



SPECIFICATION **MC.01**

CONCRIB[®]
SEGMENTAL RETAINING CRIBWALL
EARTH RETAINING STRUCTURES

Copyright – Concrib Pty Ltd, 2004
MC.01

CONTENTS

- 1.0 SCOPE OF WORKS**
- 1.1 EXTENT
- 1.2 RESPONSIBILITIES
- 1.3 RELEVANT STANDARDS OR SPECIFICATIONS
- 1.4 GENERAL
- 1.5 REGULATIONS
- 1.6 SUBMITTALS/CERTIFICATION
- 1.7 QUALITY ASSURANCE
- 1.8 DELIVERIES, STORAGE AND HANDLING
- 2 MATERIALS**
- 2.1 DEFINITIONS
- 2.2 STRETCHERS, HEADERS, TAPERS, SPACER BLOCKS, CLOSERS, BACK STRETCHERS AND FALSE HEADERS
- 2.3 FOOTING
- 2.4 CRIBWALL INFILL
- 2.5 GEOTEXTILE FABRIC
- 3 CONCRIB® DESIGN CRITERIA.....**
- 3.1 USE OF DESIGN TABLES
- 3.2 STRUCTURE CLASSIFICATION
- 3.3 CRIBWALL PROPERTIES
- 3.4 LOADS ON STRUCTURE
- 3.5 RETAINED SLOPE GEOMETRY AND SOIL PROPERTIES
- 3.6 FOUNDATION MATERIAL PROPERTIES
- 3.7 DRAINAGE REQUIREMENTS
- 3.8 OTHER DESIGN CONSIDERATIONS
- 4 CONSTRUCTION**
- 4.1 FOUNDATION PREPARATION AND INSPECTION
- 4.2 EXISTING FILL - TEMPORARY BATTERS
- 4.3 CRIBWALL CONSTRUCTION CONSIDERATIONS
- 4.4 DRAINAGE.....
- 4.5 AS BUILT CONSTRUCTION TOLERANCES
- 4.6 FIELD QUALITY CONTROL
- 5 MEASUREMENTS AND PAYMENT**
- 5.1 MEASUREMENT
- 5.2 PAYMENT.....

1.0 SCOPE OF WORKS

A Concrib® reinforced concrete segmental crib retaining wall shall consist of MICRO, MIDI, MAXI and MACRO headers, stretchers, spacer blocks, closers, back stretchers and/or left and right hand tapers all combined to create a gravity earth retaining structure.

1.1 Extent

The work to be executed under this specification is the design, supply of all materials, plant and labour for the construction of a Concrib® cribwall and associated works as indicated in the specification and on the drawings and to the entire satisfaction of the superintendent.

1.2 Responsibilities

The wall installation subcontractor shall be responsible for carrying out the installation of the Concrib® retaining walls in accordance with the specification and associated contract documents. The subcontractor shall be suitably qualified and experienced.

1.3 Relevant Standards or Specifications

Wherever reference is made to Standards Association of Australia the requirements of the editions and amendments shall apply to the relevant materials or operations and be deemed to be incorporated in this specification.

The following standards or specifications listed are applicable to this type of work:

Design & Materials

1.	AS4678:2002	Earth Retaining Structures
2.	AS3600:2001	Concrete Structures
3.	AS4671:2001	Steel Reinforcing Materials
4.	AS1726:1993	Geotechnical Site Investigations

1.4 General

Terms used in this specification shall have the meanings assigned to them as follows:

“Approved” shall mean approved in writing by the project engineer.

“Or equally approved” shall mean equivalent in performance, quality and price to that specified and approved by the project engineer.

Where limits to the assumed soil parameters of soils are defined elsewhere herein these properties shall be determined in accordance with test method outlined in AS1289 (Refer Section 1.3 of this specification).

The term “construction area” in this Part shall be defined as an area to be excavated or an area to be defined as used by the wall installation subcontractor to erect retaining wall.

1.5 Regulations

The wall installation subcontractor shall comply with all relevant Acts, Regulations and By-Laws in respect of all work specified herein, including safety rail systems, strutting, guard rails and all safety measures to be adopted in accordance with safe work practices.

1.6 Submittals/Certification

Submittals shall include:

1. Manufacturer's certification, prior to start of construction, that the retaining wall system components meet the requirements of this specification and the structural design shall meet minimum requirements for structural stability of the wall.
2. Design for the retaining wall system prepared and stamped by a Certified Professional Engineer registered in the state of the project. Engineer to have minimum 5 years experience in this design technology. The engineering designs, techniques and materials evaluations shall be in accordance with AS4678. Global stability is the responsibility of the project engineer in conjunction with the project geotechnical engineer.
3. Construction Issue drawings including notes and design assumptions, wall elevations, design cross-section wall heights, header and stretcher layout, standard details, surface and subsurface drainage provisions and construction recommendations.
4. Samples
 - Manufacturer's certification and test reports stating that the materials meet those requirements stipulated in Section 2 of this specification.
 - Cribwall components shall meet requirements of testing carried out by Queensland University of Technology Report 92 entitled :The Design & Performance Measures Segmental Concrete Crib Retaining Walls.
5. Geotechnical certification shall be carried out by a suitably qualified and experienced geotechnical engineer. The following items shall be confirmed/certified prior to start of final design and/or before start of construction:
 - Bearing capacity of foundation meets design requirements as shown on project construction drawings
 - Surface and subsurface drainage.
 - Soil shear strength parameters (effective friction angle, cohesion and bulk density) for the retained and foundation materials.

1.7 Quality Assurance

Contractor shall submit certification, prior to start of work, that the proposed cribwall system :

- has been successfully utilized on a minimum of five (5) similar projects, i.e., height, , loadings, and
- has been successfully installed on a minimum of two thousand (2,000) square meters of retaining walls.

The walls shall be designed by a suitably qualified engineer having a minimum of five-years documentable experience in the design of earth retaining structures.

Soil testing and quality assurance inspections shall be provided during earthwork and wall construction operations. Contractor shall provide any quality control testing or inspection not provided by the Owner. Owner's quality assurance program does not relieve the contractor of responsibility for quality control and wall performance.

1.8 Deliveries, Storage and Handling

The cribwall components are delivered to site in strapped bundles or stacked on pallets.

The products may be stored in the open, but away from site traffic to avoid the risk of accidental damage, and should remain packaged until required.

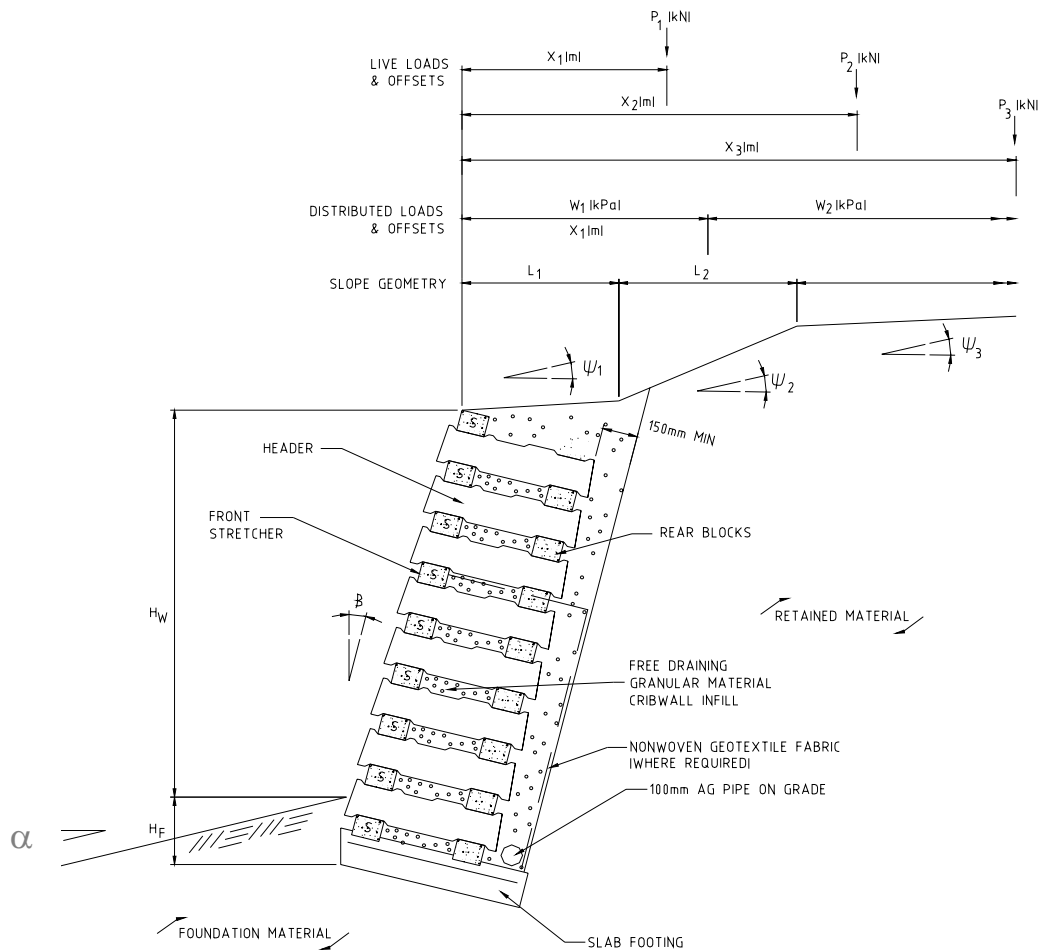
The contractor shall check the materials upon delivery to ensure that the specified materials have been received.

2 MATERIALS

2.1 Definitions

- A. Cribwall header units are the precast concrete components which run perpendicular to the face of the wall, i.e into the embankment.
- B. Cribwall stretcher and closer units are the precast concrete components running horizontally and parallel to the face of the wall.
- C. Cribwall taper units are the precast concrete components that connect to the end of a stretcher course and taper down to the stretcher course below.
- D. Cribwall back stretcher units are the precast concrete components which run horizontally at the rear face of the wall.
- E. Cribwall spacer block units are the precast concrete blocks used in the rear face of the wall between successive header courses.
- F. Cribwall false header units are the precast concrete components used in double and triple cell construction, in place of full length header units.
- G. Cribwall infill is the fill material which is used within the cribwall.
- H. Retained Fill is the insitu soil behind the cribwall.
- I. Foundation material is the soil mass supporting the cribwall retaining wall system.

Refer cross section next page detailing above definitions.



2.2 Stretchers, headers, tapers, spacer blocks, closers, back stretchers and false headers

All the above cribwall components are manufactured from 50MPa concrete with 25mm cover to reinforcement. The units shall be cast in rigid steel forms and the concrete compacted by placing a form on a vibrating table. Intense compaction of the crib components should be achieved.

2.3 Footing

The footing for a cribwall shall be designed to support the cribwall and distribute the bearing loads from it through to the subgrade. Footings may require to be reinforced, or simply a mass concrete blinding layer or alternatively a cement stabilised sand bedding layer for base course establishment.

2.4 Cribwall infill

Cribwall infill material shall be dense, hard, durable and clean materials as specified and approved by the project engineer. The most commonly used materials are from stone-quarries or riverbeds. The materials must have a minimum weight as specified on the design documents, be non-friable, non-washable and non-porous.

Recommended guidelines are given herein.

- A. Los Angeles Value (B) grading AS 1141.3 < 20%.
- B. Aggregate Wet/Dry Strength (AS1141.21)
Dry Strength shall not be less than 200kN
Wet Strength shall not be less than 100kN.
We/Dry strength variation shall not be greater than 50%.
- C. Rock size shall be between 10mm to 50mm.
- D. The loose fill density of the stone infill shall be generally being in the order of 1.5t/m³.

2.5 Geotextile Fabric

A geotextile fabric shall be used above the gravel infill material as a separation layer. Geotextile fabric shall be minimum weight of 140g/m².

3 CRIBWALL DESIGN CRITERIA

Cribwalls shall be designed in accordance with AS4678 – Earth Retaining structures and Concrib Pty Ltd recommendations.

3.1 Use of design tables

Design tables are available from Concrib Pty Ltd. Site specific geotechnical information and wall geometry will allow optimisation of cribwall geometry and overall stability. Design criteria checklists itemise all criteria required to design a cribwall in accordance with AS4678. Both single cell depth, double cell and triple cell depth wall configurations can be used subject to wall geometry, geotechnical conditions and loads applied to the cribwall.

3.2 Structure Classification

Cribwall structures shall be classified according to Table 1.1 of AS4678. This classification should be assessed with respect to likely consequences of structure failure by considering the following questions;

- Likely loss or damage to associated structures?
- Likely loss of function or facility?
- Possibility of people injury?
- Likely size and weight of facing elements?
- Height of wall?
- Proximity of nearby structure?

3.3 Cribwall properties

Cribwall properties shall be summarised according to wall height, foundation depth, cribwall infill type, cribwall face angle and respective header configurations, i.e MICRO 500, MIDI 700, MIDI LITE, MAXI 1000, MAXI LITE, MACRO 1300 and MACRO LITE.

3.4 Loads on structure

Loads applied to cribwall structures directly affect the internal and external stability of a cribwall structure. All applied dead and live loads shall be confirmed in the design process for both construction activities and most importantly loads expected to be experienced during the design life of the cribwall

structure. Loads may take the form of uniformly distributed loads, and line loads. Respective horizontal offsets from the rear of the top stretcher shall be nominated. Depending on the location of the cribwall the associated earthquake site factor and earthquake coefficient shall be determined (Refer AS1170.1)

3.5 Retained slope geometry and soil properties

Retained slope geometry shall be confirmed documenting slope batter lengths and horizontal profiles with respect to top stretcher. Such geometry effects both earth pressure and overall stability of a cribwall structure.

Retained material essentially comprises “on- site” insitu strata which the cribwall is retaining. The assumed soil properties “drained” and unit bulk unit weight shall be verified. All soil testing and verification (laboratory in insitu test methods) shall be carried out by a suitably qualified and experienced geotechnical engineer.

3.6 Foundation material properties

Foundation material essentially comprises “on- site” insitu strata for which the cribwall is founded upon. The assumed soil properties “drained” and unit bulk unit weight shall be verified. Allowable foundation bearing capacity, “drained” (long-term) and “undrained” (short-term) shall also be verified to meet those minimum design requirements shown on the project construction drawings. All soil testing and verification (laboratory in insitu test methods) shall be carried out by a suitably qualified and experienced geotechnical engineer.

Where toe slopes are evident below cribwalls, extra precaution shall be adopted to assess the potential for sliding movement of the wall and for global slip failure. This is generally countered by providing for an antislid nib incorporated into the slab footing (shear key).

Foundation bearing capacity “drained” (long-term) & “undrained” (short-term) and overall global stability shall be checked by a suitably qualified and experienced geotechnical engineer. Global stability shall be checked for circular and non-circular failure modes.

3.7 Drainage Requirements

All cribwall dimensions, slope geometry and soil properties for both retained and foundation materials have been determined assuming adequate drainage of water from the backfill materials and foundation. Adequate drainage of the backfill shall be achieved by using materials of the type specified within this specification. Unless the cribwall is designed to resist both hydrostatic and earth pressures, suitable drainage subsoil drainage system shall be incorporated into the structure design.

Where required, blanket drains may be laid either immediately behind the structure or at the interface between natural ground and the retained backfill. Alternatively, geocomposite drainage products may be used in cases where the imposed overburden stresses do not damage or crush the geocomposite materials.

Overall surface drainage above and below the cribwall also needs to be addressed to protect the surfaces against erosion and prevent surface runoff from entering the cribwall inducing additional loads not designed for. Catch drains shall be provided where required to divert flows away from the cribwall structures.

3.8 Other design considerations

Other cribwall design considerations may include:

- Land contouring at the top of the cribwall to prevent major flows of water down the face of the wall
- The possibility of the cribwall subject to flooding which would require a crushed rock spoil material for the wall infill to prevent any washing out.
- Sealing the top of the cribwall with a compacted clay plug to minimise entry of surface runoff.
- Provision of a drainage layer at the rear face of the cribwall should it be considered that the wall infill materials too impervious to maintain free draining characteristics
- Proposed structures on top of the cribwall are rigid structures; i.e rigid structures should not be built on top of a Concrib[®] wall on reliance on the wall to support such a structure.

4 CONSTRUCTION

4.1 Foundation Preparation & Inspection

The foundation preparation shall include the removal of all loose rock and soil. Any irregularities in the level of foundation shall be filled with mass concrete to form a working surface for the wall foundation.

The foundations shall be excavated as required for cribwall slab footing or base dimensions shown on the project construction drawings, or as directed by the geotechnical consultant.

The foundations shall be examined by the geotechnical consultant to ensure that the actual foundation soil strength meets or exceeds the assumed design strength. Soil not meeting the required strength shall be removed and replaced with acceptable material as directed by the geotechnical consultant. For sloped footings excavation should be started from the lowest part of the wall so that horizontal steps can be dug into rising ground then stepping up in single or multiple course heights i.e. 250mm or multiples of 250mm.

Remember that for each rise of 250mm in the footing of a wall with 1:4 batter (wall slope 1 horizontal to 4 vertical) the line of the footing on the front face will move 62.5mm closer towards the retaining embankment because of the batter.

For low height walls (<1750mm high) a blinding layer of compacted sand up to 50mm in thickness will ensure that the base stretchers are bearing on an evenly supported surface, when base course stretchers and closers are laid "on ground".

Typically a concrete footing will be required and should be poured at the 1 in 4 batter at the designed thickness and the base course of stretchers and closers can be laid directly on the concrete prior to concrete setting, or after final concrete set on a fine blinding layer of mortar mix.

4.2 Existing fill – temporary batters

Where a temporary batter is to be excavated in front of and within 10m laterally of existing structures, the crib wall shall be constructed in stages. Construction of each stage shall be completed (drainage, backfilling etc) before excavation of the next section.

Temporary batters may be excavated only in anticipated prolonged dry periods and remain open for no more than 2 weeks. Waterproof sheeting should be available to cover the batter slope during any wet weather and the contractor should be prepared to backfill the excavation in the event of prolonged wet weather.

Excavation of fill materials where the required slopes are steeper than 1 (H): 1(V) will require assessment by a geotechnical engineer to ensure stability and safety during construction.

4.3 Cribwall construction

The construction of the cribwall shall be carried out in accordance Concrib® specification and recommendations and in consideration of specifications for site management, site earthworks and any additional specifications which impact on or are impacted by the cribwall construction process.

Typical cribwall construction procedures is summarised below:

1. Ensure all applicable drawings and documentation to the specific cribwall project are on hand and is understood by all parties to the contract.
2. Ensure control line for cribwall set out is carried out by a registered surveyor.
3. Using the control line, set out the front line of the wall and or top front/back of wall usually with an offset line to provide clear working space.
4. Excavate the embankment face to the depth required to accommodate the nominate cribwall section cell depth shown on the construction drawings. The excavated batter slope shall be profiled to match the wall batter designed and the height of excavation to be assessed and approved by the project geotechnical engineer.
5. Excavate the footing in accordance with dimensions and grades shown on the drawings to correct batter, level, line, embedment, step configuration and length.
 - a. For a concrete footing, the front edge of the footing shall be formed up, reinforcement placed with correct chair height and where required shear key reinforcement tied in.
 - b. The footing shall be poured with the specified concrete strength, screeded and rough wood float to correct level and batter.
6. Stretchers to be set into concrete with min 10mm, max 25mm embedment, set to line, level and batter. For non concrete footing set the base stretcher into cement stabilised sand. Rear spacer block or back stretcher also set into concrete or blinding layer to suit header size, at correct line level and batter.
7. The first row of headers is then placed @ 1m centres, followed by stretcher row then back stretcher and spacer block row. Repeat this to maximum free standing heights of 1m for MICRO, 1.5m for MIDI, 2.5m for MAXI and 3m for MACRO.
8. Agricultural drainage pipe is then placed at the rear base of the wall with outlets to front of wall at least every 20mm.
9. Where required a geotextile fabric is then pinned against the embankment face.
10. Backfill cribwall with the specified/approved crushed rock backfill in 500mm layers and hand tamper particularly around header components.
11. Stretchers are then butted together with at least every second course checked for level with dumpy and line with stringline stretcher from end to end. Packing to be used to pack stretcher ends where height differential exceeds 3mm.
12. Header units shall be placed so as to maintain the perpends for the full height of the wall in a straight vertical line.
13. Each unit shall bear evenly on the underlaying unit.
14. Care shall be taken during compaction to avoid damaging or distorting the wall.
15. Within the top three courses of header units shall be filled with earth material (clayey if possible) after placing a geotextile fabric over the underlying cribwall infill. This earth material is to be compacted to create a "plug".
16. For wall heights over minimum state statutory requirements, a protective handrail is to be secured along the front face of the working area and raised with the wall as height increases.
17. Manual handling of cribwall components is to be limited to individual comfortable lifting capacity. Heavy components e.g. 61kg stretcher shall be a 2 man lift.

Additional construction considerations are summarised below:

- A. **Convex curves.** These can be achieved with a cribwall; however allowance must be made for the reducing stretcher course arc length with increasing height due to the 1:4 batter. Either the lower stretcher courses can be commenced with gaps between the stretchers; or as course lengths reduce with increasing height, stretchers can be cut.
- B. **Concave curves.** These can also be built, however because of the 1: 4 batter, stretcher course arc lengths will increase with increasing height. Here the bottom row of stretchers should be laid butting together, and as the wall increases in height the gaps between the stretchers become larger.

Note: the gaps in both convex and concave walls may be as large as appearance and infill retention will allow.

- C. **Corners.** Internal and external corners at almost any angle can be accommodated. For internal corners, stretcher lengths increase with increase in wall height. Therefore shorter (CUT) stretchers should commence bottom row. For external corners stretcher lengths decrease with increase in wall height. Here stretchers need to be cut shorter with each subsequent course.

4.4 Drainage

All surface and subsurface drainage shall be designed in accordance with AS4678. Drainage of the wall foundation shall be achieved by installing a continuous 100mm diameters subsoil drain at the rear (heel) of the wall. The subsoil drain shall be slotted and be capable of withstanding a vertical pressure of 120kPa. The subsoil drain shall drain to discharge at maximum 20m spacings. Outlets shall be connected to a drainage system. Outlets under footings shall be to the subsoil drain with the trench 300 x 300mm min filled with gravel and encapsulated with geotextile fabric.

Where drainage of the rear of the cribwall is not possible the base of the cribwall shall be filled with concrete to achieve a fall from the embankment face to the front face of the cribwall.

4.5 As built construction tolerances

Based upon examination of numerous completed cribwall structures, the following recommended tolerances can be achieved with good construction techniques:

- Variation in any one course shall not be more than 5mm variation from a 5m template or straight edge.
- Relative position of adjacent stretchers in any one course in plan or elevation shall be within 5mm of the true alignment.
- Alignment of headers up the face of the wall shall be within ± 20 mm from vertical in elevation
- Variation in front batter slope from design slope shall be within ± 25 mm in 3m.
- Variation within batter slope shall not be more than 20mm from 3m straight edge.
- Variation from plane surface along the wall from straight walls of not more than 20mm from a 3m straight edge.

Horizontal and Vertical control can be maintained by surveying the wall during construction. Careful planning and attention should be paid to the compaction equipment and procedures used during construction. Non-uniform compaction procedures can result in vertical and horizontal alignment control problems.

Refer AS4678 Table 6.1 construction tolerances.

4.6 Field Quality Control

- A. Quality Assurance - The Owner shall/may engage inspection and testing services, including independent laboratories, to provide quality assurance and testing services during construction. This does not relieve the Contractor from securing the necessary construction quality control testing.
- B. Quality assurance should include foundation soil inspection. Verification of geotechnical design parameters, and verification that the contractor's quality control testing is adequate as a minimum. Quality assurance shall also include observation of construction for general compliance with design drawings and project specifications. Quality assurance is best performed by the onsite suitably qualified and experienced geotechnical engineer.
- C. Quality Control – The Contractor shall engage inspection and testing services to perform the minimum quality control testing described in the retaining wall design plans and specifications. Only qualified and experienced technicians and engineers shall perform testing and inspection services.
- D. Inspection and Test Plans shall be completed and submitted by the contractor for verification that the cribwall structures are being constructed in accordance with the design plans and project specifications.

5 MEASUREMENTS AND PAYMENT

5.1 Measurement

Cribwalls shall be measured per m² face.

Cribwall right hand and left hand tapers shall be measured per unit.

Cribwall infill shall be measured per m³ imported.

The volume of excavation m³ shall be measured based upon header depth x m² face area.

Cribwall footing to be measured per m³ poured + reinforcement schedule.

5.2 Payment

The scheduled payment unit rate for cribwalls shall include the supply and installation of footings, cribwall components, cribwall infill and geotextile fabric used and subsoil drain.

Payment shall be considered full compensation for all labour, materials, and equipment to install all cribwall components and site clean up.

Quantities may vary from that shown on project construction drawings depending on existing site topography. Changes to the total quantity of materials will be at the contract unit price bid.

A lump sum price for any of these items shall not be accepted (unless otherwise agreed to).

