

SPECIFICATIONS:
KEYSTONE WALL CONSTRUCTION

REFERENCE

Site Plan, prepared by Pacific Engineering Design

GENERAL

- A. Work shall consist of furnishing and construction of a KEYSTONE Retaining Wall System or equal in accordance with these specifications and in reasonably close conformity with the lines, grades, and dimensions shown on the plans.
- B. Work includes preparing foundation soil, furnishing and installing leveling pads, drainage fill and backfill to the lines and grades shown on the construction drawings.
- C. Work includes furnishing and installing geogrid soil reinforcement of the type, size, location, and lengths designated on the construction drawings.

SUBMITTALS

- A. Contractor shall submit a Manufacturer's certification, prior to start of work, that the retaining wall system components meet the requirements of this specification and the structure design.
- B. Contractor shall submit a test report documenting strength of specific modular concrete unit and geogrid reinforcement connection. The maximum design tensile load of the geogrid shall be equal to the laboratory tested ultimate strength of geogrid / facing unit connection at a maximum normal force limited by the "Hinge Height" of the structure divided by a safety factor of 1.5. The connection strength evaluation shall be performed in accordance with NCMA test method SRWU-1.

QUALITY ASSURANCE

- A. Contractor shall submit certification, prior to start of work, that the retaining wall system (modular concrete units and specific geogrid) has been successfully utilized on a minimum of five (5) similar projects, i.e., height, soil fill types, erection tolerances, etc.
- B. Contractor shall submit a list of five (5) previously constructed projects of similar size and magnitude by the wall installer where specific retaining wall system has been constructed successfully. Contact names and telephone numbers shall be listed for each project.
- C. Owner shall provide soil testing and quality assurance inspection during earthwork and wall construction operations. Owner's quality assurance program does not relieve the contractor of responsibility for wall performance.

DELIVERY, STORAGE AND HANDLING

- A. Contractor shall check all materials upon delivery to assure that the proper type, grade, color, and certification has been received.
- B. Contractor shall protect all materials from damage due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged materials shall not be incorporated into the work.

PRODUCTS

DEFINITIONS

- A. Modular Unit: a concrete retaining wall element, machine made from Portland Cement, water, and aggregates.
- B. Structural Geogrid: a structural element formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
- C. Unit Drainage Fill: drainage aggregate which is placed within and immediately behind the modular concrete units.
- D. Reinforced Backfill: compacted soil which is placed within the reinforced soil volume as outlined on the plans.

MODULAR CONCRETE RETAINING WALL UNITS

- A. Modular Concrete Units shall conform to the following architectural requirements:
bond configuration: running with bonds nominally located at midpoint vertically adjacent units, in both straight and curved alignments.
- B. Modular concrete materials shall conform to the requirements of ASTM C1372 - Standard Specifications for Segmental Retaining Wall Units.
- C. Modular concrete units shall conform to the following structural and geometric requirements measured in accordance with appropriate references:
compressive strength = 3000 psi minimum
absorption = 8% maximum (6% in northwestern states) for standard weight aggregates
dimensional tolerances = +1/8" from nominal unit dimensions not including rough split face, +1/16" unit height - top and bottom planes
unit size = 100lbs/unit minimum for standard weight aggregates
inter-unit shear strength = 1500 plf minimum at 2 psi normal pressure
geogrid/unit peak connection strength = 1000 plf minimum at 2 psi normal force
- D. Modular concrete units shall conform to the following constructability requirements:
vertical setback = 1.25" per course per the design
alignment and grid positioning mechanism - fiberglass pins, two per unit minimum
maximum horizontal gap between erected units shall be - 1/2 inch

SHEAR CONNECTORS

- A. Shear connectors shall be 1/2 inch diameter thermoset isophthalic polyester resin-pultruded fiberglass reinforcement rods or equivalent to provide connection between vertically and horizontally adjacent units. Strength of shear connectors between vertical adjacent units shall be applicable over a design temperature of 10 degrees F to +100 degrees F.
- B. Shear connectors shall be capable of holding the geogrid in the proper design position during grid pre-tensioning and backfilling.

BASE LEVELING PAD MATERIAL

- A. Material shall consist of a compacted crushed rock base or non-reinforced concrete as shown on the construction drawings.

UNIT DRAINAGE FILL

- A. Unit Drainage Fill shall consist of clean 1" crushed rock meeting the following gradation tested in accordance with ASTM D-422:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	75-100
No. 4	0 - 10
No. 50	0 - 5

- B. Drainage Fill shall be placed within cores of, between, and behind units a minimum distance of 18" as shown on the plans.

REINFORCED BACKFILL

- A. Reinforced Backfill shall be free of debris and generally meet the following gradation tested in accordance with ASTM D-422. Use of backfill that does not conform to this specification must be approved by the Geotechnical Engineer.

Sieve Size	Percent Passing
1 1/4 inch	100 - 75
3/4 inch	100 - 75
No. 40	0 - 60
No. 200	0 - 25

- B. The maximum aggregate size shall be limited to 1 1/2 inches unless field tests have been performed to evaluate potential strength reductions to the geogrid design due to damage during construction.
- C. Unsuitable soils for backfill (high plastic clays or organic soils) shall not be used in the backfill or in the reinforced soil mass.
- D. Contractor shall submit reinforced fill sample and laboratory test results to the Geotechnical Engineer for approval prior to the use of any reinforced fill material.

GEOGRID SOIL REINFORCEMENT

- A. Geosynthetic reinforcement shall consist of geogrids manufactured specifically for soil reinforcement applications and shall be manufactured from high tenacity polyester yarn or high density polyethylene. Polyester geogrid shall be knitted from high tenacity polyester filament yarn with a molecular weight exceeding 25,000 meg/m and a carboxyl end group values less than 30. Polyester geogrid shall be coated with an impregnated PVC coating that resists peeling, cracking, and stripping.
- B. Geogrid shall be Synteen SF-55 or approved alternative. Geogrid specifications shall be furnished to ESNW for approval prior to placement.
- C. Manufacturing Quality Control
The geogrid manufacturer shall have a manufacturing quality control program that includes QC testing by an independent laboratory. The QC testing shall include:
Tensile Strength Testing
Melt Flow Index (HDPE)
Molecular Weight (Polyester)

DRAINAGE PIPE

- A. The drainage pipe shall be rigid perforated PVC pipe manufactured in accordance with ASTM D-3034.

EXECUTION

EXCAVATION

- A. Contractor shall excavate to the lines and grades shown on the construction drawings. The Geotechnical Engineer shall observe the excavation and approve prior to placement of leveling material or fill soils. Proof roll foundation area as recommended by the Geotechnical Engineer to determine if remedial work is required.
- B. Over-excavation and replacement of unsuitable foundation soils and replacement with approved compacted fill will be compensated as agreed upon with the Owner.

BASE LEVELING PAD

- A. Leveling Pad material shall be placed to the lines and grades shown on the construction drawings, to a minimum thickness of 4 inches and extended laterally a minimum of 4" in front and behind the modular wall unit.
- B. Soil leveling pad materials shall be compacted to a minimum of 95% Modified Proctor density per ASTM D-1557-91.
- C. Leveling Pad shall be prepared to insure full contact to the base surface of the concrete units.

MODULAR UNIT INSTALLATION

- A. First course of units shall be placed on the leveling pad at the appropriate line and grade. Alignment and level shall be checked in all directions and insure that all units are in full contact with the base and properly seated.
- B. Place the front units side-by-side. Do not leave gaps between adjacent units. Layout of corners and curves shall be in accordance with manufacturer's recommendations.
- C. Install shear/connecting devices per manufacturer's recommendations. Wall batter shall be 8.8 degrees from vertical.
- D. Place and compact drainage fill within and behind wall units. Place and compact backfill soil behind drainage fill. Follow wall erection and drainage fill closely with structural backfill.
- E. Maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement and compaction, shall not exceed two courses.

STRUCTURAL GEOGRID INSTALLATION

- A. Geogrid shall be oriented with the highest strength axis perpendicular to the wall alignment.
- B. Geogrid reinforcement shall be placed at the strengths, lengths, and elevations shown on the construction design drawings or as directed by the Engineer.
- C. The geogrid shall be laid horizontally on compacted backfill and attached to the modular wall units. Place the next course of modular concrete units over the geogrid. The geogrid shall be pulled taut, and anchored prior to backfill placement on the geogrid.
- D. Geogrid reinforcements shall be continuous throughout their embedment lengths and placed side-by-side to provide 100% coverage at each level. Spliced connections between shorter pieces of geogrid or gaps between adjacent pieces of geogrid are not permitted.

REINFORCED BACKFILL PLACEMENT

- A. Reinforced backfill shall be placed, spread, and compacted in such a manner that minimizes the development of slack in the geogrid and installation damage.
- B. Reinforced backfill shall be placed and compacted in lifts not to exceed 6 inches where hand compaction is used, or 8 - 10 inches where heavy compaction equipment is used. Lift thickness shall be decreased to achieve the required density.
- C. Reinforced backfill shall be compacted to 90% of the maximum density as determined by ASTM D-1557-91. The moisture content of the backfill material prior to and during compaction shall be at or near the optimum moisture content.
- D. Only lightweight hand-operated equipment shall be allowed within 3 feet from the tail of the modular concrete unit.
- E. Tracked construction equipment shall not be operated directly upon the geogrid reinforcement. A minimum fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Tracked vehicle turning should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid.
- F. Rubber tired equipment may pass over geogrid reinforcement at slow speeds, less than 10 MPH. Sudden braking and sharp turning shall be avoided.
- G. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall units to direct runoff away from wall face. The Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

CAP INSTALLATION

- A. Cap units shall be glued to underlying units with an all-weather adhesive recommended by the manufacturer.

AS-BUILT CONSTRUCTION TOLERANCES

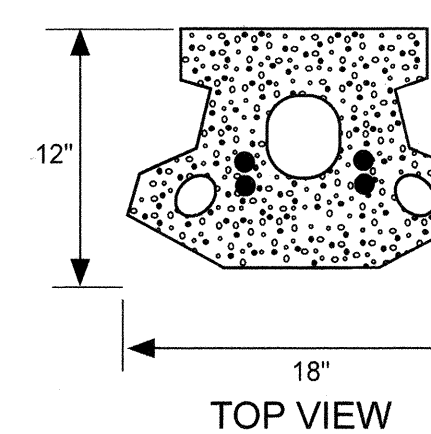
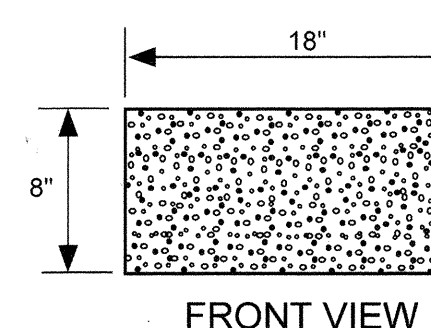
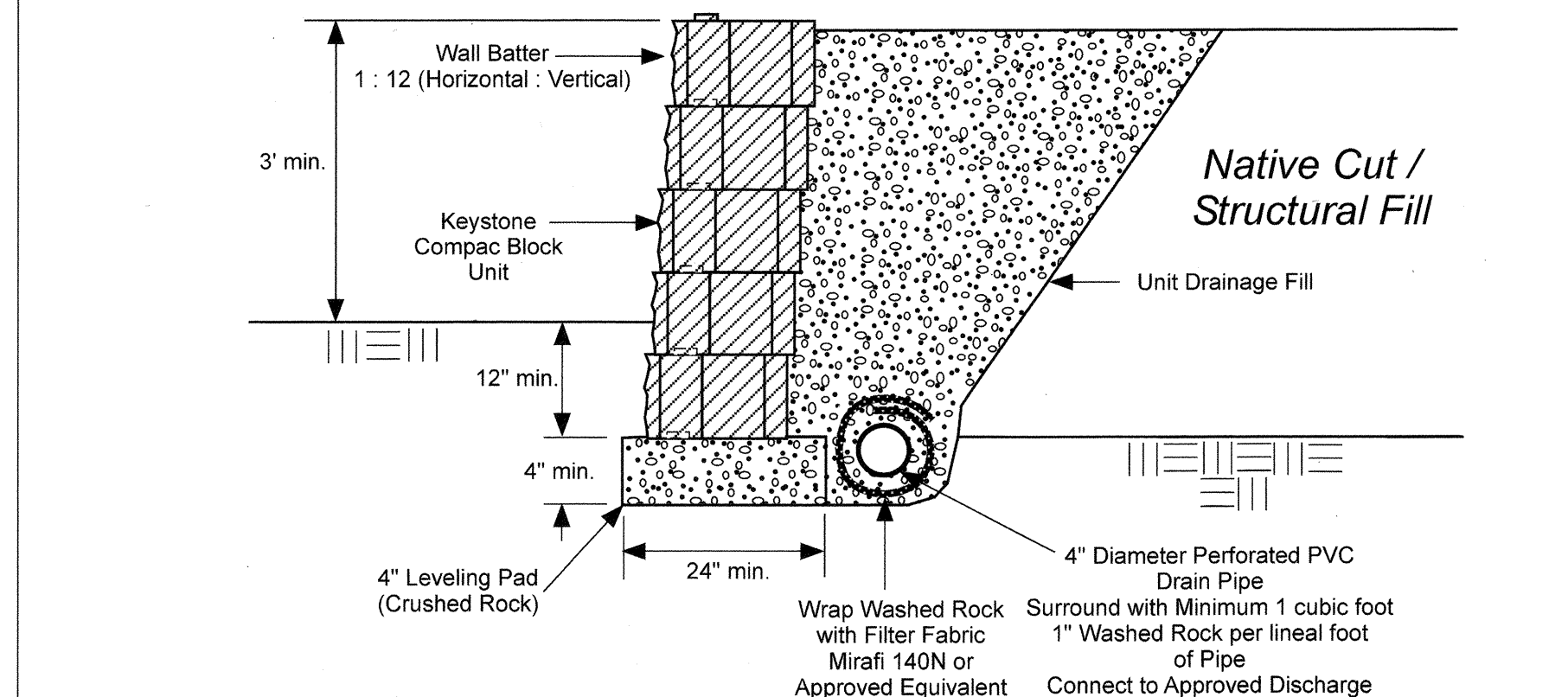
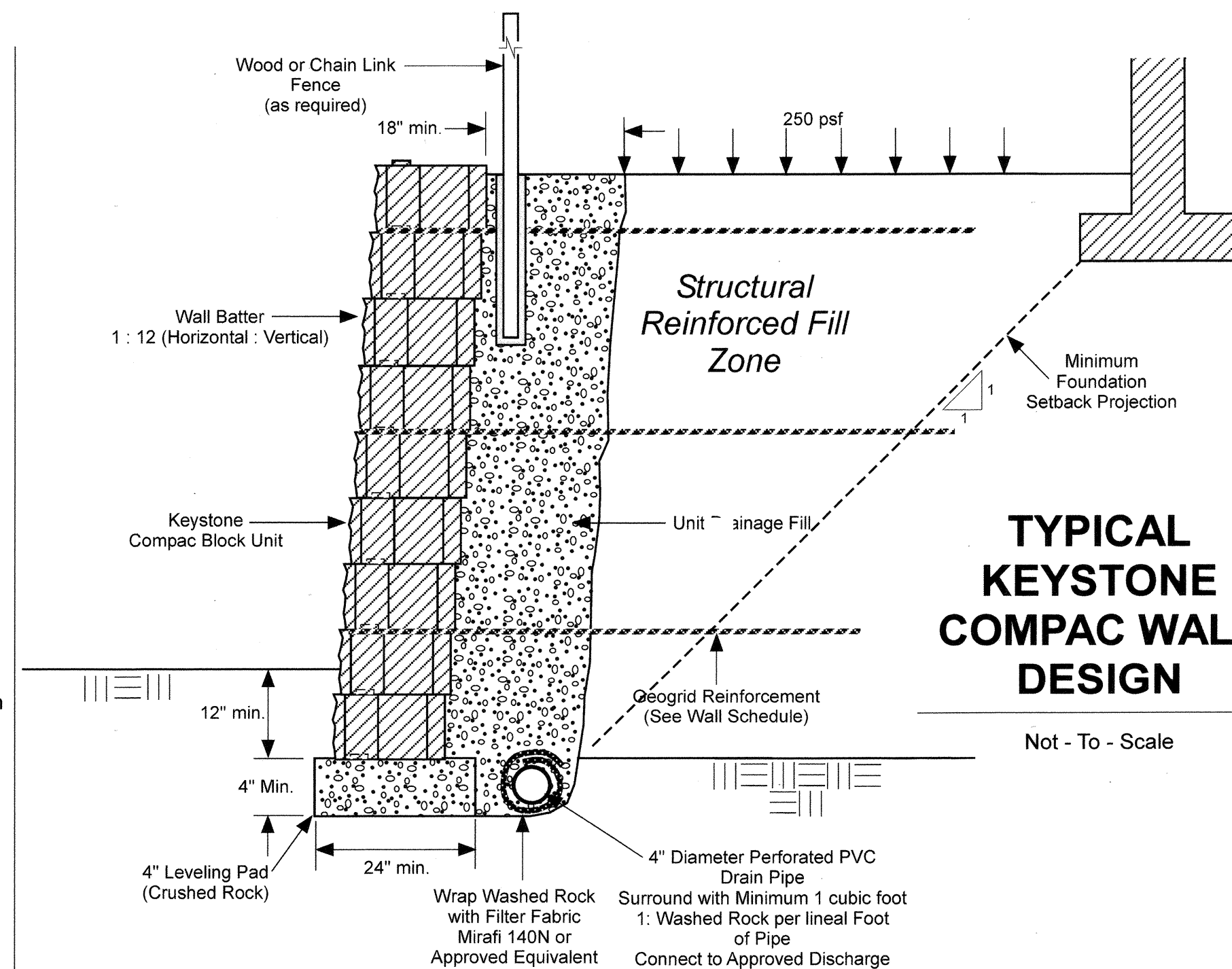
- A. Vertical alignment: +1.5" over any 10' distance
- B. Wall Batter: within 2 degrees of design batter
- C. Horizontal alignment: +1.5" over any 10' distance
Corners, bends, curves +1 ft. to theoretical location
- D. Maximum horizontal gap between erected units shall be 1/2 inch

FIELD QUALITY CONTROL

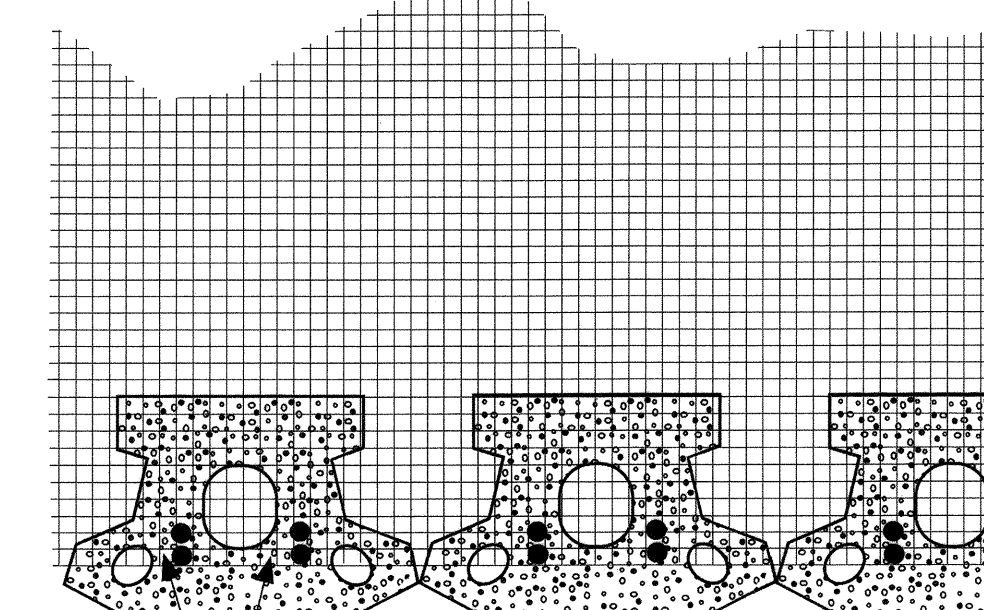
- A. The wall construction shall be observed by the Geotechnical Engineer on a full time basis. Testing of the compacted backfill shall be performed by the Geotechnical Engineer.
- B. As a minimum, quality assurance should include foundation soil inspection, soil and backfill testing, verification of design parameters, and observation of construction for general compliance with design drawings and specifications.

KEYSTONE WALL - GEOGRID SCHEDULE								
Wall Height (ft.)	Geogrid Length (ft.)*	Geogrid Layer Spacing (ft.) (Measured From Bottom of Wall)						
		1	2	3	4	5	6	7
4	4.0	2.0	-	-	-	-	-	-
6	5.0	1.33	3.33	5.33	-	-	-	-
8	7.0	1.33	3.33	5.33	7.33	-	-	-

* NOTE: Geogrid length shall be measured from back of wall.

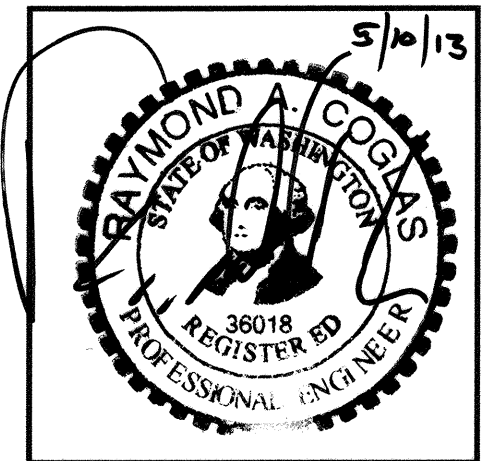


KEYSTONE BLOCK COMPAC UNIT DETAIL
Not - To - Scale



RECORD DRAWING CERTIFICATION
THESE DRAWINGS CONFORM TO THE
CONTRACTOR'S CONSTRUCTION RECORDS.
By _____ DATE _____
TITLE/POSITION _____
CONFIRMED BY CITY _____ DATE _____

PROJECT REF: FAC07-0016
45 May 16, 2013
THESE PLANS ARE APPROVED FOR
CONFORMANCE WITH THE CITY OF AUBURN'S
ENGINEERING REQUIREMENTS.
APPROVED BY: Dennis Selt
DATE APPROVED: 5/16/13



Keystone Wall Design and Notes
LAKELAND HILLS
Auburn, Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring
and Environmental Sciences

Revisions
Date
0040.12
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