STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

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JUN 0 1 2006
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REVIEW/DISCUSS WITH_____

May 31, 2006

MEMORANDUM TO: Mr. K. J. Kim, P.E.
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Mr. Mohammed Mulla, P.E.
Assistant State Geotechnical Engineer

FROM: Njoroge Wainaina, P.E.
State Geotechnical Engineer

SUBJECT: Retaining Wall Design Guidelines

The purpose of this memorandum is to introduce the Retaining Wall Design Guidelines for the Geotechnical Engineering Unit. These guidelines supercede the procedures from a previous memorandum entitled "New Retaining Wall Policies" dated April 19, 2005. These guidelines are posted on the S drive and will be continuously updated. They will also form the basis for the future Highway Design Branch Retaining Wall Manual.

These guidelines also include some of the recent changes/revisions to standards for retaining walls. These changes are summarized below:

- New borders for retaining wall plans were developed and added to the CADD geotechnical cell libraries
- The Structure Project Special Provision for MSE Retaining Walls has been revised to show payment per exposed face area effective with the July 2006 letting
- A new Structure Standard Drawing for a Gravity Retaining Wall has been developed effective with the July 2006 letting

Please do not hesitate to call Support Services with questions regarding retaining walls or when situations arise that are not addressed in the attached guidelines.

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1. Notify the Structure Design Unit when a retaining wall is identified that they are not aware of so they know retaining wall plans will be forthcoming. For retaining walls designed in-house by Structure Design (usually cantilever or sheet pile retaining walls), provide retaining wall design recommendations including bearing pressures, pile types and tip elevations, pressure diagrams, etc. to Structures. For all other retaining walls, provide the following to Structure Design:
   - Non-standard retaining wall special provision or direction as to which Structure Standard Project Special Provision to use (currently, MSE Retaining Walls is the only standard retaining wall PSP) or no special provision for sheet pile or gravity retaining walls (covered by Sections 452 and 453 of the Standard Specifications)
   - Full size sealed retaining wall plans (either post-bid or designed in-house by the GEU)
   - Quantity in square feet or meter per wall type equal to the total area of all wall envelopes for the same wall type (area for each wall envelope provided by Roadway Design for roadway walls and by Structure Design for abutment walls) or the total area of precast panels for all pile panel walls
2. Address/consider the following during retaining wall design:
   - Wall Minimization/Elimination
   - Right-of-Way/Easement Needs
   - Retaining Wall Drainage Design
   - Drainage and Utility Conflicts
   - Traffic Control Issues/Temporary Shoring
   - Aesthetic Requirements/Commitments
   - Concrete Coping Use and Type
   - Pedestrian Rail or Fence Needs
   - Guardrail or Barrier Details
   - Constructability/Division Preferences
   - Global or External Stability
   - Internal Stability for In-house Designs
3. For non-standard retaining wall special provisions, show payment per exposed face area (top of wall minus bottom of wall as defined below) with the exception of pile panel walls (payment will remain as per square feet or meter of precast panels). Use the following special provision names and identical pay item names for the non-standard retaining wall special provisions:

Special Provision and Pay Item Name	Description
"Soil Nail Retaining Walls"	Soil nail retaining wall
"Pile Panel Retaining Walls"	Pile wall with timber lagging and precast panels
"Pile Retaining Walls"	Pile wall with timber lagging and cast-in-place concrete face
"Anchored Retaining Walls"	Tieback wall
"Cantilever Retaining Walls"	Cast-in-place concrete cantilever wall

4. Incorporate the following language into non-standard Anchored Retaining Walls Special Provision regarding the welding of the piles:
   "Fabricate steel piles in accordance with Section 1072 of the Standard Specifications. If approved, steel piles may be fabricated on site provided fabrication and welding procedures are submitted and accepted before beginning fabrication."
   For the non-standard Soil Nail Retaining Walls or Anchored Retaining Walls Special Provisions, refer to the Standard Grout for Structures Project Special Provision in the materials section of the provision and direct Structure Design to include the Grout for Structures PSP in the Contract.
5. Show the following on the retaining wall plans and define in non-standard retaining wall special provisions:
   Bottom of Wall – point where the finished grade intersects the front of the wall
   Top of Wall – top of the cast-in-place face or coping (or bottom of cap if abutment wall is part of end bent or embedded in cap)
   Grade Elevation – elevation where the finished grade intersects the back of the wall
   Wall Height – difference between the top and bottom of wall elevation (used for pay purposes)
   Design Height (H) – difference between the grade elevation and the bottom of wall elevation
   Extension – difference between the wall and design height
6. Include the following note on the retaining wall plans if the existing ground line is in the vicinity of the wall:
   "BEFORE BEGINNING RETAINING WALL DESIGN, SURVEY ALL EXISTING GROUND ELEVATIONS SHOWN ON THE PLANS AND SUBMIT A REVISED WALL ENVELOPE FOR REVIEW. DO NOT BEGIN WALL DESIGN OR CONSTRUCTION UNTIL THIS ENVELOPE HAS BEEN APPROVED."
7. The GEU should strive to use numbering, stationing and labeling for retaining walls that is as consistent as possible. In addition, the content of the retaining wall plans prepared by the Unit should be relatively uniform. Use the following general guidelines for retaining walls.
   - Retaining wall plans should typically include the following: plan view, elevation or profile view (wall envelope), notes, typical sections and any special details.
   - The beginning of wall should correspond to the lowest station and the end of wall to the highest station. For stream crossings with abutment walls, the beginning of wall should correspond with the upstream direction and the end of wall with the downstream direction.
   - Show the beginning of wall, end of wall and bend stations and offsets on the plan view. Also, show wall stations and corresponding offsets at the same frequent constant stations shown on the wall envelope for walls with variable/inconsistent offsets.
   - Show the beginning of wall, end of wall and bend stations as well as stationing on some frequent constant interval on the wall envelope. The first station shown after the beginning of wall should be some even station. Continue stationing at some frequent constant interval until the last even station before the end of wall.

Show the wall envelope in the plans such that the reader views the front (exposed) face of the wall, i.e., the reader should not view the wall from behind.

- Include a graphical plot of the grade and bottom of wall elevations as well as the existing ground and temporary grade elevations, if applicable, on the wall envelope. Show each elevation both graphically and numerically at each station. Connect wall elevations with solid continuous lines and all other elevations with dashed intermittent lines.
- Number retaining walls beginning with Retaining Wall No. 1 and increase sequentially with increasing stations along the L line. If a retaining wall is located on a Y line, number the wall in the sequence based on where the Y line crosses the L line.
- Identify retaining walls with a station and either left or right. Use the first even numbered station shown on the wall envelope after the beginning of wall for wall identification.
- Identify and station abutment walls according to the line the bridge is crossing. For stream crossings with abutment walls, use the wall station corresponding to the end bent station for wall identification since the stream does not have any stations. For wall station increments in this situation, use distances left and right of the wall station identification.
- When retaining walls change alignments such as for U or L shaped walls, separate walls into multiple walls and show the equality (station and offset relative to both alignments) at the bend on the plan view and wall envelope.

8. Use the DgnSheet-03 cell from the Unit's cell library to create a border for all retaining wall plans prepared by the GEU.
9. The following retaining wall standards are currently available:
   - Structure Project Special Provision for MSE Retaining Walls
   - Structure Standard Drawing for Gravity Retaining Wall
   - Section 453 of the Standard Specifications for Gravity Retaining Walls
   - Section 452 of the Standard Specifications for Sheet Pile Retaining Walls

   When using a post-bid design MSE retaining wall, direct Structure Design to include the standard PSP in the Contract. When using a standard gravity wall, include a full size sealed plot of the structure standard drawing with the retaining wall plans.
10. Concrete coping is only required for retaining walls with pre-cast face elements (MSE and pile panel retaining walls). Cast-in-place coping may be used for walls with a cast-in-place concrete face when required for aesthetic reasons.
11. Coordinate with Roadway Design to determine if guardrail (Section 862), single faced precast concrete barrier (Section 857) or concrete barrier rail (Section 460) with a moment slab is required above and below retaining walls. When a concrete barrier rail (Structure Standard Drawing) is required above a wall, show the barrier rail with a moment slab on the retaining wall plans. Include a note on the plans that payment for the moment slab is incidental to the "Concrete Barrier Rail" pay item. When a single faced barrier is required, show the barrier in accordance with Roadway Standard Drawing 857.01 and reference Section 857 of the Standard Specifications on the retaining walls plans. Also, address barrier transition details at ends of retaining

wall and conflicts between barrier and drain holes and coping in the plans. In some situations, the barrier below the wall may be eliminated in coordination with Roadway Design for retaining walls with a cast-in-place concrete face that are not on the NHS system depending on the operating speed, ADT, aesthetics, wall alignment and accident potential.

12. One of the following options are required for abutment walls:
    - End Bent on battered piles (piles battered towards the wall) separated from abutment wall
    - End Bent on single row of plumb piles with MSE retaining wall only and reinforcement connected to the back of the cap separated from abutment wall
    - End Bent on double row of plumb piles or drilled piers separated from abutment wall
    - End Bent on cantilever retaining wall supported by either piles or shallow foundations
    - End Bent on drilled piers with either a cantilever retaining wall (cast-in-place concrete wall between columns) or a sheet pile retaining wall (embedded in cap behind piers)
13. Temporary shoring for retaining walls that is required to maintain traffic should be identified, designed and paid for in accordance with the current procedure for temporary shoring for maintenance of traffic. This includes phased MSE walls where the temporary shoring incorporated into the design of the MSE wall has historically been incidental to the cost of the wall. Temporary shoring for these situations should be shown and identified as "Temporary Shoring for Maintenance of Traffic" on the retaining wall plans with the following note:
    "TEMPORARY SHORING FOR MAINTENANCE OF TRAFFIC IS REQUIRED FROM STATION _____, _____FT (M) _____, TO STATION _____, _____FT (M) _____. SEE TRAFFIC CONTROL PLANS AND TEMPORARY SHORING FOR MAINTENANCE OF TRAFFIC SPECIAL PROVISION."
14. Temporary shoring for retaining walls that is not required to maintain traffic but is required to construct a wall such as when shoring is required to protect the integrity of a phased retaining wall will be considered incidental to the cost of the wall. Temporary shoring for this situation should be shown and identified as "Temporary Shoring for Wall Construction" on the retaining wall plans with the following note:
    "TEMPORARY SHORING FOR WALL CONSTRUCTION IS REQUIRED FROM STATION _____, _____FT (M) _____, TO STATION _____, _____FT (M) _____. SUBMIT TEMPORARY SHORING PLANS, DESIGN AND CALCULATIONS WITH THE RETAINING WALL SUBMITTALS. NO PAYMENT WILL BE MADE FOR TEMPORARY SHORING FOR WALL CONSTRUCTION. PAYMENT FOR TEMPORARY SHORING FOR WALL CONSTRUCTION WILL BE CONSIDERED INCIDENTAL TO THE COST OF THE RETAINING WALL."