

ENGINEERING DIRECTIVES AND STANDARDS

Volume	Chapter	Section	Directive Number	Effective Date
III	2	1	1	8/16/2007

SUBJECT: DETERMINATION OF QUANTITIES FOR PAYMENT OF EXCAVATION AND EMBANKMENT

1. **PURPOSE:** The purpose of this directive is to establish a uniform policy for the verification and/or determination of quantities for payment of excavation and embankment as defined in the 2000 Edition of the Standard Specifications for Roads and Bridges, Section 203, Excavation and Embankment. This directive will allow for the accurate determination of excavation and embankment quantities prior to completion of these items on the project with a minimum of manpower and with no delay in the completion of the final estimate.
2. **SCOPE:** The Standard Specifications provide for payment of earthwork items based on plan quantities. This directive will apply to all projects let under the above Specification.

3. PROCEDURES:**A. General**

General Excavation, Drainage Excavation, Muck Excavation, Embankment, and Nonplastic Embankment will be paid for by the cubic yard (cubic meter). The measurement of quantities will be computed by the average end area method and will be that area bound by (1) the original ground line established by location (plan) cross sections (if accurate) or new original cross sections obtained by the Contractor, and (2) the final theoretical pay line derived from the profile grade, typical sections, and ditch grades shown on the plans, or established by the Engineer, adjusted for field changes.

New plan quantities should be determined if there are construction revisions, revised plan theoretical grades, new original cross sections, or incorrect or omitted plan quantities. A plan change should be prepared in accordance with Subsection 104.02 for any revisions to the typical section and may be required for revisions to the plan profile or ditch grades. Plan omissions or errors in quantities should be plan changed in accordance with current department policy.

When a disagreement exists between the contractor and the engineer as to the accuracy of the plan quantities, either party may require the quantities be revised. The party requesting the revision is responsible for isolating the area in question and obtaining data required to compute revised quantities. The other party will verify the revision.

The Project Engineer should make all known corrections or revisions to earthwork templates in the early stages of project construction to insure accurate quantities are paid on partial estimates and that there is a minimum of delay in processing the Final Estimate.

Prior to acceptance by the Project Engineer any grade not within the tolerances established under Subsection 203.07 of the Standard Specifications shall be reworked by the contractor until the criteria has been met. Grade deviations allowed by the Engineer will require final cross sections be taken and any volume less than plans will be computed and deducted by the Project Engineer from plan quantity.

B. Verification of Design Quantities

Upon receipt of final plans, the Project Engineer should request a copy of design template grades and calculations for quantities of plan earthwork items from the Project Manager. The engineer should review the planned cross sections and verify that the earthwork templates are in conformance with the plan profiles, typical sections, and ditch grades. Plan review should also note areas in which earthwork calculations or quantities are not provided. A sufficient number of cross section volumes shall be verified by the Project Engineer to insure that planned quantities are accurate.

Errors or omissions found will be subject to correction by the Project Engineer or returned to the Project Manager for correction if location cross-sections are deemed accurate and no changes in profile grade or typical section is required.

In accordance with provisions of the Construction Layout item, the contractor shall provide construction template grades to the Project Engineer. The contractor's grades should be checked against the design template for discrepancies. If construction grades are accurate, the design template and plan calculations will be used for final earthwork quantities.

C. Verification of Location Cross Sections

The Project Engineer, (or the contractor under the direction of the Project Engineer by Special Provision of Construction Layout), will take original cross sections for the entire length of the project after clearing and grubbing operations. From these sections the Project Engineer will determine the accuracy of the location cross sections by using center line elevations at intervals of 100

linear feet (30 linear meters) and random sections not further apart than 1000 linear feet (300 linear meters).

The location sections may be used for payment purposes if the average differential between the location and original centerline profile and location and random original sections does not exceed ± 0.3 foot (0.1 meter) as computed by current DOTD practice (Attachment 1). If the average differential is greater than ± 0.3 foot (0.1 meter) for significant sections of the project, original cross sections will be used in conjunction with the theoretical pay line shown on the plans to compute the earthwork pay quantities.

For drainage and muck excavation the differentials shall be determined for each separate location shown on the plans. New original cross sections are to be taken for each location shown on the plans. The random section intervals are not to exceed 1000 feet, with no less than two intervals per location. Any drainage location which has a differential greater than ± 0.3 foot (0.1 meter) between the location cross sections and new original cross sections will require that the new original sections be used in conjunction with the final theoretical pay line shown on the plans to compute the new pay quantities.

Plan quantities for excavation and embankment items will be used for payment if the location cross sections are determined to be accurate and if the project is constructed essentially to the theoretical pay line.

D. Sections to be Recomputed by the Project Engineer

In all cases where location sections are unavailable, new originals are to be taken and new quantities computed.

When the average elevation differential exceeds ± 0.3 foot (0.1 meter) for significant portions of the project, the Project Engineer will determine revised quantities using the new original cross sections and plan template grades.

If the Project Engineer makes any field changes, such revisions will be noted on the As-Built Plans (Ozalids). All revisions to plan profile grades, typical sections, or ditch grades will be noted on the As-built Plans. New cross sections will be plotted and quantities recomputed for any revisions, errors or omissions found in the plan cross sections. These revised plan quantities shall be the final pay quantities.

New original cross sections or natural ground elevations are to be taken for each footing or other designated location shown on the plans for Structural Excavation. Final payment for Structural Excavation will be made in accordance with Section 802 of the Standard Specifications.

E. Payment by Final Field Cross Section

Whenever the Project Engineer elects to pay earthwork in accordance with Sub-section 203.14 (b)(2) of the 2000 Standard Specifications, the new pay quantities will be re-plotted and recomputed in the field. The new pay quantity shall be determined by using final cross sections, except where such finals exceed the construction template approved by the Project Engineer. Guardrail widening and bridge header embankments may be measured by final cross sections.

Any work in excess of the new grades, which are to be turned in with the final, shall not be included in the new revised quantities.

F. Partial Estimates

The partial estimates will be based on the percentages of work completed between balance points indicated on the plans. Guidelines are provided in the Contract Administration Manual. In no case will more than plan quantity be paid for between balance points unless the engineer increases the grade or quantity, subject to the provisions of EDSM No. III.1.1.1.

G. Final Estimates

Upon completion of the project, the planned cross sections and planned quantities, along with the re-plotted cross sections and recomputed quantities shall be submitted to the Construction Estimates Unit with the final estimate. Data to be submitted with the final shall include the final template grades or slope stake records for the project.

Revisions to the earthwork template, with the recomputed volumes due to such revisions, will be submitted to the Construction Estimates Unit in such manner to be clearly understood. Construction templates or grade notes shall be turned in with the final estimate for all projects.

Calculation sheets used to compute the location/original average differentials are to be submitted with the Final Estimate.

When the location (plan) sections are used for payment, original verification grades are to be transposed and plotted by field personnel on the cross sections furnished with the plans.

Any additional cut or fill not required by the final template grades or slope stake records, which are to be turned in with the final, shall not qualify for additional payment.

- 4. OTHER ISSUANCES AFFECTED:** This directive replaces EDSM No. III.2.1.1 dated 09/16/1982 and deletes EDSM No. III.2.1.2 dated 07/07/1981.
- 5. EFFECTIVE DATE:** This directive will become effective immediately upon receipt.

ATTACHMENT No. 1

ILLUSTRATION SHOWING METHOD OF DETERMINING AVERAGE ELEVATION OF A SECTION

For determining the differential on the centerline, the algebraic sum of the elevation differences at 100 feet intervals will be divided by the number of intervals being verified.

The differentials for sections at random intervals shall be determined by computing end areas between the original cross sections and the location cross sections being verified. The algebraic sum of the end areas at each station being verified will be divided by the net width of these two originals and the result shall be the differential for the interval. The algebraic sum of random section results will be divided by the total number of these intervals for the cross section differential.

As an alternate to the end area method, the differential may be determined by the average elevation method (see attached illustration). The differential is the difference between the average elevations of the original and location cross sections.

The average elevation of a section is the summation of the products of each elevation times the distance between the rod readings before and after the elevation, all divided by two (2) times the total width cross-sectioned.

The method is illustrated in this example.

For the section,

101.1	99.5	99.5	101.2	101.6	101.3	99.6	99.5	101.4
28	21	17	11	0	12	16	19	25

The average elevation is:

$$(101.1 (28-21) + 99.5 (28-17) + 99.5 (21-11) + 101.2(17-0) + 101.6 (11+12) + 101.3 (16-0) + 99.6 (19-12) + 99.5 (25-16) + 101.4 (25-19) \text{ DIVIDED BY } 2 (28+25) = 100.7198$$