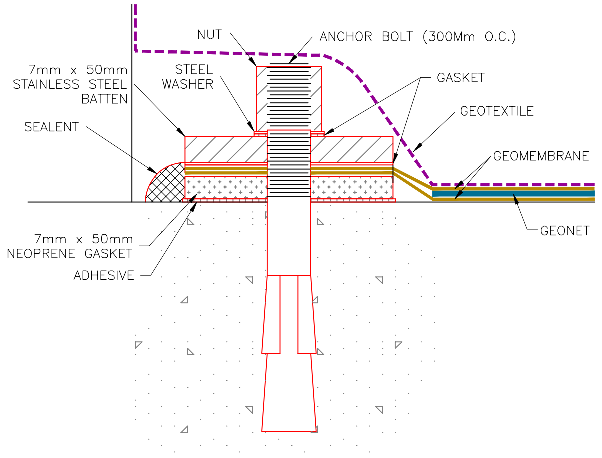


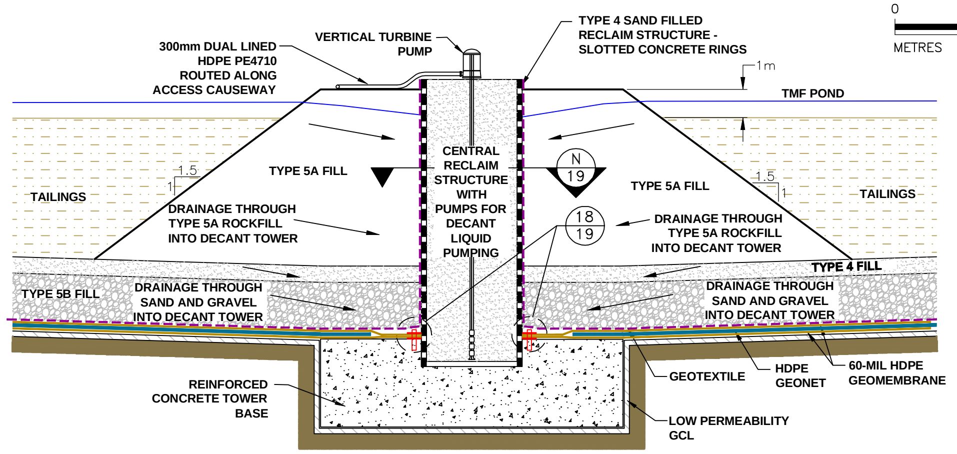
17 19 ULTIMATE RECLAIM STRUCTURE DETAIL

NOT TO SCALE



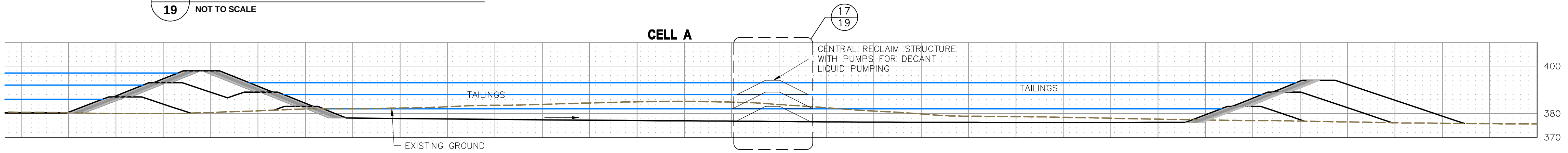
18 19 ANCHOR BOLT GEOMEMBRANE CONNECTION

NOT TO SCALE



17 19 STAGE 1 RECLAIM STRUCTURE DETAIL

NOT TO SCALE



SECTION M 19

HORZ. 1:1000
VERT. 1:1000

PRELIMINARY - NOT FOR CONSTRUCTION

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DWG No.	DESCRIPTION

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DESIGN AUTH. APPROVAL:		

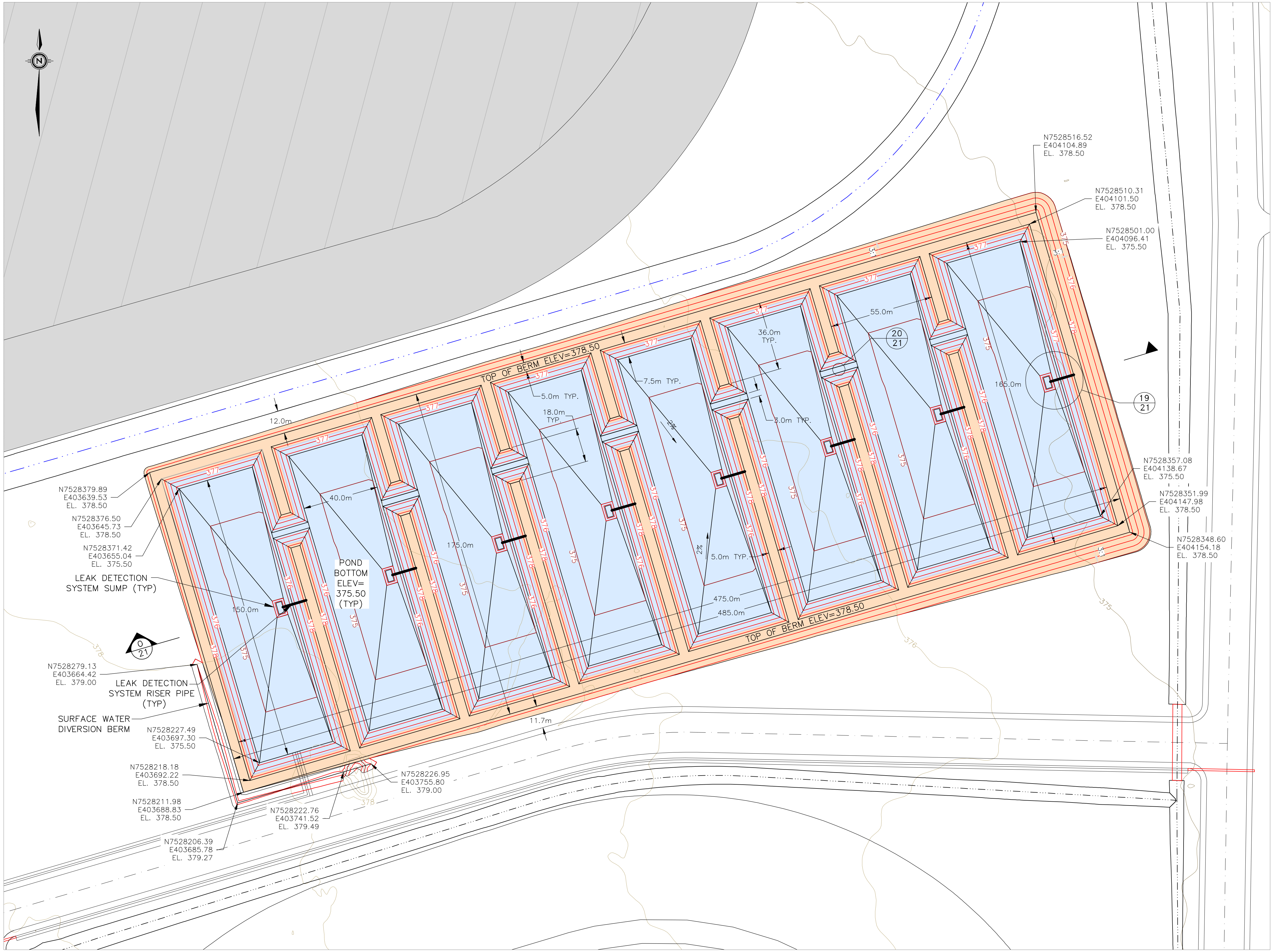
LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE
PFS DESIGN
RECLAIM SYSTEM PLAN & DETAILS

DWG No. **19** REV A

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\RECLAIM PLANS & DETAILS.dwg – 8/2/2012 11:38 AM

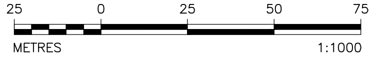


GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

GENERAL LEGEND

🟧	EMBANKMENTS
🟦	EVAPORATION POND LINER EXTENTS



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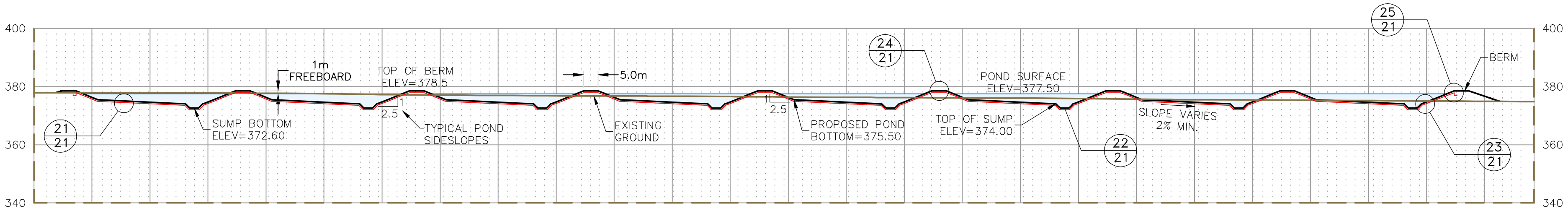
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

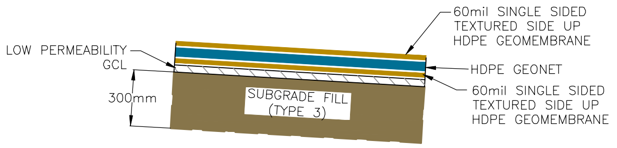
AREA TAILINGS MANAGEMENT FACILITY

TITLE
PFS DESIGN
EVAPORATION PONDS PLAN

DWG No. **20** REV A



SECTION O/21
HORIZ. 1:1000
VERT. 1:1000



21/21 TYPICAL DOUBLE-LINED POND BOTTOM DETAIL
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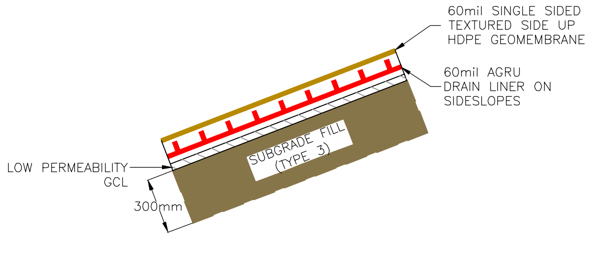
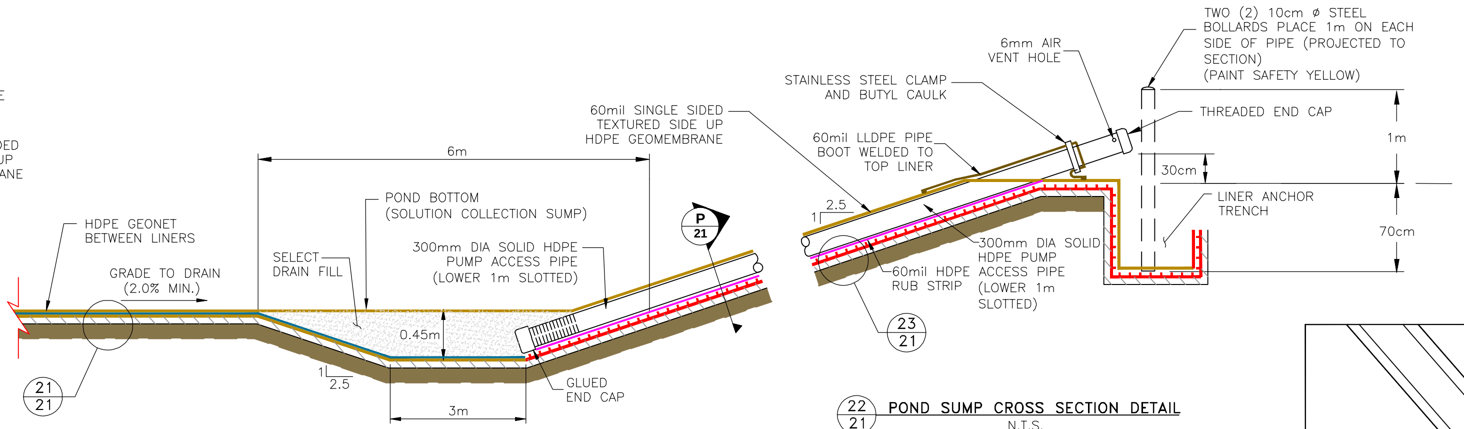


23/21 TYPICAL LINER AND DRAINAGE SYSTEM SIDE SLOPES
N.T.S.



22/21 POND SUMP CROSS SECTION DETAIL
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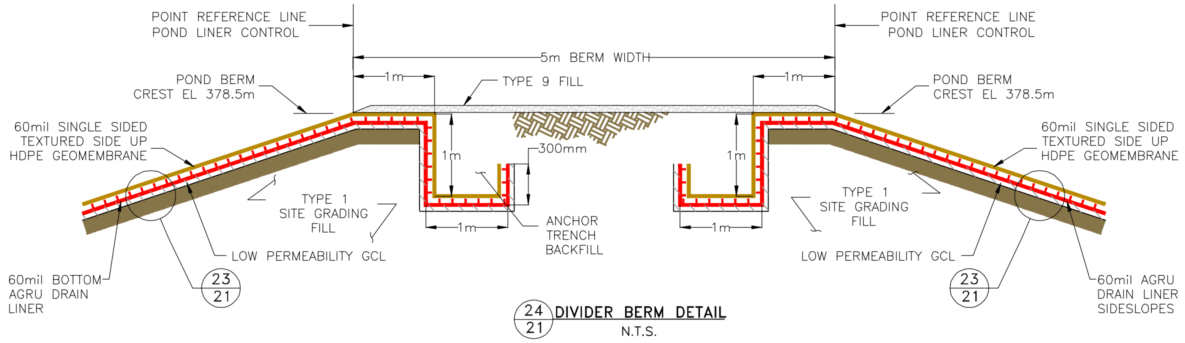

24/21 DIVIDER BERM DETAIL
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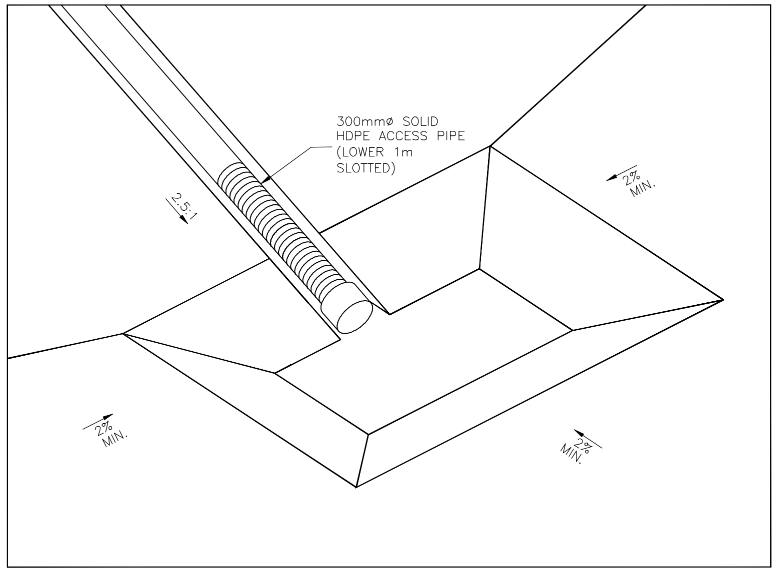

26/21 SUMP ISOMETRIC
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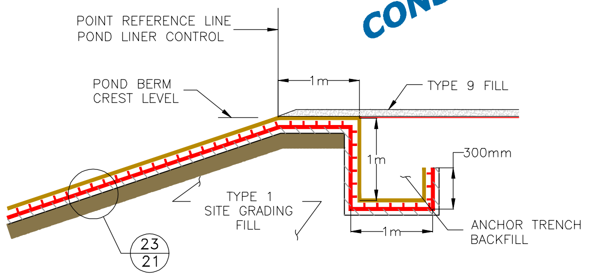

25/21 DOUBLE-LINED POND ANCHOR DETAIL
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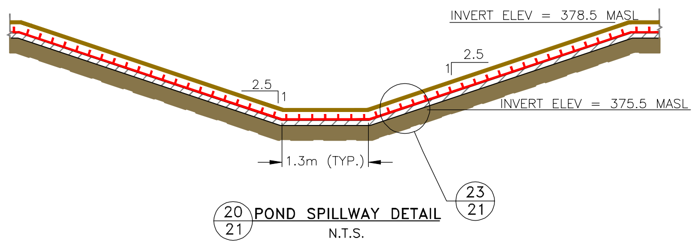
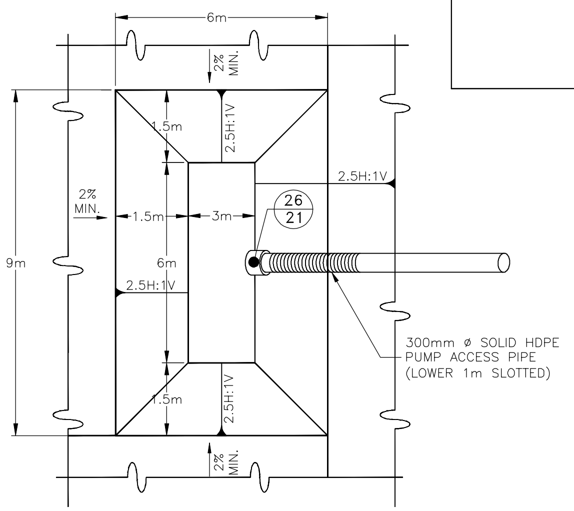
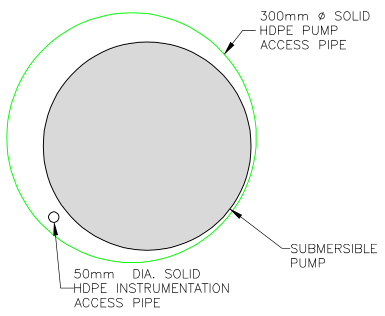


20/21 POND SPILLWAY DETAIL
N.T.S.



19/21 LCRS SUMP PLAN
N.T.S.



P/21 LCRS ACCESS PIPE
N.T.S.

REFERENCE	
DWG No.	DESCRIPTION

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
A	00/00/00	ISSUE FOR REVIEW AND APPROVAL	--		

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

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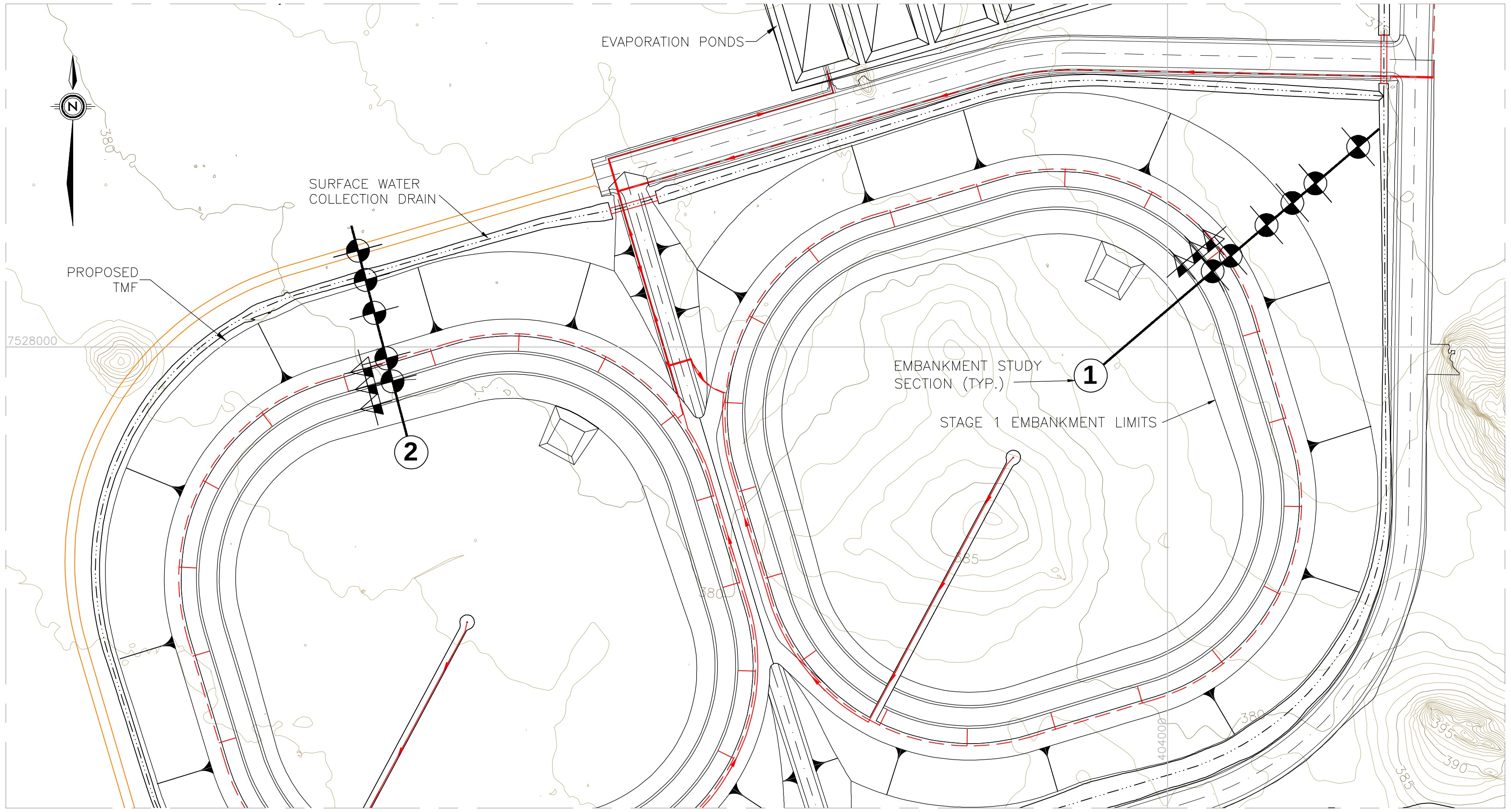
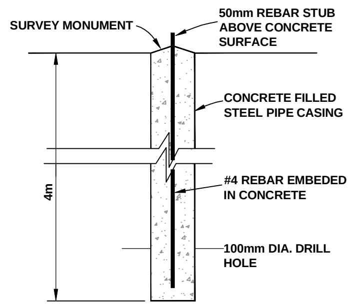
MANAGEMENT RELEASE:

SCALE (A1): **AS SHOWN**		DATE
DESIGNED:	T. MEYER	06/19/12
DRAWN:	L. STANSBURY	06/19/12
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
EVAPORATION PONDS
SECTION AND DETAILS
DWG No. **21**
REV A

Herranz, Marco – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre-Feasibility\Dwgs\Working Drawings\EVAP PONDS.dwg – 8/1/2012 6:06 PM





SURVEY MONITORING DETAIL 27/22

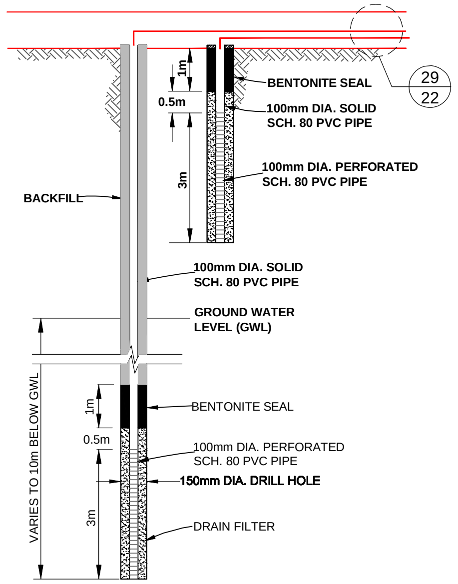
(SCHEMATIC - NO SCALE)

GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.

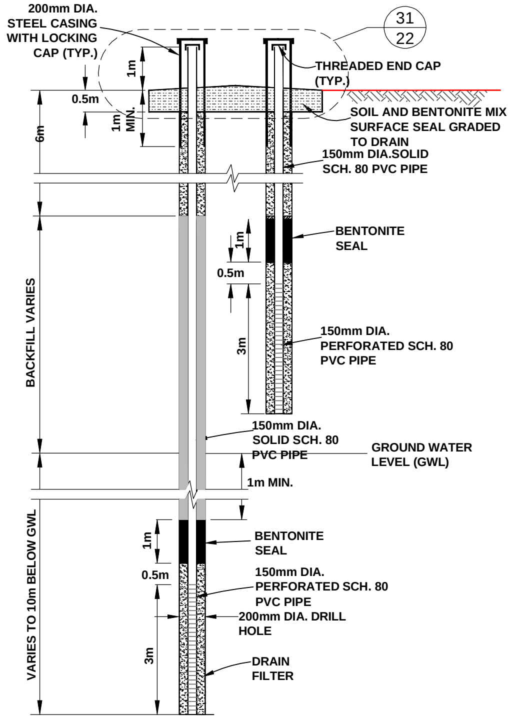
LEGEND

⯁	PLANNED SURVEY MONUMENT
⊕	PLANNED EMBANKMENT PIEZOMETER
①	STUDY SECTION NUMBER



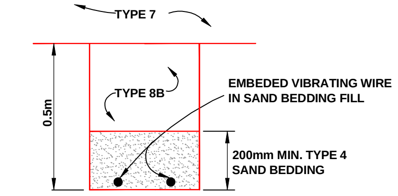
EMBANKMENT MONITORING DETAIL 28/22

(SCHEMATIC - NO SCALE)



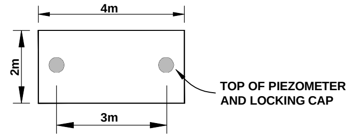
WATER MONITORING DETAIL 30/22

(SCHEMATIC - NO SCALE)



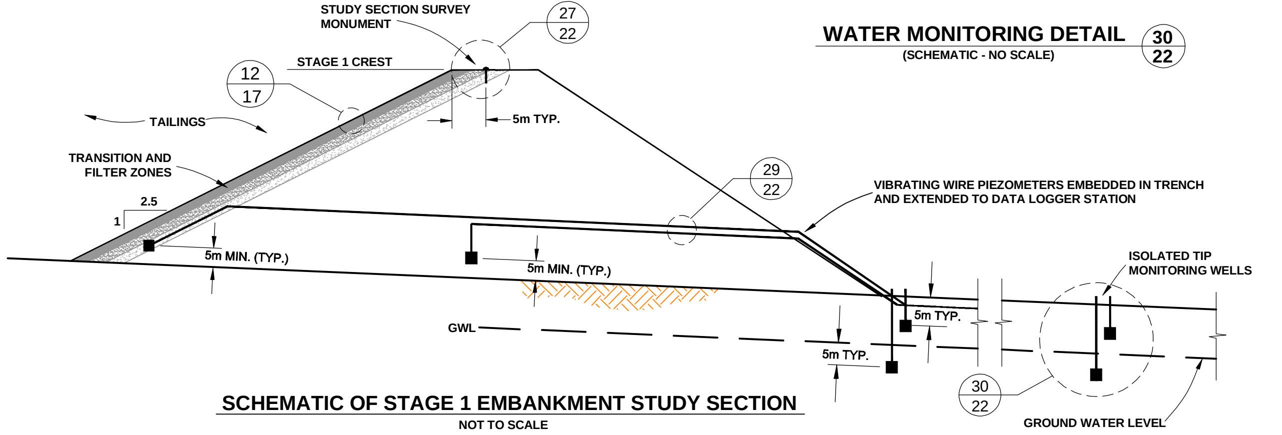
PERIMETER TRENCH DETAIL 29/22

(SCHEMATIC - NO SCALE)



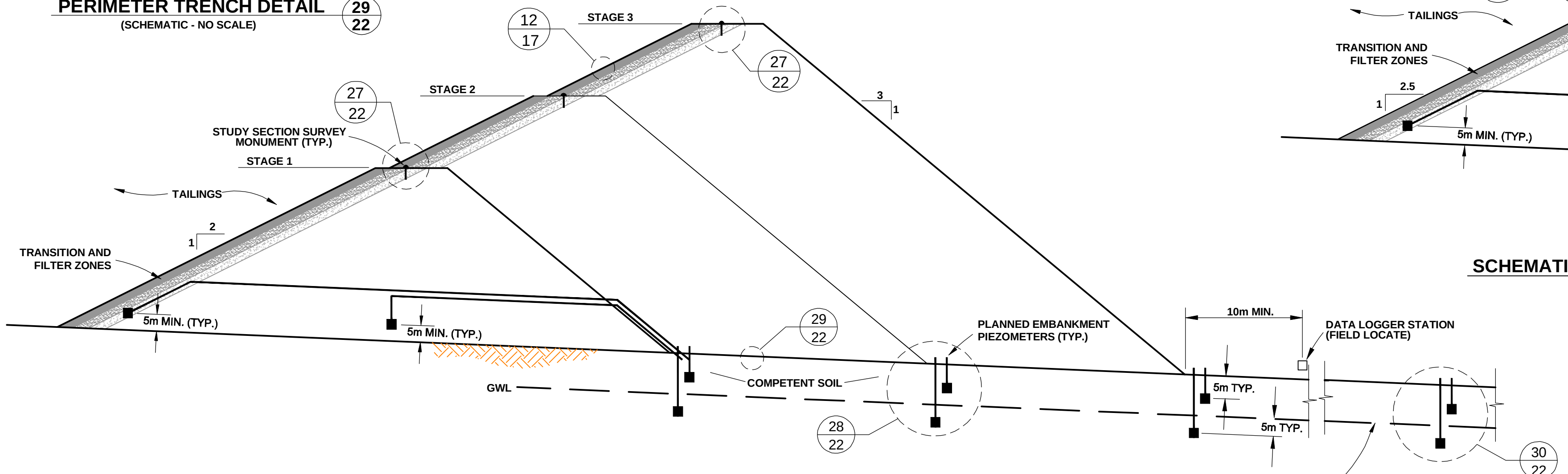
MONITORING WELL CAP PLAN DETAIL 31/22

(SCHEMATIC - NO SCALE)



SCHEMATIC OF STAGE 1 EMBANKMENT STUDY SECTION

NOT TO SCALE



SCHEMATIC OF STAGED EMBANKMENT STUDY SECTION

NOT TO SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

50 0 50 100 150
METRES 1:2000

REFERENCE	
DWG No.	DESCRIPTION

REVISIONS					
No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
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No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

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MANAGEMENT RELEASE:

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DESIGNED:	T. MEYER	21/06/12
DRAWN:	L. STANSBURY	21/06/12
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

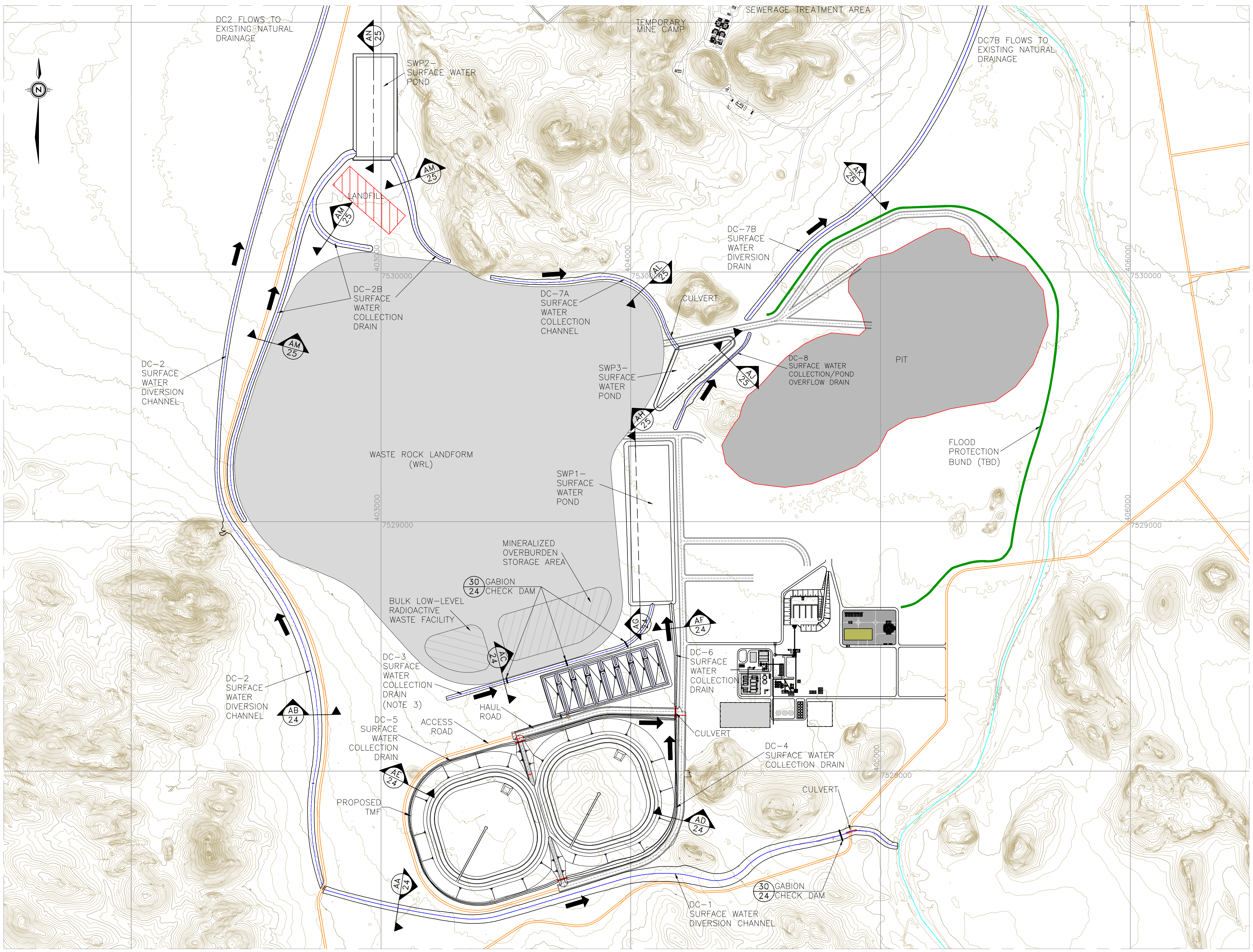
LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE PFS DESIGN
TAILINGS EMBANKMENT INSRUMENTATION
PLAN AND DETAILS

DWG No. 22

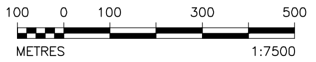
REV A



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. ALL FACILITIES SHOWN ARE PROPOSED UNLESS OTHERWISE NOTED.
4. DRAINS DC–3 AND DC–4 WILL INCLUDE GABION CHECK DAMS AT 240m INTERVALS

PRELIMINARY - NOT FOR CONSTRUCTION



Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\SWMP.dwg – 7/30/2012 2:51 PM

REFERENCE

DWG No.	DESCRIPTION

REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
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REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

Cameco

MANAGEMENT RELEASE:

SCALE (A1):	1:7500	DATE
DESIGNED:	T. MEYER	21/06/25
DRAWN:	L. STANSBURY	21/06/25
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

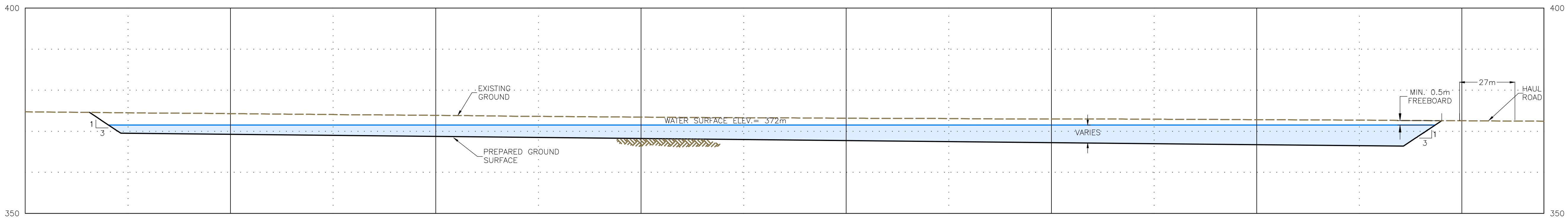
AREA TAILINGS MANAGEMENT FACILITY

TITLE

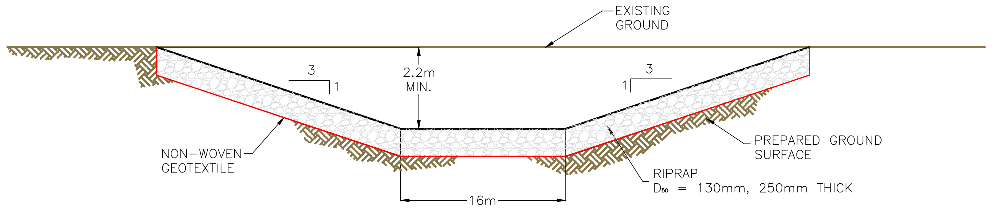
PFS DESIGN
SURFACE WATER MANAGEMENT PLAN

DWG No. 23

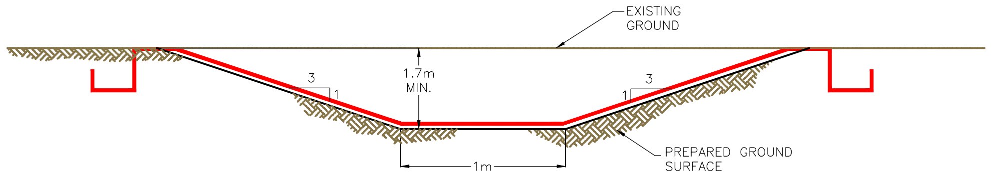
REV A



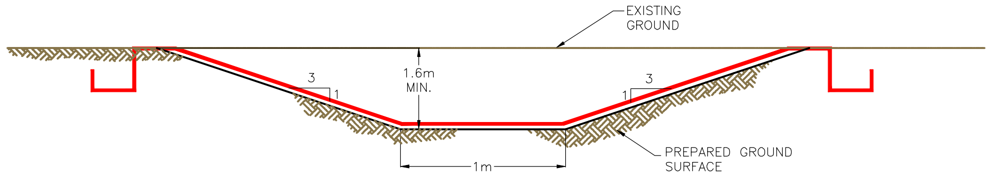
AG 24 SWP1 – SURFACE WATER POND
1:1000 HORZ.
1:500 VERT



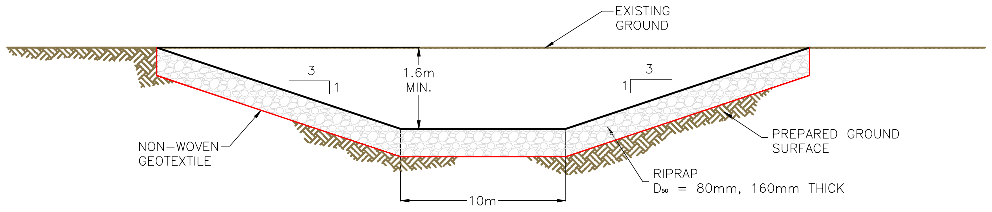
AA 24 DIVERSION CHANNEL DC–1 SECTION
N.T.S.



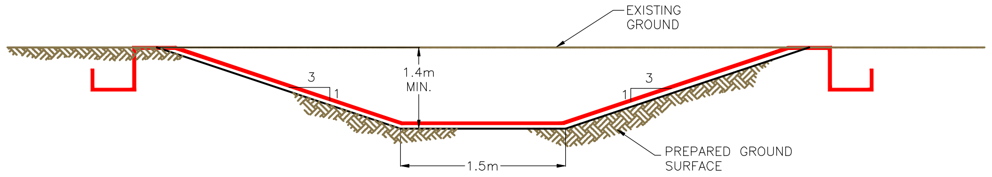
AD 24 COLLECTION DRAIN DC–4 SECTION
N.T.S.



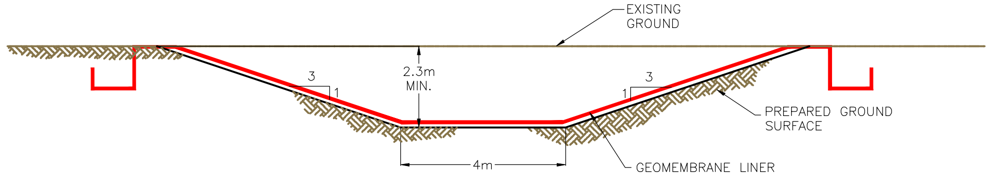
AE 24 COLLECTION DRAIN DC–5 SECTION
N.T.S.



AB 24 DIVERSION CHANNEL DC–2 SECTION
N.T.S.

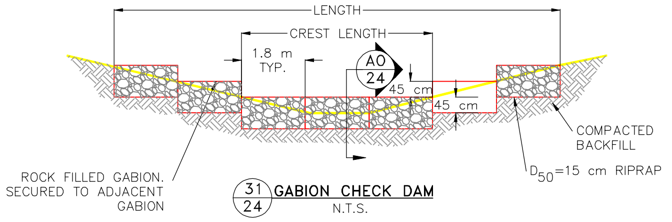


AF 24 COLLECTION DRAIN DC–6 SECTION
N.T.S.

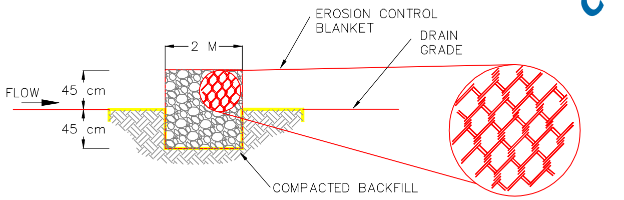


AC 24 COLLECTION DRAIN DC–3 SECTION
N.T.S.

PRELIMINARY - NOT FOR CONSTRUCTION



31 24 GABION CHECK DAM
N.T.S.



AO 24 GABION CHECK DAM DETAIL
N.T.S.

DWG No.	DESCRIPTION

REFERENCE

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REVISIONS

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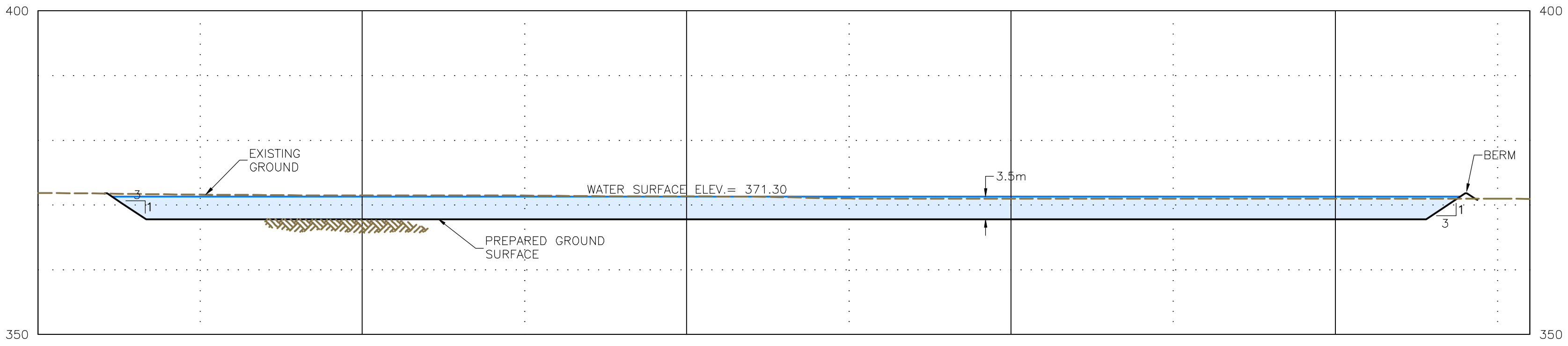
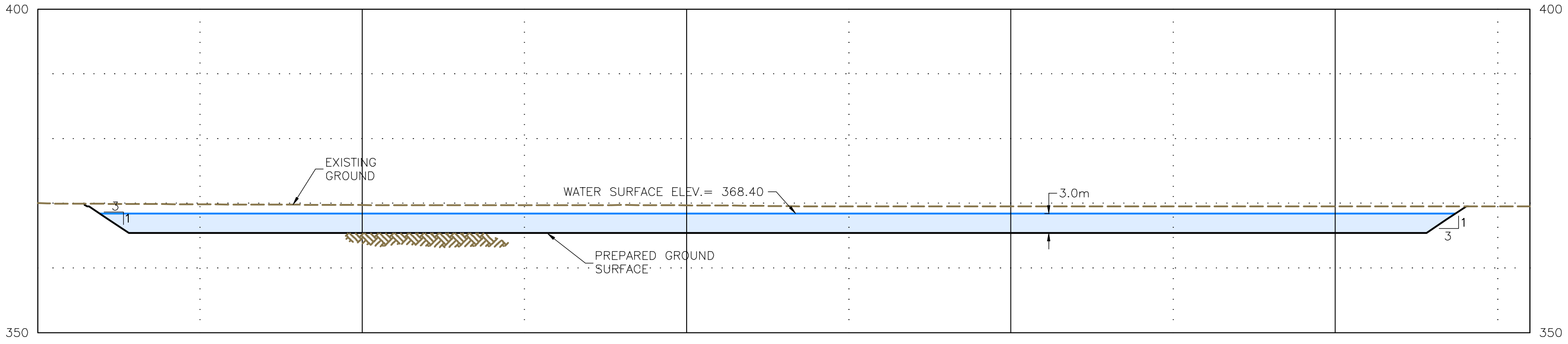
DESIGNED:	T. MEYER	21/06/25
DRAWN:	L. STANSBURY	21/06/25
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
SEDIMENT AND RETENTION POND
SECTIONS AND DETAILS
DWG No. **24**
REV A

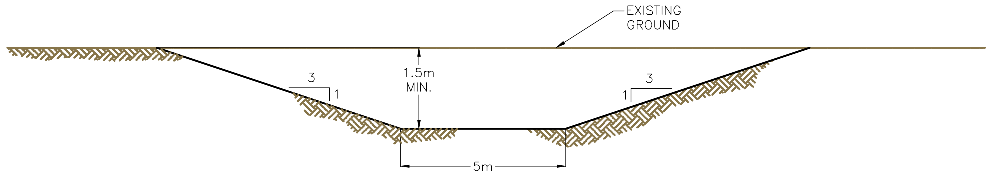
Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\SWMP.dwg – 7/31/2012 6:06 PM



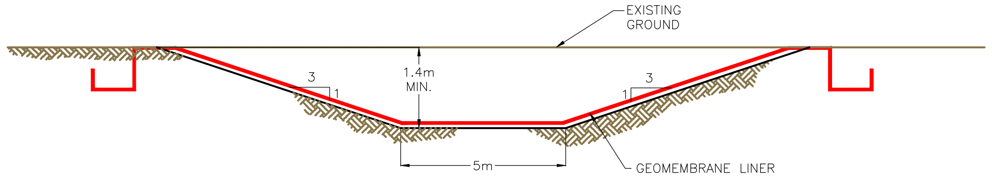
AH/25 SWP3 – SURFACE WATER POND
1:1000 HORZ.
1:500 VERT



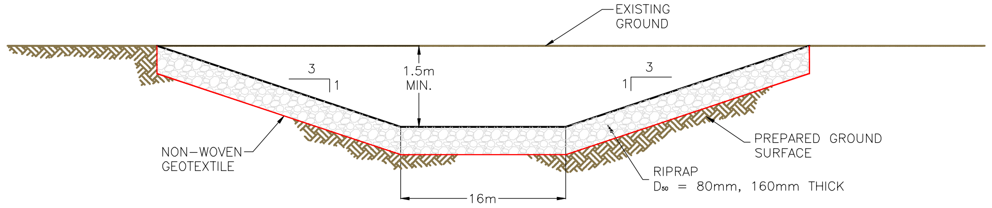
AN/25 SWP2 – SURFACE WATER POND
1:2550 HORZ.
1:500 VERT



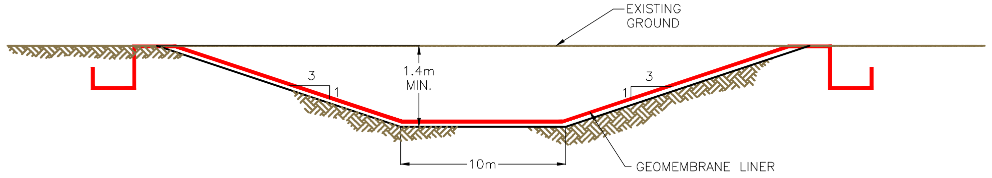
AJ/25 COLLECTION DRAIN DC–8 SECTION
N.T.S.



AL/25 DIVERSION DRAIN DC–7A SECTION
N.T.S.



AK/25 DIVERSION CHANNEL DC–7B SECTION
N.T.S.



AM/25 COLLECTION DRAIN DC–2B SECTION
N.T.S.

REFERENCE

DWG No.	DESCRIPTION

REVISIONS

No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
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No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

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SCALE (A1): 1:AS-SHOWN		DATE
DESIGNED:	T. MEYER	21/06/25
DRAWN:	L. STANSBURY	21/06/25
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

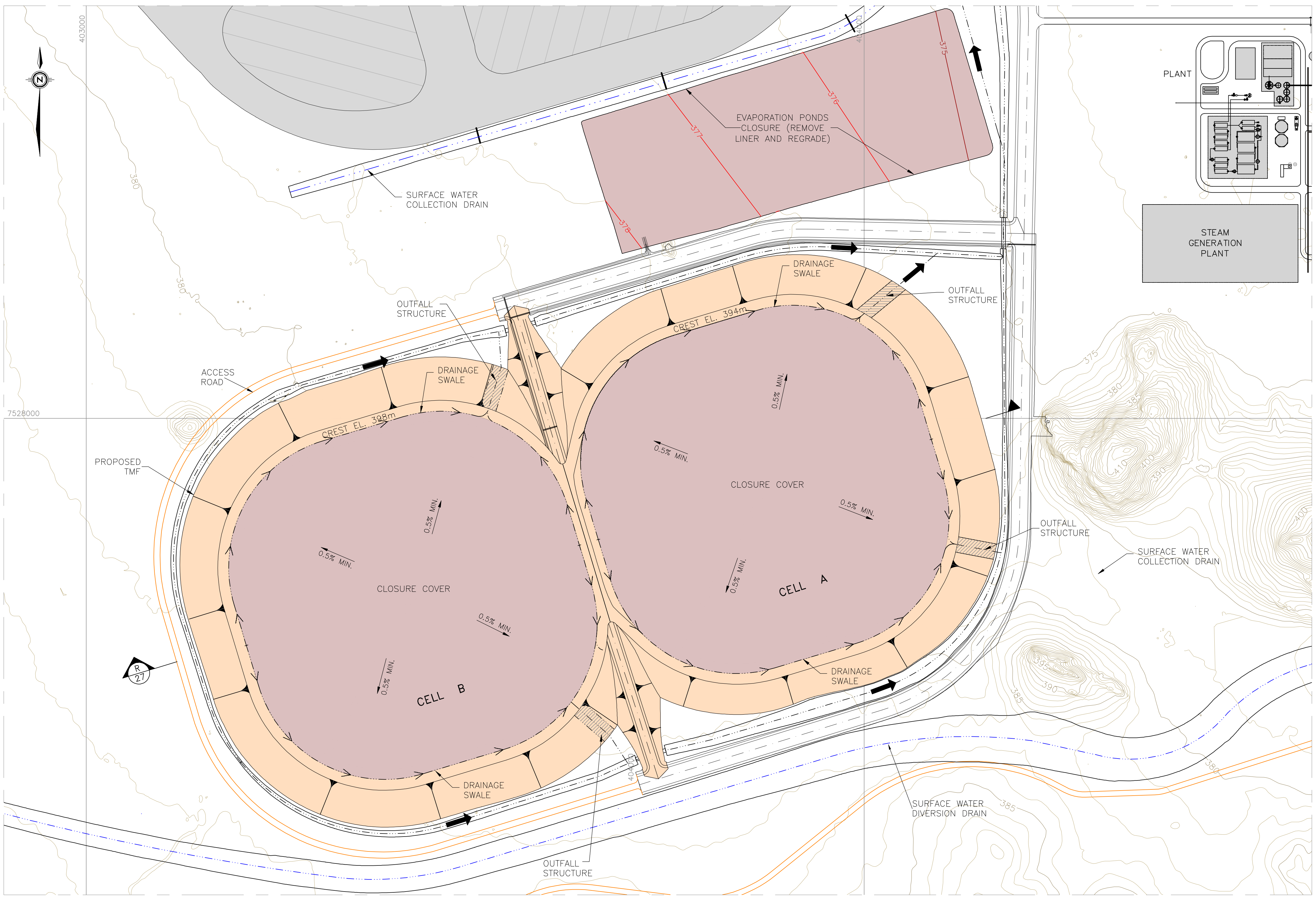
LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE
PFS DESIGN
SEDIMENT AND RETENTION POND
SECTIONS AND DETAILS

DWG No. **25**
REV A

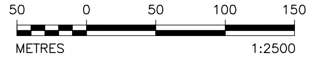
Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\SWMP.dwg – 7/30/2012 2:51 PM



GENERAL NOTES:

1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. TMF COVER GRADE OF 0.5% REPRESENTS POST–SETTLEMENT MINIMUM GRADE.

PRELIMINARY - NOT FOR CONSTRUCTION



Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\CLOSURE.dwg – 7/31/2012 3:18 PM

REFERENCE	
DWG No.	DESCRIPTION

REVISIONS					
No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.
A	00/00/00	ISSUE FOR REVIEW AND APPROVAL	--		

REVISIONS					
No.	DATE	DESCRIPTION	BY	DES. LEAD APPL.	DES. AUTH. APPL.

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MANAGEMENT RELEASE:

SCALE (A1): **1:2500**		DATE
DESIGNED:	T. MEYER	21/06/12
DRAWN:	L. STANSBURY	21/06/12
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE

AREA TAILINGS MANAGEMENT FACILITY

TITLE

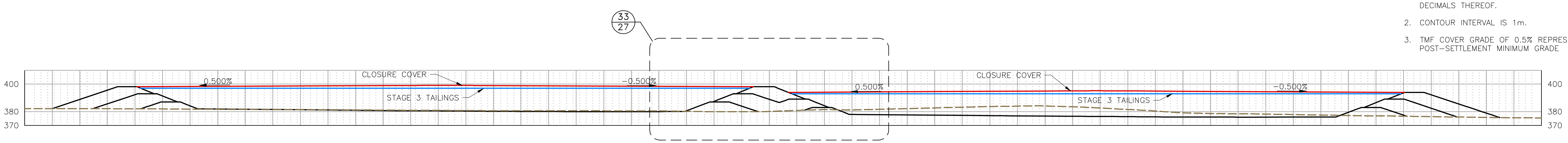
PFS DESIGN
IMPOUNDMENT PLAN AT CLOSURE

DWG No. **26**

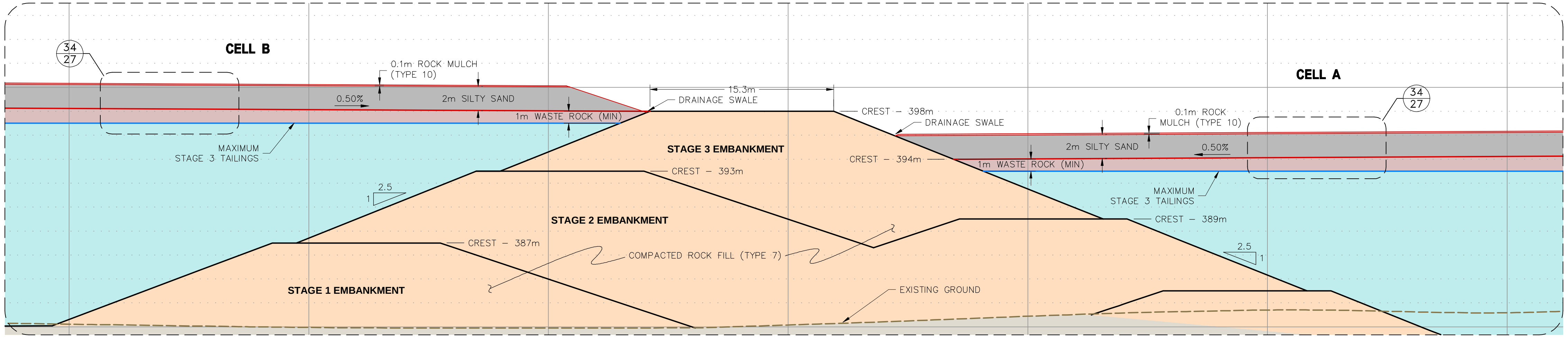
REV A

GENERAL NOTES:

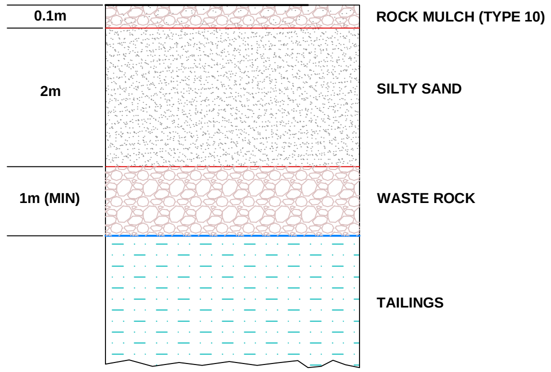
1. ALL COORDINATES ARE SHOWN IN METRES AND DECIMALS THEREOF.
2. CONTOUR INTERVAL IS 1m.
3. TMF COVER GRADE OF 0.5% REPRESENTS POST–SETTLEMENT MINIMUM GRADE.



SECTION (R / 27)
HORZ. 1:1500
VERT. 1:1500



DETAIL (33 / 27)
HORZ. 1:200
VERT. 1:200



(34 / 27) TMF PRELIMINARY COVER DETAIL
N.T.S.

PRELIMINARY - NOT FOR CONSTRUCTION

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MANAGEMENT RELEASE:

		DATE
SCALE (A1): **1:2500**		
DESIGNED:	T. MEYER	21/06/12
DRAWN:	L. STANSBURY	21/06/12
CHECKED:		
DESIGN LEAD APPROVAL:		
DESIGN AUTH. APPROVAL:		

LOC. KINTYRE
AREA TAILINGS MANAGEMENT FACILITY
TITLE
PFS DESIGN
IMPOUNDMENT PLAN
SECTIONS AND DETAILS
DWG No. **27** REV A

Stansbury, Lisa – K:\Clients\Cameco\Kintyre\Tailings PFS Design\CAD\C3D – Kintyre\Pre–Feasibility\Dwgs\Working Drawings\CLOSURE.dwg – 8/2/2012 9:34 AM