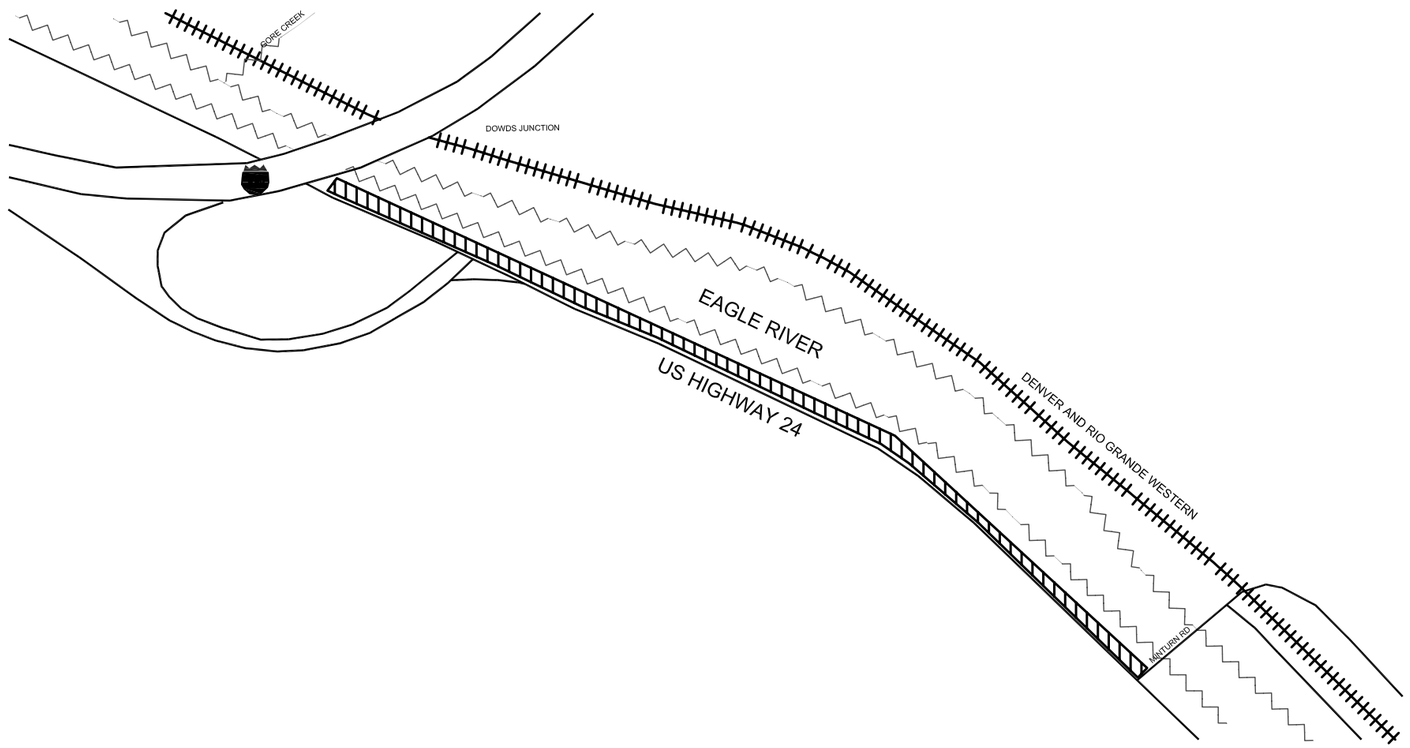
MECHANICALLY STABILIZED EARTH RETAINING WALL
FOR
PROPOSED ECO REGIONAL TRAIL
DOWD JUNCTION TO MINTURN ROAD
MINTURN, COLORADO



VICINITY MAP

DONALD R. CLARK
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14395
PROFESSIONAL ENGINEER
STATE OF COLORADO

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RW-1	COVER SHEET
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REV.	DATE	BY	DESCRIPTION
1	3/27/09	AMV	REVISED TO CHANGE WALL STATION PER CDOT PIECO TRAIL COMMENTS
2	5/27/2009	TMK	REVISED DRAWING SIZE AND DELETED PROPRIETARY PRODUCTS
3	8/24/2009	AMV	REVISED TO CHANGE WALL SPECIFICATIONS

RW-1

PROJECT MNGR.	AMV
DRAWN BY:	JKT
APPVD. BY:	DRC
SCALE:	AS SHOWN
DATE:	2/16/2009
JOB NO.	65095802
ACAD NO.	RW-1 11X17.DWG
SHEET NO.:	1 OF 6

COVER SHEET

PROPOSED ECO REGIONAL TRAIL
DOWD JUNCTION TO MINTURN ROAD

MINTURN COLORADO

Terracon
Consulting Engineers and Scientists
4685 South Ash Avenue, Suite H-4
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SECTION 1: GENERAL TECHNICAL NOTES

1.01 Description:

The work shall consist of furnishing and constructing modular block and structural geogrid retaining wall systems in accordance with this technical scope of work and in reasonably close conformity with the lines, grades, and dimensions shown on the Path Plan STA 10+50 to End for Eco Regional Trail, by Alpine Engineering, Inc., Sheet No. C004, C005, and C010, Project No. 108452A, dated August 1, 2008.

1.02 Work Included:

A. Furnishing segmental concrete facing and cap units as shown on the construction drawings.

B. Furnishing structural geogrid reinforcement as shown on the construction drawings.

C. Storing, cutting and placing structural geogrid reinforcement as specified herein and as shown on the construction drawings.

D. Excavation, placement and compaction of unit wall fill and backfill material as specified herein and as shown on the construction drawings.

E. Erection of segmental concrete units and placement of structural geogrid.

1.03 Reference Documents:

A. American Association of State Highway and Transportation Officials (AASHTO)
- T-99 Moisture-Density Relations of Soils Using a 5.5 Pound Rammer in a 12-inch Drop
- T-180 Moisture-Density Relations of Soils Using a 10 Pound Rammer in a 18-inch Drop

B. American Society for Testing and Materials Standards (ASTM)
- C-33 Specification for Concrete Aggregates
- C-140 Methods of Sampling and Testing Concrete Masonry Units
- C-150 Specification for Portland Cement
- C-1372 Standard Specifications of Segmental Retaining Wall Units
- D-422 Method for Particle Size Analysis of Soils
- D-698 Method for Laboratory Compaction Characteristics of Soils Using Standard Effort
- D-732 Shear Strength of Plastic by the Punch Tool Method
- D-790 Flexural Properties Testing of Plastic
- D-1557 Method for Laboratory Compaction Characteristics of Soils Using Modified Effort
- D-1556 Method for Density and Unit Weight of Soil in-Place by the Sand Cone Method
- D-6938 Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods
- D-4253 Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
- D-4254 Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- D-4595 Tensile Properties of Geotextiles by The Wide-Width Strip Method
- D6637 Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method
- D6706 Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil

C. National Concrete Masonry Association (NCMA)
- NCMA Design Manual for Segmental Retaining Walls
- NCMA SRWU-1 Connection Strength between Geosynthetics and Segmental Concrete Units
- NCMA SRWU-2 Shear Strength between Segmental Concrete Units

D. Alpine Engineering, Inc. (AEI), Path Plan STA 10+50 to End, Eco Regional Trail, Sheets No. C005, C004 and C010, Project No. 78510.6, dated August 1, 2008.

E. Hepworth-Pawlak Geotechnical (HP-Geotech), Subsoil Study For Site Grading and Pavement Design, Eco Regional Trail, Dowd Junction To Minturn Road, Project No. 108 452A, Dated November 28, 2008.

F. Hepworth-Pawlak Geotechnical (HP-Geotech), Confirmation of Geotechnical Parameters, received via email on February 16, 2009.

G. Where specifications and reference documents conflict, the Engineer shall make final determination of the applicable document.

1.04 Special Provisions:

A. The designs presented herein are based on wall profiles, soil parameters, foundation conditions and loadings stated in documentation as outlined in Section 1.03, Items C, through F, and Section 4.01.

B. Terracon assumes no liability for interpretation of subsurface conditions, suitability of soil design parameters and subsurface groundwater conditions made by others.

C. The reinforced backfill to be used in the wall construction must meet specific engineering requirements as outlined in the Technical Scope of Work. Terracon makes no representation that on-site soils are suitable for use in the MSE wall construction. The suitability of on-site materials for use in the MSE wall construction, as specified herein, should be determined prior to construction.

D. The contractor shall be responsible for the cost of all means of subsoil improvement; cost of additional subsoil exploration; and for all labor tools, equipment and incidentals necessary to complete the work.

E. The contractor shall be responsible for complying with all federal, state and local requirements for execution of the work, including local building inspection and current OSHA excavation regulations.

F. Prior to undertaking any grading or excavation of the site, the Contractor shall confirm the location of proposed retaining wall and all underground features, including utility locations within the area of construction.

G. All work undertaken in the construction of the retaining wall is subject to the quality control/assurance and special inspection provisions outlined in Section 3.12.

H. Terracon was not provided with complete utility information at the time of preparation of these drawings. Where there is potential for geogrid/utility conflicts, Terracon should be afforded the opportunity to review the utility plans and make modifications to these plans as necessary.

I. Terracon has completed engineering design of the proposed retaining wall, including internal stability and local external stability where applicable, based upon the information provided to us as outlined above. Terracon assumes that the suitability of placing retaining wall at the locations provided to us, including geotechnical and geological suitability, has been determined by others.

J. Any changes in planned grading, locations of structures or changes in wall profiles should be brought to the attention of Terracon for modification of the wall designs as necessary.

K. Verify all dimensions and grades prior to wall construction.

SECTION 2: MATERIALS

2.01 Definitions:

A. Structural Geogrid – a geogrid 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.

B. Geotextile – a spun-bound non-woven engineering fabric intended for tensile reinforcement with high filtration and permeability characteristics.

C. Segmental Concrete Facing Units – segmental concrete facing, machine made from Portland cement, water and mineral aggregates.

D. Cap Unit – a segmental concrete cap unit.

E. Subdrain/Heel Drain – a combined system of slotted pipe, geotextile fabric and gravel, provided for internal drainage at the face and behind the reinforced backfill.

F. Unit Fill/Drainage Layer – granular fill which is within and behind the segmental concrete facing units.

G. Post Foundation System- a 12" diameter post fence foundation system, used to facilitate fence/ railing installation.

H. Reinforced Backfill – compacted soil which is within the reinforced soil volume as outlined on the plans.

I. Foundation Soil – compacted or in-situ soil beneath the entire wall.

J. Leveling Pad – a level compacted gravel or non-reinforced concrete footing upon which the first course of segmental concrete facing units are placed.

K. Engineer – Terracon Consultants, Inc. (Phoenix)

L. Geotechnical Engineer – Hepworth-Pawlak Geotechnical (HP-Geotech)

2.02 Structural Geogrids:

A. The geogrids used in the construction of the retaining wall consist of regular grid structure of high tenacity polyester multifilament yarns woven in tension and finished with PVC coating and shall have the minimum connection strength with the segmental concrete facing indicated in this section.

B. The manufacturer shall provide the certification that the ultimate strength of the geogrid as per ASTM D6637 is equal to or greater than the ultimate strength called for on the drawings.

Geogrid Type	Ultimate Strength (lb./ft)	Long Term Design Strength (lb./ft)
Polyester	3500	1678

C. The geogrid/segmental block connection data shown below was utilized in the design of the retaining wall for this project. The manufacturer of the geogrid shall provide certification that the geogrid connection strength with the segmental facing units meets or exceeds that stated herein.

Connection Strength Properties	Peak Strength Criteria	Deformation (Service) Strength Criteria
Minimum Strength (lb/ft)	1000	707
Friction Angle (Degrees)	16	10
Maximum Strength (lb/ft)	1997	1313

2.03 Geotextiles:

A. The geotextile shall consist of spun-bound 100% continuous filament polyester needle punched engineering fabric.

B. The minimum physical properties of the geotextile will include the following:
1. Tensile Strength (ASTM D4632) – 160 lbs.
2. Burst Strength (ASTM D3786) - 280 psi.
3. Puncture Strength (ASTM D4833) - 85 lbs.
4. Permeability – 0.24 cm/sec.

C. The manufacturer shall furnish the Engineer with written certification that all geotextile used for construction meets or exceeds the minimum properties required.

2.04 Segmental Concrete facing Units:

A. Segmental concrete units shall be manufactured by a licensed Representative of the concrete facing units to be used on the project.

B. All concrete wall units including cap units shall have a minimum net 28-day compressive strength of 3,000 psi. The concrete units shall have the required freeze/thaw protection with a maximum absorption rate of 8 percent in southern climates, and 6 percent in northern climates.

1. Cementatious materials used in the manufacture of the units shall be Type I or Type II Portland cement in accordance with ASTM C-150.

2. All aggregates used in the manufacture of the units shall be normal weight conforming to ASTM C-33.

3. Other Constituents - Air entraining agents, coloring pigments, integral water repellents, finely ground silica, and other constituents shall be previously established as suitable for use in segmental concrete retaining wall units and shall conform to applicable ASTM Standards or shall be shown by test or experience not to be detrimental to the durability of the segmental concrete facing units or any material customarily used in masonry construction.

C. Exterior dimensions of units may vary in accordance with ASTM C-1372. Segmental concrete facing units shall have a minimum of 1 square foot face area each. Segmental concrete facing unit dimensions shall not differ more than ± 1/8 inch (3.2 mm) from the manufacturer's published dimensions.

D. Segmental concrete facing units with unit fill shall provide a minimum of 150 psf of wall face area. Fill which is placed within the dimensions of the units may be considered as 80% of the effective weight.

E. Segmental concrete facing units shall be capable of concave and convex alignment curves with a minimum radius of 3-1/2 feet.

F. Segmental concrete facing units shall be capable of interlocking each other to provide shear strength capacity for block-to-block combination that meets or exceeds that stated below. The manufacturer of the segmental block shall provide certification that the shear strength for block-to-block combination meets or exceeds that stated herein.

Connection Strength Properties	Peak Strength Criteria	Deformation (Service) Strength Criteria
Minimum Strength (lb/ft)	770	770
Friction Angle (Degrees)	27	27
Maximum Strength (lb/ft)	2800	2800

G. Finish and Appearance

1. All units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the construction. Minor cracks incidental to the usual method of manufacture, or minor chipping resulting from shipment and delivery, are not grounds for rejection.

2. The exposed surfaces of units shall be free of chips, cracks or other imperfections when viewed from a distance of 10 feet under diffused lighting.

H. Sampling and Testing

1. Sample and test units for compressive strength and absorption in accordance with the applicable provisions of ASTM Method C-140. Compressive strength test specimens shall conform to the saw-cut coupon provisions of section 5.2.4 of ASTM C-140 with the following exceptions:

a. Coupons shall have a minimum thickness of 1-1/2 inches (38.1 mm).

I. Color

1. The block color shall be per owner specification.

2. Block samples, indicating available colors, shall be provided to the owner/developer for color selection prior to construction.

2.05 Block/geogrid Connection:

A. The block/geogrid combination to be used shall have the minimum connection capacity requirements contained in Section 2.02 item C.

B. The contractor shall provide certification that the block/geogrid combination to be used on this project meets the minimum connection criteria specified in Section 2.02 Item C.

2.06 Base Leveling Pac Materials and Unit Fill/Drainage Layer for Block:

A. Base Leveling Pac Material: Material for leveling pad shall consist of compacted sand, gravel, crushed rock or any combination thereof (use soil types GP, GW, SW, SP or SM), a minimum of 8 inchss in thickness, constructed to the minimum dimensions shown on the construction drawings. Non-reinforced concrete may also be used.

B. Unit Fill/Drainage Layer: Fill for units shall consist of clean 1" minus free-draining well graded crushed stone or granular fill, meeting the requirements of 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

2.07 Wall Backfill:

A. Reinforced backfill shall consist of Colorado Department of Transportation (CDOT) Class 1 material meeting the following gradation as determined in accordance with ASTM D-422:

Sieve Size	Percent Passing
2 1/2 in	100
2 in	95-100
No. 4	30-65
No. 200	3 – 15

The plasticity index of the fine fraction shall be less than 6.

B. Gravel shall be angular crushed durable stone.

C. USCS soil types CL, CH, ML, MH, or SC shall not be used in any portion of the wall backfill including retained materials placed beyond the reinforced zones.

D. All reinforced backfill materials shall also have the minimum engineering properties shown in Section 4.01, Item A.

E. All backfill materials, whether on-site or imported, shall be approved by the Engineer prior to construction.

F. Test results of all proposed backfill materials, whether on-site or imported, shall be submitted to the Engineer for approval prior to construction.

2.08 Post Foundation System:

A. Post foundation system used for handrail shall be a high density polyethylene sleeve and cap with a minimum average wall thickness of 0.050 inch and shall have a nominal diameter of 12 inches and shall be 24 inches in depth.

B. The manufacturer shall provide certification that the post foundation systems is capable of handling the minimum handrail/pedestrian loads provided for by the governing building code.

2.09 Subdrain:

A. Geotextile used for subdrain construction shall be non-woven needle-punched fabric meeting the requirements of this technical scope of work.

B. Drain pipe shall be 4-inch diameter slotted PVC or HDPE such as ADS Drainguard or approved equivalent.

C. Gravel shall be clean 3/4-inch minus free draining stone or crushed rock with no more than 5% passing a U.S. No. 200 sieve.

2.10 Delivery, Storage, Handling:

A. Structural Geogrid and Geotextile

1. Contractor shall check to ensure that the proper materials have been received upon delivery.

2. All geogrids and geotextiles shall be stored above -20°F (-29°C).

3. Contractor shall prevent excessive mud, wet cement, epoxy, and like material which may affix themselves to the gridwork, from coming in contact with the geogrid and geotextile material.

4. Rolled geogrid and geotextile material may be laid flat or stood on end for storage.

5. Geogrids and geotextile shall be stored according to manufacturer's recommendations.

B. Segmental Concrete Facing Units

1. Contractor shall check the units upon delivery to ensure that proper materials have been received.

2. Contractor shall prevent excessive mud, wet cement, epoxy, and like materials from coming in contact with and affixing to the units

3. Contractor shall protect the units from damage (i.e. cracks, chips, spalls). Damaged units shall be evaluated for usage in the wall according to ASTM C-90 and ASTM C-1372.

SECTION 3: EXECUTION

3.01 Construction:

A. The excavation shall be carried to the lines and grades shown on the construction drawings and to the extent necessary to place structural geogrid at the required embedment lengths. Contractor shall be careful not to disturb base or existing soils/fills beyond the lines shown except for that necessary to comply with applicable safety regulations.

B. Excavations will be made in a manner which will not disturb the existing construction on the site. Contractor will provide protection or will construct the walls in such a manner to maintain the integrity of existing improvements during construction.

C. In-situ materials excavated from the location of the retaining walls shall be stockpiled on-site at locations designated by the owner and in locations which will not interfere with the execution of the work.

3.02 Subgrade Preparation:

A. Subgrade shall be excavated as required for placement of the leveling pad as shown on the construction drawings, or as directed by the Geotechnical Engineer. Special foundation treatment may be necessary as determined by the Geotechnical Engineer. Refer to report as referenced in Section 1.03, Item F.

B. Subgrade shall be examined by the Geotechnical Engineer to confirm that the actual foundation conditions meet or exceed assumed design assumptions. As a minimum, soil shall be proof-rolled before construction proceeds. Subgrade conditions not meeting the required strength shall be removed and replaced with acceptable material.

C. Over-excavated areas shall be replaced with compacted granular backfill material or soils approved by the Geotechnical Engineer to the lines and grade shown on the construction drawings.

D. Granular backfill shall be placed in loose lifts not exceeding 10 inches in thickness, compacted to a minimum of 95 percent of the maximum density as determined by AASHTO T-99 or ASTM D-698. The moisture content of the backfill prior to, and during compaction shall be uniformly distributed throughout each layer and shall be within a range of 2% below, to 2% above optimum moisture content.

3.03 Base Leveling Pad:

A. Leveling Pad materials shall be placed as shown on the plans, upon undisturbed soils or compacted subgrade, to a minimum depth of 8 inches.

B. Leveling Pad materials shall be compacted to provide a level hard surface on which to place the first course of units. Leveling Pad materials shall be compacted to a minimum of 95 percent of the maximum density as determined by AASHTO T-99 or ASTM D-698. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be within a range of 2% below, to 2% above optimum moisture content.

C. Leveling Pad shall be prepared to insure complete contact of retaining wall units with the base.

D. Provided that compaction is maintained, leveling pad materials may be extended linearly beyond the profiles shown on the plans to accommodate full-sized facing units.

3.04 Segmental Concrete Facing Unit Installation:

A. The first course segmental concrete facing units shall be placed on top of and in full contact with the leveling pad. The units shall be checked for proper elevation and alignment. Install the segmental concrete facing units as required by the manufacturer.

B. Units shall be placed side by side for the full length of the wall. Proper alignment may be achieved with the aide of a string line or offset from baseline.

C. Shear connectors shall be installed (where applicable) in the segmental concrete facing units and the voids in the units filled with tamped unit fill.

D. All excess material shall be swept from the top of the units prior to installing the next course. Each course shall be completely filled prior to proceeding to next course.

E. Lay up each course of segmental concrete facing units insuring that proper shear connector where applicable are placed in accordance with the manufacturer recommendations and proper batter is achieved. Backfill when the course is completed. Repeat procedure to the extent of wall height.

F. Where the wall changes elevation, units can be stepped or turned into the embankment with a convex return end as appropriate. Provide appropriate buried units on leveling pad in area of convex return end.

3.05 Cap Installation:

A. Place segmental concrete cap units as required by the manufacturer. Backfill and compact to finished grade.

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

3.06 Subdrain Construction:

A. Subdrains shall be constructed at the face of the wall and at the rear of the excavation to the lines, grades and dimensions shown on the plans. .

B. Subdrains should be sloped and drained through weep holes in the face of the wall at a maximum of 30 feet on center.

3.07 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 elevation(s) and to the extent(s) shown on the construction drawings or as directed by the Engineer.

C. The geogrid soil reinforcement shall be laid horizontally on compacted backfill. The geogrid shall be pulled taut and anchored prior to backfill placement on the geogrid.

D. Geogrid reinforcements shall be continuous throughout their embedment length(s). Spliced connections between shorter pieces of geogrid will not be allowed unless pre-approved by the Engineer prior to construction.

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. No changes to geogrid layout, including, but not limited to, length, geogrid type, or elevation, shall be made without the approval of the Engineer.

3.08 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.

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 mechanical compaction equipment is used.

C. Reinforced backfill shall be compacted to a minimum of 95 percent of the maximum density as determined by AASHTO T-99 or ASTM D-698. The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer and shall be within a range of 2% below, to 2% above optimum moisture content. If a well defined maximum density curve can not be generated by impact compaction in the laboratory, the backfill shall be compacted to a minimum of 70 percent of relative density as determined by ASTM D-4253 and D-4254.

D. Reinforced backfill shall be compacted in all areas to the lines and grades shown on the plans including all sloped areas above or between wall tiers.

C. Only lightweight hand-operated compaction equipment shall be allowed within 4 feet of the face of the wall.

3.09 Post Foundation System Installation:

A. Prepare a level area approximately 24" wide x 36" deep behind the wall face. The prepared area should be 24" below the proposed top of wall (not including the cap stone).

B. Install the post foundation system as required by the manufacturer.

C. When installing geogrid around the system, slit the geogrid perpendicular to the wall face just enough to fold around the post foundation system ensuring that the grid is properly attached to the wall face everywhere with the exception of where the post foundation system is. This method is acceptable by geogrid manufacturers when obstacles such as fence post foundations are present.

D. Backfill material surrounding the system must be compacted to a minimum of 95% of the material's maximum dry density as determined by AASHTO T-99 or ASTM D-698. Backfill and compaction within three feet of the wall should be performed with hand operated equipment as specified herein.

3.10 Geotextile Installation:

A. Geotextiles shall be placed at the locations and extent shown on the Construction drawings. Each layer shall be placed as shown on the drawings, with a minimum embedment length of 1.5 feet on the top and bottom.

3.11 Site Drainage:

A. At the end of each day's operation, the Contractor shall slope the last lift of reinforced backfill away from the wall facing to rapidly direct runoff away from the wall face.

B. The Contractor shal not allow surface runoff from adjacent areas to enter the wall construction site.

C. Finished grading at the top of the wall should provide positive drainage away from the retaining wall system to prevent infiltration of water into retained soils which may increase lateral pressures on the structure.

3.12 Quality Assurance:

A. Quality Assurance and Special Inspection for the project, shall be conducted in accordance with the applicable portions of the Uniform Building Code, International Building Code and the Building Construction and Safety Code, NFPA 5000, or as required by the governing building department.

B. All Special Inspectors shall be under the supervision of a registered engineer.

C. Testing and inspection services shall be performed only by trained and experienced personnel and experienced technicians currently qualified for the work they are to perform.

D. If Special Inspection is provided by anyone other than the Engineer of Record, the qualifications of all special inspectors shall be reviewed and approved by the Engineer of Record.

E. All work requiring Special Inspection shall be made available and remain accessible and exposed until it is observed by the Special Inspector.

F. Duties of the Special Inspector:

1. The Special Inspector shall observe the work requiring special inspection for conformance with the approved design drawings and specifications.

2. The Special Inspector shall furnish inspection reports to be kept at the site for use by the Building Official, the Contractor and the Engineer of Record. If Special Inspection is provided by anyone other than the Engineer of Record, reports shall be submitted to the office of the Engineer of Record on a weekly basis. All discrepancies shall be brought to the attention of the contractor for correction, then if uncorrected, to the design authority and the Building official.

3. Upon completion of the assigned work, the Special Inspector shall complete and sign a final report certifying that to the best of his knowledge, the work is in conformance with the approved plans and specifications, and the applicable workmanship provisions of the code.

G. Special Inspection Grading: Excavations, Grading and Filling Operations

Unless otherwise directed by the Engineer of Record or required by this Technical Scope of Work, the type and minimum frequency of testing for soils related portions of construction will be as follows:

1. Field density tests in accordance with ASTM D6938 or ASTM D1556

   Subgrade Soils-One test for every 500 to 1000 square feet of subgrade area
   Base Leveling Pad-One test for every 100 lineal feet of wall length
   Reinforced Backfill-One test for every 500 to 1000 square feet of backfill per lift

2. Laboratory moisture-density relationships in accordance with AASHTO or ASTM criteria as specified for subgrade, base leveling pad, and reinforced backfill.

3. Gradation Analyses in accordance with ASTM D422

   Unit Fill-One test for every 500 cubic yards of material
   Wall-Backfill-One test for every 500 cubic yards of material

If testing services are provided by anyone other than the Engineer of Record, reports shall be submitted to the office of the Engineer of Record on a weekly basis.

H. Special Inspection Geogrid:
Special Inspection shall be made of the type, location, elevations, orientation and extent of geogrid placement in the wall.

SECTION 4: DESIGN NOTES FOR RETAINING WALL SYSTEM

4.01 Design Parameters:

A. Design of the reinforced soil structure is based on the following parameters:

Wall Segment	Friction Angle	Cohesion	Unit Weight
Reinf. Backfill	34°	0 psf	130 pcf
Ret. Backfill	28°	0 psf	125 pcf
Foundation	28°	0 psf	125 pcf
Foundation (Global Analyses)	30°	100	125 pcf

B. Internal Stability of Walls
- Minimum Factor of Safety on Geogrid Strength 1.5
- Minimum Factor of Safety on Geogrid Pullout 1.5
- Minimum Factor of Safety on Connections (Peak Load Criterion) 1.5
- Minimum Factor of Safety on Connections (Serviceability Criterion) 1.0
- Percent Coverage of Geogrid 100%

C. External Stability
- Minimum Factor of Safety Against Base Sliding 1.5
- Minimum Factor of Safety Against Overturning 2.0
- Minimum Factor of Safety (Global Stability) 1.4
- Uniform Surcharge (Traffic) ..... 250 psf
- Backfill Slope ..... None

D. Hydrostatic Loading ..... as shown on plans

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SHEET NO.:	2 OF 6

TECHNICAL SCOPE OF WORK

PROPOSED ECO REGIONAL TRAIL
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MINTURN COLORADO

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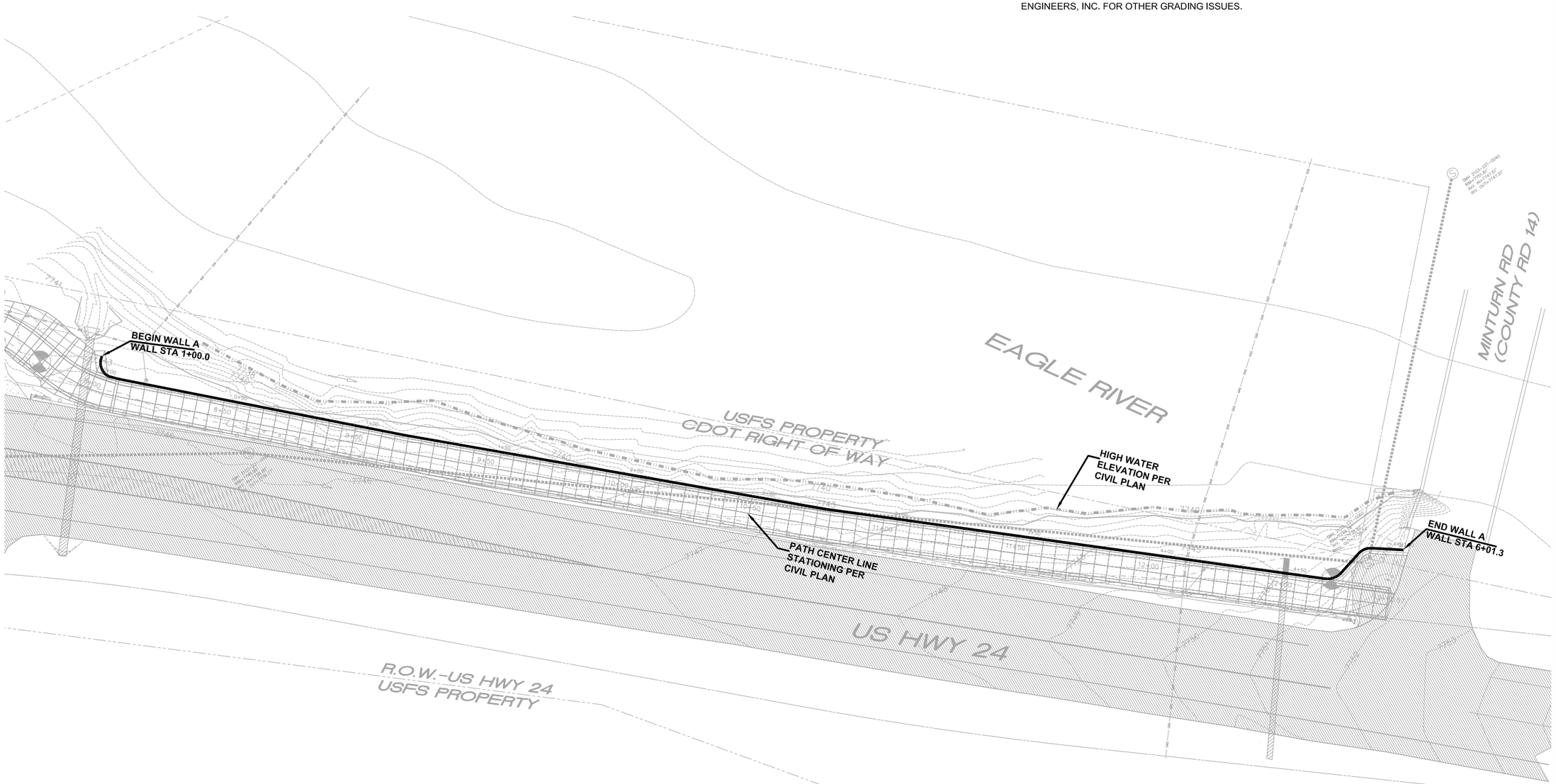
SITE PLAN BASED ON PATH PLAN STA 10+50 TO END FOR ECO REGIONAL TRAIL BY ALPINE ENGINEERING, INC., SHEET NO.C004, C005, AND C010, PROJECT NO. 78510.6, DATED AUGUST 1, 2008.

THE SITE PLAN IS FOR WALL LOCATION ONLY. REFER TO THE GRADING PLANS BY ALPINE ENGINEERING, INC. ENGINEERS, INC. FOR OTHER GRADING ISSUES.



NOTE:

THE STATIONING ON THE RETAINING WALL REFERS TO WALL STATIONS. SEE CIVIL LANS FOR CORRESPONDING TRAIL/ROADWAY STATIONING.

THE WALL STATIONING DOES NOT CORRESPOND TO THE FACE OF THE WALL SYSTEM.

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14395
PROFESSIONAL ENGINEER
STATE OF COLORADO

SCALE
1"=40'
0 20 40 FEET

RW-3	
PROJECT MNGR.	AMV
DRAWN BY:	JKT
APPV'D. BY:	DRC
SCALE:	AS SHOWN
DATE:	2/16/2009
JOB NO.	65095802
ACAD NO.	RW-3 11X17.DWG
SHEET NO.:	3 OF 6

SITE PLAN

PROPOSED ECO REGIONAL TRAIL
DOWD JUNCTION TO MINTURN ROAD

MINTURN COLORADO

Terracon
Consulting Engineers and Scientists
4685 South Ash Avenue, Suite H-4
PH. (480) 897-8200
Tempe, AZ 85282
FAX. (480) 897-1133

REV.	DATE	BY	DESCRIPTION
1	3/27/09	AMV	REVISED TO CHANGE WALL STATION PER CDOT PECO TRAIL COMMENTS
2	5/27/2009	TMK	REVISED DRAWING SIZE AND DELETED PROPRIETARY PRODUCTS
3	8/24/2009	AMV	REVISED TO CHANGE WALL SPECIFICATIONS

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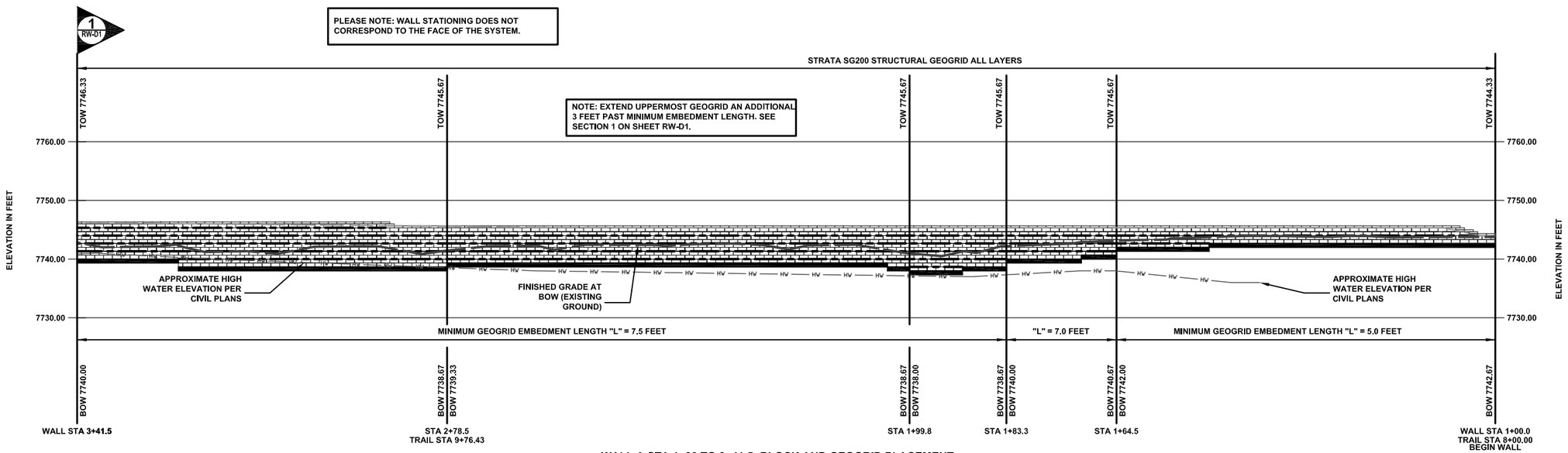
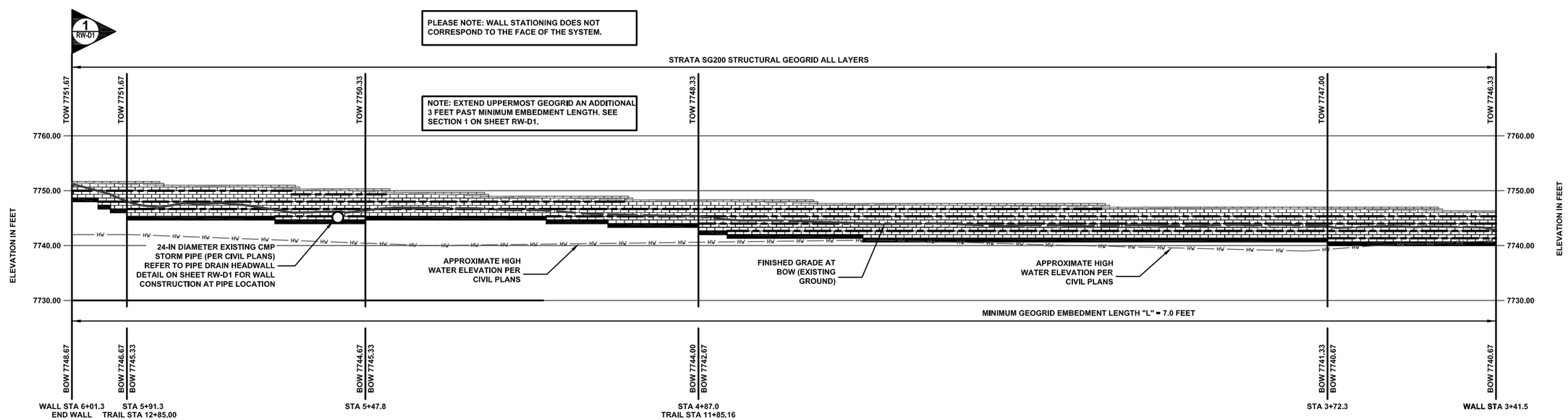
LEGEND:

- 4"x18" CAP UNITS
- 8"x18"x12" (HxLxD) BLOCK UNITS
- 8-INCH GRAVEL LEVELING PAD
- STRUCTURAL GEOGRID; MIN LTDS = 1678 LB/FT
- FINISHED GRADE AT TOP OF WALL
- FINISHED GRADE AT BOTTOM OF WALL (EXISTING GROUND)
- BOW ELEVATION AT BOTTOM OF BLOCK TOP OF LEVELING PAD
- TOW ELEVATION AT TOP OF CAP BLOCK
- STA STATION ALONG RETAINING WALL ALIGNMENT
- "L" MINIMUM GEOGRID EMBEDMENT LENGTH

PROFILE SCALE
1"=20'
0 10 20 FEET



WALL A STA 1+00 TO 3+41.5: BLOCK AND GEOGRID PLACEMENT



WALL A STA 3+41.5 TO END OF WALL: BLOCK AND GEOGRID PLACEMENT

RW-4	
PROJECT MNGR.	AMV
DRAWN BY:	JKT
APPVD. BY:	DRC
SCALE:	AS SHOWN
DATE:	2/16/2009
JOB NO.	65095802
ACAD NO.	RW4 11X17.DWG
SHEET NO.:	4 OF 6

RETAINING WALL A PROFILE

PROPOSED ECO REGIONAL TRAIL
DOWD JUNCTION TO MINTURN ROAD

MINTURN COLORADO

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Tempe, AZ 85282
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REV.	DATE	BY	DESCRIPTION
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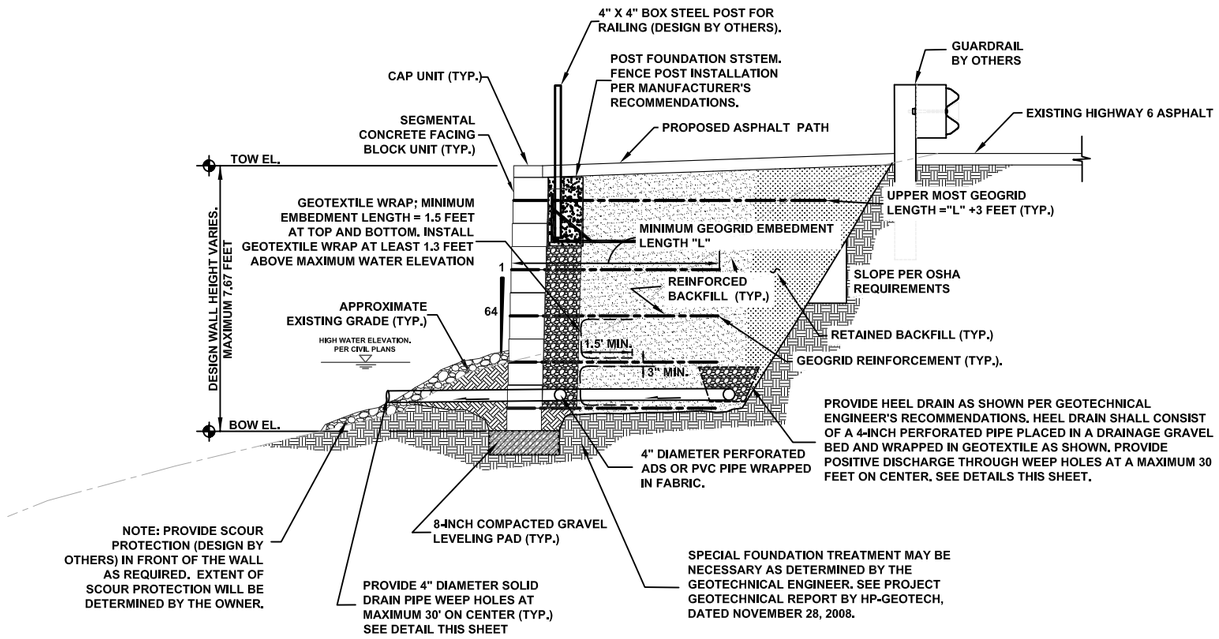
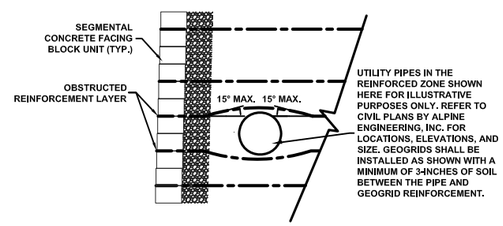
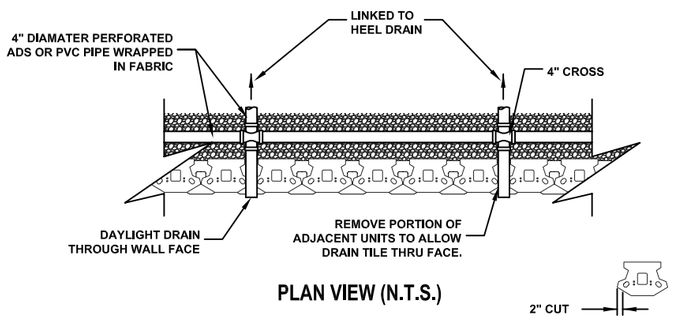
3	8/24/2009	AMV	REVISED TO CHANGE WALL SPECIFICATIONS



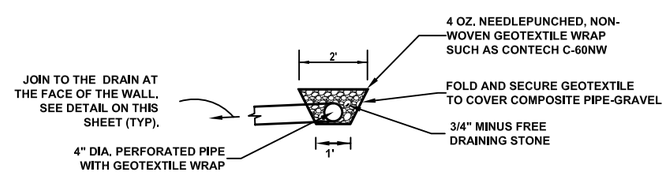
1 TYPICAL RETAINING WALL CROSS SECTION (NOT TO SCALE)



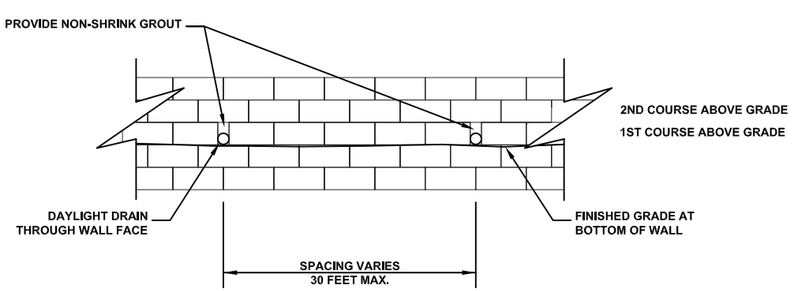
GENERAL OBSTRUCTION DETAIL



PLAN VIEW (N.T.S.)



HEEL DRAIN DETAIL (N.T.S.)



PROFILE VIEW (N.T.S.)

TOE DRAIN DETAIL (N.T.S)

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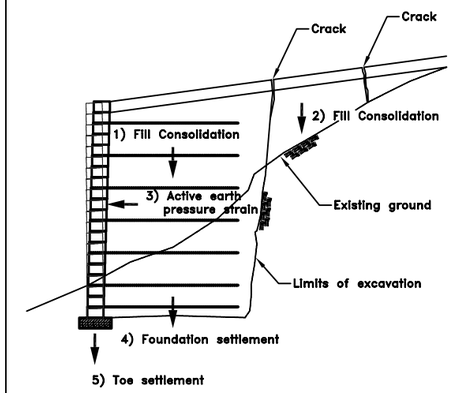
Backfill Movement and Soil Cracks

Mechanically Stabilized Earth (MSE) retaining walls are flexible reinforced soil masses, which interact with the foundation and retained backfill zones to provide a stable retaining structure. These soil zones have different stress/strain/consolidation properties which can result in differential movements and strain of the reinforced and retained soil matrix.

Relative movement of the soil masses is typically noted in taller wall or tiered structures with small soil cracks occur behind the wall structure near the boundary of soil zones with different strain properties. Experience has shown that this type of soil cracking is most noticeable after very heavy rainstorms where the additional saturated soil weight and seepage pressure involved can cause slight differential movement of the masses. A wall schematic and possible causes are shown below:



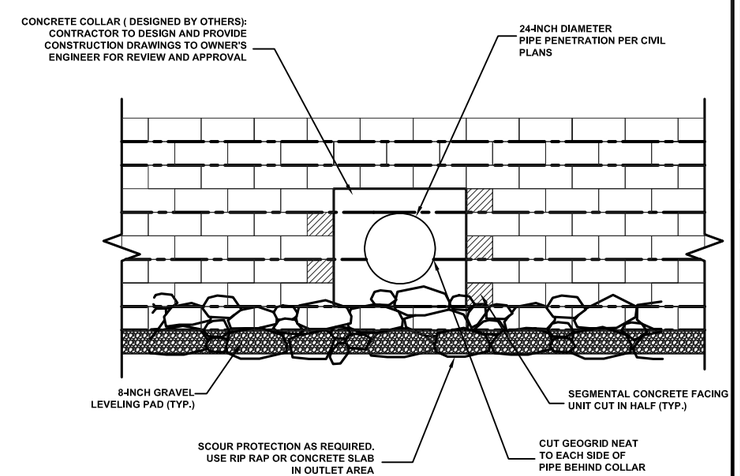
TYPICAL SECTION

Possible causes of soil cracking

1) **Consolidation of reinforced zone backfill** - Any settlement of reinforced fill relative to adjacent soils man cause cracking at end of reinforcement. If soils are placed and compacted in dry conditions, water can cause secondary consolidation of the reinforced fill and cracking at the end of reinforced zone.
2) **Consolidation of retained soil wedge** - Similar to Item 1 causing cracking at the back of fill wedge relative to existing soils.
3) **Lateral wall movement due to active earth pressure state** – lessor quality backfill soils exhibit higher lateral movement to mobilize the active earth pressure state. If the reinforced wall mass strains laterally, the fill must settle accordingly and cracking can occur.
4) **Foundation settlement** – The foundation soils of many wall structures have experienced the loading from the new fill which can cause differential settlement between the wall volume and cut slope.
5) **Toe Settlement** – The wall toe can experience more settlement than the wall heel due to the lack of overburden or confining pressure resulting in slight lateral wall movement in the upper wall section and tension cracking at the end of reinforcement.

Soil cracks can also be a sign of global instability or continuing settlement which requires evaluation by a geotechnical engineer. However, most minor soil cracking observed is structurally insignificant to the long term performance of the wall structure but can lead to reflective cracks in pavement sections and/or separation of curbs when of greater magnitude.

Significantly increasing the length of the upper reinforcement levels to help bridge the potential crack zones can be prudent precaution for projects with flexible pavements extending over all zones. High quality backfill, proper backfill placement and compaction, and firm foundations are the best precautions against soil cracking.



24-INCH Ø PIPE DRAIN HEADWALL DETAIL (N.T.S)

RW-D1	
PROJECT MNGR:	AMV
DRAWN BY:	JKT
APPVD. BY:	DRC
SCALE:	AS SHOWN
DATE:	2/16/2009
JOB NO.	65095802
ACAD NO.	RW-D1 11X17.DWG
SHEET NO.:	5 OF 6

TYPICAL RETAINING WALL CROSS SECTION

PROPOSED ECO REGIONAL TRAIL
DOWD JUNCTION TO MINTURN ROAD
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REV.	DATE	BY	DESCRIPTION
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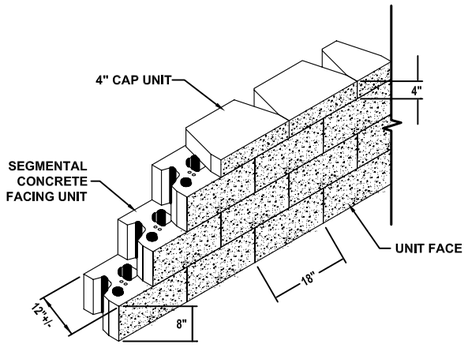
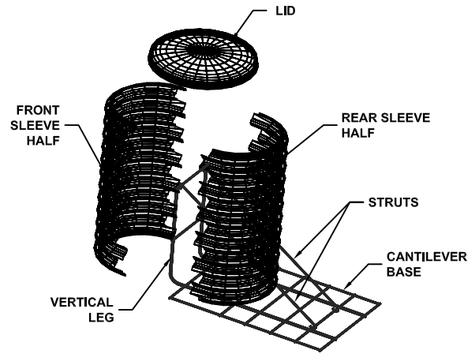
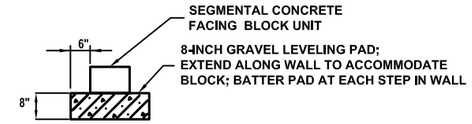
3	8/24/2009	AMV	REVISED TO CHANGE WALL SPECIFICATIONS



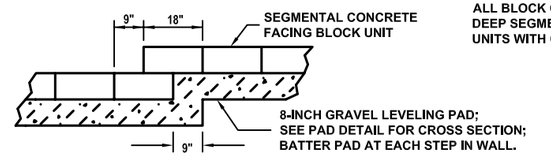
SEGMENTAL CONCRETE FACING BLOCK DETAIL



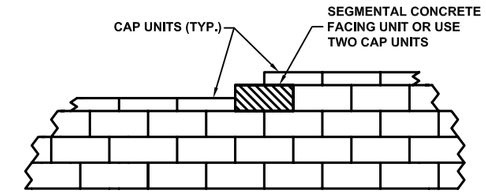
POST FOUNDATION SYSTEM



GRAVEL LEVELING PAD DETAIL

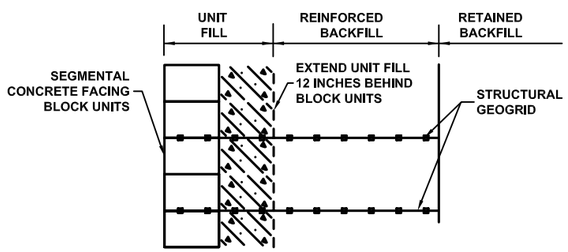


LEVELING PAD STEP DETAIL

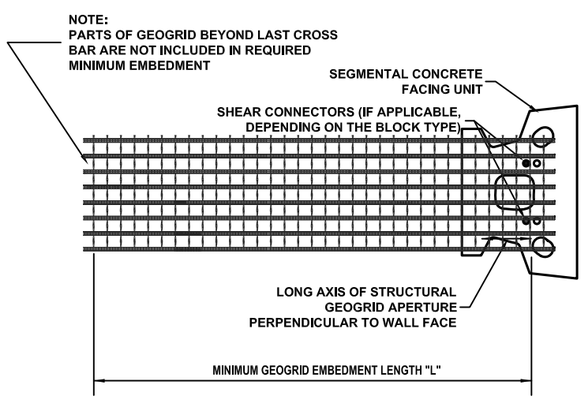


ALL BLOCK COURSES SHOWN BELOW CAP UNIT ARE 8"HIGH BY 18" LONG BY 12" DEEP SEGMENTAL CONCRETE FACING UNITS. ATTACH CAP UNITS TO BLOCK UNITS WITH CONSTUCTION ADHESIVE OR EPOXY.

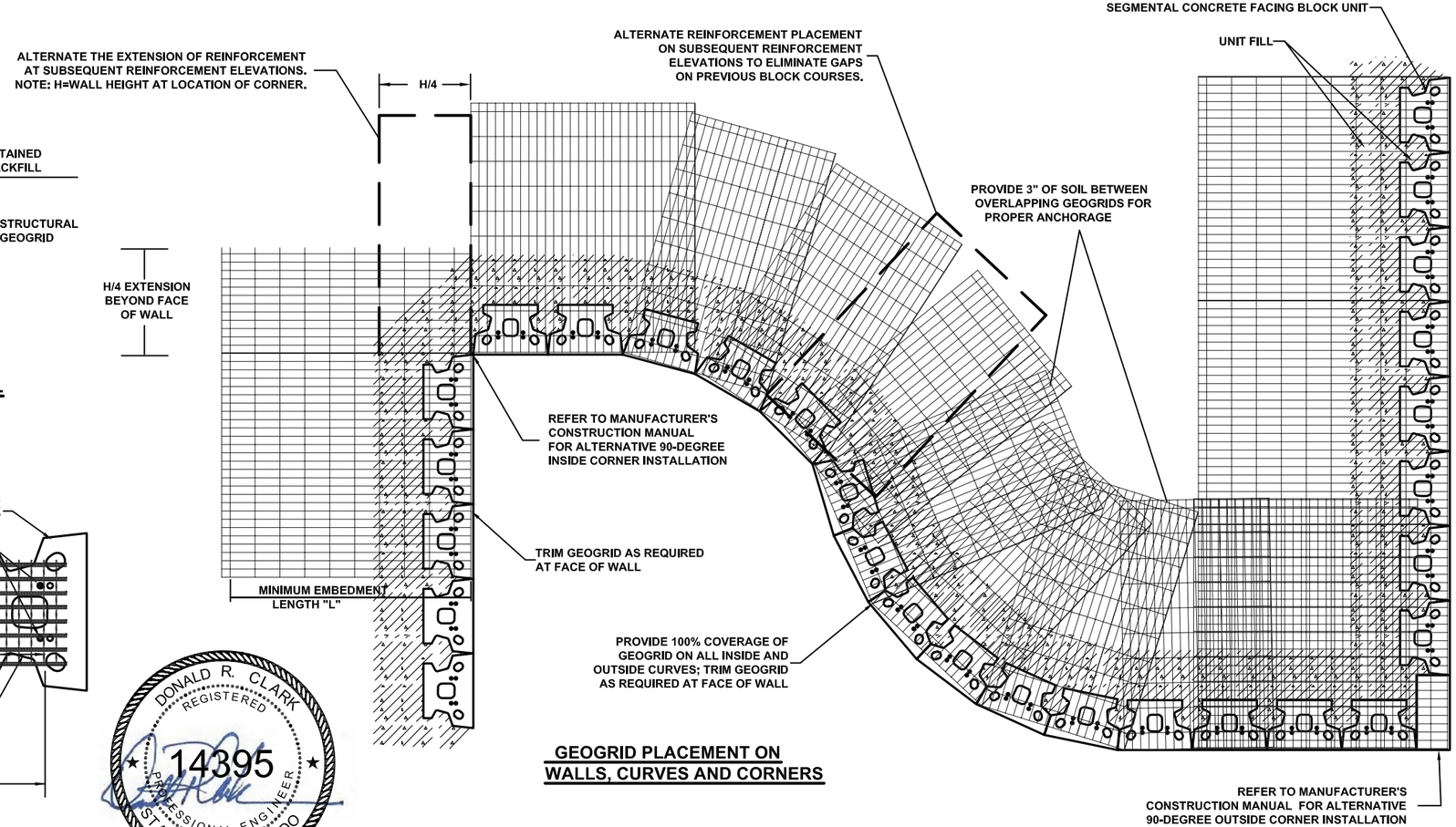
CAP STEP DETAIL



LIMITS OF UNIT FILL & REINFORCED BACKFILL



GEOGRID ORIENTATION ON BLOCK



GEOGRID PLACEMENT ON WALLS, CURVES AND CORNERS

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WALL CONSTRUCTION DETAILS

RW-D2	
PROJECT MNGR:	AMV
DRAWN BY:	JKT
APPVD. BY:	DRC
SCALE:	AS SHOWN
DATE:	2/16/2009
JOB NO.	65095802
ACAD NO.	RW-D2 11X17.DWG
SHEET NO.:	6 OF 6

RETAINING WALL CONSTRUCTION DETAILS

PROPOSED ECO REGIONAL TRAIL
DOWD JUNCTION TO MINTURN ROAD

MINTURN COLORADO

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