216 Earthwork

216.1 General

Earthwork is a generic term for all items of work, materials and operations required to construct the excavated areas and the embankments of a project.

FDOT's ***Standard Specifications*** ***Sections 110***, ***120***, and ***125*** define the terms, method of measurement, basis of payment, and pay items associated with earthwork.

Earthwork on a highway project generally consists of:

- **Clearing and Grubbing** – Removal of existing pavement to prepare the area for proposed construction. See ***Standard Specifications Section 110*** for additional requirements.
- **Embankment –** Compacted fill material needed to construct the roadway. See ***Standard Specifications Section 120*** for additional requirements.
- **Regular Excavation –** See ***Standard Specifications Section 120*** for additional requirements.
- **Subsoil Excavation –** See ***Standard Specifications Section 120*** for additional requirements.
- **Excavation for Structures and Pipe –** See ***Standard Specifications Section 125*** for additional requirements.

The roadbed is constructed by excavating soil from cut sections and placing soil as embankments in fill sections. A summary of the most common cut and fill sections is described in this chapter.

216.2 Classification of Soils

The Department uses a system of soil classification that places materials into groups and subgroups based on soil fraction, liquid limit, and plasticity index. This classification determines if and where the materials may be placed or left in their existing position on a project. The soils survey, testing and classification of materials must be performed by a qualified geotechnical laboratory. The plans will include the information about the soil classification on the soil survey sheet and by showing the boring data soil boxes on the cross-section sheets. If it is determined that an organic or plastic material must be removed below the finished graded surface, the lower limits of removal of organic or plastic material will be shown to determine the area and volume of subsoil excavation.

216.3 Cross Sections

The details of cut and fill of earthwork are shown on the cross sections. The cross sections of the existing surface are usually obtained by location field survey or photogrammetry. The finished profile grades, typical section details, pavement design details, superelevation and horizontal alignments are used in combination to develop the finished surface at each location where an existing cross section is generated. Sometimes it is advisable to develop and plot intermediate cross sections or half-sections to accurately backcheck the earthwork quantities.

Cross sections cannot be finalized until late in the design process. However, preliminary cross section surfaces, developed early in the design process, can assist the designer in establishing many of the other design elements such as guardrail, shoulder gutter, inlets, and special ditch grades. Preliminary cross sections are also used in performing the Soils Survey. Cross section surfaces should be plotted as soon as the alignment, profile grades and typical section details are established.

For guidance, see ***FDM 925***.

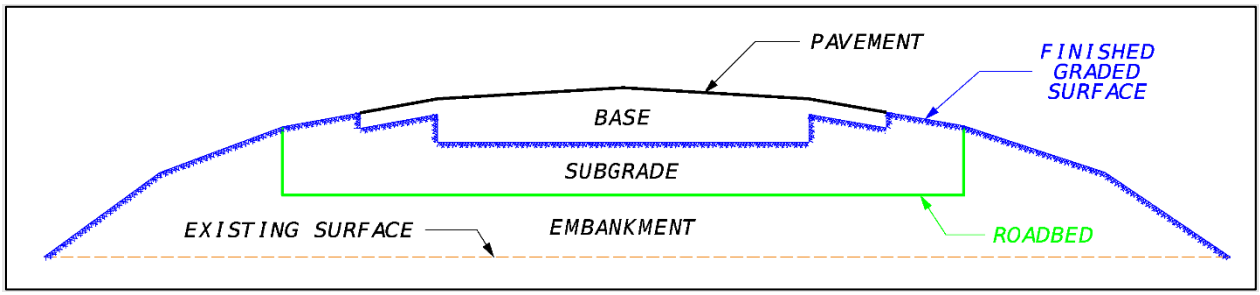
216.4 Earthwork Pay Items

Standard Specifications, ***Sections 120*** and ***125*** define the terms, method of measurement, basis of payment, and pay items associated with earthwork. Two terms that are relevant to quantifying earthwork pay items are: existing surface and finished graded surface. The existing surface is defined as the contour of the existing natural topography. The finished graded surface (illustrated in ***Figure 216.4.1***) is defined as the contour of the finished side slopes, unpaved shoulders, and the bottom of the roadway base and shoulder base for flexible or rigid pavement.

Evaluate the availability of earthwork materials within the project right of way and conduct an earthwork balance assessment prior to Phase III. Evaluate any accessibility, drainage, geotechnical, or environmental restrictions that would affect the determination of available or unsuitable earthwork.

Figures 216.4.2 through 216.4.5 illustrate cut and fill limits and details. Additional criteria and earthwork details are found in the ***Standard Plans, Indexes 120-001, 120-002,*** and ***160-001***.

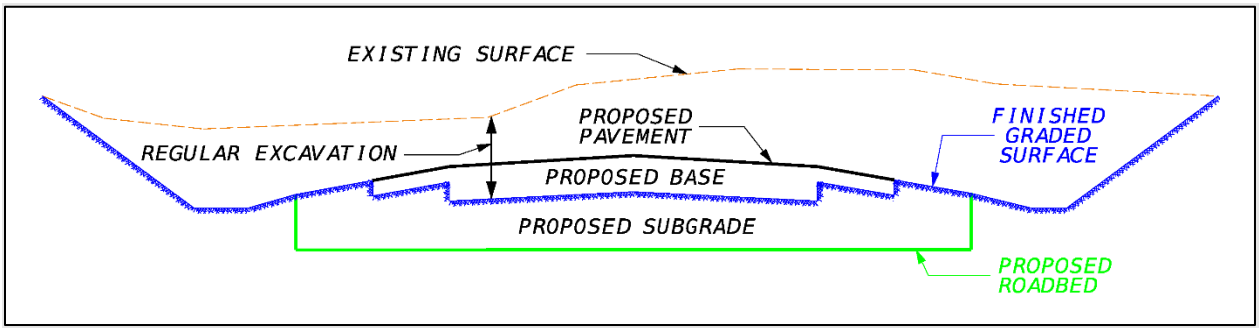
Figure 216.4.1 Finished Graded Surface



Projects are constructed over natural topography (Case I) or over existing roadbeds (Case II). Projects may also have sections where both Case I and Case II apply.

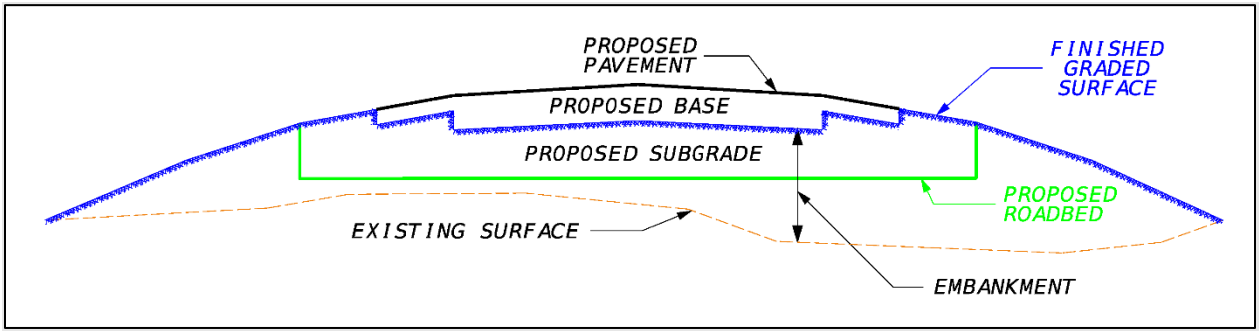
For Case I projects, calculate the Excavation quantities from the existing surface to the finished graded surface.

Figure 216.4.2 Case I Excavation



Calculate the Embankment quantities from the existing surface to the finished graded surface.

Figure 216.4.3 Case I Embankment



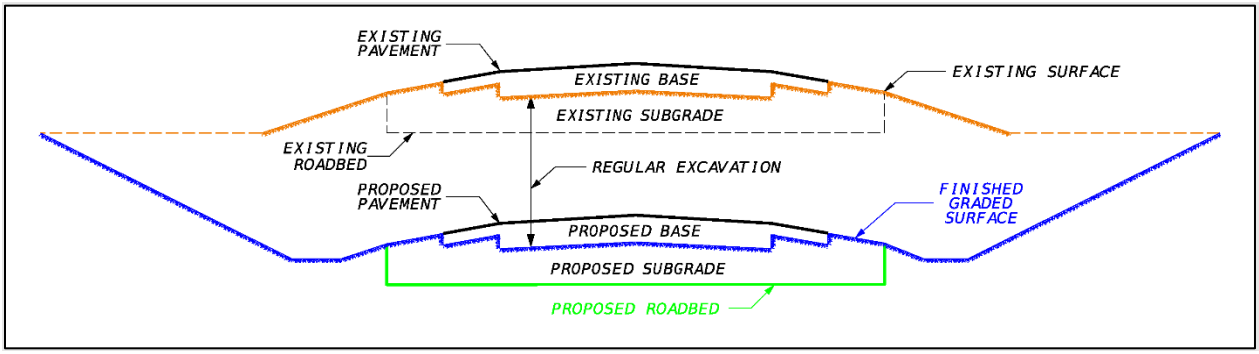
Case II projects may or may not include the removal of existing base material or removal of existing concrete pavement. According to ***Standard Specifications 120***:

- Only the asphalt on existing flexible pavement roadways will be removed (not base material) unless shown in the plans; and,
- Existing concrete pavement is only to be removed when called for in the plans.

Coordinate with the District Pavement Materials Office (DPMO) to determine if removal of existing flexible pavement base or concrete pavement is required. If the existing flexible pavement base or the existing concrete pavement are to be removed, this must be indicated in the plans and included in the Clearing and Grubbing pay items.

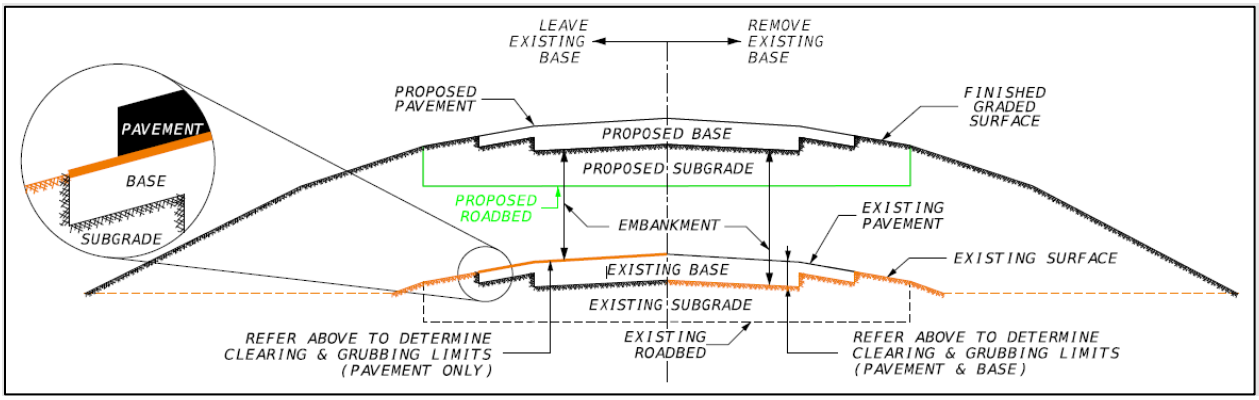
Calculate the Excavation quantities for a new roadway as shown in ***Figure 216.4.4***. For Case II projects, calculate the Excavation quantities from the existing surface to the finished graded surface of the new road; or if concrete pavement removal is called for in the plans, the calculation is taken from the bottom of the existing concrete to the finished graded surface of the new road.

Figure 216.4.4 Case II Excavation



Calculate the Embankment quantities for a new roadway as shown in ***Figure 216.4.5***. Calculate the Embankment from the top of the existing base to the finished graded surface of the new road (***Figure 216.4.5*** Left) or, if the base removal is called for in the plans, calculate the Embankment from the bottom of the existing surface (finish graded surface) to the finished graded surface of the new road (***Figure 216.4.5*** Right). If concrete pavement removal is called for in the plans, the calculation is taken from the bottom of the existing concrete to the finished graded surface of the new road.

Figure 216.4.5 Case II Embankment



216.4.1 Regular Excavation

Regular Excavation is the most general classification of earthwork excavation. Regular Excavation consists of the excavation and the utilization or disposal of all materials necessary for the construction of the roadway, ditches, channel changes, etc., except for removal of existing pavement as defined in ***Standard Specifications Section 110***.

Stormwater management facilities (e.g. wet detention ponds) beyond the roadway corridor's border width or that require considerable excavation should be summarized separately.

216.4.1.1 Regular Excavation (RRR Projects Only)

The pay item for Regular Excavation (RRR Projects Only) Lump Sum is used on resurfacing (RRR) projects that meet the following conditions:

(1) There are limited or no cross sections on the project.

(2) Existing typical sections are reasonably consistent throughout the project.

(3) If utility adjustments are a consideration on the project, the designer will need to be sure that sufficient data is available to allow the utility to be relocated or adjusted.

(4) There are no right of way requirements on the project.

(5) There is no change in the existing horizontal or vertical alignment.

(6) There are no major special ditches on the project.

(7) There are no major intersection modifications.

(8) Show quantity of Excavation in Summary of Earthwork but pay for as 1 Lump Sum.

Regular Excavation (RRR Projects Only) - Lump Sum may be used on intersection improvements and minor widening projects if they comply with the same conditions listed above.

Earthwork will be paid for as Borrow Excavation (Truck Measure) and Regular Excavation (RRR Projects Only) – Lump Sum. The designer will calculate these quantities based on information obtained from the field and the proposed typical section. The designer must conduct a thorough field review to ensure existing field conditions are accurately reflected in earthwork estimates.

216.4.2 Subsoil Excavation

Subsoil Excavation is defined in ***Standard Specifications Section 120***.

The soils investigation survey documents the organic or plastic material found on the project. Likewise, the cross sections and the earthwork calculations must use the lower limits of removal of organic or plastic material in determining the quantities for Subsoil Excavation.

Where future widening of the roadway is anticipated, specify the limits of removal necessary to accommodate the future widening.

At some locations the complete removal of organic or soft soils may not be practical due to the depth. Review the Subsoil Excavation with the Geotechnical Engineer of Record and where constructability concerns exist, consult with the District Geotechnical Engineer to review design alternatives. If a geosynthetic reinforced design is selected, refer to ***FDM 263*** for plan content and design requirements. Additional information concerning geotechnical design can be found in the ***Geotechnical Design Manual (GDM)***.

Where Subsoil Excavation is required due to plastic soils, ensure that adequate drainage of the pavement subgrade is provided. ***Figure 216.4.7*** illustrates the required excavation undercut line (i.e., grade and extent of excavation bottom) for flush shoulder roadways. To accommodate normal undercuts, the side ditches should be at least 3.5 feet below the shoulder break.

For curbed roadways, additional Subsoil Excavation may be needed beyond that shown in ***Figure 216.4.7*** or underdrains must be installed in accordance with ***Standard Plans, Index 120-002***. Coordinate the removal of plastic materials with the Drainage Engineer of Record, as it may affect various drainage design elements including the profile grade of the ditch bottoms.

The embankment quantities (areas and volumes) may be checked by calculating the areas and volumes required to fill the excavated areas created by subsoil removal. See example given in ***Figure 216.4.8***.

Do not include the payment for Subsoil Excavation in the pay quantities for other items no matter how small the subsoil quantity.

Figure 216.4.6 Undercut Detail of Plastic Material with Relation to Side Ditches

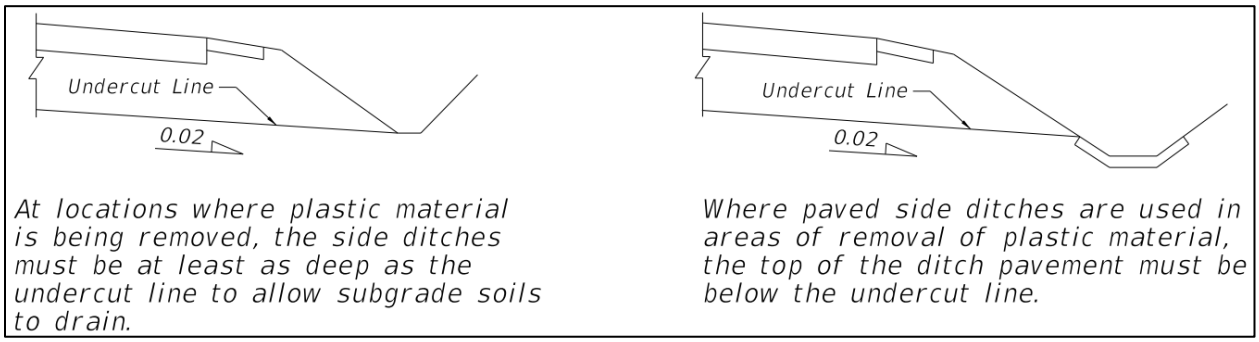
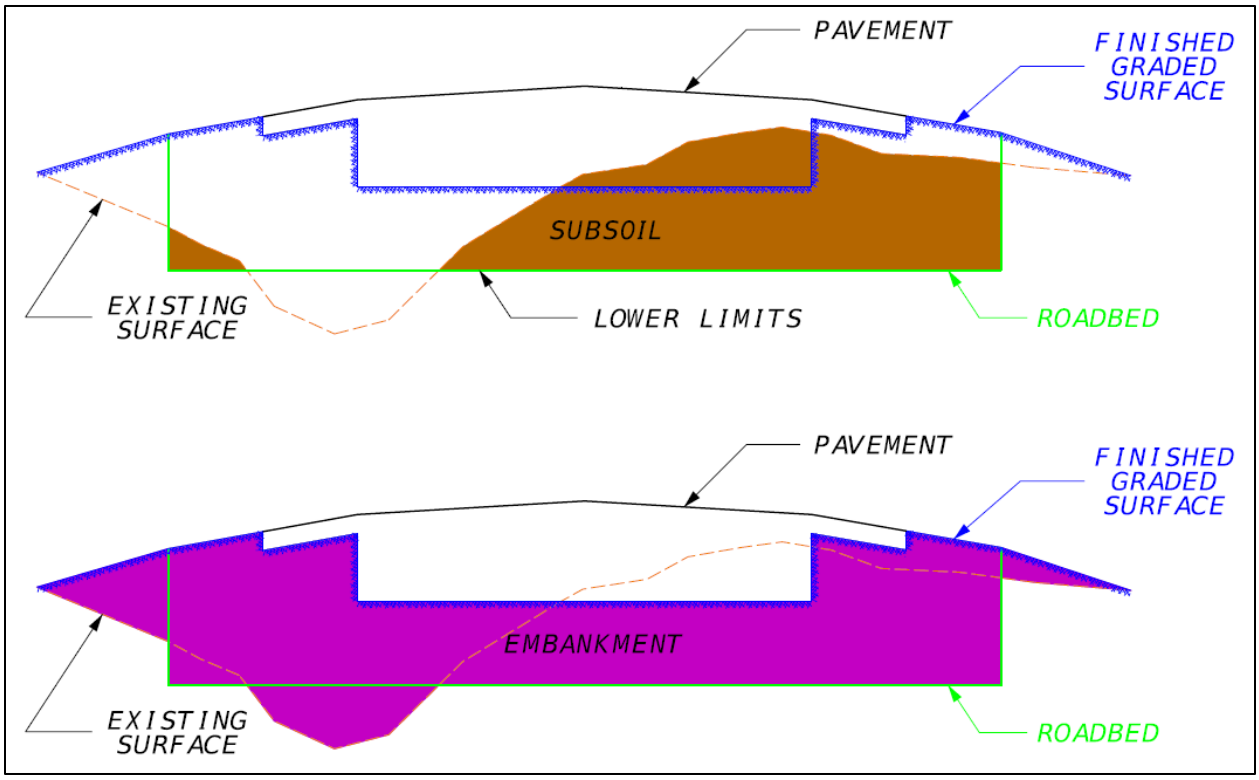


Figure 216.4.7 Excavation and Embankment



Embankment (fill) or Regular Excavation (cut) should be used in conjunction with the pay item Subsoil Excavation. Both Embankment and Regular Excavation are plan quantity items. The quantities are based on the line and grades shown in the plans and would allow construction personnel to field-verify the quantities of material used on a project. Subsoil Excavation is a field measure item, and the final pay quantity will be determined by cross section taken when the removal of the material is completed.

216.4.3 Lateral Ditch Excavation

Excavation required to construct inlet and outlet ditches at structures, changes in channels of streams and ditches parallel to the right of way, but separated from the roadway surface, may be designated by the designer as Lateral Ditch Excavation.

On projects with very little of this type of excavation, this earthwork is usually included in the Regular Excavation. If there is a significant amount of Lateral Ditch Excavation, it should be detailed, calculated, and summarized separately in the Summary of Earthwork.

Quantities for ***Excavation for Structures and Pipe*** must not be included in the quantities for Lateral Ditch or other excavation pay items.

216.4.4 Channel Excavation

The pay item for Channel Excavation consists of the excavation and satisfactory disposal of all material from the limits of the channel as shown in the plans. This work is generally called for by the plans and has lines, grades, typical sections, and other details shown for excavating a channel change or a major modification to an existing channel or stream. This work may be significantly different from Regular Excavation or Lateral Ditch Excavation, requiring draglines, barges, or other special equipment. It is typically detailed, calculated, and summarized separately.

216.4.5 Borrow Excavation (Truck Measure)

The pay item for Borrow Excavation (Truck Measure) is only used on projects with limited or no cross sections. It is used to indicate that the contractor is to furnish earthwork material from areas provided by the contractor and generally outside the project limits. This could include material with a specific minimum bearing value for building up existing shoulders when appropriate for the project.

When the designer chooses the method of payment as Borrow Excavation (Truck Measure), a fill adjustment must be made to the net total fill material calculated from the plans to allow for handling. An additional adjustment (truck) is added to obtain a

representative volume of material required. This is not a plan quantity item, but it is very important that a realistic determination of quantities be calculated by the designer.

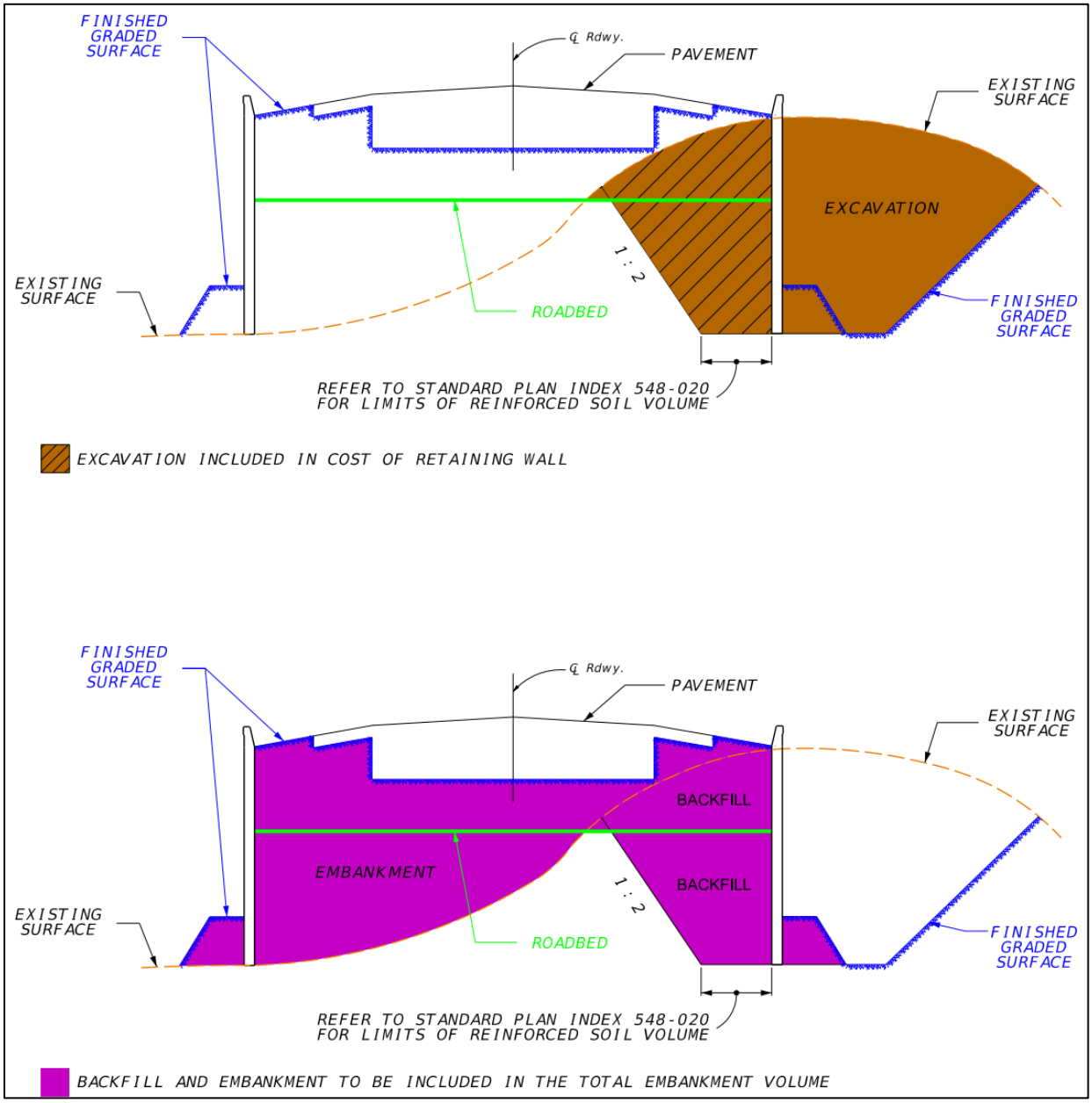
216.4.6 Embankment

Embankment includes placing material, as described in ***FDM 216.4***, or above the lower limits of removal of organic or plastic material, as applicable, to the bottom of the proposed roadbed. Refer to ***FDM 210.4*** and ***211.4*** for additional requirements for shoulder gutters.

216.4.6.1 Retaining Wall Embankment

Excavation for retaining wall construction is included in the cost of the retaining wall, but the cost of backfill or embankment for retaining walls is included in the cost of embankment. Calculate the embankment volume as illustrated in ***Figure 216.4.9***. The limits of soil volumes for retaining walls depend on the requirements in ***Standard Plans Index 548-020***, retaining wall strap length design, and the soil slope (typically 1:2). Coordinate with the structures design engineer on the retaining wall design and reinforced soil volumes. See ***Standard Specifications Section 548*** for more information on Retaining Wall Systems.

Figure 216.4.8 Retaining Wall Excavation and Embankment



216.5 Earthwork Quantities

Earthwork quantities are typically calculated using surface to surface calculation within the model. For more information, see the ***CADD 3D Modeling Course Guide*** and ***BOE Manual***.

Earthwork quantities may be checked by the method of average end areas:

$$\text{CUBIC YARDS} = \frac{EA1 + EA2}{2} \times \text{LENGTH} / 27$$

216.5.1 Variation in Quantities

When detailing and determining earthwork quantities, use the most probable base option within the optional base group. A plan note should also be shown in the plans stating which option was used for plotting the cross sections and calculating the earthwork quantities (see ***FDM 902***).

216.6 Summary of Earthwork

A subtotal for each group (e.g., mainline, side street, pond) should be shown in the Summary of Earthwork for each earthwork operation (Subsoil Excavation, Regular Excavation, and Embankment). This summary should be shown on the Summary of Earthwork in the Estimated Quantities Report. See ***FDM 902*** for information on the Estimated Quantities Report. Specify and quantify material necessary to meet the drainage design requirements, such as select material beneath swales, on fill, and ponds designed to percolate runoff.

See Chapter 8 of the ***BOE*** for examples of Summary of Earthwork.