MDT Construction Administration Manual (CAM)

MONTANA

DEPARTMENT OF TRANSPORTATION

PREFACE

The MDT Construction Administration Manual (CAM) covers construction inspection practices used during MDT construction contract administration, but also contains guidance for MDT construction engineers, inspectors and technicians. The CAM references MDT road and bridge specifications as they relate to CAM topics. This manual does not apply to Contractors, and is not a contract document.

The MDT Construction Administration Manual was developed by the Construction Bureau with input from personnel within each of five statewide construction districts, and reviewed by the MDT Construction Engineer, Construction Engineering Services Engineer, Construction Administration Engineer and Materials Engineer. The MDT CAM was extensively edited, revised and updated June 2022.

MDT CONSTRUCTION ADMINISTRATION MANUAL (CAM) REVISION PROCESS

Submit proposed revisions to the Construction Engineer using the "Revision Request Form" below. A review committee selected by the Construction Engineer meets as necessary to review proposed changes. The committee submits recommendations to and meets with the Construction Engineer to determine if proposed revisions will be made. Revisions may be reviewed by other MDT bureaus or sections. The Construction Engineer then distributes a memo attachment describing approved revisions.

Revision Review Committee

The committee provides CAM updates and maintains a chronological record of revisions.

Committee members are:

- Construction Engineering Services Engineer
- District Construction Engineering Services Reviewer
- Specifications Engineer
- District Construction Engineer

CAM Revision Request:

Submitted By:____

Date:____

Section To Be Revised:____

Section Title: ____

Page Number(s):____

Revision Description

Sections affected by the revision:

1. ________________________________
2. ________________________________
3. ________________________________

Reason for Requested Revision

Table of Contents

Construction Administration Manual (CAM)

SECTION 100

MDT MISSION STATEMENT AND LEADERSHIP

MDT serves the public by providing a transportation system emphasizing quality, safety, cost effectiveness, economic vitality and environmental sensitivity. The director is governor appointed to lead the MDT. MDT policy and operational authority other than those provided by statute are vested in the director and transportation commission. MDT division heads and DAs report to the director. The transportation commission is a five member governor appointed board serving a four year term to oversee:

- project selection and prioritization
- contract award
- federal aid allocation
- highway system designation
- highway access control
- special speed zones

MDT CONSTRUCTION ADMINISTRATION MANUAL (CAM)

OBJECTIVE

This manual is intended to assist MDT construction staff in daily duties involving contract administration, quality control and communication. This Manual seeks to instill a thorough knowledge of construction specifications, contract administration and proper inspection practice. The Manual is a companion document to the MDT Standard Specifications for Road and Bridge Construction. However, it is guidance and assistance to MDT employees only. MDT Construction Administration Manual (CAM) objectives are:

- Explain and clarify MDT construction contract administration activities.
- Serve as a single document for MDT Construction Program operations by incorporating or referencing information. The CAM is not a contract document or part of any contract.
- Discuss proper project work documentation to ensure compliance with Standard Specifications, or reference the SiteManager Training Manual.
- Document coordination with other organizational entities (MDT units, State agencies, Federal agencies) during construction.
- Where applicable, highlight critical issues common during construction.

CAM REVISIONS AND CONSTRUCTION MEMORANDA

MDT periodically updates the CAM. As needed, MDT publishes construction memoranda to communicate changes to MDT procedure, or clarify information until the CAM is revised. Construction memoranda are not contractually binding, and in most cases only offer guidance to MDT construction staff. Submit questions and suggestions regarding the CAM by email to: stmcevoy@mt.gov

INTENDED READERS

This CAM has been compiled for MDT Project Managers, Inspectors, Material Testers, and headquarter and district field construction staff. Field situations encountered by Inspectors and field construction staff are discussed throughout the CAM in relation to MDT standard specification and MDT procedure.

ORGANIZATION

CAM organization parallels the MDT Standard Specifications for Road and Bridge Construction.

COORDINATION WITH OTHER MDT POLICIES

MDT policies and procedures have been documented via a variety of sources, including State Statute and MDT memos and manuals. CAM manual procedures do not supersede MDT policy. Please notify the CES or Specifications Engineer if discrepancies between this manual and MDT policies documented elsewhere are noted.

MDT CONSTRUCTION PROGRAM OBJECTIVES

The MDT Construction Program is essential to the MDT, as a significant portion of State transportation funding is devoted to the capital improvement construction program. The program provides contract administration and engineering quality control to deliver a quality product to highway users, meet project schedules and minimize litigation risk. MDT seeks to achieve these goals at the lowest cost possible without compromising Department objectives. Construction staff are located at headquarters, district offices and construction sites throughout Montana. Construction Program implementation requires interaction with units external to the Department. CAM Section 100 describes MDT Construction Program organization, function and cooperation with governmental agencies and other external entities. Also included within Section 100 are Construction Program personnel policy and procedure.

CONSTRUCTION PHASE ACTIVITIES

Bid Letting; The Tentative Construction Plan (TCP) assigns project "ready dates" which indicate when projects are ready for letting. "Ready dates" are set three months prior to the bid letting date, and are the dates the ECCB is ready to let contracts. The "finish date" is typically within one month of the "ready date". The TCP "letting date" is the project letting date. Standard Specification Section 102 discuss MDT bidding requirements and conditions.

Award; The Transportation Commission accepts a Contractor bid proposal. Standard Specification Section 103 discusses contract award and execution.

Preconstruction Conference (PC); The MDT, Contractor and interested parties hold a preconstruction conference within 20 days before the Notice to Proceed (NP). The conference is a forum for Contractors and MDT to address construction details. Standard Specification Subsection 108.03.1 discusses the PC.

Notice to Proceed (NP); This written notice allows Contractors to proceed, and initiates contract time. The ECCB sends the NP to Contractors immediately after award, which lists a NP date about 20 days after award. Standard Specification Subsection 108.02 discusses the NP.

Construction is work performed during the first work day through final acceptance, during which project completion occurs as required by contract documentation.

90% Completion; At 90% completion, Project Managers email a "90% Complete Memo" to the District Engineering Officer (DEO), who adds estimated costs, saves the memo within AASHTOware and enters the 90% Complete Memo key date. Data entry into AASHTOware generates an automatic email to the Material and Construction Bureaus, and initiates project cost modifications, as well as material and labor certification checks.

Final Inspection; Final inspection determines if work is complete, and may include a project "Best Management Practice" (BMP) evaluation. The Project Manager develops a list of remaining work items. Standard Specification Subsection 105.15.2 discusses final inspection.

Final Acceptance and Project Closeout; After Contractors accept the final estimate and submit a "Contractor's Request and Certification for Acceptance" form, the contract is formally accepted. MDT then issues a "Certification of Completion" within 10 days, and the Project Manager closes the project. Standard Specification Subsection 105.15.3 discusses final acceptance.

CONSTRUCTION

MDT Construction Program funding is administered by:

- **The Construction Engineer and Headquarter Bureaus** under the Construction Engineer, which provide program management and support by setting MDT policy and practice, providing technical support, budgeting administration and computer application assistance.
- **District Construction** which provides field construction support, including project personnel staffing.
- **Field Construction Crews** who provide MDT field services such as contract administration, inspection, material sampling, testing and surveying.

CONSTRUCTION MATERIALS

MDT construction project material control takes place through:

- Headquarters Materials Bureau
- District Preconstruction materials labs
- 11 District and Area Labs report to respective District Material Labs
- Materials Testers serving field construction crews
- Construction crew field inspectors

CONSTRUCTION ENGINEER

The Construction Engineer (CE) administers and supervises the MDT Construction Program within the Engineering Division. CE responsibilities are to:

- Establish MDT Construction Program policies, procedures and practice.
- Manage headquarter office construction staff.
- Establish communication protocol with district offices, headquarter units, contractors, the public and media.
- Be informed about statewide construction related activities and upper management construction issues.
- Report to the Chief Engineer and MDT Director regarding significant or controversial construction issues.
- Oversee the development of Construction Program specifications, the CAM, and other documentation essential to Construction Program management.
- Participate in professional construction engineering organizations, such as AASHTO, and TRB.
- Represent MDT during construction litigation.
- Address contract change orders and claims.

MATERIALS BUREAU CONSTRUCTION PROGRAM INVOLVEMENT

The Materials Bureau tests and certifies project materials, and:

- Verifies and/or approves asphalt, concrete and cement treated base mixes. MDT does not issue mix designs, with the exception of chip seal designs performed by MDT Maintenance
- Performs testing for District labs
- Performs independent assurance testing, quality assurance control and material certification
- Conducts lab inspections
- Develops statewide materials policy and procedure
- Maintains the Materials Manual for currency
- Maintains and calibrates sampling and testing equipment
- Consults and advises on construction issues related to materials, soils, surfacing design and geology
- Assists with Value Engineering (VE) proposal review and evaluation.

PHYSICAL TEST SECTION

The Physical Test Section tests and grants acceptance for construction materials by providing guidance to district labs or testing at headquarters, and runs basic Index Tests for samples collected by the Geotechnical Section. Testing is based on the Materials Manual and MDT Standard Specifications, AASHTO and ASTM test methods and standards, and other test methods. The Physical Test Section:

- Conducts lab inspections
- Verifies mix designs
- Maintains the MDT Materials Manual
- Provides inspector and technician testing training
- Tests and approves Qualified Products List (QPL) products and pre-inspected materials
- Certifies project materials

PAVEMENT ANALYSIS SECTION

The Pavement Analysis (PA) Section operates the Pavement Management System (PMS), which gathers data and formulates strategies to optimize pavement expenditures and life expectancy. PA also conducts nondestructive testing on existing pavements to evaluate bearing capacity. Project Managers often contact Pavement Analysis for surfacing guidance. The Surfacing Design unit within PA designs surfacing sections.

GEOTECHNICAL BUREAU CONSTRUCTION PROGRAM INVOLVEMENT

The Geotechnical Bureau carries out subsurface investigations and design required for bridge foundations, earth slope stability, and earth retaining projects. The Geotechnical Manual outlines Geotechnical Bureau policy, procedure and practice.

During preconstruction, District Geotechnical Managers manage project activities performed by the Geotechnical Bureau, and are the primary contact between MDT field personnel and the Geotechnical Bureau. They also serve as technical advisors to Project Managers on geotechnical issues related to:

- Plans and specification review
- Special provision interpretation
- Response to requests for information (RFIs)

- Contractor claim evaluation
- Change order review
- Report preparation

When conditions during construction differ from evaluations made during design, the Geotechnical Bureau helps MDT field construction staff resolve construction problems relating to:

Troubleshooting: The Geotechnical Bureau is contacted by project managers to assist with geotechnical issues involving subgrade, embankments or backfill.

Piles:

- Capacity and tip elevation
- Pile Driving Analyzer (PDA) test results and pile driving log evaluation
- Hammer acceptance

Drilled Shafts and requirements that Geotechnical personnel be onsite during:

- Drilling
- Soils assessment
- Static capacity tests
- Sonic test interpretation, interpolation and analysis

Spread Footings and needed soil bearing capacity.

Rock Excavation and geotechnical inspection after blasting to check slope stability and review blasting plans.

Field Instrumentation monitoring foundation performance to detect settlement, lateral displacement, or water pressure beneath embankment.

ENGINEERING CONSTRUCTION CONTRACTING BUREAU (ECCB) CONSTRUCTION PROGRAM INVOLVEMENT

The ECCB prepares construction bid packages through final award. The Bureau compiles bid packages and lets the contract. The ECCB specifically prepares:

- **Final contract documents** including plans, specifications, engineering estimates and special provisions
- **An initial Plans, Specifications and Estimate (PSE)** package after receiving information from design units, and assembles a draft PSE package for final review and comment by MDT design units
- **A revised PSE package** before advertisement, as well as contract addenda after project advertisement.
- **Information of interest to highway Contractors via the MDT website**, including bid history, letting information, and Q&A Forum responses.

- **Responses to Q&A submissions from prospective bidders** during contract advertising
- **Contract bid evaluation and analysis**
- **Project lettings and contract award recommendation** to the Transportation Commission.

ALTERNATIVE CONTRACTING (AC) SECTION

The AC Section delivers Design-Build (DB), Construction Manager/General Contractor (CM/GC), and Job Order Contracting (JOC) projects. The section works with program managers to evaluate potential AC projects, perform Project Delivery Selection Process workshops, prepare preliminary engineering estimates and FMIS funding requests, prepare and advertise proposal requests, and manage contractor selection and design review. AC also provides alternative delivery process training for MDT, MCA and ACEC.

CONSTRUCTION ADMINISTRATION SERVICES (CAS) BUREAU

The Construction Administration Services Bureau plans and administers construction program operations.

CONSTRUCTION SYSTEMS SECTION

The Construction Systems Section develops, manages and supports computer systems used for Construction Program contract administration by Headquarters, District Construction and field staff. The Systems Section also maintains the Transport Help Desk.

CONSTRUCTION ENGINEERING SERVICES (CES) BUREAU

The CES Bureau provides technical engineering and contract administration support to field construction crews and works with the Preconstruction Program to consider construction issues during project design.

PROJECT CONSTRUCTABILITY REVIEW AND SPECIFICATIONS SECTION

Constructability Review (CR). Section personnel attend Preliminary Field Reviews, Plan-in-Hand Reviews, Alignment and Grade Reviews and Final Plan Reviews, as requested by the Consultant Design Bureau or Preconstruction designers. Project design is evaluated for constructability, and recommendations made to Preconstruction Project Managers. The Section maintains a Constructability Review database, and conducts Post Construction Reviews (PCR) to identify items that may enhance project design, and identify design shortcomings, improvements and successes. Lessons learned via the constructability review process are conveyed to the Preconstruction Program.

- **Specification Maintenance**. The Specifications Engineer oversees, amends and drafts specifications. Specification change requests are submitted to the Specifications Engineer for review and consideration, and adopted as standard or supplemental specification or special provision as needed.
- **Through Value Analysis** (VA), the MDT VA Program reviews high cost complex projects to maximize MDT product and service quality. VA uses multidisciplinary teams to identify a high value product with increased service efficiency, and generate alternatives to provide needed function at the lowest cost. For each project (“project” is any product or service) examined using the VA approach, a VA team is selected.

This multidisciplinary team includes MDT Preconstruction and Construction Program and FHWA personnel. The VA Engineer oversees the VA Program.

- **Maintains MDT standard Detailed Drawings (DDs)** and the Construction Administration Manual (CAM), and incorporates revisions as needed.

CONSTRUCTION REVIEW SECTION

The Construction Review Section monitors contract inspection and administration through field inspection. For projects administered by FHWA / MDT Partnership Agreement procedure, this section conducts reviews formerly conducted by FHWA personnel. The Construction Review Section includes Bridge Reviewers, Road Reviewers, Work Zone Traffic Control Reviewers and Materials Reviewers serving as technical and contract administration resources for MDT field construction staff and MDT preconstruction staff. Construction Reviewers:

- Review plans and specifications for compatibility with construction practice, and advise DCEs and Project Managers regarding construction issues
- Provide technical construction issue advice
- Conduct periodic project review, and issue Construction Review Reports
- Review contractor falsework, cofferdam, shoring, structural steel girder, and erection plan shop drawings
- Review prestressed beam inspection reports
- Investigate damaged or defective structural elements
- Provide construction material expertise and assistance, in coordination with the Physical Testing Section
- Assist with project environmental review involving General Storm Water Permit (GSWP) and National Pollutant Discharge Elimination System (NPDES) compliance
- Assist with conflict resolution involving construction engineering issues
- Ensure construction engineering practice uniformity throughout the State
- Assist with change order review and evaluation
- Investigate construction complaints
- Oversee the construction claims process with the Claims Review Board
- Review, develop, and implement and new construction products and procedures
- Review traffic control device setup and functionality

FHWA work zone regulations are collectively referred to as the “Work Zone Safety and Mobility Rule”. To oversee work zone regulation, the Construction Review Section employs a Work Zone Traffic Control Engineer. This person is a member of the MDT Work Zone Safety Committee, which includes Highway Bureau, Traffic and Safety Bureau and Maintenance Division representatives. The Work Zone Traffic Control Engineer conducts work zone reviews, collects project work zone data for and guides field staff regarding traffic control issues.

The Construction Review Section also reviews, evaluates and approves contractor proposed Value Engineering (VE) proposals, and coordinates reviews and investigations initiated by other MDT units. The District CES Reviewer is the contact for VE proposals. VE proposals are initiated by the Contractor, whereas Value Analysis (VA) is MDT initiated, and conducted during Preconstruction.

CONTRACT ADMINISTRATION SECTION (CAS)

The CAS administers construction projects by:

- Issuing a Notice to Proceed (NP) to successful bidders
- Processing payments for submission to the Administration Division for payment
- Monitoring project costs
- Reviewing requests to use subcontractors
- Uniformly applying documents and evaluating change orders
- Maintaining project related files and correspondence
- Preparing specifications for equipment purchase
- Preparing liquidated damage reports for the Transportation Commission
- Preparing contract modifications for fiscal programming.

DISTRICT CONSTRUCTION OFFICE ORGANIZATION

Construction related District assigned functions include the following:

- Individual construction project contract administration
- Contractor work inspection
- Traffic control plan review
- Post grading and project completion inspection
- Progress and final estimate preparation
- Change order approval
- Contractor claim review, resolution and recommendation
- Cost reduction proposal review and action recommendation
- Final inspection
- Liquidated damage assessment

District Construction Engineer (DCE)

The DCE administers District construction functions. The District Construction Operation Engineer (DCOE) assists with DCE responsibilities, such as assemble field crews. Crew staffing is determined case by case depending on staffing needs, and the size, complexity, and nature of work. DCEs supervise Project Managers and provide contract administration and construction issue guidance. DCEs are first to address contractor appeals over project decisions, and administer District operating budgets and work force needs.

District Engineering Officer (DEO)

District Engineering Officers DEOs provide administrative support and oversight to Field Construction Crews, such as:

- Construction related supply procurement. Each crew must have equipment and administrative supplies to perform their jobs.
- Checking field notes. Construction project documentation may involve periodic report, diary, and calculation reviews for compliance with MDT measurement and payment documentation standards.
- Processing estimates after Project Managers prepare and submit estimates to DEOs for review and payment processing.

- Project acceptance, which requires assembling final project documentation, including change orders, pay estimates, as-built drawings, daily diaries, test results, QA and Independent QA test results, punch lists, compliance certificates, correspondence, safety and traffic control records, and other documents. DEOs help Project Managers compile a final documentation package.

Bridge Inspectors

MDT must comply with National Bridge Inspection Standards (NBIS) for public bridges in Montana. The Bridge Bureau employs two inspectors in each district to inspect bridges with field construction crews, and report to the DCE. Bridge inspectors also assist field construction crews. Districts typically have two to five bridge inspectors.

Materials Labs

District Materials labs located within District Preconstruction report to District Engineering Services Supervisors (DESS). District Materials labs sample and test construction materials, and maintain sample records and test results. They ensure field construction crews meet material recording and documentation requirements. District labs work with the headquarters Testing Section to ensure construction materials are properly sampled and tested. Labs also help project managers interpret and evaluate test results, and provide technical testing advice. Materials labs witness gravel source sampling, and conduct surfacing investigations to ensure materials meet MDT specifications and are suitable for MDT projects.

Materials labs also work with Preconstruction conducting soil surveys for upcoming projects, and perform pavement preservation core testing.

In addition to the five District Labs, MDT has six Area Labs:

- District 1 (Missoula) Kalispell
- District 2 (Butte) Bozeman
- District 3 (Great Falls) Havre
- District 4 (Glendive) Wolf Point and Miles City
- District 5 (Billings) Lewistown

Area Labs report to District Materials Labs, and have soil testing capabilities equal to District Materials labs. Area Labs reduce sample transportation costs and provide faster results.

Field Construction Crews Organization and Activities

Field construction crew organizational structure varies by project. Appendix F illustrates basic construction crew activities from project development to post construction review.

District Construction Engineer

DCEs supervise all district construction projects, and periodically visit construction projects to evaluate progress and address issues.

Project Managers

Project Managers administer and manage several projects, and function as the highest project authority level. Responsibilities include:

- Scheduling and conducting preconstruction conferences
- Supervising surveys, inspection, testing and record keeping
- Evaluating and assessing contract time
- Interpreting plans and specifications
- Preparing monthly progress estimates for Contractor payment
- Initiating and preparing change orders
- Documenting pay quantities
- Evaluating documentation compliance
- Managing field staff
- Approving work and materials

Each Project Manager is assisted by a Crew to perform office, surveying, inspection and testing duties. Crew size and composition vary with project size and type.
Project Managers often communicate with District Office units other than District Construction. Although Project Managers report directly to the DCE, they often communicate directly with District Office functional units such as the Environmental Bureau or Materials Lab. Keep the DCE informed regarding construction issues. Material testers collaborate with Project Managers and District Materials Labs to support construction. Project Managers also communicate with Headquarter bureaus within the Construction Program. Project Managers should keep the DCE informed of communication with Headquarters.

Field Inspectors

Field Inspectors report to the Project Manager. Inspector responsibilities include:

- Materials Testing. Inspectors must be certified by the Western Alliance for Quality Transportation Construction (WAQTC) for materials being sampled and field tested. Inspectors must maintain certification, and notify supervisors before certification renewals to allow time to complete the certification process.
- Traffic Control. Traffic control inspection is performed by MDT Inspectors trained in work zone traffic control. Inspectors ensure Contractor traffic control plans meet contract document requirements, as well as “MDT Work Zone Safety and Mobility Procedures and Guidelines”.
- Environmental. Contract documents outline environmental requirements, and assign Contractor responsibility (MPDES/NPDES Permit). Inspectors monitor Contractor compliance with environmental permits, plans, and documents.
- Roadway. Roadway items include subgrade grading and other earthwork, earth retaining systems and surfacing. Road work inspection and testing requires observation and Contractor work documentation. Divisions 200 to 500 and portions of 600 provide guidance to roadway Inspectors.
- Bridge. Structural items include concrete structures, steel structures and piling. Bridge inspection and testing requires Inspectors to have Design approved shop drawings prepared by the Contractor. Photographs are invaluable to identify and document progress during construction, and satisfy designer Requests for Information (RFI).
- Drainage. Drainage items include box culverts, pipe culverts, drop inlets, inlet grates and underground drainage systems. Drainage inspections include

inspection of delivered structures and pipe for damage during transport, compliance certification, installation, and required backfill.

- Traffic. Traffic items include permanent and temporary devices, pavement markings, traffic signals, and lighting.

Field Office Person (FOP)

The FOP reports to the Project Manager, and is the central coordinator and repository for construction related documentation including:

- Project correspondence
- Environmental documents
- Human resources (EEO, DBE, OSHA)
- ROW, utility, and railroad coordination
- Material sampling and testing
- Asphalt and concrete mix design
- Legal documentation relating to bonding and insurance.
- Change orders
- Inspection and acceptance
- Contractor payment
- Daily Work Reports (DWR) and Diaries
- Shop drawings, erection and construction plans

Surveyors

Surveyors report to the Project Manager, and carry out Preconstruction Surveys, which may include:

- Topographic surveys
- Hydraulic surveys
- Control surveys

These surveys gather project design information required by MDT Preconstruction units such as Road Design, Bridge, and Hydraulics. During construction, survey control performed during design is reviewed to ensure accurate monumentation. Survey crews work closely with MDT Project Managers to locate and verify control monuments for Contractor surveyors during construction staking. Standard Specification Subsection 105.08 covers construction survey requirements. Contractors request construction staking in writing to the MDT Project Manager, who schedules a survey.

MDT is headquartered in Helena with functions delegated to five District offices. District Administrators (DAs) supervise and administer District functions. Division Administrators supervise and administer Departmental MDT functions. MDT construction staff typically coordinate with other units to address issues. MDT district office organization is shown by Figure 100-4.

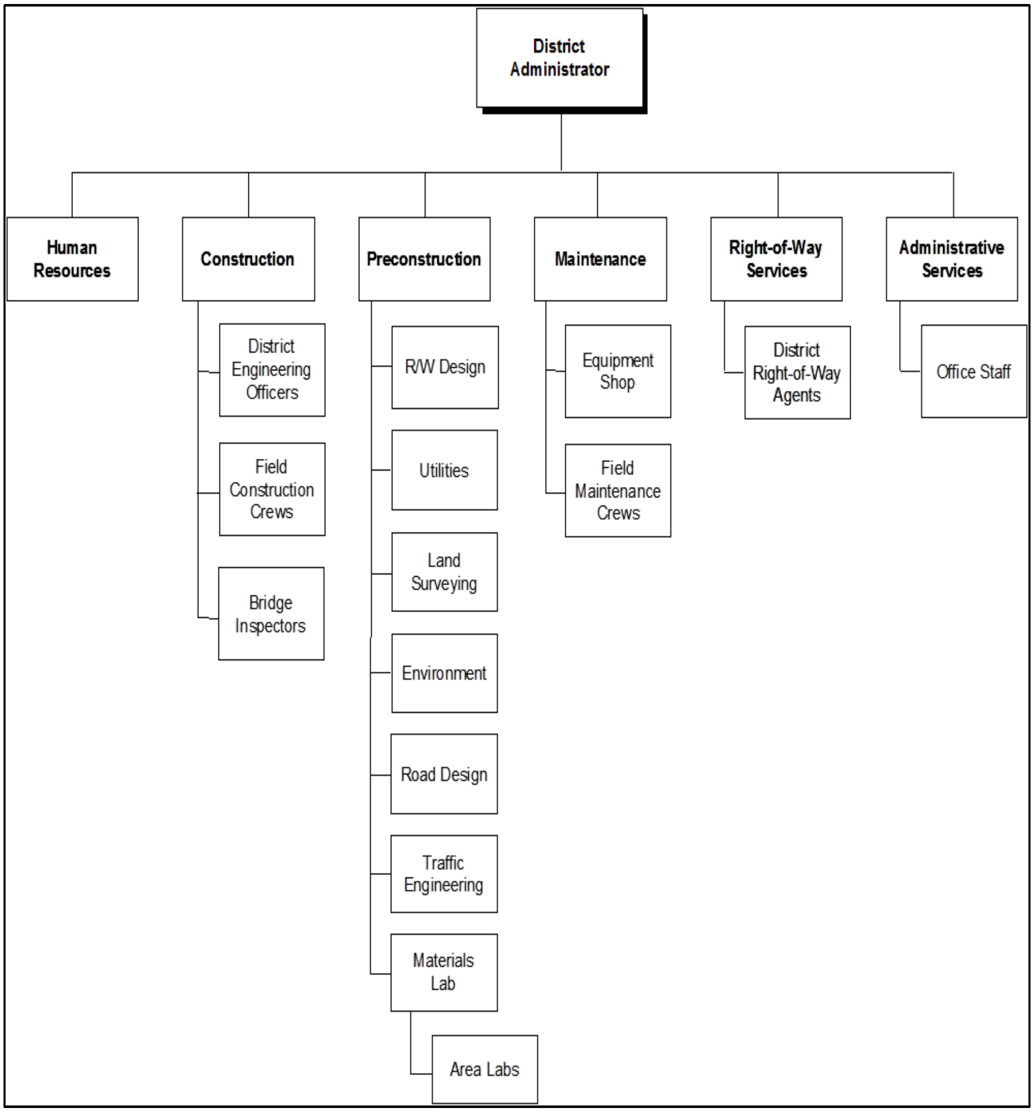


FIGURE 100-4

TYPICAL DISTRICT OFFICE ORGANIZATION

OTHER MDT ADMINISTRATIVE ENTITIES

Public Information Office

The Public Information Office (PIO) coordinates marketing activities, manages media interaction, writes speeches and press releases, and assists with media involvement to maintain public awareness of MDT activities.

Legal Services Unit

- Litigates for MDT regarding claim and contract issues
- Reviews proposed contracts and MDT agreements
- Coordinates with Tribal governments regarding MDT activities within tribal jurisdictions
- Legally advises the MDT personnel
- Ensures MDT compliance with State and Federal constitutions, law and regulation
- Reviews documentation and represents MDT during litigation
- Legally advises construction staff

Human Resources Division

Human Resources (HR) provides employee relation and compliance management to MDT and the public, and includes the:

- Occupational Health and Safety Office
- Operations Bureau
- Workforce Planning Bureau

The Workforce Planning Bureau runs the MDT Training Program, and issues MDT employee policy and procedure.

The Office of Occupational Health and Safety administers the Occupational Safety and Health Act (OSHA) to minimize work environment safety and health risks. OSHA sets standards for work environment conditions and exposure, and mandates an enforcement program to enforce standards. Contractor OSHA compliance is a contract requirement monitored by MDT field staff.

Tribal Liaison

MDT tribal liaison functions are coordinated through the Director, and include coordination with tribal attorneys, chairpersons, employment rights officers (TEROs) and planners for projects impacting tribal governments. Montana is home to eight tribal entities:

- Blackfeet Nation (Browning)
- Apsaalooke (Crow) Nation (Hardin)
- Confederated Salish and Kootenai tribes.
- Assiniboine and Sioux tribes (Fort Peck)

- Assiniboine, or Nakoda tribe, and the Gros Ventre tribe, who refer to themselves as A’aninin (Fort Belknap)
- Northern Cheyenne tribe (Lame Deer)
- Chippewa-Cree tribe (Rocky Boy)
- Little Shell Chippewa Tribe is state recognized, but without a Montana reservation.

MDT construction staff are not authorized to contact Tribal Council members. The Director is the only authorized contact, unless authority is delegated to update tribal governments about project progress, MOUs, PSAs or TERO (Tribal Employment Rights Office) Agreements.

MDT drafts Memorandums of Understanding (MOU) with Tribal Governments to define state tribal relationships, and address planning, design and construction. Every project requires a Project Specific Agreement (PSA) addressing training positions, mineral and water sources, or items unaddressed by the MOU. The District and MDT Headquarters develop agreements with tribal governments. Project Managers should be familiar with MOU and PSA commitments.

Civil Rights Bureau

- **Disadvantaged Business Enterprise (DBE).** The MDT DBE Program encourages companies owned by socially and economically disadvantaged individuals to become involved in transportation contracts. To participate in federally funded contracts under the DBE Program, companies must be a certified DBE.
- **Equal Employee Opportunity (EEO) Compliance.** For federal aid highway projects over $10,000, the EEO program ensures MDT makes a “good faith effort” to ensure applicants and employees are treated without regard to race, religion, sex, color, disability, age, marital status, political belief or national origin.
- **Labor Compliance.** This program ensures Davis-Bacon wage rates and fringe benefits are paid to construction workers on contracts and subcontracts valued over $2000.
- **Title VI.** This Program ensures MDT programs, public benefits and services do not discriminate upon race, color, or national origin.

Administration Division

The Administration Division provides accounting, financial management, purchasing, office equipment and mail service support to MDT. The Division includes the following Bureaus and Units:

- Accounting Controls Bureau
- Fiscal Operation Bureau
- Office Management Unit
- Budget and Planning Bureau
- Fuel Tax Management and Analysis Bureau Purchasing/Mailroom Bureau

Accounting functions required by the MDT Construction Program are coordinated through the Administration Division to address Contractor progress payments, construction budgeting, contract modifications, and federal aid eligibility determination. The Contract Administration Section (CAS) coordinates with the Administration Division to address these functions.

Information Services Division (ISD)

The ISD assists with Information Technology (IT) needs, and works with the Construction Systems Section to develop and implement computer programs and functionalities.

Motor Carrier Services Division (MCS)

The MCS division protects state and federal investment in the Montana highway system by regulating commercial carriers, and enforcing commercial carrier laws, rules and regulations. MCS administers state mandated oversize and overweight permitting, project diesel fuel usage, licenses and taxes (Montana Commercial Vehicle Size and Weight and Safety Trucker's Handbook). The preconstruction conference addresses issues of concern to MCS and MDT construction staff, including:

- Load restrictions
- Special fuel use
- Permits, licenses and taxes
- Oversized load detours

Maintenance Division

- Maintains roadways
- Administers maintenance, equipment and motor pool programs
- Managers the state motor pool and state equipment
- Maintains MDT facilities
- Maintains statewide communication systems

Maintenance helps ensure state roadway public safety and longevity. Headquarter Maintenance establishes maintenance policy, procedure and practice. Montana has 11 maintenance jurisdictions reporting to district maintenance offices. The Maintenance Division acquires, operates, maintains, repairs, and administers MDT vehicle usage.

Because construction projects are transferred to Maintenance after closeout, Project Managers should communicate with maintenance staff throughout construction. Invite maintenance staff to visit the construction site and provide input.

MDT construction projects occasionally include highway related facilities, such as rest areas and weigh stations. The Maintenance Division Facilities Bureau oversees facility projects, typically by securing consultant design services. The MDT "Facilities Contract Administration Guide" outlines coordination among these parties:

- Facilities Bureau
- MDT Construction Program
- Consultant Design Bureau
- Consultant Design Firm
- Consultant Architect Firm
- General Contractor

Rail, Transit and Planning Division

The Rail, Transit and Planning Division develops and implements processes, systems and planning necessary for MDT projects. The Highway Traffic Safety Bureau assists to develop safety planning solutions. The Environmental Services Bureau oversees MDT compliance with environmental regulation, and ensures environmental documentation is on record.

Aeronautics Division

The MDT Aeronautics Division fosters and promotes Montana aviation.

Engineering Division

The Engineering Division designs and constructs projects within the MDT capital improvement program, performs work in the Headquarters Office, and sets department wide policy and procedure for MDT District Offices.

Chief Engineer

The Chief Engineer supervises, sets policy for and administers engineering functions. The Chief Engineer heads the Engineering Division, which includes the Preconstruction Program, the Construction Program and Management Information and Support.

Headquarters Preconstruction Program

Headquarters Construction Program

Management Information and Support

Management Information and Support office provides support to the Chief Engineer, Preconstruction Program and Construction Program, and includes the following personnel:

- Fiscal Officer
- Management Analyst
- Human Resources Specialist
- Training and Development Specialist
- Research Specialists

HEADQUARTERS PRECONSTRUCTION COORDINATION WITH MDT CONSTRUCTION

The Construction Engineering Services (CES) Bureau

CES generates Preliminary Field Review Reports, Alignment and Grade Review (AGR) Reports, Scope of Work Reports and Plan in Hand (PIH) Reports, and receives preliminary plans distributed for AGR, PIH, and final plan review. Construction Engineering Services (CES) reviews plans and recommends changes to the Road Design Section. Constructability review takes place during the AGR stage to address roadway location, grading requirements, and constructability issues.

The Engineering Construction Contracting Bureau (ECCB)

ECCB receives project packages from Road Design for final processing before advertisement and letting.

Project design packages include final construction plans, road design cost estimates, and special provisions. The ECCB reviews and distributes final construction plans to MDT units for review. Road Design considers comments, incorporates needed changes, and makes plan revisions

.

The Contract Administration Services (CAS) Bureau coordinates with Road Design to revise MDT Standard Construction Specifications.

Field Construction Crews work with Road Design regarding roadway design items within the contract.

Change Orders are reviewed by Road Design, the CES Bureau and District Construction personnel to resolve construction issues.

The MDT Surveying Manual covers construction surveying. The District Preconstruction Land Surveying Unit is usually contacted if Project Managers require survey support.

BRIDGE BUREAU

The Bridge Bureau designs bridges and structures such as cantilevered overhead sign and sign bridge foundations, and includes the following sections:

The Bridge Design Section oversees MDT improvement projects for new and rehabilitated bridges and other structures by preparing bridge design plans, quantities, and special provisions.

The Bridge Management Section: Operates the MDT bridge inventory program, which includes:

- Bridge Management System (PONTIS), which prioritizes state bridge replacement, rehabilitation and maintenance
- National Bridge Inspection Standards (NBIS), a bridge inspection program to detect structural problems and prevent catastrophic failure
- Coordination for Montana bridge inspections
- Permit review for loads exceeding legal bridge loads

Coordination with MDT Construction Program

The Bridge Bureau conducts shop, fabrication and erection drawing review, maintains welding procedures, reviews structural modifications during construction, and offers bridge repair expertise.

MATERIALS BUREAU

Materials. The Materials Bureau samples and tests structural materials, develops material specifications and certifies bridge project materials, such as steel, concrete, paint, corrugated metal pipe and geotextiles.

Shop Fabrication. The Bridge Bureau, Materials Bureau and Construction Engineering Services Bureau collaborate to inspect structural steel fabrication, prestressed concrete girders, post tensioned concrete girders and other structural items.

ENGINEERING CONSTRUCTION CONTRACTING BUREAU (ECCB)

The Bridge Bureau and ECCB coordinate regarding:

- The Bridge Bureau sends final design plans to the ECCB for review circulation to other MDT units. Bridge then reviews comments and makes plan revisions.
- Bridge designers develop bridge item special provisions for the ECCB to include within final contract documents.

CONSTRUCTION ADMINISTRATION SERVICES (CAS) BUREAU

The Bridge Bureau collaborates with the CAS Bureau to develop structural Standard and Supplemental Specifications.

CONSTRUCTION ENGINEERING SERVICES (CES) BUREAU

Bridge Bureau coordination with the CES Bureau is described below:

New Materials, Techniques or Construction Practices: When bridge design involves materials, construction techniques or practice not previously used in Montana, designs are reviewed by the CES Bureau for constructability.
Field Inspections: The Bridge Bureau coordinates with the CES Bureau and District Construction to carry out field inspections.
Shop Drawings: The Bridge Bureau reviews and approves Contractor submitted structural steel and prestressed concrete beam shop drawings, and coordinates CES Bureau and District Construction reviews.
Technical Assistance: The Bridge Bureau provides structural item technical assistance during construction.
Change Orders: The Bridge Bureau receives bridge construction change orders, and works with the CES Bureau and District Construction to resolve construction issues.
Claims: The CES Bureau may consult the Bridge Bureau when claims involve structural items.

RIGHT OF WAY (ROW) BUREAU

ROW evaluates right of way issues, acquires land, manages acquired land, and provides assistance and payments to construction impacted entities. Administrative and functional ROW sections are located at MDT headquarters, whereas field ROW personnel work within District ROW. The ROW Bureau is divided into sections:

Appraisal Section monetarily evaluates real property acquired by the MDT, and develops appraisal policy, procedure and instruction.

Acquisition Section acquires real property and provides relocation assistance to individuals impacted by MDT projects.

Design/Plans Section and **Access Management Section** draft ROW plans, and prepare legal descriptions, deeds and exhibits required for acquisition.

Real Estate Services Section administers the MDT Property Management Program, which includes lease administration, clearing ROW, property disposal, and easement discharge and abandonment
.

Outdoor Advertising Unit coordinates outdoor advertising.

Utilities Section obtains cost estimates and secures utility and railroad company agreements for facility relocation or adjustment required for construction (MDT ROW manual).

Right of Way (ROW) Coordination with Construction Program

Project Managers should first contact District ROW Supervisors regarding ROW issues, who may in turn contact the ROW Bureau. District ROW secures access agreements to ROW controlled by entities outside MDT. Construction tasks include obtaining ROW agreement copies and interpreting ROW plans, ensuring contracts reflect MDT ROW commitments, and ensuring construction takes place according to ROW agreement(s).

Utilities
Project Managers should first contact a district preconstruction Utilities Unit within District Preconstruction to contact the ROW Bureau Utilities Section. Utility adjustments are ideally completed before the project ready date, after which only relocations needing Contractor coordination should remain unfinished. The Utilities section manages utility conflicts after letting dates, and develops needed special provisions.

Railroads
Project Managers contact the ROW Bureau Utilities Section regarding railroad issues during construction. MDT railroad agreements are contingent upon the existence or absence of highway easements.

No Existing Highway Easement Construction on RR property not already subject to a highway easement requires a “Construction and Maintenance Agreement” (Railroad Highway Agreement) to be drafted, assigning respective construction responsibilities to the MDT and the Railroad.

Existing Highway Easements Construction within MDT easements over RR property requires a flagging agreement covering the work area.

CONSULTANT DESIGN BUREAU

The Consultant Design Bureau administers and manages the Consultant Program and the MDT Transportation Alternatives (TA) Program, for which it hires consultants.

Coordination with MDT Construction Program

The Consultant Design Bureau oversees and coordinates Consultant contract work, which typically requires Consultants to advise MDT construction during construction, and be responsible for errors and omissions (E&O) during construction. The Consultant Design Bureau and CES Bureau coordinate to resolve E&O issues, as directed by MDT “Design Errors or Omissions Policy” (MDT Consultant Services Manual Ch 12). The Consultant Design Bureau staff administers consultant projects, but may hire consultants to provide construction engineering inspection (CEI) services.

TRAFFIC AND SAFETY BUREAU

The Traffic and Safety Bureau facilitates MDT traffic engineering activities and highway safety programs, and includes the following Sections:

Traffic Engineering Section administers:

- Traditional traffic engineering elements and activities such as signals, signing and speed studies
- Geometric design elements including intersections and interchanges
- Safety improvement design (MDT Traffic Engineering Manual)

Safety Management Section administers the following MDT safety programs:

- Safety Improvement Program, which prioritizes safety improvement projects to optimize safety funds
- Crash Surveillance System, which identifies correlations between crashes compared to statistical statewide trends
- Safety Management System, a multidisciplinary team approach intended to reduce crash number and severity.

Rail/Highway Safety Section identifies safety improvements to public highway railroad grade crossings to reduce train/vehicle collisions.

Coordination with MDT Construction Program

Traffic Engineering Section projects are coordinated with the MDT Construction Program much like with the Road Design Section. Traffic Engineering and the Construction Bureau coordinate to install and manage the following:

Cantilevered and Overhead Sign Structures

For certain projects, contract documents assign Contractor responsibility for cantilevered or overhead sign structural design. In such cases, the Traffic Engineering Section includes these elements within the contract:

- Boring log
- Vertical and lateral clearances
- Sign dimensions
- Wind and static loading

Contractors provide manufacturer recommended structural and foundational design, and submit calculations with shop drawings to the Project Manager, who forwards information to the Bridge Bureau for review and approval.

- During construction Contractors submit a proposed electrical materials list, and shop drawings and specifications for conduits, conductors, and signal heads. Project Managers send this information to the Traffic Engineering Section Electrical Unit for review.
- The Materials Bureau tests pavement markings and highway signs during construction.

ENVIRONMENTAL SERVICES BUREAU

The Environmental Services Bureau is located within the Rail, Transit, and Planning Division, and ensures MDT compliance with environmental law, regulation and policy, and submits project environmental documents and permits. Environmental Services includes:

Engineering Section; Ensures project compliance with Federal, State and Tribal environmental regulation. Section responsibilities include environmental document preparation and coordination with State, Federal and Tribal Agencies to secure permits and approvals.

Resources Section; Identifies environmental resources within project limits in coordination with the Engineering Section, and evaluates potential environmental impacts. Environmental resources include biological, historical and archaeological features, as well as socioeconomic impact. This Section also coordinates with State, Federal and Tribal agencies to secure permits and approvals.

Hazardous Waste Section; Identifies and evaluates potential project air quality impacts, noise and hazardous waste sites.

(See the MDT Environmental Manual. Subsection 107.K and Section 208 discuss MDT and Contractor compliance with Federal and State environmental law, regulation and policy.)

Project Coordination with MDT Construction Program

Contract documents include environmental compliance and mitigation requirements. The Environmental Services Bureau monitors compliance with environmental commitments and permit obligations made during preconstruction. District Environmental Services periodically inspects for environmental compliance.

Project Managers must contact Environmental Services about environmental issues Construction issues requiring coordination between the Environmental Services Bureau and the Construction Program include:

Unanticipated Impacts. Environmental or other impacts unanticipated during preconstruction should be evaluated by Environmental Services.

Environmental Complaints. Entities external to MDT, such as the Montana Department of Environmental Quality or the public, may express Environmental concerns to MDT relating to air quality, fuel contamination or noise. In such cases, Project Managers may contact the Environmental Services Bureau for assistance.

Archaeological Resources. Highway construction may encounter archaeological resources, requiring Project Managers to contact Environmental Services.

Hazardous Waste. Highway construction may reveal hazardous wastes including asbestos, lead paint, treated timber, soil and water contamination or underground storage tanks. The Environmental Services Bureau Hazardous Waste section addresses hazardous waste issues during construction. Contract documents include hazardous waste remediation during preconstruction. The Hazardous Waste Section ensures asbestos removal is completed prior to demolition. Project Managers contact the Hazardous Waste Section if unexpected hazardous waste is encountered.

Other. Project Managers coordinate with Environmental Services to address various environmental issues, including noxious weed and invasive species containment, wetland impact and migratory bird protection compliance monitoring.

Local Agency Projects. If local agencies assume maintenance responsibility after construction, Project Managers must coordinate with Environmental Services to transfer the Notice of Intent (NOI) and General Storm Water Permit to the agency.

Training. Environmental Services Bureau provides training courses for MDT construction staff handling environmental issues.

ENGINEERING INFORMATION SERVICES SECTION

The Engineering Information Services Section (EISS) supports the preconstruction program bureaus and:

- Maintains and administers MDT Engineering Project Scheduling Program (EPS) training, and manages the MDT Project Content Management System (PCMS).
- Maintains, administers and supports the MDT Computer Aided Design and Drafting (CADD) system.
- Coordinates with construction staff as needed.

DISTRICT OFFICES

Montana is divided into five MDT Districts (Figure 100-5): Missoula (District 1), Butte (District 2), Great Falls (District 3), Glendive (District 4) and Billings (District 5). Although District offices provide MDT field services and may replicate headquarter activities, Headquarter Divisions and Bureaus set statewide policy and support District Offices. District units carry out most field work. Bridges are designed in Headquarters, whereas road design and traffic engineering projects may be designed by a District or Headquarters.

District Office responsibilities include:

- State highway system maintenance, such as snow removal and pavement maintenance.
- Nomination for improvement projects
- Bridge inspection to gather NBIS data
- Reviewing and approving requests to access State highways
- Serving as liaison between local and tribal governments and MDT Headquarters
- Conducting field and soil surveys
- Conducting public hearings and public information meetings
- Reviewing and developing traffic control plans during construction
- Field utility agreements and ROW acquisition

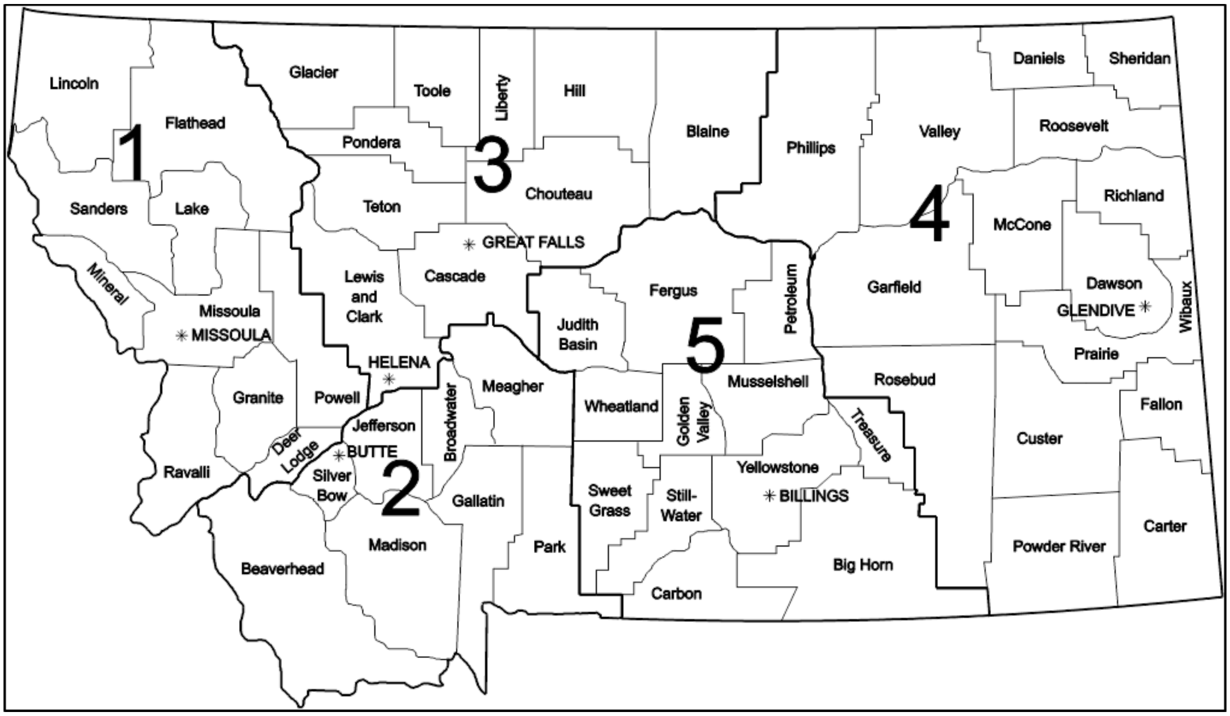


FIGURE 100-5
MDT DISTRICTS

District Administrator

District Administrators (DAs) direct District function and report to the MDT Director. They manage District staff and issues, deal with the public, media and local governments, and develop District budgets.

Human Resources

District Human Resource offices administer human resource policy at the District level, and support the Construction Program by coordinating MDT construction employment. Human Resources also:

- Posts position vacancies
- Hires and dismisses employees
- Imposes disciplinary action
- Handles labor union issues
- Trains employees
- Interprets MDT employee policy

Project Managers collect, certify, and forward project payrolls to the headquarters Civil Rights Unit, which reports to the Director.

Preconstruction

Project Managers generally contact a particular unit when construction issues arise requiring coordination with District Preconstruction:

- The Land Surveying Unit employs Registered Land Surveyors to supervise and direct preconstruction and construction surveys. Surveyors prepare and review survey documents, advise field survey personnel regarding survey procedures, develop and recommend survey methods for construction and preliminary survey, and train field personnel.
- The Environmental Services Unit provides field services for the MDT Headquarter Environmental Program, including Contractor erosion and sediment control compliance. Each District is staffed with an Environmental Engineering Specialist (DEES).
- Materials Lab

Maintenance

Project Managers should involve District Maintenance in project construction. Field construction staff should contact district equipment shops for construction vehicle maintenance and repair. Coordination between MDT construction and MDT District maintenance may include:

- Inviting maintenance staff to preconstruction conferences.
- Sharing maintenance to highway elements between Contractors and MDT Maintenance as required by contracts.
- Project Manager coordination with Maintenance regarding mowing and pavement striping.
- Project Manager coordination with District Maintenance to assess haul road damage and state facility repair.
- Project Manager Notice of Intent (NOI) and General Storm Water Permit (GSWP) transference to Maintenance at project completion.
- Delivering salvaged material delivered to MDT Maintenance yards. Construction contracts indicate salvage materials and an MDT contact through whom Contractors coordinate delivery.

Right-of-Way (ROW)

ROW Issue Management

Administrative Services

District Administrative Services (DAS) supports field construction staff, by assisting with payroll, accounting and miscellaneous purchases. DAS also provides IT hardware and software support and troubleshooting. Administrative Services may contact the Construction Systems Section at headquarters for assistance.

EXTERNAL AGENCIES

Federal, state, local and external entities are often involved in MDT projects to secure funding, cost share, use public land, and ensure regulatory compliance. Contract documents address project requirements governing external coordination. In some cases, other agencies have authority to withdraw participation, or delay project work. Most problems are avoided through personal contact and good relationships with project representatives. Project Managers and other MDT construction staff should follow these guidelines when coordinating with external agencies:

- Before the project, contact agency local representatives to provide contact names, phone numbers, email and mailing addresses.
- Explain the work and invite local representatives to tour the site.
- Periodically initiate contact to update local representatives.
- Answer questions promptly.
- As stipulated by agreements or MOUs, provide authorized representatives with project documents related to work quality and contract administration.
- Accompany representatives during field inspection.
- Solicit advice and recommendations regarding construction work of interest to external agencies.
- Resolve unanticipated construction impacts using MOU procedures.

Agencies may request an action unaddressed within an Agreement or MOU, or violating MDT policy. Project Managers must understand the problem and explain the MDT position. If an issue exceeds Project Manager authority or cannot be resolved at the field level, refer the agency representative to the DCE or DA.

Federal Highway Administration (FHWA)

FHWA administers federal aid program funding for highway improvements nationwide to ensure state DOTs comply with Federal law while spending federal funds, and meet engineering requirements for proposed projects. FHWA maintains a division office within each state.

FHWA Program Level Oversight

FHWA and MDT have entered into a Partnership Agreement establishing policies and procedures MDT must follow to secure federal funding. FHWA performs periodic risk assessment reviews as needed. As part of overseeing the MDT Transportation Program, FHWA may perform an MDT Construction Program Review.

US Environmental Protection Agency (USEPA)

- **Section 401 Water Quality Certification.** USEPA administers compliance with Clean Water Act Section 401. In most cases, if a Section 404 USACE Permit is required, a Section 401 Water Quality Certification is required.
- **Section 402 NPDES Permit.** USEPA administers the National Pollutant Discharge Elimination System (NPDES) Program under Clean Water Act Section 402. NPDES Permits for construction requires a Storm Water Pollution Prevention Plan (SWPPP).

USEPA has delegated Section 401 and Section 402 authority to the Montana Department of Environmental Quality (DEQ). USEPA retains Section 401 and Section 402 responsibility on Tribal Lands.

US Forest Service (USFS)

USFS is responsible for the management of all national forests. MDT frequently works with USFS during construction, especially in the western part of the State. USFS and MDT have a Memorandum of Understanding (MOU) and agreed upon procedures describing coordination between the two agencies for projects impacting national forests. The USFS is invited to field reviews during preconstruction, receives major project reports and may inspect construction sites.

National Park Service (NPS) and Bureau of Land Management (BLM)

Coordination with NPS or BLM is necessary where MDT projects are in the vicinity of NPS or BLM lands, although MDT has no formal agreement with NPS or BLM.

US Air Force (USAF)

USAF operates the Malmstrom Air Force Base in Great Falls. MDT coordinates with the USAF for projects impacting the Malmstrom base or missile cables. Preconstruction field surveys identify potential impacts to underground missile silo cables. MDT highway construction operations cannot impede nuclear material transporters or security vehicles.

US Army Corps of Engineers (USACE)

USACE administers Section 404 Program provisions under the Clean Water Act, which prohibits unauthorized discharge of dredged or fill material into “Waters of the United States” which includes wetlands. Such discharges require a Section 404 Permit. The term “discharge of fill material” includes the addition of rock, sand, dirt, or concrete incidental to construction. USACE has granted Nationwide General Permits for minor activity categories involving dredged or fill material discharge. USACE also issues Regional General Permits for other activity categories within specific Corps Districts. If neither permit category applies, an Individual Section 404 Permit may be required. Contract documents specify Contractor requirements pursuant to Section 404 Permits obtained during preconstruction. Contractors are responsible for other Section 404 Permits required for Contractor construction activities.

US Fish and Wildlife Service (USFWS)

The Fish and Wildlife Coordination Act requires consultation with USFWS for actions proposing to control or modify stream waters or water bodies to prevent wildlife resource damage and loss. Although the USFWS is not a regulatory agency, USFWS preconstruction involvement may include specific construction requirements.

MONTANA STATE AGENCIES

Department of Agriculture

MDT and MDT contractors must comply with Montana Department of Agriculture requirements and the County Noxious Weed Management Act, as well as weed control application and herbicide licensing.

Department of Environmental Quality (DEQ)

MDT projects must abide by Montana DEQ air and water quality regulation, erosion control measures, storm water runoff permits, hazardous waste management, petroleum release and underground storage tanks. DEQ permits, certifications and approvals, may be obtained during preconstruction, or Contractor obtained through DEQ.

Department of Fish, Wildlife and Parks (FWP)

MDT coordinates with the Montana FWP to remove animal carcasses and beaver dams, protect streams and wetlands, and install informational signs to enhance access. FWP ensures MDT projects comply with Montana Stream Protection Act Section 124, which requires FWP approval for work in named water bodies or stream tributaries to streams, lakes or ponds. Details regarding agreements between FWP and MDT are contained in a Memorandum of Agreement and Approval.

State Historic Preservation Office (MSHPO)

During project development, the Environmental Services Bureau must identify National Register of Historic Places (NRHP) eligible archaeological and historic sites near the project. If an MDT project impacts an eligible site, MDT must mitigate adverse effects through agreements among MDT, the SHPO and the Advisory Council on Historic Preservation.

Montana Bureau of Mines and Geology (MBMG)

The Montana Bureau of Mines and Geology archives information describing Montana mineral and water resources. Impacts to ground water may require coordination with the Bureau.

Department of Natural Resources and Conservation (DNRC)

MDT works with DNRC to reclaim aggregate source sites, lease state lands, work in fire restriction zones, obtain water usage permits, and coordinate water right transfers and irrigation. MDT and DNRC share a Memorandum of Understanding (MOU) assigning respective responsibilities.

County and Other Entity Requirements

Counties and cities often share MDT project cost, as defined by an Agreement between MDT and a local agency to address:

- Funding
- Maintenance responsibilities
- MDT commitments
- Local government authority and responsibility during construction.
  If a local agency assumes responsibility for maintenance after construction, the Project Manager should invite an agency representative to final Inspection. At project closeout, Project Managers transfer documentation such as Notice of Intent and General Storm Water Permits to the agency, as is necessary for a State maintained facility.

If a local road is used for hauling, Project Managers coordinate with agency representatives to assess maintenance and damage repair. Whenever possible, document haul route condition before and throughout construction.

Transportation Alternatives (TA) Program

The TA program is managed by the Consultant Design Bureau. District Liaisons in District Construction oversee TA projects during construction, and ensure projects have MDT inspectors observing construction. Project administration must ensure compliance with federal and state regulation and specifications. Construction invoices are submitted by local participating agencies.

Tribal Governments

The Aquatic Lands Conservation Ordinance (ALCO) permit is specific to and required on tribal lands. Contract documents outline project specific requirements for construction on Tribal Lands.

RAILROAD AND UTILITY COMPANIES

MDT projects are often constructed over or within railroad right of way (ROW) along which utilities are often encountered during construction. When necessary, the Headquarters MDT Utilities Section within the ROW Bureau executes an agreement with the utilities to define respective responsibilities.

Treated railroad ties must be disposed of by an approved method, and included as a project cost. MDT may retain untreated temporary planking, and if so, a special provision will detail storage and handling requirements for stock piling at the construction site.

EMPLOYEE SAFETY

Employees should be safety conscious and hazard aware. MDT Safety Policies and Procedures Manual requires safety equipment, safe driving safely and accident reporting. Project Managers are responsible for MDT employee safety. Contractors are responsible for contractor employee safety and safe project conditions for MDT and the public.

The Occupational Safety and Health Act (OSHA) imposes employee safety requirements at construction sites.

Project Safety Meetings

MDT recommends at least monthly safety meetings during construction. Project Managers should require attendance to discuss accident causation and prevent future accidents.

Medical Treatment

Promptly seek medical treatment for injuries. First aid kits are available at project and district offices and many project vehicles.

Employee Training and Certification

MDT often requires formal training or certification to ensure personnel are qualified to perform duties. The MDT Training and Certification Policy is based on input from MDT, FHWA and the industry. Most outside training is sponsored by the NHI or ASCE. MDT may use a third party, such as a state university, to administer coursework, for which a certificate of qualification is issued for completion.

The Civil Engineering Technician Advancement Board and District HR staff implement the MDT Training and Certification Policy (MDT Policy 3-0801 and MDT Employee Handbook). For construction advancement information, refer to or ensure:

- Policy 3-0191 "MDT Helena Materials Lab Technician Recruitment and Advancement"
- Policy 3-0193 "MDT Civil Engineering Technician Advancement"
- Policy 3-0184 "Civil Engineer Advancement"
  MDT is a Western Alliance for Quality Transportation Construction (WAQTC) member. WAQTC administers the Transportation Technician Qualification Program (TTQP) to ensure:
  - Construction and Materials staff have necessary skills to conduct Quality Assurance (QA) activities. The QA manual is located within Appendix I.
  - Laboratories performing agency sampling and testing meet acceptable performance levels
  - MDT requires technicians who performing applicable Departmental work successfully complete the TTQP, and all laboratories performing MDT sampling and testing be qualified by the Montana Laboratory Qualification Program for the work they are performing. See the WAQTC Administrative Manual for more information.

PUBLIC RELATIONS

MDT benefits from and encourages a positive public image based on good working relationships between MDT staff, Contractors, agencies and the public. Employees should:

- Perform duties in a businesslike manner
- Be courteous and helpful
- Provide information and address inquiries
- Be patient and polite in all situations. Politely end conversation with abusive individuals.
- Answer questions and provide information. If information is not immediately available, provide a name and phone number with the information needed to a supervisor.
- Be informative. If public interaction involves an unspecific or controversial issue, defer to the Project Manager, who may refer to a MDT Public Information Office.

Public Records and Citizen Rights

The Federal Freedom of Information Act does not apply to MDT. However, the Montana Constitution and MCA Chapter 6 entitled "Public Records" grants citizens the right to inspect and obtain public records. Project Managers should arrange a visit appointment, and notify Legal Services after a visit request is made.
Citizens, including Contractor personnel, may inspect hardcopy and electronic daily correspondence, estimates, field notes, quantity calculations, test reports, materials certifications, inspection reports, field project diaries and construction project information, although certain documentation may not be accessed. The public should not access or be able to view Contractor payrolls, accident reports, MDT ROW agreements and documents containing personal information. Normally, such documents are not on

the construction site. Consult the DA or Legal Services about whether information is public.

Public access must be considered when writing correspondence, reports and records. Information must be factual, and opinions grounded in fact and or supported by evidence. Avoid derogatory or speculative statements. Do not use field diaries to express personal opinions about individuals, contractors, policies or procedures. Diaries and Daily Work Reports may be used as court evidence and are open to public inspection.

Standard Policy

Most requested information can be located and presented. In other cases, a lot of information may be requested, or a request is vague. Advise interested parties to submit written requests. MDT makes files, plans, notebooks, and other information available at the location information is normally maintained, but physical material information must stay within an MDT room or office. If certified copies are requested, consult Legal Services through the DA.

Legal Action Policy

Information requested as part of expected or pending legal action requires specific procedure. Consult Legal Services through the DA if a request purpose or nature is uncertain, and inform the DCE when unusual or controversial record requests are made.

Public Relations

Handling a request or complaint in person is best. Be courteous, help motorists by offering directions, alternative routes, or mileage, but refer policy requests to Project Managers.

Property Owner Relations

Highway construction often impacts property owners, and presents an important public relations responsibility. If possible, Project Managers and Contractors should meet with property owners before work begins to outline project work and landowner impact. Assure landowners every effort will be made to minimize nuisance and inconvenience. Provide an MDT contact, office location and telephone number, and document land owner communication.

Threats to Field Personnel

MDT has no authority to address threats. Report threats made by contractors to the Project Manager to address the issue with the Contractor Superintendent. In response to citizen threats, MDT employees should:

- Not be confrontational
- Immediately report the incident to the Project Manager, and prepare a written report listing names, dates, locations, and incident description
- Let project managers contact local law enforcement
- Have a project manager contact the DCE and Legal Services Unit at Headquarters

News Media or Elected Official Relations

Newspapers, radio and television can be helpful to convey information to highway users. Coordinate news releases and media contact through the Public Information

Office (PIO). Generally, project specific information is addressed at the District level, whereas Department policy, funding and controversial issue information is addressed via coordination with Headquarters. Districts ordinarily issue media releases regarding road closures. Project Managers supply travel information to the Travel Information Coordinator within the Maintenance Division to generate construction road reports.

Contractor Relations

Contractor interactions are not considered public relations. Contract documents discuss formal relationships between MDT and Contractors (Standard Specification Subsection 105.05). Working relationships between Project Managers and Contractors are important factors in project completion, and affect work progress and quality. Good relationships expedite completion and encourage high quality work, while poor working relationships often cause delays and substandard performance. Maintain good communication with Contractors. Problems and disputes often escalate if parties do not communicate well. Contractor and Departmental interests do not always align. MDT seeks quality work, and to open public facilities without delay. Despite conflicting interests, most disputes and are resolved through discussion and understanding. Be objective and professional to resolve disputes quickly.

Consistent contract administration is important to contractor relations. MDT consistency builds contractor confidence and good Contractor relationships. Take time to make sound decisions, and understand problems. Seek help with problem resolution if needed. Contractors are required to have a Superintendent on site, and Contractor direction must be issued directly to the Superintendent. Never instruct workers about how to perform work.

MDT often has contact with subcontractors and suppliers, but Contractors are responsible for subcontractor and supplier work and materials. Do not work directly with subcontractors or suppliers regarding payment or issues significantly affecting contract work. Contractors are responsible for scheduling and compensating subcontractors. Avoid disputes between Contractors and Subcontractors.

Ensure MDT Inspectors understand communication channels. Before major operations such as paving, meet with Contractor personnel and Inspectors to address communication protocol. Avoid inappropriate language and criticizing Contractor work, equipment or operations. Identify as early as possible when work may have to be redone. During disagreements, be firm and courteous. Never allow Contractors access to Department offices or laboratories without MDT personnel present, and never allow Contractors to access Departmental computers.

Tribal Government Relations

MDT cooperation with Tribal government promotes a positive working relationship. Project Managers should be familiar with the Memorandums of Understanding (MOUs) and Project Specific Agreements (PSAs) regarding tribal lands. Tribal Employment Rights Office (TERO) agreements are in place with each tribe. TERO Agreement issues should be resolved between the Contractor and the TERO officer, but may be delegated to MDT personnel. In this case, refer issues first to the Project Manager, then DCE, then to the DA. Such issues should be mentioned to the MDT Legal Section for tribal affairs, or to the Chief Counsel.

UNIQUE SAFETY ISSUES

Hazardous Materials

Highway construction workers frequently have contact with hazardous materials, which OSHA defines as “materials which can pose an unreasonable risk to health and safety of people or property.” The Hazardous Materials Regulations (Title 49, Subpart H) require HM-126F training for individuals handling hazardous material. Training enhances hazmat employee safety awareness and reduces hazmat incidents. The NIOSH Pocket Guide to Chemical Hazards covers industrial hygiene and protection for chemically exposed workers.

Work Zone Safety

MDT Engineering Memo No. 07-03 delineates MDT Policy regarding “Work Zone Safety and Mobility.” MDT publication “Work Zone Safety and Mobility” documents MDT unit roles and responsibilities in policy implementation. CAM Appendix G explains Construction Zone data, and how it may be used to improve work zone safety and mobility.

Employees must also comply with the requirements of the October 9, 2008 MDT Policy No. 3-0804 “Hard Hats, Safety Vest, High-Visibility Clothing Policy,” issued by the MDT Safety Management Engineer. This Policy refers to the November 24, 2008 “Federal Rule, 23 CFR 634.3 — Worker Visibility”, which states that workers within the federal highway ROW exposed to traffic or construction equipment must wear high visibility safety apparel.

Approved high visibility vests, hard hats and other personal protective devices are required when employees are outside vehicles working within the MDT ROW. (Standard Specification Section 618)

COMMUNICATION

MDT Distribution Procedure

Changes in policy and procedure, directives and information from Headquarters Construction are transmitted to the DA, DCE, Project Managers or other appropriate personnel. Districts distribute correspondence to field personnel. Letters, memoranda, and emails directed to Headquarters from field offices must be submitted through the district office. Material reports, shop drawings, transmittals, change orders and estimates are transmitted according to established procedure.

Contractor Communication

During a project, Project Managers and Contractor Superintendents serve as primary contacts between MDT and Contractors. Disagreements, contract document questions and other communication issues must be summarized in writing by the Contractor as a letter or Request for Information (RFI) to the Project Manager. Although RFIs are not widely used, they are effective for documenting questions, correspondence or inquiries.

Contractor correspondence should be brief, factual, address pertinent issues and requirements, respond to questions, cite supporting documentation, and sent to the prime Contractor.

Letters to Contractors or others parties should cite specific event details, dates, times, quantities, circumstances, communication, and involved individuals. Project

Managers should follow district policy drafting contractor letters. Use the MDT letter template available on the Intranet.

Document Signatures

MDT employees frequently sign documents on behalf of supervisors. The following procedures ensure uniformity:

- Supervisors designate employees to sign on their behalf during absences.
- Designated employees use their own signature rather than a supervisor name and adding their own initials.
- If a supervisor name or title is printed on the document, employees should sign their own name, and write “for” before the printed supervisor.

These procedures also apply to fiscal documentation, such as FHWA documents, vendor claims and personal expenses.

Routine Correspondence Signatures

Routine correspondence signature rules are subject to supervisory discretion, but the signature area must display supervisor name and title, rather than an employee signature.

Electronic Communication

When possible, MDT staff should use electronic communication for construction correspondence. Hardcopy communication policies apply to electronic communication, so emails are public information. Hardcopy and electronic communication may both be used during litigation.

DOCUMENTATION

The MDT Construction Program has a well defined, comprehensive system for documenting construction activities, legal and regulatory compliance, and general decisions. MDT construction staff use documentation to accomplish program objectives, pay contractors, evaluate change orders, provide MDT legal defense and information for work within project limits. Documentation should recount events, actions, outcomes and reasoning.

MDT Project Content Management System (PCMS)

The PCMS was implemented over several phases starting December 2021, and manages electronic design and project content to administer the Construction program. PCMS allows project document storage, production, document sharing, printing, and delivery, and works in compatibility with CAD and other project related documents. PCMS also supports electronic project delivery and 3D design by facilitating improved business processes, such as electronic review and approval for project plans and documents.

Electronic Filing System

The Construction Filing Document explains MDT directory structure, various document types and other information for electronic construction document usage and management. Project Managers maintain electronic project documentation within the MDT share drive.

Construction Report

Construction reports are generated nightly and available on the MDT website to provide an ongoing construction project summary by district.

Digital and Video Camera Usage

Digital and video cameras capture construction progress and completion. Mute sound except when needed, keep clips to less than one minute, shoot in “economy” mode, and take low resolution photos unless sharper resolution is needed. Copy video clips and still pictures to AASHTOware and the share drive as soon as possible.

After contract award and before the Preconstruction Conference, video the project showing mile markers at the beginning and end of each clip. Show bridges, irrigation structures, utilities, ROW features, approaches, material sources and accesses. Record permanent signage, detours, merges, crossovers, flagger stations, traffic control signals, equipment entrances, work zones, temporary signage and changes to these features. Also document accident sites, TC devices, equipment, and flaggers. Features such as vegetation, haul roads, and staging areas should be recorded before and after incidents. Video and photograph features related to field issues that may become a claim or require force account usage.

MDT CONSTRUCTION SOFTWARE

With support from the Information Services Division (ISD), The Construction Systems Section maintains, updates and supports information technology systems used by construction personnel.

AASHTO Trns•port

AASHTO Trns•port manages preconstruction and construction contract information. Each Trns•port module addresses a specific construction phase through contract archiving.

SiteManager

SiteManager is a client/server based construction program providing data entry, tracking, and contract data analysis from award through construction completion. SiteManager is used by Inspectors, Project Managers, support personnel, auditors, lab personnel and management, and is currently (12/2021) being phased out for AASHTOware.

SiteManager stores the following documents or provides the following functions:

- "Inspector Daily Work Reports" document onsite work events and observations regarding conversations, personnel and equipment, work items, situational descriptions and quantities. Project information is sent to Inspectors via laptops for reference and data editing capability. Field information is entered and sent back to the server for Project Manager review and approval.
- "Contract Records" records project data, including correspondence, stockpiled materials, dates, checklists, funding and plan discrepancies.
- "Contractor Management" maintains Subcontractor and subcontract item records.
- "Contractor Payments" generates estimates, records, contract and line item adjustments, price adjustments, project tracking, approval, finalization and discrepancy resolution for overruns and tested materials.
- "Change Orders" creates, reviews, approves and tracks change orders, and allows electronic change order review and approval.
- "Materials Management" tracks and reports material samples and test results from job sites, plants and test labs. Available information includes materials, lab qualifications, testing personnel, qualified products, producer supplied materials and calibrated equipment. Aggregate, concrete and bituminous concrete mix designs are approved and verified in association with individual contracts. Sampling and testing requirements as well as sample test results are also managed by the program.

SiteXchange

SiteXchange loads subcontractor information into SiteManager.

Estimator Software

Estimator prepares cost estimates using cost and bid based data. Estimator is currently (10/2021) being phased out, and is being replaced (anticipated 10/2022) with "AASHTOware Estimation", which transitions bid item price data from the "AASHTOware Concepts Cost Estimate Phase" (used by designers) to the "AASHTOware Project Cost Estimate Phase", during which ECCB updates item price and quantity as needed prior to project bidding.

The bid history profile in AASHTOware researches preliminary prices. Average prices are most commonly used and applied as the PSE Package is assembled. Item prices for items such as Mobilization, Traffic Control, Erosion Control, Critical Path, and Contractor Survey & Layout are determined by the District DCE or DCOE via the District Questionnaire. Large lump sum prices are researched by the designer, added to the Concept Cost Estimate and submitted to ECCB. Final bid item prices are determined during Board of Review (BOR) meetings, where specific item cost considerations are taken into account to finalize an engineering estimate.

Bid Express Software

Contractors use Bid Express to electronically submit bids and bid bonds. Paper bids are no longer accepted by MDT. Project bid files are created in AASHTOware before advertising, and posted to the MDT “contracting and bidding” webpage, from which contractors upload bid files into Bid Express to prepare and submit project bids.

OTHER MDT SOFTWARE

QA Suite

Project Managers, field staff and lab technicians use QA Suite to evaluate contract material compliance, and calculate contract incentives or disincentives. QA is used to calculate incentives and disincentives for contract item requirements such as volumetric properties, ride, and density.

Claims Database Tracking System

Standard Specification Subsection 105.16 discusses the Oracle MDT Claims Database Tracking System available. The system reminds MDT construction staff of critical dates by which to enter claim data. Past claim data can be queried for future claim reference and research.

Engineering Software Applications

Engineering software available via the MDT Intranet for construction personnel usage.

PathWeb

This program displays state roadway imagery by milepost and route. Users select imagery at particular locations to virtually travel and view roadway intervals.

SECTION 101
DEFINITIONS AND TERMS

Section 100 — General Guidelines

Construction Audits review construction activities for compliance with Department policy and procedure.
Construction Project Review (CPR) Program ensures field personnel properly inspect and document construction activities.
Construction Project Audits (CPA) identify new methods, techniques and strategies to improve project performance by auditing past projects.
Claims Review Process addresses construction claims to assign a claim value.
Construction Project Program Reviews. The Annual Construction Project Review Program is updated based on risk identified by prior reviews, and recent MDT and FHWA input.
Hazardous Materials. Highway construction workers frequently contact hazardous materials, designated by OSHA as “materials posing an unreasonable risk to health and safety”.
Partnership Agreements govern stewardship and oversight for federally funded projects. Full oversight projects are administered by FHWA under the current Partnership Agreement. Partial oversight projects are administered by MDT, and normally not subject to detailed FHWA review and approval. These projects are also known as state administered projects.

Section 102 — Bidding Requirements and Conditions

Standard Specifications. The “MDT Standard Specifications for Road and Bridge Construction” defines MDT highway construction standards.
Supplemental Specifications are additions, deletions or revisions to MDT standard specifications since the last standard specifications quarterly version.
Special Provisions are project specific requirements included to address unique project features, processes or characteristics unaddressed by standard and supplemental specification. Special provisions may be “project specific,” or “standard.” Standard Special Provisions address unique features processes or changes to Department specifications for frequently occurring situations, and may be used with various similar projects.
MDT Detailed Drawings provide road and traffic drawing details to ensure project design element and feature consistency for items such as guardrail, sign posts, fencing, and drainage appurtenances. Detailed drawings provide design element dimensions, layout and construction details.
Bid Proposals are a monetary amount proposed by contractors to build and complete a project at that price within a specified contract time.
Table of Contractor Submittals lists MDT Contractor submittal requirements during construction, including submittal deadlines.
Questions and Answer (QA) Forum is an online forum provided by MDT for contractors, subcontractors and suppliers to ask questions, request clarification or

identify errors, omissions and ambiguities in the bid package. The QA forum addresses project related inquiries and comments after advertisement and but before bid letting. Bidders must report bid package errors found after the Q&A forum is closed, and are contractually bound by posted clarifications and supplied information. Forum information may change until 5:00 PM the day before letting, and is officially part of the contract.

Section 103 – Reserved; in progress

Section 104 — Scope of Work (SOW)

Differing Site Condition refers to unforeseen physical conditions or unexpected subsurface conditions.

- **Type 1.** Subsurface physical conditions differing materially from those indicated in the contract
- **Type 2.** Physical conditions so unusual they could not have been “reasonably anticipated” by an experienced and prudent contractor

Value Engineering (VE) refers to an improved construction technique, alternative material or other innovation recommended by the Contractor to provide cost savings using a product of equal or greater quality than called for by the contract.

Section 105 — Control of Work

Random Sampling. Random samples are mandatory for QA item properties such as strength, compaction and density testing on completed roadways. Sampling sequences for each lot are selected before work begins. Random stationing numbers are established for each lot and QA item, and sampled correspondingly.

Lots. QA items and materials are divided into lots, or a defined quantity of continuous production, which may span more than one work shift.

Acceptance Tests refer to QA sample testing. Acceptance samples are taken according to random sampling sequences, and tested according to specified procedures. Tests are evaluated at lot completion.

Shutdowns are a planned cessation of construction work. The only shutdown recognized within Standard Specifications is “winter shutdown” (Standard Specifications Subsection 104.05.4).

Work Suspension The action taken by a Project Manager to cease project work. Project Managers issue an official “work suspension order.”

Stop Work Order Project Managers may stop work on a specific work item. Directives to the Contractor must indicate the work item being stopped.

Quality Assurance (QA) refers to acceptance sampling and testing to determine if work and material meet Standard Specification requirements.

Quality Control (QC). Typically QC refers to Contractor methods to control the quality of products incorporated into final work.

Claim A demand or assertion by one party seeking an adjustment or reinterpretation of contract terms, monetary payment, or time extension. The following definitions relate to claims:

- **Disagreement** Unresolved dispute
- **Notice of Claim** Claims process initiation
- **Mediation** Disagreement resolution using a neutral third party
- **Impasse** A disagreement unlikely to be resolved
- **Basis of a Claim.** Facts upon which a claim is submitted
- **Faulty Submission.** A submission not complying with specification time or content requirement
- **Claims Assistance Team.** Team assisting with claims
- **District Claims Packets** include the original claim, supporting documentation, and District evaluation and recommendation. Claims packets are maintained during the claims process to document the process
- **Claims Database and Tracking System.** The claims database and tracking system notifies staff of data entry deadlines. The database stores and queries data to assist with future claims, research problem areas or trends, and determine if training or changes are needed
- **Authorized Representative.** Includes the District Construction Engineer (DCE) and Project Manager

Section 106 Material Control

Certificates of Compliance (COC) verify materials conforms to specification. COCs are issued for products which have consistently meet specifications, and allow tentative material acceptance prior to testing.
Qualified Products List (QPL). A registry of accepted materials meeting MDT Specification.
Buy America Act requires federal construction contracts to use domestic iron and steel for materials incorporated into permanent work. The following terms apply:

- **Melting:** scrap steel into a furnace and for recycling into new steel products. If melting occurs in the US, products are considered US made.
- **Smelting:** extracts metal from ore to produce molten metal. If smelting occurs domestically, resulting products are considered made in the US, even if ore is imported.
- **Domestic Origin:** Used to describe a product made from domestic manufacturing processes.
- **Manufacturer Certification:** A document furnished by the manufacturer listing the name, address and location for the manufacturing facility where the process occurred, heat numbers or other identification used to identify the material, and manufacturer signed statements attesting to domestic origin.
- **Mill Test Report:** A base metal report from production mills documenting chemical and physical analysis, heat or lot numbers, and material manufacturing specifications. Chemical and physical analysis must meet ASTM, AASHTO and ANSI specifications.
- **Heat Numbers:** Manufacturer identification numbers used to track steel batch manufacturing location.
- **Broker:** A person or business purchasing finished products from a manufacturer to sell for another in exchange for a commission.

- **Bill of Lading:** A document issued by a carrier to a shipper listing and acknowledging goods received for transport via specified delivery terms.

Section 107 — Legal Relations and Public Responsibility

Tribal Lands

- **Memorandum of Understanding (MOU)** outlines a governmental relationship relating to planning, design and construction.
- **Project Specific Agreements (PSA)** outline training positions, mineral and water sources or other items unaddressed by an MOU.
- **Tribal Employment Rights Office (TERO):** This tribal office prevents employment discrimination against Native Americans, ensures compliance with the TERO code intended to give Native Americans employment and training preference, and maximizes Native American employment opportunities on and near Tribal lands.

Material Safety Data Sheets (MSDS) provide workers and emergency personnel procedures for safely handling substances, and include physical data (melting point, boiling point, flash point), toxicity information, health risks, first aid information, reactivity, storage and disposal advisories, required protective equipment and spill handling procedure information.

Competent Person as defined by OSHA, is a person capable of identifying existing and predictable situational hazards, or unsanitary, hazardous, or dangerous working conditions, and having authorization to issue corrective measures.

FHWA Form 1273 lists requirements having to do with nondiscrimination, payrolls, minimum wage payment rates, fringe benefits, material certifications, subcontracting and required recordkeeping.

Section 108 — Prosecution and Progress

Subcontract Agreement: A subcontracting arrangement exists when a person, firm, or supplier contracts to perform contract work under a prime contractor.

Activities Schedule Chart (ASC): A chronologically sequenced, time scaled bar chart showing project activities. ASC charts show relationships between “Activities” and “Activity Duration.”

Written Narrative (WN): A narrative describing work sequence, activity relationships and duration, and planned work.

Critical Path: Longest continuous activity sequence through the network schedule defining minimum project duration. Activities having zero float define the critical path.

Critical Path Method (CPM): Planning and scheduling a construction project by arranging activities based on preceding relationships. Activity durations and relationships determine when Activities can be performed to establish critical path. Also referred to as “Network Scheduling.”

Section 109 — Measurement and Payment

Unit Price payment uses existing items and unit prices from the bid, or establishes new items and unit prices to pay for extra work. Unit prices are used when construction items are used as a basis for Contractor payment.
Lump Sum Price is used to pay for completed work as a single unit. ”Lump sum” price is the cost for all work associated with a construction element. Lump sum payments include all materials, labor and equipment costs.
Force Accounts pay contractors for extra work based on labor, equipment and material costs.

Section 110 — Post Construction

Post Construction Review (PCR) is a process to review and discuss completed projects. Discussion topics may include successful methods, problems and solutions. Follow up discussion encourages contract uniformity and cost effectiveness to reduce future change orders and claims.
Final As-Built Plans provide a permanent record of completed projects, and document changes not shown in the plans.

Section 203 — Excavation and Embankment

Excavation. Roadway excavation includes loosening, digging, loading, hauling, placing, compacting, finishing and removing excess materials within roadway cut sections. Excavation types include:
Unclassified Excavation is nonspecific or “unclassed” material in the contract. Rock, clay, sand, gravel and other materials, whether mixed or encountered separately are removed and discarded under one bid item unit price.
Borrow Excavation is usually separated into “unclassified” borrow and “special” borrow. Unclassified borrow is an earth material quantity to be moved from its present location to a needed position in the roadbed. Unclassified borrow material is generally soil material suitable for embankment construction. Special borrow material is preapproved to meet special requirements including R-value, gradation, AASHTO soil classification or unit weight requirements.
Street Excavation refers to embankment material needing removal to attain plan elevation, and includes all embankment between back of sidewalk to back of sidewalk.
Muck Excavation contains soil or organic matter unsuitable for foundation material, regardless of moisture content, removed from marshes, swamps, and bogs over which embankments will be constructed. Muck excavation may also be removed to stabilize material under embankment loads, or stabilize unsuitable soils encountered within the existing roadway prism to provide a stable embankment foundation.
Sub-Excavation does not require special payment and is typically field measured and paid under an existing bid item for related work.

Dig-out refers to a volumetric bid item to remove localized unsuitable subgrade material during roadway rehabilitation projects.
Excavatable refers to material removable with a hand shovel. "Non-excavatable" material cannot be removed with a backhoe.
Crawler Tractors and Scrapers are used for steep grades and short hauls.
Rubber Tired Tractors and Scrapers are high speed two or four wheel rubber tire tractors and scrapers used for medium to long hauls.
Trucks/Graders/Front-end Loaders are used when load limits are imposed or long haul distances are needed.
Excavation Projects have excavation exceeding 20,000 cubic yards, or excavation quantity exceeding embankment quantity.
"Embankment in Place" Projects involve less than 20,000 cubic yards and minor risk to Contractors.
Rock Blasting uses explosives to loosen material where ground cannot be ripped.
Presplitting. Rock cuts are presplit by drilling a series of closely spaced (≤30" apart) parallel holes approximating design cut lines and grades. Presplitting takes place prior to blasting.
Mass Diagrams plot positive and negative earth volumes over project length, indicate relative cut and fill quantities throughout the project, and allow excavation and embankment estimation at specific project stationing.
Neat Line defines excavation limits to which work will be built or formed.

Section 207 — Culvert Excavation and Trench Excavation

Flowable Fill is aggregate bedding material with a small amount of cement and water added to help the material flow.

Section 208 — Water Pollution Control and Stream Preservation

National Pollutant Discharge Elimination System (NPDES). NPDES is Clean Water Act Section 402 authorizing the US EPA to regulate point source pollutant discharge.
Montana Pollutant Discharge Elimination System (MPDES) requires a permit commonly known as the "Storm Water Construction General Permit" for construction activity storm water discharges.
Storm Water Pollution Prevention Plan (SWPPP) is required to be granted a Storm Water Construction General Permit.

Section 401 — Plant Mix Pavement

Grade S Volumetric refers to standard grade plant mix normally used when plant mix quantity exceeds 2000 tons, but also used in specific cases when plant mix quantity is less than 2000 tons.
Commercial Plant Mix. This plant mix grade is used when plant mix quantity is less than 2000 tons, and a hot plant is not economical.
Warm Mix Asphalt is produced and placed at lower temperatures than typical hot mix. Reductions of 50 to 100 degrees Fahrenheit are possible.

⅜ Inch Grade S Plant Mix Wearing Course functions as a chip seal but also imparts structural value.
Plant Mix Seal Courses are similar to chip seals, but used in areas where chips pose concerns.
Micro-surfacing is a polymer-modified, asphalt emulsion based, dense graded, cold mixed, quick setting, asphalt resurfacing material.
Mineral Fillers are modifiers to improve aggregate gradations, typically added to materials from unusually clean sources (low 200 mesh %).
Anti-stripping Additives used in plant mix help prevent aggregate stripping with moisture and traffic exposure.
International Roughness Index (IRI) is a numerical index established to model "ride" or road smoothness.
Leveling Courses level existing roadway surfaces before the main surfacing course is placed. Leveling courses are typically used to mitigate rutting or warped roadway sections.
Isolation Lifts are used to isolate crack sealant beneath the main lift before lift application to prevent existing crack sealant from warming, expanding and rising during overlay placement.

Section 402 — Bituminous Materials

Asphalt Binder refers to asphaltic material used to bind aggregate particles together, is solid or semisolid at ambient temperature, and liquified when heated.
Asphalt Cement is an asphalt binder graded on viscosity and penetration values obtained through standardized testing.
Performance Graded Asphalt Binders (PGAB) are identical to asphalt cements. Binder selection depends on geographic location, application, climate, pavement temperature and traffic loading.
Emulsified Asphalt is an emulsion of asphalt, water and emulsifying agent used in asphalt pavement construction, typically tack coats.
Cutback Asphalt is a blend of asphalt material and petroleum solvents used typically for asphalt prime coats on subgrade (MC-70).

Section 403 — Crack Sealing

Crack Sealing prevents incompressible material and water intrusion into cracks.
Crack Routing creates a smooth surfaced groove to permit sealant into the crack, and better sealant adherence.

Section 407 — Bituminous Prime and Tack Coat

Prime Coats protects underlying layers from moisture by providing a temporary waterproofing layer.
Tack Coats are light asphalt emulsion applications between hot mix asphalt lifts designed to create a strong adhesive bond to prevent "shoving" due to shear forces.

Emulsified Asphalt Treated Aggregate (EATA) minimizes chemical dust control and provides an improved, temporary riding surface.

Section 409 — Seal Coat

Seal Coat is an application of bituminous material followed by an aggregate covering to an existing roadway.

Section 410 — Bituminous Surface Treatment

Bituminous Surface Treatment (BST) is a thin protective wearing surface applied to a pavement or base course to resist traffic abrasion, reduce dust and provide a low cost all weather surface.

Section 411 — Cold Milling

Cold Milling is using milling equipment with a rotating cylindrical grinding head to remove pavement to desired depth, and restore pavement grade and cross-slope.

Section 501 — Portland Cement Concrete Pavement

Tie Bars and Dowels are short steel bars used for the stabilize pavement joints.
Slip Form Paving spreads, consolidates, forms and finishes concrete pavement using a machine moving itself forward on side forms.
Stationary Side Forms are installed before paving for mechanical spreaders to travel along while spreading concrete using a helical screw or a blade.
Conventional Saws are single bladed, water cooled, walk behind saws requiring a continuous water supply and at least two people.
Early Entry Saws are lighter than conventional saws, allowing them to be used on green concrete 1 to 4 hours after placement, depending on weather conditions and concrete mix characteristics.

Section 551 — Portland Cement Concrete

Slump is an empirical characteristic describing concrete workability.
Retarding Admixtures slow cement hydration lengthen set time during hot conditions with large concrete masses to overcome accelerated set times.
Accelerating Admixtures shorten concrete set time, allow cold weather placement, early form removal, early finishing and in some cases early load application.
Water Reducing Admixtures require less water to mix concrete of equal slump, or increase concrete slump without increasing water content.
Air-Entraining Admixtures retain small air bubbles within concrete for enhanced freeze thaw durability.
Bonding Admixtures bond fresh concrete with set concrete.
Pneumatically Applied Mortar (shotcrete) is Portland cement, water and sand pumped through a hose and ejected at high velocities.

Section 552 — Concrete Structures

Reinforced Concrete contains reinforcing steel to carry tensile loads.
Prestressed Concrete is reinforced with prestressed high strength steel strands. serving the same purpose as in reinforced concrete. Steel strands induce compressive loads to carry tensile loads.
Falsework temporarily supports concrete forms until concrete is self supporting. Falsework carries vertical loads induced by poured concrete and formwork.
Forms contain fresh concrete before setting, and impart shape and surface texture.
Concrete Foundation Types.
Drilled Shafts are deep cylindrical shafts filled with reinforced concrete to transfer vertical structural loads to stable soils or bedrock.
Spread Footings are reinforced concrete on undisturbed soil.
Abutments are concrete walls supporting bridge ends. Integral abutments serve as end bents and abutments in superstructures, and have a pinned connection between the backwall and pile cap.
Prestressed Concrete is reinforced with prestressed high strength steel strands. serving the same purpose as in reinforced concrete. Steel strands induce compressive loads to carry tensile loads.
Bents or Piers are rigid reinforced concrete or steel frames supporting the superstructure. Piers are intermediate supports.
Wingwalls are concrete structures at abutment ends to retain fill beneath bridge approaches.
Cofferdams are temporary enclosures built within or near a water body allowing an enclosed area to be pumped.
Tremies are water tight pipes or tubes equipped with a hopper for placing concrete under water.
Cross Hole Sonic Logging measures concrete density and structural integrity within poured shafts to identify structural anomalies.

Section 556 — Steel Structures

Composite Steel Welded Plate Girders optimize weight to strength, fabrication and erection costs. Top flanges are typically thinner than bottom flanges.
Rolled Beams use symmetrical cross sections with equally dimensioned top and bottom flanges, and relatively thick webs.
Bolt Tensioning Methods
Specified Nut Tightening requires nuts to be turned a specified number of turns past snug tight condition. Turns needed to tension a bolt depend upon bolt length, the slope of the outer faces of connection plates or structural members, and washer type.
Calibrated Wrench Tightening uses a calibrated torque wrench to deliver specified torque to a bolt or nut, and relates bolt tension to the torque needed to turn the bolt.
Direct Tension Indicator (DTI) Tightening uses collapsible washers to indicate when bolt tension is reached. Washers under the bolt head collapse when bolts are properly tightened.

Section 559 — Piling

Friction Piles rely on residual friction developed between a pile surface and adjacent soil to transmit pile loads to soil.
Bearing Piles transmit loads to bedrock or stable strata. Although friction is developed between the pile and the adjacent soil, bearing piles rely on hard material to support the pile tip.

Section 561 — Bridge Deck Milling

Hydro-demolition utilizes high pressure water to remove deteriorated concrete.
Scarification is concrete or asphalt pavement removal to specified depth using a milling machine

Section 563 — Modified Concrete Overlay

Latex admixtures are used to improve bonding in concrete.

Section 565 — Bearing Devices

Elastomeric Bearing Plate. A rubberized elastic pad used for bridge bearing. Elastomeric bearing pads compress under vertical loading, but withstand horizontal rotational and shear forces.

Section 603 — Culverts, Storm Drains, Sanitary Sewers, Stock Passes, and Underpasses

Corrugated Metal Pipe (CMP) is fabricated from corrugated steel or aluminum sheets.
Reinforced Concrete Pipes have steel reinforcement.
Structural Steel or Aluminum Plate Pipes have a specific shape profile or cross section, and specified chemical composition and mechanical properties.

Section 614 — Retaining Walls

MSE Walls are constructed using earth fill with metallic or polymeric reinforcing within the soil mass. Wall facing may be concrete panel, modular blocks or exposed welded wire.
Cast in place (**CIP) Concrete Cantilever Walls** are best for sites having good bearing material with minimal differential settlement.
Gabion Walls are constructed by placing rock in galvanized wire containment, and most cost effective for small, short walls, with locally available rock. Gabion walls are useful where equipment access is limited.
Rockery Walls are constructed by stacking large rocks to create a wall as the fill is raised behind the wall. Granular filters are used between rock and fill to prevent fill migration.

Prefabricated Modular Walls include concrete and metal bin walls and concrete crib walls. Components are prefabricated before field delivery to minimize construction time.
Cantilever (Sheet Pile) Walls are driven with a pile hammer and most suitable where conditions are amenable to pile driving. Sites with significant rock or cobbles and boulders are unsuitable.
Soldier Pile Walls install H-piles every 8 - 10 ft, then span horizontal support between piles. H-piles are usually grouted into a drilled hole, but may be driven. Most soldier pile walls have concrete facing and lagging placed after the wall is full height.
Anchored Walls are essentially sheet pile or soldier pile walls exceeding normal cantilever wall height by using a bar, wire or strand grout anchored into a nearly horizontal borehole to stabilize the wall face.
Soil Nail Walls are constructed by drilling a hole for and grouting steel rods at 4-6-ft spacings. They are typically covered with vertical drainage strips between the nails and covered with shotcrete.

Section 618 — Traffic Control

Construction Zones are areas where construction, repair, maintenance or survey work is performed by MDT, local authority, utility company or private contractor under contract with MDT or local authority. Construction zones may include work zones.
Project Advisory Committee. Project specific group to review and manage project impacts to stakeholders.
Public Information Plans include communication strategies to inform road users, the public, area residents, businesses, and public entities about the project, expected construction zone impacts and changing project conditions.
Significant Project is a project that by itself or in combination with other nearby concurrent projects causes unacceptable construction zone impacts.
Stakeholders are those affected by construction, including business owners, road users, governments, regulators, and tribes.
Traffic Control Plan (TCP) measures within the contract move road users through a construction zone, work zone or incident area, and address traffic safety and control.
Transportation Management Plan (TMP) is a set of strategies to manage construction zone impacts, and for complex projects may include a Public Information (PI) Plan and Transportation Operations (TO) Plan.
Transportation Operations Plans (TOP) identify strategies to mitigate transportation system construction zone impacts. Construction zone impact areas can extend to areas beyond the project area. A TOP should cover items such as traffic signal timing, signing along detours, and detour capacity issues.
Traveling Public are users of public transportation infrastructure including cars, buses, trucks, bicyclists and pedestrians.
Work Zone. Areas where construction, repair, maintenance or survey work occurs.
Work Zone Mobility is the ability to move travelers through or around a work zone to minimize delay.
Work Zone Safety is the effort to minimize public and highway worker hazards within work zones.

Section 620 — Pavement Marking Application

Interim Pavement Markings are temporary markings applied before permanent marking application.
Temporary Pavement Markings. Temporary pavement markings guide drivers before long term pavement marking application.

Section 622 — Geotextiles

Geotextiles are permeable materials comprised of fibers or yarns combined into planar textiles. Geotextiles are used for strength, separation, drainage and filtration purposes.
Geogrids are polymer mats constructed of coated yarns or punched and stretched polymer sheets commonly used for soil reinforcement.
Geonets are netlike polymeric materials having parallel ribs used for planar liquid or gaseous drainage.
Geocomposites generally consist of a geonet, cuspate or dimpled polyethylene drainage core wrapped in geotextile, often used as edge, wall, vertical and sheet drains.
Geomembranes are impervious polymer sheets used to line ponds or landfills, or encapsulate moisture sensitive swelling clays to control moisture. Various materials are used for geomembranes such as polyvinyl chloride, high density polyethylene, polypropylene, or polyester.
Geosynthetic Clay Liners (GCL) are manufactured hydraulic barriers consisting of sodium bentonite clay bonded between two geotextiles, or attached to a geomembrane adhesive.

SOIL ENGINEERING TERMS

Dust Ratio is the ratio of the aggregate portion passing the 200 mesh sieve to the portion passing the 40-mesh sieve, which cannot exceed two thirds.
Degradation Value ranges from 100 to 0, and indicates the quality of fines produced by aggregate abrasion in water (100 is superior, below 35 is poor).
Gradation describes material range and relative particle size distribution.
Well Graded Soils contain particles of all sizes, but few fines.
Poorly Graded Soils have very small particle size ranges. Soils having intermediate size deficiencies, or those containing excessive fines are also considered poorly graded.
Liquid Limit is the moisture content defining the boundary between liquid and plastic states for the minus No. 40 soil fraction, and is the moisture content at which soil will close a standard groove over 1/2 inch when subjected to 25 blows in a liquid limit device.
Moisture Content is soil water divided by the oven dry soil weight, expressed in percent.
Optimum Moisture is the moisture content allowing maximum dry unit weight to be obtained for a given compaction effort.
Plastic Limit is the moisture content defining the boundary between plastic and semi-solid states for the minus No. 40 soil fraction, or the minimum moisture content at which soil can be rolled into a 1/8” diameter thread without crumbling.

Plastic Index is the numerical difference between the moisture content of the Liquid Limit and the moisture content defining the Plastic Limit.
R-Value stands for "Resistance Value" and indicates material stiffness. R-value testing expresses material resistance to deformation as a function of the ratio of transmitted lateral pressure to applied vertical pressure. R-values and traffic loading are used in pavement design to determine surfacing structure.
Wear Value refers to an aggregate specification for each project using aggregate defined as the percentage of dry weight lost during coarse aggregate abrasion in a Los Angeles Machine with an abrasive charge.

SPECIFIC GRAVITY TERMS

Absolute indicates the weight of a solid volume to the weight of equal water volume at a given temperature.
Apparent is the weight of a volume of impermeable material to the weight of impermeable pores to an equal water volume.
Bulk is the weight of a permeable material volume including voids to the weight of equal water volume.
Permeability is the ability soil to transmit liquids, and dependent upon grain size distribution.
"**Rice" Gravity** is the maximum absolute specific gravity of an uncompacted bituminous mixture.

HIGHWAY TERMS

Base serves as a pavement foundation.
Base Course is high quality material placed over subgrade to ensure induced stress does not exceed subgrade strength.
Binder Course is the gravel course between base and surface courses in sheet bituminous concrete pavements.
Bleeding occurs when binder migrates to create a surficial bitumen film.
Blow Ups are localized buckling or shattering within rigid pavement caused by excessive longitudinal pressure.
Cement Treated Base (CTB) is well graded aggregate, Portland cement and water compacted to density to serve as a paving base.
Construction Joints are vertical planes of separation within a pavement.
Contraction Joints are joints constructed where contraction stresses will otherwise cause a crack. Contraction joints cause cracking to occur along a straight line.
Corrugations are regular transverse pavement undulations.
Cracking is vertical splitting due to natural stresses or traffic action.
Crazing is fine surficial concrete cracking from rapid surface drying shrinkage.
"D" Lines are fine, closely spaced cracks paralleling edges, joints and cracks. They usually curve across slab corners, with initial cracks forming close to edges.
Disintegration is deterioration into small fragments
Distortion refers to surface profile changes distorting an original surface.
Expansion Joints allow longitudinal expansion.

Faulting is vertical displacement between adjacent surfaces along joints or cracks.
Flecking is random exfoliation of coarse aggregate particles from concrete surfaces, caused by a poor aggregate bonding.
Flexible Base and Pavements are made from well graded aggregate and asphalt cement with low bending resistance to encourage conformance to underlying structure and distribute loads. Flexible pavements include a wearing surface, base, subbase and subgrade.
Frost Heaving is surficial lifting and volume distortion due to ice formation within soil, rock, pavement, and structures.
Joints are constructed junctions between adjacent pavement sections or between pavement and structures.
Leveling Courses are thin pavement lifts placed immediately over base material or rutted pavement to remove irregularities prior to an overlay.
Longitudinal Joints are joints parallel to or along centerline to control longitudinal cracking.
Map Cracking is random surface cracking over an entire surface or localized area.
Pitting is aggregate displacement from a pavement with little displacement of cementitious material.
Plane of Failure is the depth at which wheel path voids equal passing lane voids.
Progressive Scaling is concrete surficial scaling continuing to occur at deeper levels.
Pumping is displacement and ejection of water carrying suspended fine particles at joints, cracks and edges.
Raveling is progressive surficial aggregate loss.
Resurfacing refers to additional surfacing over an existing pavement to improve smoothness or structural strength.
Rigid Base Pavement most often refers to Portland Cement Concrete surfacing.
Rutting refers to longitudinal depressions formed by wheel path loading.
Scaling is fine material loss from concrete surfaces.
Scratch or Wedge Courses are placed to correct crown or super elevation.
Settlement is surface subsidence.
Shoving is wavelike bituminous pavement displacement due to traffic acceleration and deceleration.
Shoulder refers to the roadbed margin outside travel lanes.
Spalling is rigid pavement fracturing and chipping at joints, cracks or edges.
Stripping is asphalt separation or dissolution from aggregate.
Subbase is specified material placed as a pavement foundation.
Subgrade refers to material immediately below subbase, base or pavement.
Sub-sealing or Undersealing refers to pumping waterproof material under pavement to prevent water or suspended solids from filling voids beneath pavement.
Surface Course is the surface lift providing resistance to traffic abrasion and also having structural value.
Surface Scaling is mortar loss to expose surrounding coarse aggregate.
Surface Texture refers to pavement surface character, and depends on size, shape, aggregate arrangement and binder.
Thrust is lateral pressure exerted by rigid pavements against adjacent surfaces.
Warping is surface deviation from an originally constructed surface or cross section.

Warping Joints. A joint allowing pavement slabs to warp when moisture and temperature differences occur within pavement.

CONCRETE TERMS

Admixtures are materials other than cement, aggregate and water used in concrete to entrain air, retard, or accelerate setting.
Anchorage refers to reinforcing bars or attachments to them to resist pull out.
Bleeding is the separation of a liquid from a liquid-solid or semisolid mixture.
Consistency refers to fresh concrete fluidity, commonly known as "slump."
Curing Period is the time needed to prevent surface cracking and ensure strength development.
Fineness Modulus (FM) is an index describing aggregate fineness. FM is the summed percentage of material retained on standard sieves divided by 100. Coarser aggregates have a larger FM.
Honeycomb refers to mortar deficiency between coarse aggregate particles.
Laitance is weak material consisting principally of lime, formed on a concrete surface when excess water is mixed with the cement.
Saturated Surface Dry refers to an aggregate condition in which all pores are filled with water, but surfaces are moisture free.
Yield refers to the concrete volume produced per cement sack.

ASPHALT TERMS

Asphalt Cement is asphalt especially for use in bituminous pavements.
Batch refers to a mix quantity discharged from a mixer before additional materials are used for a subsequent batch.
Bleeding is excessive surficial asphalt due to excessive prime, tack coat, or asphalt.
C-Factor refers to asphalt cement viscosity change during mixing relative to the viscosity change during a Thin Film Oven test. C-factor is used to determine whether incomplete combustion or burner fuel contamination may be causing asphalt concrete pavement tenderness.
Cutback Asphalt is asphalt cement rendered to liquid by fluxing with petroleum distillate; includes these categories: RCs — Rapid Curing; MCs — Medium Curing; SCs — Slow Curing.
Emulsion refers to an asphalt emulsion with water using an emulsifying agent.
Prime Coat is an application of low viscosity liquid asphalt to a base prior to paving.
Tack Coat refers to a thin layer of bitumen, road tar, or emulsion applied to enhance adhesion with subsequent courses or lifts.
Volume Swell is the volume increase within compacted aggregate, soil, sand, or an aggregate combination passing the 10 mesh sieve, (2.0 mm) and stabilized with bituminous material, when soaked in water for a standard duration.

ASPHALT MIX DESIGN TERMS

Acceptance Samples and Tests assess specified material quality.
Air Voids refer to the total air volume between coated aggregate particles within compacted pavement, as a percent of compacted pavement volume.
Anti-Rutting Specifications are intended to reduce rutting. The revised aggregate gradation specification requires a minimum 70% mechanical fracture on at least one face of 4 mesh material, to conform to the density gradation curve. The specification allows a 1.05 pay factor as an incentive to maintain density and uniformity. Mix temperature is specified in the mix design memorandum. A Quality Assurance Plan is also required.
Coarse Aggregate Angularity is the mass aggregate percent larger than No. 4 mesh (4.75 mm) having multiple fractured faces.
Final Record Samples and Tests are randomly taken tests from completed construction projects or completed project portions, and provide an independent spot check of and supplement to acceptance testing.
Fine Aggregate Angularity refers to percent air voids within loosely compacted aggregates smaller than a No. 8 mesh (2.36 mm).
Flat and Elongated Particles are the mass percentage of coarse aggregates having a maximum to minimum dimension ratio exceeding 5.
Immersion Compression is a method for measuring cohesion loss from water on compacted bituminous mixtures containing penetration graded asphalts.
Independent Assurance Samples and Tests are taken to spot check and supplement acceptance testing results. Samples are split into two or three portions and tested by the field, district or area, and Materials Bureau to compare testing procedures between the three labs.
Marshall Method of Asphalt Mix Design uses plastic flow resistance measurements in cylindrical plant mix specimens when lateral surfaces are loaded by a Marshall apparatus. Mixes should have sufficient asphalt, mix stability, voids and workability.
Marshall Stability is measured during Marshall apparatus loading, and used to determine if compacted plant mix will resist distortion from traffic loading.
Marshall Flow refers to lateral deformation at maximum stability during Marshall apparatus loading, measured in hundredths of an inch, but recorded as a whole number (0.15 inches = 15).
Quality Assurance. A method used to monitor plant mix and concrete material qualities. Random sampling and testing is used to establish price adjustments.
Sand Equivalent (or Clay Content) refers to clay material within aggregate finer than a No. 4 mesh (4.75 mm).
Superpave is a term designating superior Performing Asphalt Pavements, which incorporate performance based, asphalt material characterization and design conditions to control rutting, low temperature cracking and fatigue cracking.
Voids in Mineral Aggregate (VMA) is the intergranular space between aggregate particles within compacted pavement, including air voids and effective asphalt content, expressed as a percent of total compacted sample volume.

Voids Filled with Asphalt (VFA) is the volume percentage of intergranular void space between aggregate particles occupied by asphalt.

SECTION 102
BIDDING REQUIREMENTS AND CONDITIONS

MDT Standard Specification Section 102 describes MDT Contractor bidding requirements as administered by the Engineering Construction Contracting Bureau (ECCB) at Headquarters.

102.1 Joint Venture Bids
Subsection 102.01, Standard Specifications

102.2 Bid Package Contents
Subsection 102.02, Standard Specifications

Importance Hierarchy

Contract Documents provide Contractor project construction guidance. Standard Specification Subsection 105.04 stipulates the following hierarchy used to prioritize conflicting information in the event of documental discrepancies:

- Contractor Question and Answer Forum
- Special Provisions
- Table of Contractor Submittals
- Contract Plans
- Supplemental Specifications
- MDT Standard Specifications
- Supplemental Detailed Drawings
- MDT Detailed Drawings

Plan Dimensions Standard Specification Subsection 105.04 states that if a discrepancy regarding plan dimensions exists within contract documents, the hierarchy of importance:

- Plan information such as length, width, depth, height, and distance values shown on construction plans
- Calculated Values such as calculations based on dimensions or features depicted on construction
- Scaled Information derived from measured plan features using a standard

Contractor Question and Answer Forum (Q&A Forum)

- The Contractor Question and Answer Forum found on the MDT website is the only mechanism bidders use to present questions and comments to MDT regarding bid packages. Contractor inquiries must be submitted through the Q&A Forum.
- Questions submitted to the Q&A Forum are posted to the MDT website, and distributed to the Preconstruction Project Manager, District Construction Engineer, District Construction Operations Engineer, Construction Project Manager, FHWA and involved staff. District personnel collectively approve information to be posted. Questions remaining after Q&A closure must be

submitted to the ECCB, which will post question responses prior to bid opening. Questions and MDT responses, plus addenda issued by MDT during advertisement, become part of contract documentation, and supersede other contract documents in accordance with the hierarchy above.

Plans Development

Preconstruction program bureaus or consultants prepare contract plans based on MDT geometric, structural, traffic engineering, and environmental design criteria, as well as project site constraints such as soils, topography and ROW. MDT construction staff ensure Contractors construct projects in accordance with contract requirements. Project Managers resolve problems arising during contract interpretation or implementation. The MDT Preconstruction Program has developed standard language and nomenclature to convey information to Contractors. For help interpreting contracts, refer to:

- Detailed Drawings
- Road Design Manual Chapter 4
- Structures Manual Chapter 5
- Traffic Engineering Manual Chapter 3
- CADD Standards

MDT Standard Specifications

- MDT Standard Road and Bridge Construction Specifications define MDT highway construction standards. The Specifications Section updates Standard Specifications biennially. Individuals, companies or MDT staff may submit proposed Standard Specification changes to the Construction Administration Services (CAS) Bureau via a revision process described on the MDT website. Unless stipulated within the contract documents, Contractors must comply with Standard Specifications as called for by:
- The contract
- Legal requirements
- Highway element construction methods
- Material control and acceptance
- Item measurement and payment
- MDT typically does not instruct Contractors regarding work methods. Standard Specifications stipulate expected results, as well as acceptance based on statistical sampling. Contractors select preferred equipment and work methods to meet specified results, except when work is done on a Force Account basis. MDT uses Quality Control and Quality Assurance to grant acceptance and control materials during construction.

Supplemental Specifications

Supplemental Specifications are additions, deletions or revisions to Standard Specifications before changes are incorporated into the newest Standard Specifications version. Supplemental Specifications are updated as needed, part of contract documents, and available via the MDT website.

Special Provisions

Special provisions are contract provisions addressing unique features, processes or changes to Department specification, and may be project specific, or a standard Special Provision. Project specific special provisions are developed by design teams as needed for individual projects to address particular features or processes. Standard special provisions address unique features, processes or changes to Department specifications for frequently encountered situations. The Engineering Construction Contracting Bureau (ECCB) coordinates with design teams and Construction to identify and include standard special provisions.

MDT Detailed Drawings (DD) provide road and traffic details for routine design elements remaining consistent from project to project. Detailed Drawings for features such as guardrail, sign posts, fencing, and drainage appurtenances provide dimensional and construction details. The first three digits of a detailed drawing number refer to standard specification. For example, DD 606-05B entitled “Metal Guardrail” references Standard Specification Section 606 “Guardrail and Concrete Barrier Rail”. Detailed Drawing hardcopies may be printed from the MDT website. Proposed DD changes must be submitted to the Construction Engineering Services (CES) Bureau for review. When Supplemental Detailed Drawings are required, CES distributes proposed changes as necessary. The ECCB includes a “Supplemental Detailed Drawings Table” within the contract documents. Minor text changes are also noted in the table.

Bid Proposal is a Contractor bid submission via MDT issued forms to construct a project at a quoted price within a specified contract time.

Contractor Submittals

Bid Packages include a project specific “Table of Contractor Submittals” summarizing MDT Contractor submittal requirements during construction, and the number of copies to be submitted before stated deadlines. During construction, Project Managers use extended tables available on the Construction Forms website, to monitor Contractor submittal compliance.

FWHA Form 1273 “Required Contract Provisions” is included with federal aid contracts, and addresses nondiscrimination, payroll, minimum wage payment rates and fringe benefits, material certification, subcontracting and recordkeeping.

Numerical Project Designations

Project Number / Project IDs are used by the Fiscal Programming Bureau to assign a Project Number or Project ID to MDT Projects. Table 102-1 lists federal project number designations. Table 102-2 lists example Project Numbers for various federal aid funding designations. Projects paid fully by state funding are designated “SF.” MDT Maintenance coordinates state funded projects.

TABLE 102-1
FEDERAL AID PROJECT NOMENCLATURE

Example Project: NH 1-9(23)565		
NH designation	Funding Designation (below):	Designates roadway system or work type being performed.
1	Route Number	Refer to the Montana Federal Aid Log for route numbers and descriptions. Route number may indicate Interstate, Primary, Secondary or Urban Route.
9	County Designation	Sequential County number through which a route has traveled. “9” indicates the 9^{th} County on the route at the project location. Sequential County numbers increase eastward and northward.
23	Agreement Number	Sequential number indicating the number of projects along this route within the county section.
565	Milepost on Route:	Refers to the milepost nearest the project beginning. Specific for that segment of the route. Normally increases eastward and northward.

TABLE 102-2
EXAMPLES OF PROJECT NUMBERS

STPU 1201(4):	Urban area project. “12” designates urban area. “01” designates urban route number. See the “Montana Federal Aid Log” for project locations and route limits.
STPE 25(28):	County project. “25” designates the alphabetical county number, 1 (Beaverhead) thru 56 (Yellowstone). This designation does not coincide with the Montana license plate numbering system by County Seat.
BR 9025(10):	Off system bridge project, where “90” designates off system bridge, and “25” designates alphabetical county number.
STPX 81024(1):	State Highway project.
NH-IM-STPP 0002(401):	Miscellaneous. Project is either Statewide, has multiple locations, or project is on more than one route.

Federal Aid Funding Designations

Interstate Program

I = Interstate
IR = Interstate Resurfacing
IM = Interstate Maintenance

Primary Program

F = Consolidated Primary

Surface Transportation Program

S = Secondary
RS = Rural Secondary
STPS = Rural Secondary
M = Urban
STPU = Urban
STPP = Primary (minor arterial)
STPP = State Flexible
RRS = Rail/Hwy Crossing Hazard Elimination
STPRR = Rail/Hwy Crossing Hazard Elimination
RRP = Rail/Hwy Crossing Protective Devices
STPRP = Rail/Hwy Crossing Protective Devices
HES = Hazard Elimination
STPHS = Hazard Elimination
STPRR = Safety
STPRP = Safety

STPHS = Safety
STPE = Transportation Enhancements

Bridge Program
BR = Bridge Replacement
BH = Bridge Rehabilitation

Congestion Mitigation and Air Quality Improvement Program
CM = Congestion Mitigation and Air Quality

Highway Planning and Research Program
HPR = Highway Planning and Research
RD = Research Development
TT = Technology Transfer
PL = Metropolitan Planning

Innovation Projects
DPI = Innovation Projects

Discretionary Funds
PH = Public Lands

State Funded Projects with the following prefixes are totally State funded, either by the Reconstruction Trust Fund or the State Earmark Account:

- RTI = Interstate
- RTF = Primary
- RTS = Secondary
- CRA = City Rest Areas
- RT = Off System Roads
- RT = District wide PE Projects (Highway Preservation)
- SI = Earmarked Account
- SF = Earmarked Account

Uniform Project Number or Control Number (CN)

The Project Analysis Bureau assigns a four digit Control Number (CN) to MDT projects. The uniform project number (UPN) is the CN plus a three digit Federal Agreement number identifying the MDT assigned unit. The UPN is a project accounting number tying together project phases.

Contract Number

The Engineering Construction Contracting Bureau (ECCB) assigns a unique five digit contract number to MDT construction projects, which may include multiple projects.

102.3 Contractor Registration
Subsection 102.03, Standard Specifications

102.4 Proposal Issuance
Subsection 102.04, Standard Specifications

102.5 Proposal Work Quantities
Subsection 102.05, Standard Specifications

Importance Hierarchy

Contract quantity estimates are approximate, and intended for bidding only. In most cases, MDT Inspectors determine actual payment quantities during construction, according to measurement and payment requirements described within Standard Specification Section 109. Each item used for construction measurement and payment is given a 9 digit number with an associated item title and description. These numbers are used for project tracking during construction. The first three item number digits reference a Standard Specification section. For example, item 606010030 “Guard Rail-Steel” references Standard Specification Section 606 “Guardrail and Concrete Barrier Rail.”

102.6 Document and Work Site Examination
Subsection 102.06, Standard Specifications

Importance Hierarchy

Contractor Site Visits

Bidders should review the project site and expected work conditions and perform subsurface investigations as needed. MDT personnel assists Contractors by providing field condition information when possible. Note Contractor site visits within project diaries. Refrain from addressing project related questions otherwise best submitted to the Q&A Forum.

Pre-Bid Conferences

Justification

MDT schedules mandatory pre-bid conferences for unique projects or those with unusual features, including:

- Design/build projects
- Research projects
- Unusually complicated projects
- Native Lands projects

Unless mandated by Tribal MOU, Districts usually determine if pre-bid conferences are necessary. Bidders must attend pre-bid conferences for bids to be considered responsive.

Native Lands Projects

Contractors bidding projects on Native lands must attend pre-bid conferences facilitated by the District DCE or Project Manager to ensure bidders are aware of reservation requirements. Bidders must be represented at the pre-bid conference. Subcontractor are not required to attend pre-bid conferences. Tribal governments usually have tribal representatives from employee rights, transportation planning and environmental offices attend the conference to address tribal requirements, laws, contacts. MDT representatives provide Tribal representatives an opportunity to address the group. MDT and Tribal representatives discuss Tribal requirements including:

- Memoranda of Understanding (MOU)
- Project Specific Agreements (PSAs)
- Tribal Employment Rights Office (TERO) fee
- Improvements or Services (IOS) fee
- Tribal contacts
- TERO hiring requirements
- Tribal regulations regarding fringe cash benefits to workers
- Tribally significant areas
- Tribal environmental requirements
- Proven reservation material sources

Bidding Requirements
102.07, Standard Specifications

Bid Proposal Rejection
Subsection 102.08, Standard Specifications

Proposal Guaranty
Subsection 102.09, Standard Specifications

Proposal Delivery and Public Opening
Subsection 102.10, Standard Specifications

Proposal Withdrawal
Subsection 102.11, Standard Specifications

Debarment
Subsection 102.12, Standard Specifications

Materials Guaranty
Subsection 102.13, Standard Specifications

Venue
Subsection 102.15, Standard Specifications

Consent to Contract Provisions
Subsection 102.16, Standard Specifications

Public Works Contracts
Subsection 102.17, Standard Specifications

SECTION 103
CONTRACT AWARD AND EXECUTION

Proposal Considerations
Subsection 103.01, Standard Specifications

Contract Award
Subsection 103.02, Standard Specifications

The Engineering Construction Contracting Bureau (ECCB) initiates contract award. Legal Services, FHWA, Civil Rights, the Construction Engineer, Chief Engineer and other representatives meet one week after letting to approve the bid before:

- The Transportation Commission accepts recommendations from the bid review meeting to award the contract.
- ECCB requests and receives concurrence to award the contract on FHWA full oversight projects. FHWA concurrence regarding partial oversight or State delegated projects is discretionary.
- ECCB prepares a congratulatory letter, and submits two original contracts to the Contractor for signature.
- Required Contractor documentation is received by the ECCB, and the MDT Director signs the contract. The ECCB may submit bid evaluations to Project Managers.

Claim Assignment
Subsection, 103.03, Standard Specifications

is distinct from Standard Specification Subsection 105.16 “Claims for Adjustments and Disputes.”

Award Cancellation
Subsection 103.04, Standard Specifications

Return of Proposal Guaranty
Subsection 103.05, Standard Specifications

Contract Bond
Subsection 103.06, Standard Specifications

Contract Execution and Approval
Subsection 103.07, Standard Specifications

Failure to Execute Contract
Subsection 103.08, Standard Specifications

Bid Documentation Submission
Subsection 103.09, Standard Specifications

If the bid documentation submission Special Provision is included in the contract, Standard Specification Subsection 103.09 requires low bidders to submit requested bid documentation. Claims filed against MDT are opened in accordance with Standard Specification Subsection 105.16. When bid documents are opened after a Certified Claim has been filed, MDT staff may access bid information. Contact the Construction Engineering Services Engineer about bid documentation review after Certified Claim filing.

SECTION 104
SCOPE OF WORK

Contract Intent
Subsection 104.0, Standard Specifications

Contract documents address work performance requirements. If disagreement occurs over contract documents, Project Managers should interpret documentation to make a decision, or contact the Preconstruction Program for assistance. Issues regarding contract intent unresolved at the project level should be directed to the District Construction Engineer.

Differing Site Conditions, Work Suspensions, and Significant Changes in the Character of Work
Subsection 104.02, Standard Specifications

Field site conditions sometimes include situations unanticipated during preconstruction. Project Managers may suspend work and identify a significant change to the character of the work, or a significant quantity change. Standard Specification Subsection 104.02 provides strategies to address these situations equitably.

Differing Site Conditions Subsection and Contractor Pre-Bid Responsibility 104.02.1, Standard Specifications

Differing site conditions must be weighed against Contractor responsibility. Standard Specification Subsection 102.06 instructs Contractors not to take advantage of bid package errors, omissions or ambiguities, and immediately notify the Engineer in writing if an error, omission or ambiguity exists, and why it appears erroneous, omitted or ambiguous. Prime contractors must advise subcontractors of this obligation, and emphasize their responsibility to include this information within subcontracts. The Department will clarify the error, omission or ambiguity, and may issue an addendum to bidders before opening bid packages. If MDT denies a Contractor claim for additional compensation based on Subsection 102.06, Project Managers present documentation defending MDT against the claim. Standard Specification Section 101 defines “differing site condition” as: subsurface or latent physical site conditions differing materially from those in the contract, normally encountered or generally recognized as inherent in contract work, and qualifying as “unknown physical site conditions.”

Construction Industry Terms

The phrase “differing site conditions” is defined as type 1 or 2 unforeseen physical or subsurface conditions:

Type 1; Differing Site Condition:

Subsurface or latent physical conditions materially different from those indicated in the contract.

Type 2; Differing Site Condition:

Physical conditions so unusual for the work they could not have been anticipated by an experienced and prudent contractor.

Differing field conditions must be assessed based upon a comprehensive representation of the contract, from which reasonable inferences should be drawn. Differing site conditions may include subsurface conditions, plan inaccuracies, and environmental issues or considerations. Both contract and federal law require contractors to identify differing site conditions, and notify Project Managers in writing. Project Managers must review Contractor differing site condition assertions, and respond to Contractors in writing. The Department must respond promptly when notified of a differing site condition. If the Contractor is not responsible for the site condition, Project Managers identify the best solution and issue needed change orders. Differing site conditions can impede project success and have great financial impact, and if not dealt with promptly may lead to claims. Knowledge of contract provisions and site conditions benefit both Contractor and MDT. “Differing site condition” examples follow:

- MSE Wall. Plans and specifications do not include existing MSE wall removal to construct a new interchange ramp. The Contractor identified the discrepancy in the plans and requested a change order. The Project Manager examined the site and agreed that plans did not include for MSE wall removal. The Design Project Manager agrees the removal item was not included. Project Manager then requests the Contractor submit an agreed time for wall removal, along with an appropriate contract time extension.

- Excavation Material. The Contractor submitted a letter to MDT for a differing site condition claiming roadway excavation material quantification was inaccurate, citing “additional cost and time to locate an alternative material source, and excess material disposal.” The Project Manager examined the site and contacted the Design Project Manager. Both agree the claim was invalid, so the Project Manager rejects the claim in writing.

Engineer Ordered Work Suspensions
Subsection 104.02.2, Standard Specifications

Project Managers may order a work suspension due to:

- Project personnel and public safety
- Contractor failure to implement Project Manager orders or contract provisions
- Fire danger
- Hazardous waste or archaeological site presence

As discussed within Standard Specification Subsection 104.02.2, Contractors must request additional compensation, compensable delay, and/or contract time extension, due to work suspension.

Significant Changes to the Character of Work

Standard Specification Subsection 104.02.3 Pertains to significant changes in the character of work:

- Standard Specification Subsection 104.02.3A defines significant change as “when the character of the work as altered differs materially in kind or nature from that included in the original proposed contract.” Project Managers determine what constitutes a significant change in accordance with Standard Specification Subsection 104.02.3A.

- Standard Specification Subsections 104.02.3B and 104.02.3C define a significant change within the context of a proportional increase or decrease in contract quantities based on whether an item is “major” or “minor”. Standard Specification Subsection 101.03 defines major work items as “Individual bid items having an original contract value at least 5% of the original contract amount”. Items not considered “major” items are considered “minor” items.

If a significant change occurs, Project Managers must determine if a price adjustment is warranted. If so, a change order must be executed documenting significant change. Factors to consider include item bid history for constructed quantities, work complexity, fixed costs included in the item such as mobilization and overhead. Costs are often not discernable from Contractor documentation:

- If quantities increase, unit cost should decrease from the original contract price, as fixed overhead costs remain constant but distributed over more units than paid under original plan quantities.
- If quantities decrease, then unit cost increases, as fixed overhead costs are absorbed into fewer units.

Change Orders
Subsection 104.02.4, Standard Specifications

Change orders are an administrative tool to amend contracts between MDT and Contractor. They authorize and document contract revisions to eliminate contract items, alter item quantities, allow for extra work at agreed prices, and allow scope changes. Change orders become a part of the contract, but are not required to issue incentives and disincentives, fuel price adjustments, or other adjustments for miscellaneous materials or items failing to meet specifications. These changes are documented using a monthly progress estimate line item adjustment, rather than a contract quantity adjustment.

Project Managers and Contractors must review proposed change order details to develop a timely solution. Potential change orders must be discussed with District Construction Engineers (DCE), District Construction Engineering Services (CES) Reviewers, and experts before finalization.

Change orders must be fair, especially for incentive/disincentive projects creating a Contractor windfall at significant cost to MDT. Excepting extenuating circumstances, change orders must be executed or approved before change order work begins. MDT may unilaterally execute a monetary change order due the Contractor for work currently part of a pending claim.

MDT SiteManager Change Order (CO) Process SiteManager Training Manual Section 10 outlines CO preparation and processing:

- CO identification and approval
- CO documentation within SiteManager, including discussion, review and approval
- Sitemanager and AASHTOware data entry by MDT staff, and CO status
- CO content
- EPM CO Checklist

Design Project Manager CO Discussion and Coordination

Verbal CO discussions between construction personnel and experts are essential to identify change scope, cost, and discuss Federal eligibility and ensure statewide consistency. Although Design Project Managers (DPMs) lack CO approval authority, include DPMs in CO discussions. Design Project Manager input is helpful when MDT has been granted regulatory permits. For example, design or slope changes should be discussed with Design Project Managers, as these changes may impact agency issued permit conditions.

Emergency Approval

MDT may grant emergency approval to work before a CO is granted when a delay poses immediate danger to the public or workers. Emergency approval can also be granted if work delays harm project progress or damage property. Only the Chief Engineer, Construction Engineer or Construction Administration Services Engineer can grant emergency approval. In their absence, District Construction Engineers may grant approval. When contacting headquarters, Project Managers should describe the problem, suggested solution, intended work, estimated quantities and expected costs. Project Managers must document approval using the CO checklist. Work cannot be charged to new contract items in daily work reports until CO approval. Emergency approval is indicated on the change order, and allows Contractors to proceed with work before approval. Project Managers must document work within the DWR or Diary. Project Managers are encouraged to expedite CO review and approval processes through clear and effective communication.

Change Order (CO) Preparation COs direct Contractors to change part of the contract agreement. Use the "EPM Change Order Checklist" to prepare COs and address the following:

- Include items altered by the CO, such as quantity increases or decreases, or new contract items. Project Managers must include items associated with the change plus additional contract time to help MDT and the Transportation Commission understand cost impacts and prevent future disputes.

- Until a CO is signed and approved, work is not contractual, and Federal aid participation for FHWA-oversight projects is unguaranteed. Obtain signatures before CO work begins.
- Attach supporting documentation including justifications, cost breakdowns and supporting documentation as CO attachments.

Negotiations

Extra work payment must be agreed upon by Contractor and MDT before work begins. CO work is paid at the contract price, at an agreed unit price or as force account work. Payment method is made in accordance with Standard Specification Subsection 104.02.3. Additional work covered by contract bid items is paid at unit prices, unless circumstances render prices inapplicable. If work prices cannot be negotiated, extra work is tracked through force account governed by Standard Specification Subsection 109.04.2 and 109.D.2.

Do not allow Contractors to revise standard CO language. MDT, the Commission and FHWA must be satisfied COs address potential costs, and Contractors are bound by negotiated prices. Major contract changes may affect other contract items, prices for which must be addressed in the CO. Contractors must justify additional items, and include affected item changes to CO work. Including items affected by the CO order minimizes risking item overruns later, needing another CO, or future claims.

Check funding categories against CO work items to ensure work is eligible for appropriately sourced funding, such as State or Federal funds, city and county jurisdictions or other entities like utility companies. Project categories must be correct when project agreements are modified to ensure proper funding for each CO work item, as incorrectly categorized work items void the CO, and require a new CO placing the work item in the correct category. Contact the Construction Administration Services Engineer (CASE) for assistance placing work items in proper categories.

“Agreed Price” Change Order (CO)

Agreed price COs require less documentation than force account administration. Use these resources to assess equipment, labor and material prices:

- Historical Bid Prices. The MDT website and DSS database (Bid History tool, Oracle application) allow Project Managers to view District or Statewide historical project data, and price evaluations for similar quantities. Items added by CO typically cost more than items included within the original contract. Other bid documentation used to assess item prices includes subcontracts, Contractor bid documents and Estimator models, available through the Engineering Construction Contracting Bureau.
- Use contract labor rates for comparison.
- Material representative price quotes can be used to establish prices.
- The ‘Rental Rate Bluebook” publication is available from District Engineering Officers.

Agreed prices may be based on comparisons with established item prices or a Project Manager cost estimate. Previously established prices may be derived from average low bid prices, similar work costs, or previous work. When work does not involve large costs, acceptance may be a matter of judgment. Cost comparison for an agreed price item should closely represent item worth.

- If a work item comparison cannot be established, a cost estimate may be prepared by Contractor or Project Manager. Contractor estimates must be verified by the Project Manager, and CO prices must be supported by the District. Excessive Contractor estimates are unacceptable, unless a Contractor satisfactorily explains higher cost(s).

- Project Managers must include a 1% gross receipts tax, TERO and IOS fees. Although they appear as a line item adjustment within monthly progress estimates, these fees must be addressed when issuing COs for agreed price or miscellaneous work items.

Major item Overhead Costs

Fixed overhead costs typically constitute a smaller percentage of major item contract items. Fixed overhead rates obtained by reviewing subcontracts, claims and sequestered bid documents average 10% of major item unit price.

If a major item final quantity is between 75% and 125% of plan quantity, no adjustment is needed. If a major item underruns more than 25%, redistribute unrecovered overhead over the remaining quantity unit price. Likewise, when a major item increases by more than 25%, the unit price of the quantity above 125% of plan quantity should be decreased by a fixed overhead percentage. In the absence of Contractor documentation justifying cost, a 10% decrease for quantities exceeding 125% of original plan quantity is assessed.

Overhead Costs

If a major item quantity decreases 50% or more, the Contractor may not be able to recover overhead costs within the unit price. Significant underrun impacts are more serious for Subcontractors working on a single or limited number of items when the unit bid price contains fixed overhead costs.

Joe Dirtman, Project Manager
MDT Field Office
Anywhere, Montana 59010

RE: STPP 61-1(0)5
Anywhere N&S

Dear Project Manager:

The following is our price breakdown for the unit price of $21.02/Ln Foot for the work included on Change Order Number 1 as you requested.

Materials: 300 ft of 24-in CSP pipe @ $7.50/Ln Foot............................ **$2250.00**

Labor:	Foreman	15 hours	x	$21.00/hr	$315.00
	Laborer (2)	10 hours	x	$15.00/hr	$300.00
	Operator	15 hours	x	$17.50/hr	$262.50
	Teamster	5 hours	x	$18.50/hr	$92.50
					$970.00
	80% Burden				$776.00
	Total Labor				**$1746.00**

Equipment:				
	2000 Cat 720 Excavator	15 hours	x $75.00/hr	$1125.00
	2001 Kenworth Dump Truck	5 hours	x $40.00/hr	$200.00
	2001 Ford F350 pickup	15 hours	x $7.50/hr	$112.50
	2000 Wacker 10 hours	x	$ 5.00/hr	$50.00
	Total Equipment			**$1487.50**
	Total Cost			$5483.50
	Prime Markup 15%			$822.53
	Total Price			**$6306.03**

If you request any further information, please contact our home office.

Sincerely,

____
Jones General Contracting Services

FIGURE 104-1
TYPICAL CONTRACTOR PRICE BREAKDOWN

Fixed overhead rates obtained through subcontract reviews, claims and sequestered bid documents have averaged approximately 20% of non-major item unit price. Overhead percentage depends on the work item and bid structuring. Typically, overhead percentage is inversely proportional to item quantity. Smaller original quantities, involve a larger overhead percentage within the unit price.

In the absence of Contractor documentation, unit price decrease is 20% for the quantity exceeding150% of plan quantity. If the final quantity of a non-major item is between 50% and 150% of plan quantity, no adjustment is made. When a non-major item is underrun more than 50%, redistribute unrecovered overhead over the of the remaining quantity. Likewise, when a non-major item increases more than 50%, the unit price of the quantity above 150% should be decreased by the fixed cost percentage for the original bid quantity.

EXAMPLE 104 -1A

NON- MAJOR ITEM EXAMPLE

Given: Plan quantity for clearing and grubbing (Item # 201310000) = 8.2 acres, a non-major contract item. Awarded unit price is $2125/acre. Cost breakdown for this item is:

Equipment (includes maintenance and fuel) = $810/acre
Labor = $733.80/acre
Profit = $188/acre
Fixed overhead (mobilization, insurance, bond, etc.) = $393.20/acre

Measured clearing and grubbing quantity is 3.7 acres, an underrun of 54.9%.

Solution: Fixed costs the Contractor is entitled to recover is:

(8.2 – 3.7) x $393.20/acre = $1769.40

This amount is redistributed over the actual work quantity to calculate the new unit price:

$1769.40/3.7 + $2125 = $2603.22/acre

Comment:

Had the Contractor placed overhead ($393.20/acre x 8.2 = $3224.24) in Mobilization (Item #192000000), and provided an initial bid price of $1731.80/acre, no adjustment would be made, as Contractor fixed costs are paid under “mobilization”. The $1731.80/acre unit price is correct for the quantity exceeding 150% (>12.3 acres) of the $2125/acre bid price.

Contract Time Adjustments

Time adjustments should be discussed with the Contractor before CO preparation, and should be increased with additional work. Review proposed contract time extensions for reasonability based on a Contractor updated schedule, and document how the time adjustment was determined. Contractor time extension reimbursement is a negotiable item, but Contractors must demonstrate additional work affects the critical path. CO overruns including traffic control items, and asphalt cement percentage increases should not include additional contract time. Adjust contract time using the Time Adjustment category on the EPM CO Checklist. If time is adjusted, the Time Adjustment function must be checked on the header window. This window is used to adjust contract time.

Estimate Discrepancy

- Item overruns create discrepancies in SiteManager when the quantity placed exceeds the allowed percentage of 50% for major items and 999% for other items. When estimate discrepancies exist, Project Managers must resolve the discrepancy via CO, and add a comment explaining the resolution.
- If the 50% specification allowance was used in SiteManager, it would result in small dollar amount COs because price adjustments only apply to the quantity exceeding 150%.
- Estimate discrepancies are generated in SiteManager based on Line Item Number. MDT policy is based on the percentage by which the Line Number overruns. If an item discrepancy exists in SiteManager, but contract quantity has not reached the listed percentage, a CO is not required. Contact the Construction Administration Services Engineer (CASE) with contract and item information. With agreement by the CASE, Project Managers override the discrepancy, and the CASE will turn off the discrepancy during the final process.

Documentation

- Prepare and attach documentation to support a CO as needed. COs involving agreed price must accompany associated documentation submitted by the Contractor or the Project Manager, such as Contractor letters, requests and item cost estimates, with an amount representing overhead and profit. Attachments must confirm agreed cost and price, include estimated material quantities, and justify agreed price work. Other documentation may include letters from city, county or agency representatives.
- If a Contractor refuses to sign a CO, SiteManager allows the CAS Engineer or Construction Engineer to unilaterally override the approval process, and authorize the work. The Project Manager then contacts the CASE or CE, one of whom updates the CO status to “pending”, and selects approval names. The same Department personnel are selected according to typical approval rules, the only difference being that Contractor roles are omitted. When Project Managers approve the CO, they add a comment in SiteManager indicating “contractor refused to sign CO,” or “change in funding only.”
- If work price cannot be agreed upon, Contractors may file a claim against MDT. If Contractors elect not to file a claim, a written statement to the Project Manager must be submitted before project closeout, indicating the Contractor has no claim against the disputed CO.

Extra Work
Subsection 104.03, Standard Specifications

Extra work is unforeseen and outside the contract scope, but required for project completion. Standard Specification Section 101 defines “extra work” not to be a contract item quantity increase. Extra work payment is made using force account or agreed price, and documented via CO (Standard Specification Subsection 104.02.4) or paid under Miscellaneous Work (Standard Specification Subsection 104.04).

Miscellaneous Work
Subsection 104.04, Standard Specifications

Do not use Miscellaneous Work to reimburse Contractors when a change order is appropriate. Standard Specification Subsection 104.04 is intended for minor work items, not as a change order substitute.

Maintenance of the Work
Subsection 104.05, Standard Specifications

Contractors are responsible for existing highway facility maintenance during construction. Costs to repair guardrail, traffic control devices or other structures are Contractor responsibility until final written project acceptance (Standard Specification Subsection 105.15) by the Transportation Commission. Trash, debris and other roadway obstructions also must be removed by the Contractor. Third parties inflicting damage are responsible for repair costs. Contractors must repair and be reimbursed for damage by unidentified third parties under applicable work items. Construction field staff should review projects daily to identify maintenance work needing Contractor attention. Regularly inspect riding surfaces, temporary striping, signs and message boards. MDT Maintenance Section Supervisors and field construction staff should communicate regarding maintenance issues, and document damage using photographs and video. Figure 104-2 outlines the MDT Accounts Receivable (AR) process for repair cost collection during construction.

Traffic and Detour Maintenance

Standard Specification Subsection 104.05.3 requires Contractors to maintain construction work to accommodate traffic.

Traffic Maintenance During Work Suspension Subsection 104.05.4, Standard Specifications

Project Managers must assign winter maintenance and repair responsibilities before work suspension. Contractors may perform maintenance and repair, or have the Department do so during suspension. Project Managers must compile a written agreement for the work if Contractors request the MDT perform these functions. If Contractors cease operations to work elsewhere, they assume maintenance responsibilities. Before work suspension, Project Managers must ensure the roadway is smooth and safe, conduct reviews during suspension, and notify Contractors of needed maintenance. Communicate with District Maintenance Section Supervisors to discuss potential issues.

Irrigation Water Maintenance Subsection 104.05.6 Standard Specifications

Contractors must contact water using landowners near the construction site, and when irrigation is part of a ROW Agreement. Project Managers may require Contractors to fence the site for safety. By statute, MDT is required to maintain irrigation conveyances.

On-Site Material Usage
Subsection 104.05, Standard Specifications

Subsection 104.06 allows Contractors to request acceptance for onsite material use. Excavated material may be used for other contract items with written Project Manager approval. Existing concrete or asphalt may be crushed or milled to produce embankment material, or used with separate material item. Removal is paid for as a removal item, and placement is paid as embankment. Contractors must provide material and material quality documentation.

Written authorization is required for excavation outside slope and grade lines. Excavation should never adversely affect project appearance or function.
Should acceptable materials be found onsite, Contractors may use these materials under certain conditions, although this practice may increase haul distance and encourage poorly located borrow and waste areas. Project Managers must approve materials inconsistent with planned usage. Materials within project limits meeting Standard Specification may be used for embankment construction. Project Managers will notify Contractors if onsite materials meet contract requirements, but may direct Contractors to remove and discard unsuitable excavation based on contract requirements.

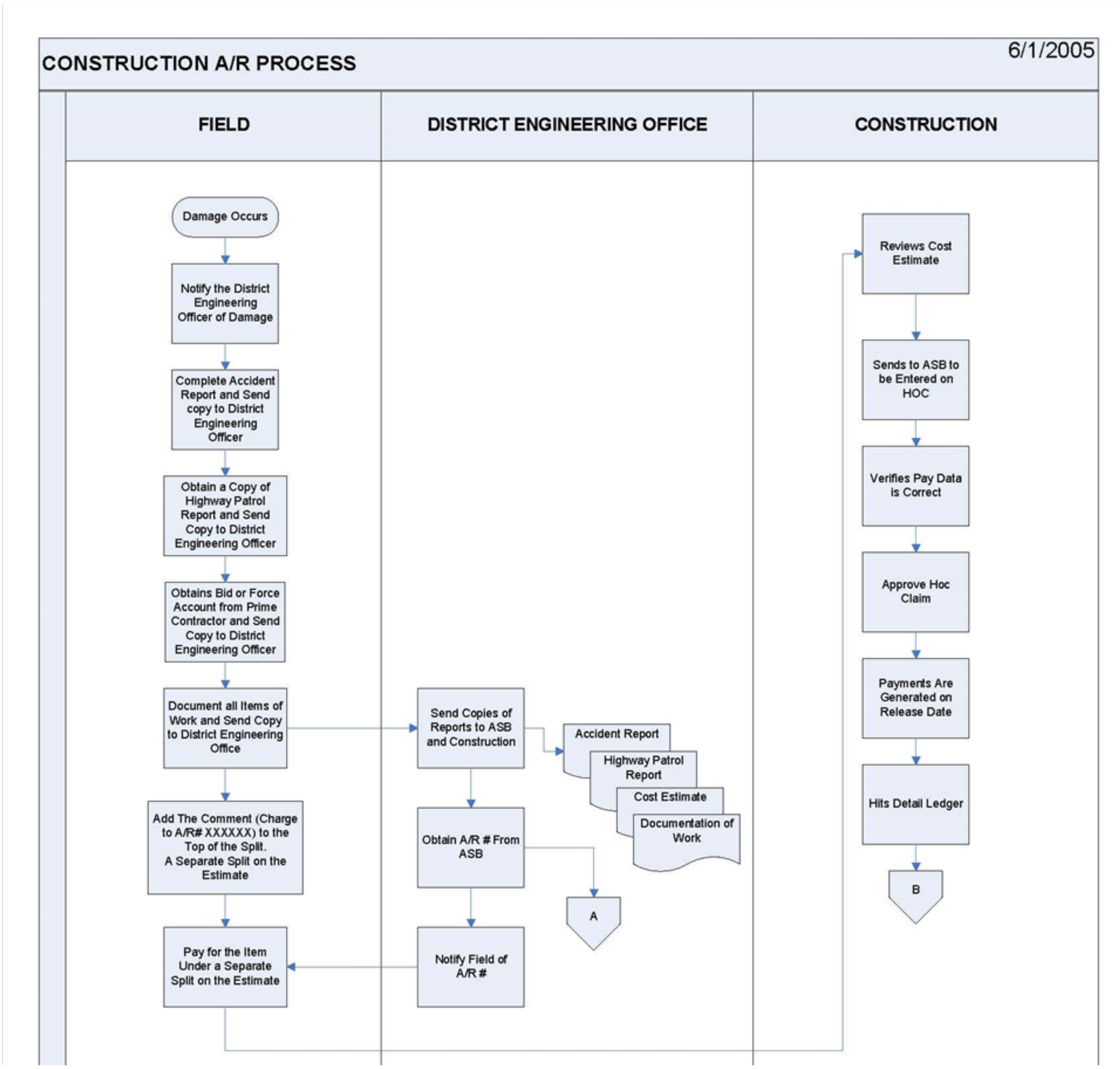


FIGURE 104-2
CONSTRUCTION A/R PROCESS

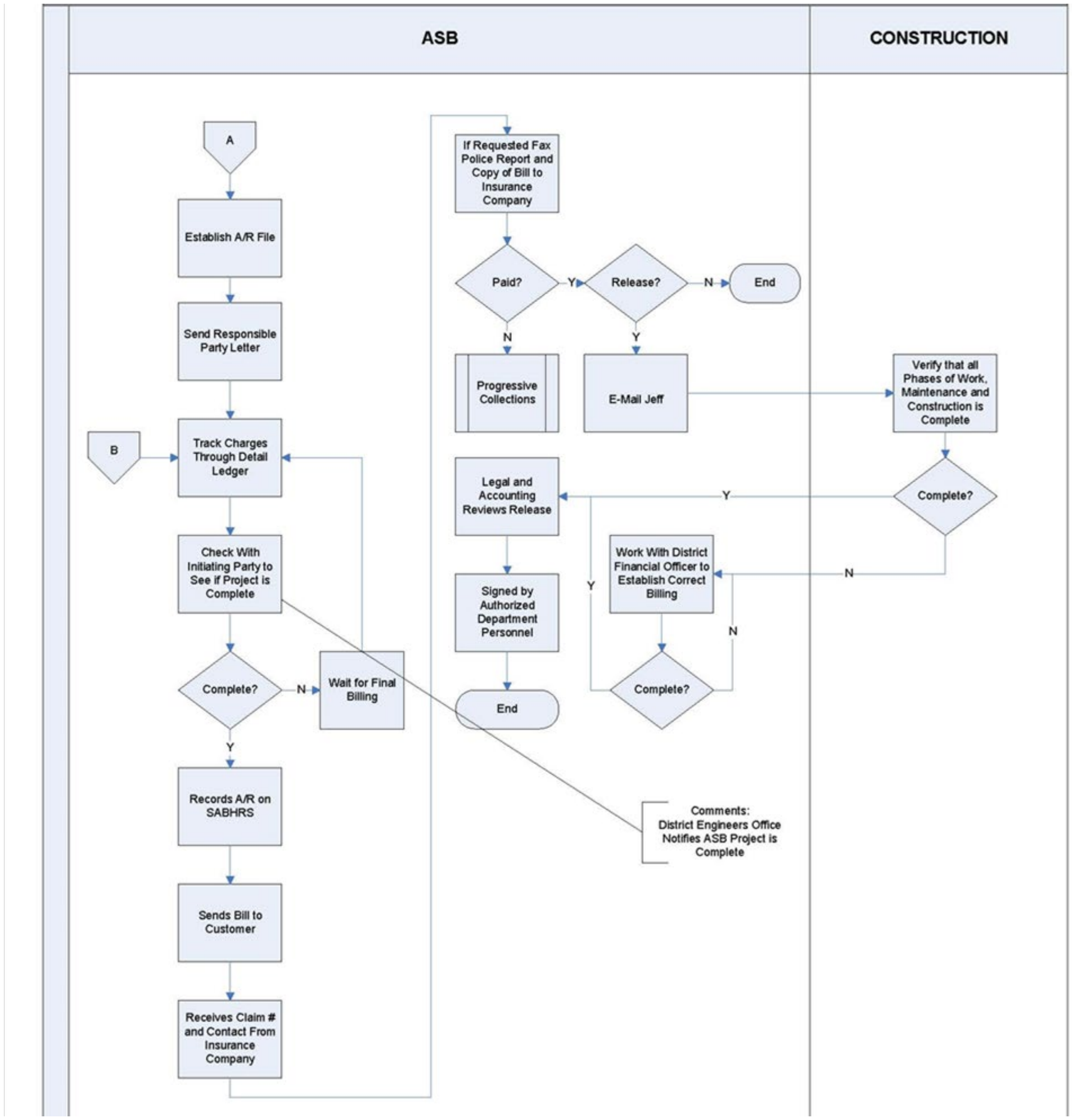


FIGURE 104-2 CONSTRUCTION AR PROCESS (cont)

For safety reasons, MDT Maintenance forces may correct traffic control deficiencies when Contractors are physically unable or do not quickly make changes. Contractor failure to perform is cause for Project Managers to stop work. Keep the Project Manager informed of traffic control deficiencies and immediately address dangerous situations.

More frequent oversized and overweight loads on Montana roadways during construction require travel restriction notices. Ordinarily, oversized/overweight restrictions are identified within District Department Weekly Road Reports. Size and weight restrictions may vary during construction, and MCS should be notified accordingly. Project Managers may contact MCS about situations unaddressed by Special Provision.

Final Clean Up
Subsection 104.07, Standard Specifications

Project Managers prepare a punch list based on items identified by MDT field staff. Punch lists may address areas used during construction by the Contractor or Subcontractors, and are required by Standard Specification Subsection 106.02.5 to address final borrow and aggregate source cleanup. Involved parties should be contacted for input before an initial punch list is developed. A final punch list should later be developed. Punch list items should be identified as soon as possible during work, and include items requiring action. Creating intermittent punch lists as Subcontractors complete work before demobilization is helpful. Project Managers should review landowner agreements for specific final cleanup requirements, although MDT does not ordinarily have contracts with landowners. Agreements between Contractors and landowners are between those two parties. Landowners believing a Contractor has not fulfilled agreement terms may attempt to involve MDT. Beyond a willingness to assist, MDT has no contractual requirement or authority to administer or enforce these agreements.

Value Engineering (VE) Proposals
Subsection 104.08, Standard Specifications

Construction Engineering Services (CES) processes Value Engineering (VE) Proposals and coordinates VE review and investigation by other MDT units. Contractor VE Proposals must meet Standard Specification Subsection104.08 requirements. Contractor Value Engineering (VE) proposals typically offer an improved construction technique, alternative material, or other change to lower project cost. Project function and quality must at least be maintained or enhanced. Cost savings are shared between Contractor and the Department, excepting estimated road user savings, which are not shared with Contractors. The Construction Engineering Services (CES) Bureau processes Value Engineering (VE) proposals in accordance with Standard Specification 104.08, and coordinates review and investigation by other Divisions and Bureaus providing technical advice and recommendation. VE proposals should be evaluated in a timely manner and a response prepared within the proposal time frame. If additional time is needed, EPMs should inform the Contractor. District CES Reviewers coordinate proposal review and track review progress, while a CAS Bureau CO Specialist maintains pertinent proposal information. The CES Bureau shares information learned during the VE process, so innovative practices can be considered for future projects.

Pre-Bid Information

Value Engineering generates contract savings, but should not provide a competitive advantage to bidders.

Post Ward Information

The Department only accepts proposals submitted in accordance with contract provisions. Contractors risk developing a rejected proposal if the proposal does not satisfy special provisions. Departmental comment on tentative proposals should be general, and does not constitute acceptance.

Evaluation

VE proposal are initially reviewed to determine whether a detailed investigation is warranted. Costs incurred by the Department during a preliminary review stage are not charged to Contractors. Cost effective proposals meeting service requirements are given a detailed review, analysis and investigation. Department costs during the detailed review stage are shared between Department and Contractor. Acceptable VE proposals do not impair essential functions, service life, reliability, operation economy, maintenance effectiveness, aesthetics or safety. Previously considered alternate construction methods, pay item or specification deletions, or changes compromising essential design criteria do not constitute a VE proposal.

Preliminary Review

The District notifies the District CES Reviewer and Change Order Specialist upon receiving a VE proposal:

- Districts review the proposal for completeness, content (Standard Specification 104.08), concept, cost data and evaluation time.
- The District sends the proposal to the Construction Engineering Services Reviewer, who checks the District Preliminary Review.
- The CES Bureau then sends the proposal to involved Divisions and Bureaus and FHWA (federal oversight projects) to preliminarily review technical and functional details.
- Divisions, Bureaus and the FHWA preliminarily review proposed features to determine if the proposal warrants detailed investigation and analysis. Preliminary review only requires sufficient detail to identify design standard problems, service requirements, materials properties and other factors affecting performance and operation.
- The proposal is preliminarily reviewed by the Construction Engineering Services (CES) Bureau to identify problems, develop a review time and cost estimate, and explain why investigation is warranted.
- The CES Bureau summarizes and evaluates the preliminary review, and makes a recommendation to the Construction Engineer.
- The CES Bureau notifies the District of rejected proposals, and gives the Contractor written notice of and reasons for rejection. Contractors may then revise the proposal to address issues.

Detailed Reviews

- The CES Bureau notifies involved divisions, Bureaus and FHWA to proceed with investigations. This work is recorded on timesheets as activity 065.
- Detailed Reviews ensure project functions are unimpaired, and may include a design review, consultant design review, materials testing evaluation, quantity calculation review and cost estimate review. Detailed reviews may also include MDT with Contractor meetings to consider solutions.
- Each Bureau submits a review report to the CES Bureau recommending the proposal or portions of it be accepted or rejected. Reports may include needed contract document changes to implement the proposal. Quantity, cost and time estimates required for redesign or plan revision should be included.
- CES compiles detailed review reports to summarize findings and provide recommendation to the Construction Engineer.
- CES provides review costs to the District Construction Engineer and Project Manager.
- The Construction Engineer accepts or rejects the proposal, and notifies the District Construction Engineer and Project Manager. Districts then notify the Contractor in writing of the decision.
- For accepted proposals, Districts prepare a change order with supporting documentation. Adjusted contract amounts should indicate VE proposal savings,

minus half the review cost. A CO is then submitted to the CAS Bureau for approval.

- The District prepares a CO to document cost sharing for rejected proposal reviews.

Department Evaluation and Implementation Expenses

Departmental costs incurred during Detailed Reviews are shared equally between Contractor and Department, and may include investigation and review, redesign or design checks, quantity calculations and estimates, plan revision, further sampling and testing, and field surveys. Departmental costs incurred from Value Engineering implementation are shared equally by Contractor and Department, and may include additional inspection, testing or surveys to implement the proposal, and increased pay item quantities, road user costs, traffic control cost and erosion control cost.

EXAMPLE 104-2
VALUE ENGINEERED GUARDRAIL

The Contractor has proposed to replace a planned box beam guardrail with a new rail type to reduce unclassified excavation….

Detailed Review Costs:	$ 1,100
ACME Type Guardrail (2500 ft):	$ 190,000
Guardrail – box beam (2500 ft):	$ 180,000
Unclassified excavation (10,000 cy):	$ 50,000
Net Savings:	$ 38,900

Change order amount = (50% × $38,900) = $19,450 reduction

Value Engineering (VE) Templates

- Memo template is used for CES Bureau evaluation and recommendation to Construction Engineer.
- Memo template is used for VE acceptance or rejection to the DCE from Construction Engineer.

SECTION 105
CONTROL OF WORK

Engineer Authority
Subsection 105.1, Standard Specifications

Standard Specification Subsection 101.03, identifies the Engineer as "The District Administrator acting directly or through an authorized representative, responsible for engineering and administrative project supervision." As discussed in Standard Specification Subsection 105.01, the DA has decision making authority over very high level issues such as claims or contract termination. The term "authorized representative" for construction projects includes the DCE and Project Manager. DCEs may seek approval and input from a DAs regarding major issues.

Work Suspension

Justification

Project Managers may order a Contractor work suspension on the basis of safety, Contractor failure to enforce contract provisions or Project Manager directives, fire danger, hazardous waste or archaeological site presence. Shutdown defined by Standard Specification Subsection 104.05.4 is "winter shutdown". If a Project Manager ceases work, a "work suspension" is issued.

Beyond Contractor Control

If work suspension is necessary for reasons outside Contractor control, Project Managers inform the Contractor, and document the suspension in the daily Diary, explaining the rationale to suspend work. If possible, when notifying the Contractor of work suspension, Project Managers should include a resumption date. Contractors may request compensation for delays, or additional contract time in response to work suspension. Standard Specification Subsection 104.02.2 discusses additional Contractor monetary and contract time compensation in response to work suspensions.

Delays Within Contractor Control

When work is suspended for reasons within Contractor control, contract time is charged. Noncompliant materials, failure to have materials available, inadequate manpower and equipment, or ignoring Project Manager directives are events within Contractor control warranting work suspension. Notification to suspend work must be in writing, and cite Contractor deficiencies necessitating suspension. Time charged during work suspension is evaluated and reported in Site Manager. A letter from the Project Manager authorizes work resumption.

Contractor Responsibility

Contractors must protect work by providing adequate roadway drainage, opening ditches, installing shoulder drains, maintaining BMPs or executing Project Manager requested measures. Contractors must store materials in a manner to minimize public hazard or damage during suspension. MDT is not responsible for stored materials.

Contractor Furnished Drawings and Submittals
Subsection 105.02, Standard Specifications

Working drawings are stress sheets, shop drawings, erection plans, falsework and framework plans, cofferdam plans, steel bending diagrams, or supplementary plans Contractors must submit to Project Managers.

Working drawings are listed in the MDT Special Provision “Table of Contractor Submittals.” See Standard Specification Subsection 105.03.4 for information regarding Contractor submittals. Contractors must provide drawings for specific work items such as fabricated structures or construction. Standard Specification Subsection 553.03.2 requires Contractors to submit fabrication drawings for prestressed concrete members, along with a required number of working drawing copies working to the Project Manager, who with other MDT personnel reviews drawings for completeness. Consultants are typically responsible for consultant project working drawing review. Project Managers and Contractors must approve direct communications between consultant designers and Contractors. MDT Consultant Services Manual Chapter 8 discusses construction support services typically part of consultant design contracts.

Drawing Review Status:

- **No Corrections.** “APPROVED” on working drawings if information complies with design and specifications.
- **Minor Corrections.** “APPROVED EXCEPT AS NOTED” on working drawings, but Contractors are not required to resubmit.
- **Major Corrections.** “RETURNED FOR CORRECTION” is indicated if design vs specifications discrepancies exist. Drawings are revised and resubmitted. Project Managers should review contracts for review durations, and provide MDT inspection staff with working drawings approved for construction.

Site Manager

See the Construction Filing List for documents requiring entry into the Correspondence Log. If an entry is required, include the cover letter from either 1) the Contractor indicating receipt of the working drawings or 2) from the working drawing reviewer describing needed changes. This information is beneficial later when analyzing delay disputes.

Conformity with Plans
Subsection 105.03, Standard Specifications

Occasionally items do not meet contract requirements but will serve the intended design purpose. In such situations, the Engineer or Project Manager identifies acceptable work to remain in place and be covered by Quality Assurance (QA) processes or specification. The following information (pages 83-98 below) assists Project Managers (PMs) and inspection personnel assess the need for and calculate miscellaneous work item deductions for work not meeting contract requirements, but serving the design purpose. District Construction Engineers, District Materials Supervisors, and Materials Bureau personnel are available for assistance.

Water Pollution, Stream Preservation, Silt Fence
Subsections 622.03.5, 716.06, and Section 208, Standard Specification

Review and compare silt fence certification and material test results to standard specification requirements. Verify contractor provided material is used for intended project purposes. If so, accept the material using a form 46. Verify proper material references such as “sediment control” or “erosion control” materials are recorded on form 46. Silt fence must meet Section 716, Subsection 716.06 and Table 716-6 requirements.

- Reject uninstalled silt fence material not meeting specification.
- Replace installed silt fence adversely affecting sediment control.
- If silt fence serves the primary function at a reduced life or value, apply an invoice price reduction to failed lots.
- Apply a 3% invoice price reduction to silt fence representing failed lots. (Do not apply price reductions to the bid price.)

Aggregate Surfacing, Aggregate and Select Backfills

These items may be stipulated by special provision. If select backfill fails specification Project Managers may:

- Discuss project specifics and material failures with the district Geotechnical Engineer to determine if backfill will serve intended primary function and purpose over a reduced service life.
- Replace material failing to serve intended backfill function.
- Impose a price reduction for items serving the primary function at reduced service life. Apply a 10% item deduction to account for shorter service life due to poor drainage properties.
- All tests failed. Apply a 10% deduction to item bid price.

<u>Example:</u> Bridge end material must meet A-1a (0) material specifications with 100% passing the 75mm, and maximum 8% passing the 0.075mm sieve.

Sieve	Test 1	Test 2	Test 3	Test 4	Test 5
50 mm 100	100	100	100	100	100
25 mm 60-80	96 *	91 *	96 *	73	78
12.5 mm 40-60	62 *	40	60	35 *	46
4.75 mm 20-40	35 *	16	36 *	18	27 *
0.425 mm 5-20	13	7	15	7	11
0.075 mm 0- 8.0	7.1	4.1	8.6 *	4.3	6.8

Plasticity Index (PI)
Standard Specification Section 301 and Section 701, Materials Manual MT 208

Soil Liquid Limit (LL) is the water content at which soils change from plastic to liquid state. The Plastic Limit (PL) is the lowest water content at which soil remains plastic. Plasticity Index (PI) is the mass water content percentage range yielding a plastic state. Soil PI is the numerical difference between LL and PL (PI = LL– PL).
Project Managers should discuss PI failures with the District Materials Supervisor or Materials Bureau before making material decisions.

An example of a Crushed Top Surfacing (CTS) Grade 3B material failing the Plasticity Index (PI) specification follows. PI was required between 3 - 10, but was zero, and:

- The material is expected to serve its intended purpose over a reduced service life.
- A 3% bid price reduction per sublot was imposed.
- Consider the cost of hauling a clay material to the site to be spread and worked into the gravel surfacing.
- Magnesium chloride was applied on a separate project having the same PI failure to make up for a low fines percentage.
- PI above the upper limit (10) may increase dust during dry conditions or the surface may become slick during wet conditions. The magnesium chloride application mitigated these conditions.

Example: Special Borrow Deduction

According to special provision, material must meet an A-1-a(0) soil classification, with 100% passing the 75mm screen, and no more than 5% passing the 0.075mm sieve. Test results are:

0.075 mm = 7.0
0.075 mm = 7.8
0.075 mm = 7.0
0.075 mm = 7.7
0.075 mm = 5.9
0.075 mm = 7.8
0.075 mm = 8.2

13,099.9 m^3 were placed at \$20.00/m^3

In this case the Project Manager (PM) may replace failing special borrow if engineering judgment indicates the primary function will be unserved. If PM decides the special borrow will serve the primary function at a reduced life or value, impose a 10% price reduction to the item bid price. This deduction accounts for extra cost to improve the special borrow, or accept an installed lower quality material likely to shorten design life due to insufficient drainage properties. PM may discuss alternatives with the Geotechnical Section to decide if test results compromise the special provision permeability requirement.

Special Borrow Deduction =

10% x bid price \$20.00 = \$2.00 x 13,099.0 m^3 = \$26,199.80 deduction.
Because this deduction exceeds \$5000.00, a change order is needed.

Plant Mix Pavement, Hydrated Lime
Subsections 401.02.2 and 713.02, Standard Specifications.

If lime fails, submit a repeat sample for testing. If the failing sample cannot be repeated, impose a deduction to the hydrated lime bid item.

Example: Field hot plant deduction

Lime specification calls for a 3% maximum retained residue on the No. 30 sieve, but this test retained 6% residue, so fails the lime test. Recommended deduction is the difference between the allowable percentage retained and the test result percentage retained (|3% - 6%|) = 3%. This percent difference is multiplied by the bid price and multiplied by the percent tonnage (in this case 20%) incorporated into the work portion represented by the test. Verify current specification percentage requirements.

Deduction = 3% x $250,000 x 20%
= .03 x $250,000 x .20
= $ 1500

Example: Commercial plant mix deduction

Sampling reveals avg Grade S mix lime: 3.4%
Commercial mix cost: $250,000
Total project lime tonnage: 200
Failing lime incorporated into the work: 40 tons
Lime tonnage incorporated into the work: 20%
Test results – 68.9 on CAO + MGO
Deduction = 3.4% x (commercial mix cost) x (percent of tonnage incorporated into work)
= .034 x $250,000 x .20 = $1,700

Example: Grade S plant mix deduction:

Deduction = (% difference between specification and test result) x (lime bid cost)

Bituminous Material and Emulsified Asphalt
Subsection 402.03.5, Standard Specifications

Crack Sealing
Sections 402 and 403, Standard Specifications

Crack Sealing materials are tested for resilience and cone penetration. Recommended penalties for failing materials are based on a judgement that the material will function but over a reduced service life. This judgement is weighed against future construction replacement costs and road user delays.

Resiliency tests determine how materials recover after impact or loading. Lower resiliency materials may cause rocks and debris to remain trapped in the sealant, and shorten sealant service life. Elasticity is also reduced during cold conditions.

High resiliency sealant may not bond with previously applied sealant or crack walls. Sealant may also be stronger than adjacent plant mix, and develop new plant mix cracking with thermal contraction. In cases involving crack sealing resilience failure, reject uninstalled material, and do not install. Impose a price reduction if material is installed but will function at reduced life or value. Impose a 10% contract unit price reduction or replace material representing lots failing a single specification.

A 25% unit price reduction or replacement is recommended for lots failing resilience and cone penetration testing. Use a 10% deduction for each failure, and a 5% deduction for cumulative effects.

Example: Crack sealing failure

Sealant resilience specifications for a particular project are 30% - 60%, but resilience test results are 22%. The recommended formula for deduction is 1- (22% / 30%) = 27%, indicating the material should be replaced.

Example: Crack sealing failure

The crack sealing resilience specification is 30-60%, but test results are 25%. The cone penetration result is 169 with a specification of 100-150. A higher cone penetration result means the sealant is softer. The bonding test passed.

- If bonding tests fail, replace the material.
- If material is uninstalled, reject the material and do not install.
- If material is uninstalled but will fulfill the primary function over a reduced life with reduced value, impose a price reduction. If engineering judgment indicates the material will not perform its primary function, replace the material.
- A 10% unit price reduction or replacement is recommended for lots failing a single specification.
- A 25% unit price reduction or removal is recommended for lots failing resilience and cone penetration specifications. Impose a 10% deduction for each failure, and a 5% deduction for cumulative effects.

Example: Crack sealing failure

The crack sealing resilience specification requires test result values of 30%-60%, but a test result is only 22%. If material is uninstalled, do not install.

- If material is installed and engineering judgment indicates primary function will be attained over a reduced life or value, impose a price reduction.
- If engineering judgment indicates the primary function is jeopardized, replace.
- Impose a 10% unit price reduction for failed lots, or replace the material.

SS-1 and/or CSS-1 Penetration Failure

Standard Specification Table 702-2 entitled "Schedule of Tolerances" lists minimum and maximum penetration tolerances within 10% of specification requirements. For emulsified asphalt requirements, see AASHTO M 140, Table 1 or AASHTO M 208, Table 1 and 702.01.

SS-1 and CSS-1 current penetration specification:

- $100 \leq SS \leq 200$
- $100 \leq CSS\text{-}1 \leq 250$

Recommended action for bituminous material:

- Accept material outside the tolerance range at a 10% invoice price reduction.
- Material outside the tolerance range by twice the allowable tolerance is accepted at 25% invoice price reduction.
- Material outside the tolerance range at triple the allowable tolerance is accepted at 50% invoice price reduction, or rejected by the engineer.

Example: SS-1 and CSS-1 deduction

Lab results SS-1 - 84
Allowable limit for SS-1 would be 10% of 100 = 90
Twice the allowable limit – 80
Material between 80 and 90 has a 10% deduction applied

Portland Cement Concrete
Standard Specification Section 551 and Subsection 551.02

If cement fails “insoluble residue” or “loss of ignition” testing:

- Ensure sampling and testing procedures are compliant with correct standards and procedures.
- Properly secure sample bags during transport to prevent foreign material contamination. If a sample is suspect, sample and test again to verify results.
- Refer to standard specifications for guidance when concrete fails material testing. If concrete cylinder strength results are within tolerance, adverse structural affects are not a concern.
- And concrete cylinder strength results are within tolerance, adverse structural affects are not a concern.
- Possible causes of high insoluble residue values may be a contaminated tank or silo, poorly cleaned tanks or trucks, improper cement gradation requirements during cement manufacturing or sample contamination
- If the primary function of this item is diminished, PM may replace the item. If the primary function is undiminished or provides a reduced life or service value, impose a price reduction:

  (1 – (Maximum allowable insoluble residue % / Actual insoluble residue %)) = % deduction. Use the contractor invoice cement price for the price reduction. If the contractor does not supply an invoice, use the concrete bid price, or replace the item.

Example:

The chemical analysis result for an insoluble residue is 0.83%. Maximum allowable insoluble residue according to AASHTO M85 and ASTM C150 is 0.75%.

Price reduction = 1- [0.75 maximum allowed /0.83 actual] = 9.64 % deduction

- Invoice cement price = $100.00/ton
- Concrete mix design contains 6.5 cement sacks/cy
- 600 cy within a lot
- 6.5 sack/cy x 600 cy/lot = 3,900 cement sacks
- 2000 lbs/ton ÷ 94 lbs/sack cement = 21.3 sacks cement/ton
- 3,900 sacks ÷ 21.3 sacks/ton = 183.1 tons cement in this lot
- 183.1 tons x $100.00/ton = $18,310

$18,309.86 x 9.64% = $1,765.07 deduction/lot

Concrete Aggregates
Subsection 551.02.8, Standard Specifications

If concrete aggregate fails aggregate gradation requirements, eject uninstalled aggregate, and do not use. Replace the material if engineering judgment indicates aggregate will not serve its primary function. Impose a price reduction using the following two methods if aggregate will function over at a reduced life or value. Use the option calculating the least deduction, unless a higher deduction is warranted. Determine the extra cost necessary to generate aggregate meeting more uniform gradation requirements. Also consider accepting a product of lesser value with shorter design life due to noncompliant design properties. Apply a 5% invoice price deduction to concrete failing contract requirements. If the contractor does not provide invoice documentation, apply a 5% deduction to the bid item price. Project Managers may adjust quantities to match placed material quantities.

Example:
A concrete slope protector concrete quantity is very large. If a 5% deduct is assessed for a large volume concrete placement, and only one test is available for a small portion, Project Managers may estimate the quantity represented by the failing sample, and apply the deduct to that estimated quantity:

If gradation fails by 5% on any screen aside from the 200 (0.075 mm) screen, the No. 200 (0.075 mm) screen is out greater than 2%, or fineness modulus fails specification, conduct additional product research and evaluation to assess item acceptability and diminished service life. Contact the Materials Bureau and a district Construction Reviewer for more insight.

Example: CA3A testing lot deduction
The CA3A test failed the 5.7% specification value. Results indicated 5.0%.
This 0.7% difference should not be detrimental to the concrete.
CA3A controls set and hydration. If setting times test ok, no detrimental effects are assumed.

Deduct 5% from the cement invoice price for failed lots.

Bridge Deck Concrete Standard
Sections 551 and 552, Standard Specifications

The following situations illustrate pay factor selection for fogging, water cure and silane sealer operations. Project managers may adjust pay factors between 0.90 and 1.0 as needed.

Fogging:

- pay factor- Fogging equipment met contract requirements, was functional during the entire placement, and used sufficiently to maintain a moist concrete surface. Fogger was not used to add finishing water.
- 0.90 pay factor- Fogging equipment frequently added finishing water, which elevated the water/cement ratio within surficial concrete. Equipment did not conform to specification, or fogging did not diminish surface drying, as indicated by surface discoloration.

Water Cure:

- pay factor- Wet burlap, water hoses and plastic sheeting met and were placed according to water cure provision requirements. The entire surface was wet throughout the 14 day cure period. Vapor barrier sheeting remained in place. Temporarily uncovering edges to construct barrier rail or install guardrail is acceptable.
- 0.90 pay factor- Multiple surface areas were not continuously maintained in wet condition.

Silane Sealer:

- pay factor- Sealer met and was placed according to contract requirements.
- 0.90 pay factor- Bridge deck was not cleaned, and material was not placed according to contract requirements, or was exposed to rain before drying.

Prestressed Concrete Members
Section 553, Standard Specifications

Apply price reductions to damaged prestressed concrete members and those failing contract requirements.

Minor Defects such as minor spalling, honeycombing, voids, gouges, scratches, and minor cracks: The Materials Bureau recommends needed repair.

Typically no deduction is imposed for these defects unless an aesthetic treatment such as colored concrete is diminished. A 10-15% deduction is recommended.

Mislocated holes, inserts: No deduction is recommended if repairs are completed without adverse effect on the final product. Impose a 10% deduction for a damaged members.

Durability and Substandard Material Properties: Mitigation is recommended if possible. If a member has low entrained air content but is deemed acceptable, concrete sealing may be required. Impose a 25% deduction. Failure to galvanize or paint steel hardware warrants a 25% deduction.

Structural Issues:

- short or projecting rebar or strands
- absent projecting rebar or strands

- damaged shear teeth
- unbonded strands or reinforcement
- fractured flanges
- shifted embedded plate
- Repairs fully restoring element structural integrity and durability do not warrant deductions. If a repaired element remains inferior but is acceptable to MDT, a 25% -50% deduction is recommended.

Fences / Metal Fence Posts Weight
Subsection 712.02.7, Standard Specifications

Verify metal post specification failures with the contractor:

- Ensure testing was conducted according to ASTM A 702 testing standards and procedure. Ensure rejection and retesting procedures are applied to failing tests.
- Guidance regarding metal fence post failure:
- Reject uninstalled posts.
- If posts are installed, remove posts if posts will adversely affect fence structure or function.
- Impose a price reduction if engineering judgment indicates posts will fulfill their primary function at a reduced life or value.
- Apply the price reduction to the steel post invoice price. If invoice documentation is unsupplied, replace the item or use the fence item contract bid price.
- Apply a 40% reduction to the invoice price for posts in the failing lot. Post weight is critical to fence structure.

<u>Example:</u> Failing post lot

40% deduction to all posts in the failing lot
$2.70 invoice cost per post
400 post lot
400 x $2.70 = $1,080.00 total invoice post cost for this lot
Total lot deduction is ($1,080.00 x .40) = $432

<u>Example:</u> Failing post lot

Fence system deduction
If multiple fence items fail specification, add the deductions. Recommend fence system replacement for total deductions > 50%.
Barb spacing fails; apply a 30% deduction.
Fence post weight fails; apply a 40% deduction.
Total deduction = 70%
70% > 50% for items in the same fence system, so recommend fence replacement.

Metal Fence Post Anchor Plate Assembly
Subsections 607.02 and 712.02.7, Standard Specifications

Metal fence post anchor plates occasionally fail. Before contacting the contractor about anchor plate failure, ensure testing was conducted according to ASTM A702, and proper rejection and retesting procedure have been followed. When anchor plate assemblies fail, Project Manager (PM) may replace posts with failing anchor assemblies or all posts within a failing lot if the failure adversely affects fence structure or primary function.
Use a price reduction if engineering judgement indicates posts with failing anchors will fulfill primary function at a reduced life or value. Use the steel fence post invoice price to calculate price reduction. If the contractor fails to supply invoice documentation, use the item bid price to calculate the deduction, or replace the item.

Example: Anchor plate deduction

- Anchor plate weight = 207 g
- Minimum required anchor plate weight = 290 g
- 207 / 290 = 71.4% of required weight
- 100% - 71. 4% = 29% deduction applied to the post lot
- $2.70 invoice post price
- 400 posts / lot
- 400 x $2.70 = $1,080 total lot value
- Total lot deduction for this lot is: $1,080.00 x .29 = $313

Barbed Wire Spacing
Standard Specification Subsection 712.02.2

Barbed wire failing to meet barb spacing requirements may be sampled for all specification requirements and submitted using form 45. If barb spacing fails, review the ASTM Standard (see attachment), and impose a deduction as recommended below. If barb spacing is accepted in the field using form 46, note within the remarks section of form 45 that barb spacing was field accepted and does not need inspection. If wire fails barb spacing requirements, reject uninstalled wire. If material is uninstalled and PM decides this item adversely affects the fence system primary function, replace the item. If PM decides the item will fulfill its primary function at a reduced life or value, impose a price deduction:

% Deduction = % barbs not meeting minimum spacing requirements.
Monetary ($) deduction = % deduction x barb wire invoice price.

Example: Barb spacing deduction

- MDT specification requires 93.5% of barbs to be at correct spacing.
- In field, only 70.2% of barbs in the sample meet specification spacing requirement.
- Deduction ($) for failed lot = (93.5% - 70.2%) x $10.00/rod x rods/lot.
- If the deduction exceeds item price by 50% or more, reevaluate the lot to determine if the product should be replaced at PM discretion.
- If material remains in place, total item deduction is assessed on a case specific basis.

Woven Wire Standard
Specifications Subsection 712.02.1

Reject uninstalled material failing material specifications. If installed material fails specification and PM decides this item will diminish the primary function of the fence system, replace the item. If PM decides this item will serve the primary function at a reduced life or value, impose a price deduction:

(break strength tested/min required break strength) = % deduction. (% deduction) x (fence bid item cost) = $ deduction

Example: Woven wire deduction

• tested break strength	455 lbs
• minimum required strength	460 lbs
• tested bar diameter	0.094 in
• required min bar diameter	0.096 in
• tested bar gauge	13.0
• required min bar gauge	12.75
• required min bar gauge	12.75

1- (455/460) = 1.1% deduction for this element.
1- (12.75/13.0) = 1.9% for this element
total deduction = 1.1% + 1.9% = 3% bid item deduction for failing fencing lot.

If deductions are 50% of item cost, evaluate whether a product should be replaced at PM discretion. If the item is not replaced, deductions are assessed on a case specific basis. Other fencing characteristics like bar spacing may have deductions applied to invoice price instead of bid item price. For fundamental items such as woven wire, apply deductions to the bid item.
Lower gauges indicate thicker material. Because diameter and gauge are directly related, deductions need only be applied to failing gauge measurements.

Example: Price reduction for woven wire lacking minimum coating

Specification requirement: Top Spelter & Bottom Spelter 0.30 oz/sq ft
Specification requirement: Bar Spelter & Stay Spelter 0.28 oz/sq ft

Test Result – Top Spelter	0.24
Test Result – Bottom Spelter	0.17
Test Result – Bar Spelter	0.23
Test Result – Stay Spelter	0.22

Price Reduction Formulas: (specification min - test result) / (specification min) = (% below specification min)

Top Spelter	(0.30 – 0.24) / 0.30	= 0.20
Bottom Spelter	(0.30 – 0.17) / 0.30	= 0.43
Bar Spelter	(0.28 – 0.23) / 0.28	= 0.18

Stay Spelter (0.28 – 0.22) / 0.28 = 0.21
(total % below specified min) / (number of elements) = (avg price reduction for sample quantity)
(0.20 + 0.43 + 0.18 + 0.21) / 4 = 0.255
(avg price reduction) x (invoice price / measurement unit) x (sample quantity) = (total price reduction)

Conduits and Pull Boxes
Standard Specification Section 616, Subsections 703.02.1 and 703.02.2

This section discusses plastic conduit flattening, galvanized rigid conduit and Preece test failures. Also discussed are wall and outside diameter thickness requirements. Promptly submit samples to prevent sunlight UV damage to plastic, and conduct steel conduit testing promptly to prevent galvanization damage. Collect samples during installation to ensure they represent installed material. Guidance for accepting these materials follows:

Plastic Conduit

The flattening test is a pass or fail test during which conduit is compressed to 40% of original volume, then checked for cracks large enough to allow moisture intrusion and diminished conduit strength. Failing conduit has usually been weakened by sunlight (UV radiation). Unless conduit is crushed, longevity is often unaffected. Reject UV damaged uninstalled conduit. Use engineering judgment to decide if installed material should remain in place. If conduit material strength is of primary importance, replace the conduit. Impose a deduction to conduit protecting other material which will serve its purpose over a reduced life. A 10% conduit bid price deduction or replacement is recommended.

Galvanized Rigid Steel Conduit

The Preece test is a pass or fail test identifying areas lacking galvanization. When dipped in solution, areas without proper galvanization precipitate copper. Inadequately galvanized conduit has a shorter design life, and if uninstalled should be rejected. Installed material may be left in place if structural strength is unrequired. If conduit protects other material, the material will serve its purpose, and replacement could be detrimental, impose a 10% bid price deduction or replace the conduit.
Outside diameter and wall thickness requirement failures shorten conduit life, diminish strength and must meet minimum requirements. Conduit requiring but lacking structural strength must be replaced. Conduit may be assessed a deduction when replacement could be detrimental, and it will still protect other materials over a reduced life. Use a price reduction proportional to thickness deficiency to account for reduced life and strength. Divide actual thickness by required thickness to calculate percent payment for each failure or whether replacement is necessary. Replace conduit that is too thin.

Example: Steel conduit wall thickness deduction for 6 mm EMT steel electric conduit:

- Measured outside diameter thickness (17.20 mm) divided by minimum required outside diameter (20.92) = 82% x bid price, or an 18% deduction.
- Measured wall thickness (1.01 mm) divided by minimum wall thickness requirement (2.31 mm) = 44% bid price payment, or a 56% deduction.

- Due to measured wall thickness < 50%, conduit should be removed. If engineering judgment indicates and the contractor can prove in writing the material will serve intended function over a reduced life, use a percentage deduction.

Example: 53 mm steel conduit (EMT) deduction

- Measured outside diameter thickness (55.67 mm) divided by minimum required outside diameter (60.285) = 92% bid price payment, or an 8% deduct.
- Measured wall thickness (1.67 mm) divided by the required minimum wall thickness (3.285 mm) = a 50% deduction. Replace the conduit. If engineering judgment indicates and the contractor can prove material will serve its purpose over a reduced life, use a percentage deduction. If conduit thickness fails markedly, the wrong conduit type may have been used. As per standard specification 703.02.02, steel conduit is tested according to ASTM A239.

Example: 21 mm EMT steel conduit has failed a Preece test and:

- Measured wall thickness (1.23 mm) divided by minimum required wall thickness (2.38 mm) = 52% bid price payment, or a 48% deduction.
- Because both indices failed, replace the conduit. If engineering judgment indicates and the contractor can prove the material will serve the intended purpose over a reduced life, use a percentage deduction.

Pavement Marking, Temporary Striping, Yellow & White Paint
Section 620, Standard Specifications

Identify specified paint products and related contract standard specifications and special provisions. Pavement markings with material properties 15% outside specified values require repainting at contractor expense. If the material serves the design purpose, apply a 50 % reduction to the contract unit price. Reduce the unit price 5% for each pavement marking property 0 -5% percent outside specification, 10% for each marking property 5 - 10% outside specification, and 15% for each marking property 10 -15% outside specification.

Geosynthetics, Geotextiles & Geomembranes
Sections 622 and 716, Standard Specifications

Apply price reductions to geosynthetic materials after using proper sampling procedures and promptly submitting samples for testing (subsections 622.02.2; source approval, and 622.02.3; sampling). Install geosynthetics after material testing and acceptance. The PM may contact the Geotechnical Section for assistance to find out whether a geosynthetic will serve primary strength and permeability functions. Project Managers have the following options to address material failure. Reject uninstalled material.

If material is installed, PM may replace the item if failure adversely affects riprap system primary function. If geotextile is damaged during installation but PM decides it will fulfill its primary function over a reduced life or value, impose a price reduction:

- divide the test result percentage by the test specification percentage requirement, and multiply ratio by the unit bid price to calculate the reduced unit price. Example: (test result of 34.9% divided by test specification of 40.9%) = 85.3%, so pay (0.853%) x (invoice price) for that lot.
- And multiple tests fail specification, sum the % deduction from failing tests up to 50%. ("Erosion Control Class III" has 8 different tests completed on one sample to determine material properties.) At ≥50% deduction, evaluate the item to determine if replacement is necessary.
- PM may choose to leave material in place. If material remains installed, a unit price reduction is assessed on a case specific basis. Review item failures with the geotechnical section.

Miscellaneous Materials and Dust Palliatives
Special Provision(s) and Subsection 713.03, Standard Specifications

Liquid calcium or magnesium chloride items are typically included as a special provision, and paid at the unit bid price for dust palliative. Check the contract to identify which material is used. Payment includes all costs to furnish, deliver, haul and apply liquid calcium or magnesium chloride.

Deduct five percent of the unit bid price for each percent (round to whole percent) calcium or magnesium content falls below the specified minimum. Five percent of the unit bid price is deducted for each percent sulfate content exceeds the maximum specified. The maximum sulfate requirement in magnesium chloride solution ensures the solution is applied easily and consistently, without clogging tanks or equipment. This item specification is especially important for MDT Maintenance. Specific gravity is a good indicator in deciding whether to accept dust palliative.

Example: magnesium chloride fails specification requirements.
If magnesium < specified minimum:

Apply a 5% reduction to the unit bid price for each 1% results show magnesium is below the minimum requirement:

- Bid price = $100/mt
- Minimum requirement = 30.5%
- Test Result = 29.7%
- 30.5% – 29.7% = 0.8% = 1 when rounded
- 1 x 0.05 x bid price $100/mt = $5/mt deduction
- $100 – 5 = $95 x (metric tons represented by sample)
- If sulfate > maximum requirement,
  Apply a 5% unit bid price reduction for each 1% results show sulfate is above the maximum limit. Use the method above to calculate the deduction.

Wood Fiber Mulch Standard
Specification Subsection 713.10

"Mulch" contains mulch and compost. Refer to seeding special provisions for mulch requirements. Sample results indicate 20% moisture, although 15% is the allowed maximum. Excess mulch water indicates insufficient mulch was applied because some mulch was replaced by water, as mulch is applied as weight/area (kg/Ha or lbs/ac). Calculate the moisture weight above the maximum limit (5%), then multiply this weight by the unit mulch price to calculate the price deduction.

Example: Mulch deduction

Bid Price: $2740/Ha includes:
2200 kg Mulch / Ha
1100 kg Compost / Ha

Costs: Mulch $8.50/bag (18.7kg)
Compost $3.40/bag (18.7kg)

- Mulch has 20% moisture. Maximum allowed shown in Table 713-5 is 12%, +/- 3% or 15%.
- 2200kg @ 15% moisture = 1870kg mulch and 330kg water
- 2200kg @ 20% moisture = 1760kg mulch and 440kg water

Results:

- 110kg / Ha less mulch than required.
- 8.50 / (8.50 + 3.40) = 71.4% of cost is mulch
- 110 / 2200 = 0.05 unplaced mulch
- 0.05 x 0.714 = .036 cost unplaced mulch
- 0.036 x 2740 = $98.64/Hadeduction per Ha
- $98.64 x 4.759 Ha = $469.43 ➔ $469 total deduction

Materials Acceptance and Rejection

Per Section 3.1 of MT-503 “Samples and Certifications”, every item used must be sampled and accepted before incorporation into the work, unless acceptance can be made using manufacturer certification, field tests, field inspection reports or the QPL.

The Project Manager, DMS, Area Lab Supervisor or Materials Bureau must identify methods used to accept or reject materials. MDT evaluates sample test results and construction products to determine if work and materials conform to Standard Specification requirements.

If an obvious defect is observed, Inspectors notify the Project Manager, who notifies a Contractor representative. Take a sample or test to document the defect. When Inspectors and Contractors agree, test records are not essential. Recommended practice is to acquire and retain defect test records in case of disagreement. Inspectors should note defects within the DWR, and inform Project Managers of discussions, defects, and corrective action(s) taken. If a material defect exists, Contractors should submit a corrective action plan before the material is installed.

Do not reveal failing tests to Contractors. Inspectors should provide test results and let Contractors know if material does not meet specification requirements, and let Contractors initiate corrective action.

Project Managers may allow some material incorporation into the work prior to acceptance pursuant to Standard Specification Subsection 106.01.2 Test results for oil product sampling involving asphalt cements, emulsified asphalts, and pavement marking paints may be unavailable before work is completed. In such cases, these products may be accepted with a price reduction applied if results fail.

Non-QA Contract Items

Standard Specification Subsection 105.03.1 applies to items uncovered by QA. Project Managers decide if work or materials meet contract requirements. If not, Project Managers must determine if work serves the design purpose, or if work must be redone at Contractor expense. Completed work or material may be accepted with a price adjustment if it serves the design purpose.

The CES Bureau has prepared miscellaneous deduction guidance (pages 83-98 above) to assist construction field staff implement Standard Specification Subsection 105.03.1. This information helps Project Managers and field crews understand and calculate deductions for miscellaneous work items not meeting contract requirements but still serving the design purpose. The guide contains correspondence, examples and notes using past deduction methods, but does not supersede or replace contract specifications or special provisions, and does not preempt Project Manager decision authority or engineering judgement.

Project Managers may assess deductions by estimating reduced service life, or referring to the Miscellaneous Deduction Help Guide. Project Managers prepare project documentation, and enter a line item adjustment for the deduction on the estimate. Non-QA items include glass beads, fencing items and cement. Project Managers use project memos to document miscellaneous pay adjustments or reductions to a non-QA item.

Quality Assurance Subsection

105.03.2 Standard Specifications

Quality assurance sampling and testing determines if work and materials conform to Standard Specification Subsection 105.03.2, for which QA tolerances are specified. Acceptance is granted using statistically based formulas to evaluate test result data. MDT uses QA formulas to identify acceptable products, and whether an incentive payment or price reduction is applied. MDT field staff should use Standard Specifications to be aware of QA items and apply QA specifications. MDT personnel must be WAQTC certified to sample and test materials accepted via QA.

QA Contract Items

Standard Specifications Subsection 105.03.2 outlines QA tested items and procedures. MDT evaluates the following items for acceptance under QA provisions:

Plant Mix Bituminous Surfacing

- Aggregate gradation (Special Provisions, Subsections 401.03.1(C), 401.03.3(B) (C) and 701.03.2)
- Density and Compaction (Special Provisions and Subsection 401.03.12)
- Volumetric acceptance (Special Provisions)
- Fracture (Subsection 401.03.3.C.1 and 701.03.1)

Plant Mix Seal (Special Provisions)

Vacant

Aggregate Surfacing

Includes base, top, selected and sand surfacing and cover material (Subsections 301.03.1 and 701.02, and Special Provisions).

Concrete Pavement Aggregate

- Gradation (Subsections 701.01.1 and 701.01.2)
- Fineness modulus (Subsection 701.01.1.F)

Ride Specification for Flexible Pavement

Performance Graded Asphalt Binder (PGAB)

- High and low temperature components (Subsection 402.03.8)
- Ductility (Subsection 402.03.8)

Quality Control

Inspectors should understand the difference between QC and QA. QC is a method to control manufactured product quality, and may be statistically based. During MDT construction projects, QC is Contractor responsibility intended to identify and address deficient materials before incorporation into the work. Contractors choose the methods to express test data, and monitor product production. MDT suggests but does not require Contractors to use a statistical quality control method.

Inspectors are not responsible for Contractor quality control sampling or testing decisions. Inspectors observing questionable methods or material defect should inform Project Managers, document information within the DWR, and discuss the issue with the Contractor. Contractors commonly use QA test results as their own QC before making changes, but the QA process should not be considered a substitute for Contractor QC procedures. MDT is required to make test results available to Contractors, but not to make a special effort to do so.

Incentives

Quality incentives encourage higher quality projects and materials by rewarding Contractors for better quality material and workmanship than required.

Disincentives

Quality disincentives are not Contractor punishment, but compensation to the Department for decreased service life or performance. Contractors usually make operational changes to ensure subsequent test results meet contract requirements. Project Managers should document Contractor actions and offsite testing before the next work day. Test results failing to meet specified contract compliance values may require work suspension until corrective action is taken.

At Contractor request, MDT may consider leaving material in place and applying an item deduction. A Contractor written request to leave material in place as well as documentation explaining why material will be left in place should be recorded. A contract change order accepting uncompliant material is not required in this case, as standard specifications provide acceptance criteria. A change order may be used if more formal documentation is needed.

Quality Assurance Definitions

Definitions applying to the QA process (not to be confused with the QA Suite program) are:

Random Sampling is mandatory for QA tested items. Sampling sequences within each lot must be selected for each QA item, and sampled according to random location or lot number. Random number generators determine sample amount and station location. MDT personnel must not reveal this information to Contractors.

Test Method.

Specifications identify test methods for each QA item. The MDT Materials Manual lists needed equipment and testing procedures.

Lots

QA item amounts are evaluated in lots, or a quantity of continuous production, which may include more than one shift. Materials Manual MT-601 lists required lot size and testing frequency within an item lot.

Acceptance Tests

QA samples and tests are referred to as “acceptance tests”. Acceptance samples are taken according to random sampling sequences. MDT must test according to procedure, and evaluate tests when a lot is completed. MDT issues QA volumetric final acceptance after plant mix production is complete and final targets have been set. MDT evaluates volumetric lots during production under initial targets. Initial evaluation results may change after final targets are set, and final incentive or disincentive has been calculated.

Tests Outside Tolerance

If one or more sub-lot tests is out of tolerance, MDT must evaluate the lot for reasonable conformity. A form is set up for most QA items. The QA volumetric program searches for outlier test results, statistically analyzes volumetric samples, and notes outliers as test results not falling within the range of remaining tests. Inspectors verify sample and testing validity, and numerical test inputs. Project Managers and District Material Supervisors then exclude outliers from QA Incentive calculations. Inspectors should complete, check and distribute test results as work progresses. Project Managers should ensure QA results are promptly checked, signed, and distributed.

Quality Assurance Procedures

Project Managers or Lab Supervisors promptly enter QA item samples and test information into the QA Suite computer program. Do not stockpile samples for later testing. Density acceptance core samples don't need to wait 24 hours, but are "dried to a constant mass" (MDT Materials Manual MT-314).

Verify QA data, and contact ISD or the Specifications Engineer with QA Suite questions. Enter data when lot testing is completed, and share results with the Contractor. When consultants conduct material testing, forward results to the Contractor. Project Managers must inform Contractors of failing tests and provide test results for inspection, but Contractors themselves must ascertain corrective action. Retain test results within project files.

Inferior material may be incorporated if MDT is testing is slow, or if Contractors rely on Departmental QA data for QC. Project Managers or Lab Supervisors should promptly provide QA test results so Contractors can take corrective action. QA testing and evaluation should occur no later than subsequent lot placement, unless delay is caused by the Contractor or beyond Departmental control.

QA data entry process:

Only one project crew or lab member enters contract material specifications into the QA Suite. Review the contract to verify the hierarchy of importance (Special Provisions→ Supplemental Specifications→ Standard Specifications), ensure correct material specification numbers are used, and mark "Edit Complete" for each material and specification. A different worker checks material specification entries, and locks the specifications and materials. The District Office then finally checks QA material specification entries regarding:

- Incentive sieves
- "F" factors
- Gradation table correspondence and correct gradation ranges
- Compaction incentive ranges
- Contract and base price
- Final adjusted lot tonnage in relation to use quantities
- Aggregate fracture

Project Managers perform a final material specifications check. If corrections are required, the material or specification is unlocked for changes, and relocked. Contractors should never access MDT computers or visit MDT offices or laboratories without MDT personnel present. Contractors requesting completed test information should be provided a disc copy.

MDT seeks to avoid unbalanced bids, which reduce Contractor exposure to item price reductions under QA evaluation.

Requirements Common to Quality Assurance Testing

Random sampling is mandatory for QA items, and used for mechanical testing and field density testing. MDT uses stratified random sampling by dividing each lot into three to seven sublots, from which samples are randomly selected to ensure each lot portion has an equal chance of selection. The QA Suite generates random numbers. If a seed number is required, separate seed numbers must be used for each lot to avoid generating the same random number sequence. MDT Materials Manual MT-416 describes random sample selection using random number tables.

- Inspectors initially select lot sampling sequences. Do not share this information with Contractors. Retain the original hard copy random sample selection numbers with notes for that item in the project file. Sample according to the random sequence. Do not wait for Contractors to make adjustments, or adjust sample timing as a convenience to MDT or Contractor. Project Managers may always take additional samples to identify defective materials. Do not mark random sample locations or mark roadway compaction/density testing locations before sampling. Contractors must have completed work within the area before Inspectors mark sample locations using construction staking.
- To ensure statistically valid QA evaluation, MDT must witness Contractor collected samples at random intervals. Contractor failure collect to samples at required intervals is cause to stop work. Contractors must collect samples in accordance with approved techniques. Contractors not using proper sampling technique assume full responsibility for the sampling method.
- If samples are unsafely taken, MDT will notify the Contractor to stop production until safety is addressed, and samples are taken safely at proper intervals. Although Project Managers have authority to impose corrective action, Project Managers should not advise contrary to local, State or Federal safety regulation. Contractors are responsible for safety compliance, and a written plan should be submitted by the Contractor to ensure safety. Verify the plan is followed, and document subsequent action.

Lots

QA item quantities are segregated into lots, or material quantities produced by the same process. The specification for each QA item defines the lot material quantity. Lots are segregated into sublots, and each sublot is represented by a sample to avoid closely spaced samples. Minimum and maximum sublot numbers are listed within individual material specifications (Standard Specification Subsection 401.03.3, MDT Materials Manual MT-601).

Acceptance Tests

QA samples represent sublots, within which MDT tests each sample for acceptance. Acceptance samples must be taken according to random sampling sequence. Contractors operate sampling devices on Contractor equipment, take roadway samples after lay down, or obtain a composite sample at the production location. Contractors are required to provide proper sample size. Inspectors must witness sampling and splitting, for which MDT conducts tests according to specified procedure.

MDT evaluates test results for complete lots, and evaluates lot quality to determine if contract requirements are met. Federal regulations require agency personnel to conduct Independent Assurance sampling and testing, as conducted by the Materials Bureau and/or District/Area Labs. MDT tests Independent Assurance samples to check results obtained during acceptance sampling and testing.

Formulas Evaluation

When test results fall outside tolerance limits, MDT evaluates the lot element for Standard Specification Subsection 105.03.2 and special provision conformance, and proper formula selection. Be sure to use the correct formula. Formula 1 within Standard Specification Subsection 105.03.2 is only used if a maximum limit is specified, or the average test value is above specification midpoint or job mix target value. Formula 2 is used if a minimum limit is specified, or a test value average is below the specification midpoint or job mix target value.

"F" factors are listed within the Standard Specifications, Supplemental Specifications or special provisions. The QA Suite produces a form for each QA item, which should be checked and provided to the Contractor at lot completion. Project Managers use the QA Suite to enter, evaluate and administer QA data. Use the latest QA version, and verify correct material specifications have been entered.

Quality Disincentives

MDT applies disincentives when "P" value is three or more to compensate the Department for decreased service life due to inferior quality. Contractors may not accept a price reduction in lieu of producing specified material.

After entering test results into the QA Suite, a second person approves test data and locks access to it. The QA Suite calculates a deduction and determines whether material is to be removed. Project Managers should not apply deductions until all item work is complete so incentives and disincentives are reflected on monthly progress estimates.

Project Managers should keep Contractors informed of incentives and disincentives when information becomes available, and remind Contractors that incentive and disincentive values may change.

Halting Production

Specifications require Contractors to halt production and make adjustments to comply with specifications when three consecutive lots have a "P" value of five or more, or beginning with the second lot, three tests within any lot have an element outside specification criteria, and total lot "P" value is five or more.

QA Suite will indicate these conditions and whether a Contractor must halt production. Project Managers should inform Contractors that consecutive testing indicates defective material. Contractors must adjust material production to meet specification, but MDT does not instruct Contractors about how to make corrections. The QA process allows Contractors to make adjustments easily, and MDT field personnel may provide courtesy testing if time is available. Contractors must supply quality materials and have a QC program in place.

Project Managers are allowed discretion in deciding whether adequate adjustments have been made to continue production. One passing test is not evidence an adequate adjustment has been made. Consecutive test series evaluated according to specification and showing a “P” value less than three are in conformance with aggregate gradation, compaction and volumetric properties. Project Managers issue a “halt production order” to the Contractor as soon as the lot is evaluated and computations are checked. Halting production orders do not apply to asphalt cements due to delays in obtaining test results. Without compelling reasons to do so, MDT does not test stockpiled material before incorporation into permanent work.

Multiple “P” Values

Some QA work items are tested for several properties using a single sample. Specifications require each sieve be evaluated separately, as multiple sieves may not comply with specification within a single sample. “P” value is calculated for each failing specified sieve. Positive “P” values are added to obtain lot “P” values. Negative “P” values are disregarded.

Contact the DCE if a lot “P” value is 25 or more. MDT must evaluate every test in the lot to determine if material should be removed.

Quality Incentives

MDT applies quality incentives to plant mix surfacing density and ride measurement. Incentives share savings with Contractors for increased service life due to high quality work, and encourage Contractors to apply new methods to improve quality and produce a uniform product satisfying job mix densities and targets. MDT also uses quality incentives to offset price reductions.

Progress Estimates

Project Managers enter incentives and disincentives into Site Manager or AASHTOware for progress estimate inclusion when work items are completed. Record incentives and disincentives in the same category as placed quantity for QA items.

QA Suite Files

Transfer electronic QA computer data to Helena headquarters daily, and at least weekly. When a work item is complete, create a corresponding QA item sample record in Site Manager. The sample type is entered “See QA Suite for Results”. Acceptance method is entered as “Test Results.” No test data for the sample indicates QA data has been entered, checked, submitted to Helena, and incentives or disincentives applied to the estimate.

Flexible Pavement Ride Specification

The ride specification quantifies MDT surface tolerances for QA program entry. See Standard Specifications Subsection 401.03.14. “Ride” is a value used to evaluate surface tolerances. Ride specifications provide Contractors an incentive to deliver a smooth surface with increased longevity, and share cost savings with Contractors to recover reduced service life costs. Ride specification and testing equipment simulate the “ride” experienced by a person in an “average” vehicle. Luxury car occupants perceive ride differently than ¾-ton pickup occupants because suspension systems vary. Ride quality and pavement compaction are related, but compaction should not be sacrificed for ride quality.

The International Roughness Index (IRI) is a numerical value representing ride and surface smoothness experienced by the "average" vehicle. Lower IRI numbers indicate smoother ride.

Road surface profiles (PI models) locate and measure roadway dips, bumps, and areas requiring corrective action, but may not indicate irregularities greater than 25 feet. Standard Specification Subsection 401.03.14 describes defect measurement and correction. MDT uses the QA Suite to calculate QA incentives and disincentives associated with the ride specification.

Special Situations

"Bad" Samples and Tests

- Contractors may contend failing samples are "unrepresentative", or the tester has performed the test correctly. Inspectors should emphasize all samples are randomly selected, so any material portion has an equal probability of being sampled. Contractors must provide aggregate and asphalt sampling equipment, and benefit by providing quality sampling devices. MDT performs sample testing.
- Contractors must control production and provide specified material. Some Contractors conduct QC testing while MDT conducts QA testing. Contractors often obtain different test results due to construction variability, which includes sampling, testing, production and material variability, all of which are expected and accounted for by defined tolerances. Retain aggregate samples until shift end or until results are checked. MDT uses QA test results for material acceptance. Verification samples are not taken under QA.
- Inspectors may encounter:
  1) nuclear gauge readings indicating subgrade meets density (non-QA item) requirements, but visibly deflects under equipment loading (Standard Specifications Subsection 105.03.2).
  2) Weak embankment, with rutting and shoving.
- Testing is not exact, and has a corresponding tolerance. QA tests not meeting requirements are failing tests. Tests must be completed in accordance with the Materials Manual. District Labs audit field personnel standard practice conformance using independent quality assurance testing.
- QA tests serve as acceptance tests. FHWA requires QA sampling and testing frequency as stipulated by project contracts. FHWA payment often depends upon QA tests taken at this frequency. Conducting multiple tests to obtain a passing test is unacceptable.
- MDT project personnel must abide by Standard Specification Sections 105.09 and 105.10 governing the authority and duties of Project Managers and Inspectors. Project Managers or Inspectors observing a failing test or defective roadway section must reject such materials or products until corrective action is taken to meet specification. Inspectors noting deficiencies should document findings and notify the Project Manager, who must inform the Contractor of needed changes, and require the Contractor submit a corrective plan.

Obviously Defective Material

Visibly defective material may not be selected for QA sampling. Inspectors and Project Managers must isolate and reject obviously defective material, regardless of location within a lot or sampling sequence. Rejected material should undergo sampling and testing, with repairs meeting specifications. Project Managers may request samples at any location if material is suspect, but these tests are not included in QA, and only used to identify “obviously defective” material.

Repairs and Corrections

Do not allow contractors to repair areas producing failing tests, as often happens in cases of poor compaction. A lot is comprised by all tests, and MDT uses all sublot tests to evaluate lot quality. If a price reduction is to be prevented, the entire lot, not just the area around a failing test, must meet specification. To ensure the entire lot meets specification after repair, MDT must select new random sample locations. If a test is rejected, the entire lot is not represented, rendering the lot evaluation invalid.

Removal and Replacement

Project Managers may require material subject to QA to be removed and replaced if “P” value is or exceeds 25. Leaving substandard material in place risks early failure, while removal and replacement increases Contractor cost. Project Managers should include the DCE and staff in the decision to remove material. Use sublot tests and other information to determine lot quality. If warranted, conduct additional testing, and examine design parameters. If evidence indicates premature failure risk, material should be removed. MDT can only waive QA requirements using a change order. Do not use a standard deduction.

Work Related to Quality Assurance

Plant mix volume swell is not QA tested, but MDT tests for acceptance when a material source is tested for approval. MDT considers results acceptable if the test average is within specification limits, and no more than one out of any five consecutive tests is outside specified limits. Material sources must be approved before plant mix operations begin. Samples may be taken from a production belt by the Contractor and witnessed by MDT personnel. Contractors must furnish blended material percentages, and samples should be blended to these percentages. If a Contractor does not furnish blended percentages, MDT cannot test samples for aggregate acceptance.

Asphalt content significantly effects plant mix surfacing, and is determined over a set time period by measuring the asphalt used per unit mix amount. Significant void, stability or volumetric property changes legitimate further testing. Materials are subject to Standard Specification Subsection 105.03.1 requirements, and MDT applies a price adjustment if the material will not serve the design purpose. Such material must be replaced at no cost to the Department.

Volume swell and plasticity index elements are not covered by QA. Only ductility temperature components are covered under QA. Although other properties such as viscosity are non-QA MDT does sample, test, and evaluate non-QA items in accordance with the MDT Materials Manual and individual specification.

Numerical Rounding

Aggregate Gradation

Record aggregate weight retained on each sieve to the smallest scale graduation. Record the percent passing each sieve size as follows:

- For sieves larger than the 200 mesh, record percent passing to the tenth of a percent, and lot average to the nearest 1%.
- For the 200 mesh sieve, record percent passing to the hundredth of a percent, and lot average to the tenth of a percent.

Compaction

For plant mix density inputs, calculate percent of target density and round as follows:

- 106: Density (lbs/ft^{3}or kg/m^3): 0.1
- 107: Rice density: 0.001

“P” Values

Round individual “P” values to two places and “P” value totals to one place.

Concrete Cylinders

Round individual concrete tests and lot averages to the nearest 10 psi (1 MPa)

Ride Specification

When performing ride pay factor calculations using 32-bit floating-point double-precision method, round the second term to three places before subtracting from the first. Round “P” value to two places.

Volumetric Rounding

108: Voids – Bricks: 0.01
Sublot: 0.1
Lot: 0.1
109: D/A – Sublot: 0.1
Lot: 0.1
110: VFA – Bricks: 0.1
Sublot: 1
Lot: 1
111: VMA – Bricks: 0.01
Sublot: 0.1
Lot: 0.1

Contractor Submittal Table
Subsection 105.03.4, Standard Specifications

Contractors must provide deliverables listed within the “Table of Contractor Submittals” to the Project Manager. Contractors failing to make required submissions are in breach of contract even if MDT fails to identify the omission. MDT is not responsible for checking every dimension and item within Contractor submittals.

- Project Managers use the “EPM Log of Table of Contractor Submittals” to track Contractor signing, roadway and bridge special provision submittals, and when a Contractor plans work item construction or fabrication.

Coordination of Contract Provisions
Subsection 105.04 Standard Specifications

Contractor Cooperation
Subsection 105.05 Standard Specifications

Contractors are required to have an authorized, supervisory level representative on the project at all times, and must provide written notification to the Project Manager identifying the supervisory representative before starting work. This notification usually occurs at the preconstruction conference. The Contractor must provide written notice 24 hours prior to changing supervisory representatives. If the Contractor representative fails to maintain the ability to be contacted in a timely manner, contract time may be charged.

Contractor Cooperation Subsection
105.05 Standard Specifications

Montana law allows utilities within MDT ROW, but utility conflicts can be costly to the Department. Project Managers should monitor and document Contractor with utility company coordination, and monitor Contractor schedules to ensure the schedule accounts for utility issues. Project Managers should involve the Utilities Section to coordinate work and agreement preparation with utility and railroad companies.

Standard Specifications Subsection 105.06 addresses planned utility work when conflicting utilities are relocated by the utility company. The Department prefers to relocate utilities in conflict with construction before the contract is awarded. Utilities conflicting with construction are adjusted or relocated via Owners using their own resources or private contract, or by the Department under a separate contract before construction or by inclusion as a contract item.

Occasionally, utility work does conflict with project work. The Department attempts to accurately represent existing utilities to bidders. If a utility is not located before construction, Contractors must contact the utility to schedule utility relocation, which must take place within the ROW and within construction limits.

Utility discovery may constitute a “differing site condition” or qualify as “extra work”. The Department handles utility discovery according to Standard Specification Subsections 104.02.1 and 104.03. These determinations often require a cost adjustment, and warrant contract time adjustment if critical activities are affected. If critical path items are delayed by utility conflicts, Contractors may be entitled to a time extension, but not monetary compensation.

Cooperation Between Contractors
Subsection 105.07 Standard Specifications

Standard Specifications apply when multiple Contractors work concurrently on the same project, or contractors work on tied projects. When Contractor access is restricted, or work is performed out of sequence, Contractors may attribute difficulties to an adjacent Contractor. In these cases, PMs often schedule coordination meetings to avoid conflicts, resolve issues and ensure Contractor cooperation.

Construction Stakes, Lines, and Grades
Standard Specification Subsection 105.08, survey guidance to field personnel

Construction surveys verify horizontal and vertical control points established during initial preconstruction surveys, or may include measurements to verify or determine payment quantities. Construction staking establishes line and grade control, delineates work areas, and serves as a basis to verify completed work locations and quantities. Normally, MDT provides essential controls for establishing lines and grades, and the Contractor sets supplemental stakes for their own convenience, method of operation or equipment. In some cases as with large structures, Contractors may set most control points. Construction survey duties may include:

- Stake centerline
- Check, set or reestablish bench marks
- Check plans, grades and calculations
- Revise grade
- Stake culverts and check culvert length
- Slope stake for earthwork
- Layout sidewalk, curb, and gutter
- Layout interchange, ramp, and frontage roads
- Check finished subgrade and surfacing grade

Lead workers must inform Project Managers of survey activities. Projects requiring contractors to perform all or partial staking, are usually subject to staking special provisions, or Subsection 105.08.2 requirements. Districts may include Contractor staking within the contract for various reasons, but staking is usually included within the contract when field crews are unavailable to carry out staking. In these cases staking is a contactor bid item, so inspectors should verify work is performed as directed by the contract. Project Managers may deduct earnings from the Contractor Staking lump sum for noncompliance.

MDT construction surveying procedures and features

Equipment

MDT robotic total stations and GPS instruments must receive regular maintenance to function correctly.

Contractor Staking Coordination

Staking is critical when Contractors use modern, high production equipment and methods. Detailed planning and cooperation with the Contractor ensure that staking begins as soon as possible before construction as weather and soil conditions permit. Project Managers should consult with Contractors as soon as possible after award to coordinate staking. Coordination discussions may be held before the preconstruction conference, in which case staking plans should be confirmed at the conference. Contract documents may require Contractors to maintain an updated work schedule so work force and equipment needs can be anticipated to ensure timely staking. Contractors must notify (via Form CSB105_08_1) Project Managers of staking needs (such as elevation checks) to allow timely staking and efficient personnel usage. Project Managers should establish such protocol at the preconstruction conference.

Monuments

Contract documents or ROW agreements may specify existing monument preservation, reference or recordation. If these tasks are Contractor responsibility, the Project Manager, Contractor and Contractor land surveyor must coordinate with the District Land Surveyor prior to monument destruction or perpetuation. Project Managers must coordinate with District Land Surveyors in advance if monument preservation or recordation is MDT responsibility. Survey monuments and control points disturbed during construction must be reset by MDT District Land Surveyors.

Earthwork Quantities

Project Managers must plan and perform preliminary work to permit cross section calculations and analysis, by collecting data at intervals representing terrain. Topographic elevations or distance measurements must be taken at locations to reflect earth removal quantities, as cross sections ultimately determine earthwork pay quantities. DTM Delta surfaces may be used to calculate topsoil, stockpile, and borrow source quantities.

Lines and Grades

Unless otherwise stipulated, Departmental survey crews set construction stakes, establish lines, slopes, continuous profile grade and all construction survey features. Project Managers furnish Contractors with necessary survey data. Contractors must preserve survey stakes. Project Managers should discuss construction stake preservation at the preconstruction conference. Stake replacement and associated work delays are Contractor responsibility. MDT may deduct stake replacement costs from construction payments if continual, willful or careless destruction by the Contractor continues.

Contractor Staking Checks

If Contractor staking is contract specified, the Department may inspect and randomly check layout and control work, and may require work to be redone. Contractors must secure work dimensions, lines, grades and elevations. Departmental inspection does not relieve Contractors of any contract responsibility. Compensation is not allowed for corrective work. Project Managers must ensure Contractors submit notes and other data according to the contract. Contractors are required to check and rework sections if work is not within specified tolerance. Payment should be withheld until the section is rechecked and within tolerance.

Contractor Survey Equipment Usage

Contractors may use GPS machine grade control, but Project Managers should independently recalculate line and grade. Federal regulation directs MDT not to use Contractor tests or measurements for payment determination, so measurements must be obtained by MDT personnel using Department furnished survey instruments.

Design Error Reporting

Project Managers identifying design errors affecting line and grade should contact the MDT Design or Consultant Project Manager. Design Consultant Project Managers must provide explanation, resolve errors and notify Contractors as soon as possible.

Survey Tolerances and Inspection

MDT field construction staff must check Contractor line and grade, and items listed within Standard Specification Subsection 105.08.5 before accepting work.

Bridge Survey
Subsection 105.08.2, Standard Specifications

Bridge layout and engineering control requires precision unnecessary for most other highway construction. Use bridge construction survey equipment capable of delivering required accuracy and precision. Corrections to span length, pile location, column length and cap elevation errors are costly, and often lead to cost responsibility and claim disagreements.

Contractor Responsibilities

Standard Specification Subsection 105.08.2 governs contractual requirements for Contractor bridge survey work. MDT establishes control points defining roadway and bridge centerline, and elevation control. Contractors complete remaining layout to identify excavation, piling, cofferdam, foundation and other structural element locations in accordance with MDT survey control points

Department Responsibilities

Bridge staking methods provide an independent check of structural element layout, and reduce delays and expense due to improperly located structural elements. Staking methods also aid in monitoring field engineering costs. MDT marks centerline with clearly identified points near each planned structure. These points augment primary survey controls typically established for references. MDT establishes centerline points so Contractors can layout remaining work.

Bridge Construction Survey Procedures

- Check Plan Dimensions before staking. Verify slab, girder, shoe, crossbeam, column and footing elevations.
- Check Span Lengths and Skew Angles**.**
- Review Roadway Plans for construction features affecting structural layout and reference locations, including special embankment requirements.
- Check Alignment and Stationing as staked in the field. Ensure staked lines and stations match the plans.
- Check Alignment and Stationing as staked in the field. Ensure staked lines and stations match the plans.
- Plan Layout and Referencing to control work with required accuracy. Establish point references to serve the intended purpose as long as required. Use readily accessible locations and secure them from construction impact. Place references where all portions of the substructure are visible.
- Perform Layout Referencing and Field Checking. Complete the layout referencing and field check primary horizontal and vertical control before construction work begins on any structure.

Bridge Inspection Elements

- Contractors are responsible for bridge layout, but construction staff should field check Contractor line and grade layout items and stages listed within Table 105-1 prior to work completion. Project Managers should encourage frequent bridge construction checks. Compare column height to approach fills and other bents. Taping between bents can reveal layout problems and prevent costly extra work.
- Verification checks are a good idea before reinforcement placement, when mistakes could require reinforcement adjustment or additional excavation. Additional verification checks do not substitute for mandatory verification checks described above, or substitute for Contractor layout responsibility.
- Do not allow bridge element work to continue without required verification checks.

TABLE 0-1
BRIDGE CONSTRUCTION

Unit	Type Verification	Verification Location	Frequency	Timing
Bents	Location	Center	Each Span	Prior to Excavation or Forming
Cofferdam	Location and Elevation	Center and Corners	Each Cofferdam	Prior to Driving Sheet Pile and After Ring is Set
Piling	Location	Pile Center	Each Pile	Prior to Driving
Piling	Elevation	Existing and Cutoff Elevation	Each Pile	Prior to Cutoff
Drilled Shafts	Location	Shaft Center	Each Shaft	Prior to Excavation
Drilled Shafts	Elevation	Top of Shaft	Each Shaft	Prior to Starting Cap
Footings	Location	Footing Center	Each Footing	Prior to Starting Excavation
Footings	Elevation	Corners	Each Footing	Prior to Starting Excavation
Embedded Items	Location and Elevation	Center	Each Item	Prior to Placing Concrete
Columns	Location and Elevation	Footing & Column Top	Each Column	Prior to Placing Forms, Steel and Concrete
Bent Caps	Elevation	Corners	Each Bent Cap	Prior to Placing Concrete
Beam Seats	Leveling	Corners and Mid-Point	Each Seat	Prior to Setting Beams
Structural Steel Splices	Elevation	At Splice	Each Splice	Before Start of Deck Forming

Unit	Type Verification	Verification Location	Frequency	Timing
Tenth-Points	Elevation	Each 10th Point	Each Beam or Girder	Before Start of Deck Forming

TABLE 0-2
BRIDGE CONSTRUCTION
(cont)

Project Manager Authority and Duties
Subsection 105.09, Standard Specifications

As Chief Inspectors, Project Managers address questions regarding material acceptability, completed work, plan and specification interpretation, and represent the Department at the project. Project Managers administer and oversee construction contracts to ensure projects are built to contract and Department requirements, and may suspend or reject noncompliant work. Administrative responsibilities include routine construction contracting management, such as recording work progress, Contractor payments, documenting changes, and State and Federal regulatory compliance.

Project Managers exercise authority through Contractor superintendents or designated representatives, but should not direct workers external to MDT. Project Managers may offer suggestions to Contractors in lieu of uncompliant work, but not directives. Verbal and written communication with Contractors is vital during construction. Verbal orders should accompany written documentation. Project Managers must not make unauthorized commitments, promises, demands or instructions, either in writing or verbally outside the scope of plans, specifications and special provisions.

If a request is made to discharge a Contractor employee (Subsection 108.05 Standard Specifications), Project Managers should first discuss discharge with the Contractor superintendent and the DCE, document discussion, then issue written instruction for employee dismissal.

Project Manager oversight responsibilities include construction activity observation, material sampling and testing, contract document interpretation, contract requirement measurement, and construction cost and time management. Other responsibilities include:

- Creating and maintaining trust and teamwork to maintain positive relations with field personnel, MDT and Contractor staff, outside agencies, private citizens and involved parties.
- Administering projects efficiently, effectively and in accordance with MDT policy. Trained personnel must provide required inspection, sampling, testing and documentation.
- Major project related issue involvement, inspect projects often, and review work item progress.
- Ensuring design is compatible with project site conditions.
- Communicating promptly and accurately to manage project information.
- Ensuring Department policy and procedure are followed during contract administration. Highway projects may be complicated by design or site condition changes. Project Managers must guide Department personnel and Contractors through project complications.

Project Managers should avoid unilateral decisions affecting project scope, schedule or cost, as Project Managers are part of a project management team. Project management applies to project development and design through construction and maintenance. Project Managers may consult CES Reviewers, Construction Engineers, CAS Engineers, Materials Engineers, Environmental personnel, Design Project Managers, the Claims Assistance Team, or the FHWA Field Operations Engineer.

Inspector Authority and Duty
Subsection 105.10, Standard Specifications

Field Inspectors should observe work but avoid giving specific instruction regarding operations, equipment, or construction methods. If instructions are given and work quality subsequently becomes deficient, MDT may be liable. However, Inspectors should ensure the Department receives work as required by the contract. Discuss uncompliant work with the Contractor for corrective action. Document conversations in writing within the DWR. If deficiencies are not addressed by the Contractor promptly or with a correction plan, Inspectors should inform Project Manager and Contractor superintendent. Project Managers may also issue a written order instructing the Contractor to bring deficient work into compliance with specification. Inspectors should issue judgments accurately and fairly. Field Inspectors must document Contractor work within Daily Work Reports, and report to the Project Manager. Information reported to Project Managers may include Contractor inquiries, specification interpretation, or plan and quantity concerns.

Work Inspection
Subsection 105.11, Standard Specifications

Contractor work and site activities must conform to contract documents. Plans and specifications describe required work, materials, workmanship and construction procedures. Plans illustrate project features, while specifications stipulate materials and workmanship. Contractor work must conform with the contract. Inspection duties include:

- Observing and measuring Contractor workmanship, materials and methods for contract compliance.
- Communicating with Contractor superintendent about work requirements.
- Assist Contractors in interpreting plans and specifications.
- Documenting inspection observations and measurements including labor, equipment and material usage tracking.
- Measuring work for payment.
- Observing construction for safety regulation compliance, traffic control requirements, and construction related government regulations pertaining to air quality, noise, erosion control, equipment licensing, and federal aid requirements. Project Managers may decide if corrective action is appropriate, but should make decisions consistent with local, State and Federal regulation. Contractors must comply with all safety, environmental and federal aid requirements.

Inspectors are not required to inspect items until completion, but the Department encourages Inspectors to inspect work in progress to help Contractors avoid repeat work and work suspension. Notify Contractors of noncompliant work upon identification.

Example:

reinforcing steel inspection for a bridge deck can occur once rebar has been installed and tied. However, if an error in bar spacing is identified in the bottom mat, considerable time and effort must be expended to correct the problem. Periodic rebar inspection could prevent this problem. Contractors should notify inspectors if continuing work will prevent further inspection and testing. Contractors should notify MDT when concrete pouring is scheduled to enable MDT to inspect rebar clearance. Inspectors should assist Contractors in reviewing contract documents to ensure work meets Department standards the first time, and to avoid repeat work, contract disputes, delays, confrontations and risk.

Unacceptable and Unauthorized Work Removal
Subsection 105.12, Standard Specifications

Subsections 105.09 and 105.12 describe Project Manager authority over unacceptable and unauthorized work removal. Do not allow work deficiencies to continue.
Project Managers and Inspectors will likely encounter nuclear gauge readings indicating compliant density even when material is visibly rutting, shoving or deflecting under construction equipment loading (Subsection 105.03.2, Standard Specifications). If embankment visibly deflects, inform the project superintendent and Project Manager unacceptable work must removed.

Equipment
Subsection 105.13, Standard Specifications

Acceptance
Subsection 105.15, Standard Specifications

Site Manager

Site Manager Training Manual Section 13 describes contract finalization and the final estimate process. Project Managers must follow Standard Specification Subsection 105.15 requirements.

90 Percent Completion Date

At 90 percent completion, Project Managers complete and send a 90 Percent Complete Memo to the District Engineering Officer (DEO). District Engineering Officers add a 90% estimated cost, save the memo to the share drive, and enters a 90% Complete Memo date within Site Manager or AASHTOWARE. An automatic email is sent to the Materials Bureau, Civil Rights Bureau and others, and initiates project cost modifications and materials and labor certification checks.

Project Finalization
Subsection 105.17, Standard Specifications

Final Project Walk Through

The final walk through verifies work completion and acceptance. This inspection may be used to support transfer or termination of the General Permit for Storm Water Discharges Associated with Construction Activities (Storm Water Permit).

When physical project work is complete, Project Manager, DCE and Contractor carry out a final walk through to identify remaining work items. If final inspection includes inspection for transfer or Storm Water Permit termination, include the DEES, Maintenance Chief or designated representative, and a City or County representative to participate in the inspection. Project Managers should perform final inspection soon after work completion. The final walk through process is not contingent upon warranty expiration. Delayed inspection impacts Contractor bonding and insurance, as because bonds are withheld until the Transportation Commission accepts the contract. Project Managers enter a final walk through date into Site Manager or AASHTOware, prompting the system to generates email to involved personnel. This date initiates project finalization and final documentation.

Project Managers submit punch list items to Contractors within 30 days of the final walk through inspection request. When punch list items are completed or resolved, Contractors request a final verification. Project Managers then grant Conditional Final Acceptance within 30 calendar days after the final verification request. Contract time assessment ends when contract specific warranties expire, but may be suspended before expiration.

General Storm Water Permit (GSWP) Transfer to MDT or Agency

A Storm Water Permit Close Out Checklist is completed during final inspection. Storm Water Permits may be transferred to MDT Maintenance or a local entity if site conditions and compliance records are acceptable. The transfer process is outlined in the MDT Environmental Services Bureau Transfer Procedure for General Permit for Storm Water Discharges.

For projects outside Reservations, Storm Water Permit compliance responsibility is transferred from Contractors to MDT, County or City, and requires a completed Permit Transfer Notification (PTN) form submittal with fee to DEQ at least 30 days before the transfer date. PTN fees are paid by Contractors to MDT. The PTN form and transfer fee is then submitted to the DEQ.

Storm Water Permit responsibilities are not proposed for transfer until construction activities have ceased, compliance issues are resolved, BMPs are inspected and accepted, and records and inspection reports have been furnished to MDT, County or City. MDT may require certain BMPs to be removed, maintained, installed or replaced by another BMP type before permit transfer. Additional inspections may be required to verify corrective action addresses deficiencies identified during inspection. Contractors must comply with permit terms and further inspections until DEQ makes a determination.

Final Acceptance

Final Acceptance is granted when Project Manager and Contractor agree all punch list items identified during final inspection are complete, and project specific warranties have expired. This date is recorded on a “Certificate of Work Complete Form” (CSB105_17_2), completed by the Contractor and approved by the Project Manager.

Contract time charges cease after this date. Project Managers may suspend contract time when only punch list work remains, depending on item quantity and importance. Punch list work requiring Work Zone Traffic Control, monitoring or testing by an MDT Inspector or warranty work requires contract time assessment. If the "Substantial Work Complete" form is submitted before items are complete, the form is rejected.

Final Materials Certification

The final materials certification process should be completed within 90 days after final acceptance. Site Manager sends Project Managers material certifications and documentation deficiencies during construction. Project Manager and inspection crew members must ensure deficiencies are resolved before project completion.

Final Estimate Process
Subsection 105.17.3, Standard Specifications

Project Managers should refer to the "Final Payment Process".

Claims for Adjustment and Disputes
Subsection 105.16, Standard Specifications

Contractor claims should be resolved promptly at the lowest level possible. DAs investigate, review, and evaluate claims before issuing claim decisions. Provide FHWA with written claim notices when federal funding is involved, and keep FHWA officials informed. Claims and claim notices must come from Prime Contractors. Fostering an open and equitable approach to disagreements, adjustments and changes is the best way to avoid claims. Field staff should identify and report issues to avoid conflict. Contractors must provide timely notification and provide supporting information to initiate a claim. Effectively manage Contractor claims by:

- Emphasizing documentation to project staff.
- Documenting phone conversations within diaries, and record written notes describing discussions.
- Organizing project records and claim documentation for later assessment.
- Following contract conditions so Contractors cannot assert MDT set a precedent by neglecting to enforce the contract.
- Having MDT personnel follow the claims process.
- Issuing nonconformance notifications as required.
- Frequently meeting with Contractors to discuss issues and schedules. Address issues promptly. Notify the DCE, CES Reviewer and the Legal Services Bureau promptly in the event of potential claims.

<u>Claim Definitions</u>

Disagreement: Unresolved dispute.
Claim Notice: Unresolved disagreement initiating the claims process.
Claim: An assertion seeking: a) an adjustment or interpretation of contract terms, b) additional monetary payment, c) contract time extension, or d) other contractual adjustment(s).
Mediation: Disagreement resolution using a neutral and independent third party.
Resolution: Solution agreeable to both parties.
Impasse: Situation for which resolution is unlikely.

Basis of a Claim: Facts upon which a claim is based.
Faulty Submission: A claim not complying with specification, deadline or content requirements.
Claims Assistance Team: A qualified team evaluating Certified Claim submittals, usually including Project Manager, DCE, CES Engineer, CAS Engineer, DCE, CES Reviewer, Legal representative, and FHWA Operations Engineer. Materials Engineer, Geotechnical Engineer, Bridge Engineer, Audit, and Environmental representatives may provide technical assistance.
Certified Claim: Form CSB105_16_2 submitted by Contractors when a solution is not reached 14 calendar days after a written claim notice. (Standard Specification Subsection 105.16.2).
Claims Review Board: The board to which Contractors appeal claim decisions made by the DCE. (Standard Specification Subsection 105.16.3).
District Claims Packet Submission: Within 15 days after the Request of Appeal, the DCE submits a claims packet to the Construction Engineering Services Engineer, including the original claim, supporting documentation, and the District evaluation and recommendation. The claims packet should be compiled at claims process beginning, with items added throughout the process. The Construction Engineering Services Engineer (CESE) uses claims packets to conduct research, and submit a recommendation to the Board. Claim packet copies and the CESE "summary of findings" and recommendations are submitted to Board members 15 days before board meetings.
Claims Database and Tracking System: This system stores claim information, and provides search and query capabilities.

Project Manager Responsibilities

Project management disputes can be avoided by reviewing and discussing project schedule, recognizing inaccurate schedules, and requesting that Contractors submit updated schedules. After claim submission Project Managers:

- Scan and email the Claim Notice to DCE, CES Reviewer and FHWA Operations Engineer on oversight projects.
- Enter claim notice information into the Claims Tracking System (CTS), an automated system generating email notifications to additional MDT and FHWA staff.
- Distribute CTS entered data to the Claims Assistance Team (CAT), including the FHWA. Project Managers use the team to resolve and defend claims, assist Project Managers and update personnel.

Claim Cost Field Documentation

Project Managers must verify Contractor claim cost documentation by noting details such as whether equipment was present or broken down on certain dates, or how many employees were onsite working on a particular task. Photos are a good way to record progress, working equipment and site conditions. Periodic aerial photography should be considered in cases at risk of major claims.

Contractors are required to update and submit cost records every 30 days until a claim is complete. Project Managers compare cost records against project records as they develop, noting and documenting discrepancies. Complete and accurate Daily Work Reports and Diaries are essential to verifying this information.

Claim Settlements

Claim settlements are implemented via change order procedure. Settlements after work completion are known as claim “settlements”, and discussed with the FHWA if federal funds are involved.

SECTION 106
MATERIAL CONTROL

Highway service life depends on materials provided and installed by contractors to meet specifications and testing requirements. MDT design and inspection ensures materials meet quality control standards. Various methods are used to accept or reject Contractor materials. MDT field construction personnel help verify material acceptance.

Supply Source and Quality Requirements
Subsection 106.01, Standard Specifications

MDT Materials Program relationship to the MDT Construction Program:

Physical Test Section, Materials Bureau

The Physical Test Section ensures all project materials meet MDT requirements, establishes MDT sampling and testing practices, coordinates acceptance testing, conducts lab inspections, verifies mix designs, maintains the Materials Manual, and provides inspector and technician testing training.

Material acceptance is assessed based upon manufacturer certification, the Qualified Products List (QPL), field tests and inspection, laboratory testing, manufactured product laboratory testing and fabricated item inspection during fabrication. The Physical Test Section provides testing guidance to District/Area labs, and test verification at Headquarters. Except as noted, the following tests are only performed at Headquarters:

- Asphalt and concrete mix designs

- Chemical:
  - -Corrosion properties for culverts
  - -Organic content
  - -pH
  - -Soluble sulfate
  - -Micro-Deval device (Headquarters and Billings)

- Geosynthetics:
  - -Grab elongation/strength
  - -Tear strength
  - -Puncture strength
  - -Permittivity

- Resistance value (R-value)
- LA Abrasion
- Concrete and aggregates properties
- Hamburg wheel track (Headquarters and Billings)
- Rebar/strand/wire mesh (Headquarters and Billings)

Physical Test Section personnel annually inspect and evaluate District and Area Labs. Acceptance testing must be performed by a certified lab. Headquarter labs are certified by the AASHTO Materials Reference Library (AMRL), but District/Area Labs are not. However, District and Area Labs as well as lab trailers must be approved by independent Quality Assurance personnel who calibrate equipment, check personnel certifications, and observe testers operating equipment. The Physical Test Section is also responsible for material certification.

Geotechnical Section Lab

The MDT Geotechnical Section operates the soil testing and Physical Test Section lab at Headquarters. Both classification tests and engineering property tests supporting field exploration and foundation design for MDT projects are carried out here. Classification tests include moisture content determinations, Atterberg limits, and grain size analysis. Engineering property testing includes triaxial and direct shear soil strength determination, soil compressibility consolidation tests, soil permeability tests and unconfined rock compression and point load tests.

District Materials Labs

District Materials Labs are located within District Preconstruction, and report to District Engineering Services Supervisors (DESS). District Materials Labs obtain samples, test construction materials, and maintain sample and test result records. District Materials Labs (DML) ensure Field Construction Crews meet project material record and documentation requirements. DMLs also work with the Headquarters Physical Test Section to ensure materials are sampled and tested according to MDT policy and procedure, interpret and evaluate test results for project managers, and provide technical testing advice. District Materials Labs sample aggregate sources and conduct surfacing investigations to ensure materials meet MDT specification, and work with District Preconstruction to conduct Soil Surveys and core existing pavements before pavement preservation projects. Soil testing determines

- AASHTO soil classification
- Corrosive and chemical properties
- Specific gravity
- Atterberg limits
- Proctor compaction
- R-value

When District Labs lack soil analysis equipment, District Labs submit samples to the Physical Test Section to avoid project delays. The Geotechnical Lab may assist District Labs with sampling.

Area Labs

MDT has five District Labs throughout the State:

- District 1 (Missoula) Area Lab in Kalispell
- District 2 (Butte) Area Lab in Bozeman
- District 3 (Great Falls) Area Lab in Havre
- District 4 (Glendive) Area Labs in Wolf Point and Miles City
- District 5 (Billings) Area Lab in Lewistown

Six Area Labs report to respective District Materials Labs. Area Labs have the same soil testing capability as District Materials Labs, but at a more convenient location.

Civil Engineering Technicians

The following individuals oversee project field testing, and implement the MDT field Materials Program and witness Contractor sample collection. Civil Engineering Technicians are categorized as:

District/Area Lab Materials Testers, who test for individual construction projects. District/Area Materials Labs provide Materials Technicians for sampling and material testing. Testers are not assigned to individual Projects, and report to District Materials Supervisors, but routinely take direction from Project Managers. Technicians typically perform Marshall and gyration compaction testing.

Field Inspectors witness Contractor QA sampling, and are certified to sample and test materials, and conduct testing in a field trailer. Data is then entered into SiteManager or AASHTOware. Inspectors also prepare transmittal forms for District or Headquarters Lab submission, and provide construction inspection.

Construction Materials Reviewer

Construction Materials Reviewers are located within the Headquarters Construction Engineering Services Bureau, provide material technical assistance, and conduct construction material reviews. During construction, Reviewer duties are assigned by the CES Engineer, Materials Engineer and Physical Testing Engineer. Construction Materials Reviewers:

- Provide technical expertise and training for volumetrics, plant mix provisions and plant mix operations.
- Act as a liaison between District, Materials Bureau and CES Bureau.
- Act as a liaison between Project Manager, Contractor and Consultant.
- Provide expertise on plant mix plants, crushers and PMS equipment.
- Conduct construction reviews, write review reports and follow up on action items.
- Calibrate equipment and check operation and proper settings.
- Spot check testing procedures.
- Verify proper MDT equipment and aggregate sieve usage.
- Assist with QA data entry.
- Sample material for volumetric analysis and Hamburg testing.
- Discuss change orders.
- Assist District and Area Labs.

Specification Precedence

As established by Standard Specification Subsection 106.01.2, the order of precedence governing materials specifications is:

- MDT Materials Manual
- AASHTO standards
- ASTM standards

MDT Materials Manual

The Materials Bureau Physical Test Section maintains the Materials Manual. Sampling and testing is administered according to “Part II -Tests” of the AASHTO

Standard Specifications for Transportation Materials and Methods of Sampling and Testing, adapted for application in Montana and covering concrete, soil and aggregate, and bitumen aggregate.

Standard Specification Division 700 - Materials

Division 700 covers specifications for construction materials including aggregates, bituminous materials, guardrail, drainage pipes, traffic control devices and others. Division 700 is based on Part I "Specifications" of the AASHTO Standard Specifications for Transportation Materials and Testing, for application in Montana. Field personnel must be familiar with Division 700 specific material requirements, material submittals and Compliance Certificates.

Division 700 references, specifications and standards include:

- American Society for Testing Materials (ASTM)
- American National Standards Institute (ANSI)
- American Welding Society (AWS)
- American Water Works Association (AWWA)
- American Wood Protection Association (AWPA)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Code

Material Control

The MDT Materials Manual describes field procedures for material sampling, testing frequency, and acceptance, and covers:

- manufacturer supplier certification
- trade name products
- fabricated items
- small quantity items
- optional samples
- sample policies and procedures
- The MDT "Materials Sampling, Testing and Acceptance Guide" for major items to be sampled and tested, and items accepted based on manufacturer certification, including highway materials associated with SiteManager Materials Codes (which refer to Specification Sections), test methods, sample sizes, sampling rates and frequencies, witnessing and testing responsibilities.
- The following numbering system is used by MDT field staff:

  MT-510 "Field Numbering Concrete Cylinders" establishes a statewide system for numbering concrete test specimens.

  MT-512 "Method of Numbering Subgrade Material, Surfacing Material, Bituminous Treated Material and Liquid Asphalt" establishes field item number assignment.

  MT-513 "A Guide to Laboratory Forms" Part I covers sample submission for testing. Part II lists forms used when submitting material inspection reports and certifications.

Quality Assurance

Standard Specification Subsection 105.03.2 outlines MDT Quality Assurance (QA) requirements.

Training

MDT is a member of the Western Alliance for Quality Transportation Construction (WAQTC), which ensures construction staff conduct Quality Assurance for the Materials Bureau, and that MDT sampling and testing labs perform acceptably. MDT sampling and testing technicians are required to complete WAQTC training, and attend mandatory refresher courses. The Materials Bureau web page lists qualified technicians and certification expiration dates.

SiteManager

Materials sampling and testing requirements are defined in SiteManager and AASHTOware based on MT 601 and contract requirements, allowing users to monitor sample numbers, samples taken, required sample tests and test status. Sample deficiencies are identified concurrently with construction estimates to ensure material sampling and testing is performed as the bid item is paid. SiteManager and AASHTOware users must be trained and certified to enter material testing data, and have current WAQTC or ACI certification.

Policies and Procedures

Contractors must meet material and documentation quality control as required by Standard Specification Section 106, and assume acquisition, development, production and material expenses necessary for project incorporation. Project Managers must approve material.

Timing

Contractors must submit a work materials supply list before work incorporates the material. The Bureau makes arrangements for material inspection and testing. Materials uncompliant with standard specification are rejected, and the Contractor is notified.

Contractors must likewise notify the Materials Bureau when a material supplier changes. If Contractors do not submit a "List of Materials Suppliers" before the Preconstruction Conference, Project Managers should request the list at the conference.

Contractor Supplied Information

Contractors must furnish documentation certifying material acceptability, especially for manufactured products. Project Managers must obtain approved material list copies, manufacturer certifications, shop drawings, onsite dimensional inspections, and other certification proving material inspection and approval.

Materials Acceptance or Rejection

MT-503, Section 3.1 "Samples and Certifications":

- Every item must be sampled and accepted before incorporation into the work, unless acceptance is made on the basis of manufacturer certification, field tests, field inspection or the Qualified Products List (QPL).
- Project Managers, District Materials Supervisors, Area Lab Supervisors or the Materials Bureau identify material acceptance or rejection methods, and evaluate test results to determine if work and materials conform to Standard Specification.
- Inspectors first notify the Project Manager, then a Contractor representative of obviously defective material. Testing should be used to document defective material. If Inspector and Contractor agree regarding material defect, and the

Contractor intends to correct the defect, test records are not essential, although it is good practice to acquire and retain test records. Inspectors should include documentation within Daily Work Reports and inform Project Managers of discussions, defects, and corrective action. Contractors should submit a corrective action plan to Project Managers before material is installed.

- Inspectors should never inform Contractors a test is failing, only provide test results and state that the material is noncompliant. Contractors must decide upon corrective action.
- Project Managers may allow material incorporation into the work prior to acceptance according to Section 3.2.1, MT-601, but acceptance is pursuant to Standard Specification Subsection 106.01.2. Test results for sampling oil products such as asphalt cements, emulsified asphalts, and pavement marking paints may not be available until after work completion. In such cases, products may be accepted with a price reduction or removed in the case of failing tests.

Alternative Materials

Proprietary materials may be required by agencies based on environmental process hearings, and may be required to comply with recommendations or public meeting findings. Decorative signs and powder coated decorative signals are common examples of materials selected via public interest finding.

Materials from Outside Montana

Materials manufactured outside Montana are tested and inspected by commercial testing laboratories. The Materials Bureau may arrange testing with other State DOTs. Materials should not be used until Project Managers have received material reports and materials are inspected onsite. Occasionally materials fabricated out of state have been tested and received at the jobsite, even though a materials test report is unavailable. SiteManager or AASHTOware notifies Project Managers when test reports are received at Headquarters, allowing material installation subject to field approval.

Outside Material Agency Testing

Correspondence regarding outside agency testing should be directed to the Materials Bureau. MDT Inspectors or testers may visit material production plants. The Materials Bureau notifies Project Managers of materials tested and approved by commercial labs.

Department Informational Testing

Informational testing is not required but may be performed as a Contractor courtesy. Because it encourages Contractors to rely upon unofficial results, minimize courtesy testing. Such testing does not take precedence over random Quality Assurance (QA) sampling testing. Contractors must develop a material Quality Control (QC) plan until MDT QA testing and acceptance is operational. Document conversations with Contractors regarding results within the Daily Diary. Project Managers should note failed test results and inform Contractors when test results do not meet specification, without interpretation, and allow Contractors to evaluate results for themselves.

Local Material Sources
Subsection 106.02, Standard Specifications

Aggregate material must be obtained from Departmentally identified or mandated sources or approved Contractor sources, which may produce materials for aggregate surfacing, selected surfacing or borrow from pits or quarries. Contracts may also identify optional Contractor sources. In these cases, Contractors determine the extent to which sources are used. Normally MDT requires aggregate source approval, determines source quality, and tests Contractor sources before approval. MDT rejects sources producing material not meeting specification. Contractors begin aggregate production before source approval at their own risk. Uncompliant material delivered to the project may be rejected, and final acceptance is contingent upon jobsite acceptance.

Compliance Certification
Subsection 106.03, Standard Specifications

Standard Specification Subsection 106.03 allows material usage without testing if a Certificate of Compliance (COC) accompanies the material to confirm product compliance. However, acceptance and payment is still unguaranteed as MDT may always randomly test permanently incorporated material. COC certification constitutes final acceptance for materials not requiring testing. COCs are issued for industry products having reliably met specifications. The Materials Bureau monitors these industries for MDT standards compliance, and notifies district offices if material from a particular supplier is unacceptable. COCs also allow conditional material acceptance prior to testing. Certifications should list material type, manufacturer, applicable specification(s), required tests, a signature of the individual responsible for results, and an issue date. This information must be attached to Form 406 for steel and iron products, and signed by the prime Contractor. For untested materials, a COC must be attached to Form 46. In this case, no Contractor signature is required.

Standard Specification Subsection 106.01.2 allows Project Managers to grant written permission to place materials before receiving certifications if an immediate public danger is imposed without placement, or if work delay may cause project or adjacent property damage.

Contractors incorporate material into permanent work prior to providing certifications at their own risk. Project Managers withhold payment for materials until required certifications are received, reviewed and accepted. If certifications are not received, Project Managers may require in writing that materials be replaced at Contractor expense. Send written correspondence copies of this directive to the District Construction Engineer and DA.

Plant Inspection
Subsection 106.04, Standard Specifications

MDT inspected material plants include asphalt plants, aggregate crusher and screening plants, concrete plants, steel fabrication plants, concrete girder plants, precast concrete culvert plants, plants creating precast concrete members, aggregate mixing plants and wood mills.

Qualified Products List (QPL)
Subsection 106.06, Standard Specifications

The Materials Bureau maintains the QPL, and verifies items meet MDT specification. Materials may be QPL listed or accepted via testing. Materials require QPL approval or contract documents may stipulate product acceptance criteria. QPL items are subject to:

- Quality Control Testing. Producers must have a quality control (QC) plan and perform testing to ensure consistent product quality.
- National Transportation Product Evaluation Program (NTPEP). Listings may be added to the QPL without additional testing when NTPEP testing demonstrates a

product meets MDT Specification. Products removed from the NTPEP listing are also removed from the QPL.

- Random Testing and Auditing. MDT may test QPL materials at the manufacturing plant, project site and other locations. MDT may also test samples to verify Specification compliance. If field products appear questionable, Project Managers should submit sampled material to the Materials Bureau. QPL listing does not guarantee QPL material acceptance.
- Disqualification. Products outside MDT Specification may be removed from the QPL.

Material Handling and Storage
Subsection 106.07, Standard Specifications

Contractors must obtain approval to store materials within the ROW. Consult the Bridge Bureau regarding material storage on structures. Project Managers should not assume approved materials will remain acceptable during and subsequent to storage. Aggregates break down under prolonged weathering periods. Metals rust and materials may be degraded by sunlight, water, soil or pollutants. Inspect stored materials prior to work incorporation. Stockpiled material payment should be withheld if materials are not preserved in originally inspected condition.

Check storage environments to make sure they are material safe. Harmful practices such as stacking may cause bending, denting, or crushing. If material is damaged due to a particular storage environment, payment allowance should be recovered until after repair or replacement.

Departmentally Furnished Materials
Subsection 106.08, Standard Specifications

Project Managers responsible for furnished material should:

- Review material special provisions. Orders for materials manufactured specifically for the project such as signals or signs should be verified to ensure availability.
- Retain copies of written Contractor requests for State furnished materials.
- Ensure Contractors sign material receipts, and place a copy in the project file.
- Contractors must replace materials in kind if state furnished materials are damaged or lost before installation.

Domestic Materials
Subsection 106.09, Standard Specifications

Buy America Federal Requirements

23 CFR 635.410 “Buy America” requirements apply to Federal aid projects and steel and iron materials, as well as manufactured iron in any percentage or form within manufactured products. Buy America requirements should be discussed at the preconstruction conference for Federal aid projects. See MT-601 Section 3.2 for Form 406 requirements, which must be completed by Contractors.

Contractors must furnish and install domestic steel and iron materials as required by 23 CFR 635.410. Manufacturing processes must take place domestically to qualify as “domestic” materials. Manufacturing begins with initial melting and mixing, and includes bending and coating. Products processed outside the United States are foreign material sources. Steel and iron product manufacturing is complete when a product is ready for use as fencing, posts and girders. Products are also considered complete if a material can be incorporated as components of a more complex product through added manufacturing. Final assembly is not required in America if a component is merely installed without the steel or iron component subjected to additional manufacturing. The MDT “Buy America Help Guide” provides additional guidance.

Waivers

MDT cannot waive domestic steel and iron usage for federal aid projects without FHWA approval. The MDT Construction Engineer must approve waiver requests before contacting FHWA. Waivers discussed within 23 CFR 410(c) should only be considered to address extraordinary circumstances. FHWA Division Administrators may grant waivers with concurrence from FHWA Headquarters in Washington, DC., but evaluation may take months. Contractors must submit the following to Project Managers when requesting a Buy America waiver:

- Item description
- Manufacturer or supplier item cost
- Product country of origin
- Waiver rationale

When preparing waiver requests for FHWA, Project Managers must provide the Contractor waiver submission with federal aid project number, description, location, and project redesign analysis using alternative domestic material. If specified materials are unavailable domestically, unavailability must be identified, and the waiver processed during Preconstruction. FHWA waiver approval is required prior to allowing foreign steel or iron usage.

Minimal Use

As stated in Standard Specification Subsection 106.09, minimal foreign steel or iron usage is allowed if material cost does not exceed 0.1 percent of total contract cost or $2,500, with cost being the value of steel and iron products delivered to the project. Contractors must request foreign steel or iron usage in advance, and provide cost invoices to MDT. Foreign iron or steel exceeding minimal use values must be replaced with domestic material. Minimum steel or iron quantities are per the entire contract, not per Contractor or Subcontractor. Contractors must submit a written record with a running foreign material total demonstrating that allowable foreign material usage amounts are not exceeded. Project Managers should document usage quantities.

Definitions

Standard Specification Subsection 106.09 defines the following terms:

Melting is heating a solid until it melts by placing scrap steel into a furnace for melting, before being recycled into steel products. If this process occurs in the US, the product is considered “US made.”

Smelting is iron extraction from ore to produce molten metal. Products are “US made” if smelting occurs in the US.

Domestic Origin means all manufacturing processes occurred domestically.

“Manufacturer Certification” is documentation furnished by manufacturers listing name, manufacturing location, heat numbers or other identification identifying the material, with a signed manufacturer statement attesting to domestic origin.

Mill Test Report is a base metal report from the production mill listing chemical and physical analysis, heat or lot numbers, and material manufacturing specifications.

Chemical and physical analysis reporting is required by ASTM, AASHTO and ANSI specification.
Heat Numbers are manufacturer identification numbers tracking steel batch manufacturing locations.
Broker indicates a person or business purchasing finished products from a manufacturer to sell those products in exchange for a commission.
Bill of Lading refers to documentation issued by shippers listing and acknowledging receipt of goods for transport and listing delivered terms.

MDT Procedures Subsection

MT-601 lists required procedures and forms for manufacturers to be in compliance with Standard Specification Subsection 106.09. District Offices employ a Buy America Specialist to advise field construction staff regarding Buy America compliance. Contact the Steel Fabrication Specialist at MDT Headquarters Materials Bureau for Buy America assistance.

Bituminous and Concrete Mix Designs and Surfacing Materials Source Testing Subsection 106.10, Standard Specifications

SECTION 107
LEGAL RELATIONS AND PUBLIC RESPONSIBILITY

Laws, Rules, and Regulations
Subsection 107.01, Standard Specifications

Contractors are required to obey laws applying to highway construction work, and bear the cost and inconvenience of regulations, permits, and certifications. Specifications and special provisions identify legal requirements with which Contractors must comply, although legal requirements external to the Department may apply. Violations of Federal, State, Tribal or local laws must be communicated in writing to Contractors after discussion with the DCE.

Inspectors report violations to the Project Manager, who communicates violations to the Contractor and appropriate agencies. Failure to report violations to appropriate agencies may legally implicate MDT, especially on account of environmental violations. Contact Legal Services with questions involving MDT or Contractor compliance or legal violation.

MDT field personnel must verify Contractor and Subcontractor employees secure an approved subcontract, or include workers on Contractor payroll.

Tribal Land Projects

MDT projects are often constructed on Tribal Lands. Although highways themselves are MDT jurisdiction, they are also controlled by Tribal governments. Disagreements may arise between Department and Tribal governments and Contractors. MDT and Tribal governments must cooperate during project construction. MDT usually has a lead role in ensuring cooperation. MDT special provisions for Tribal Lands projects instruct Contractors to be aware of and comply with Tribal requirements, and emphasize MDT authoritative limits while working on Tribal lands. Contact the DCE or Legal Services if complications arise during Tribal Land projects. Tribal governments also have reservation specific laws.

Contractors must comply with contract terms as well as Federal, State and Tribal laws not superseded by a Memorandum of Understanding (MOU) or Project Specific Agreement (PSA). Tribal authorities must comply with Federal and Tribal laws. MDT employees must comply with Federal and State law and contract terms, but usually are not bound by Tribal law, unless required by the contract. TERO (Tribal Employment Rights Office), transportation planners or other Tribal personnel may observe the project and ensure hiring, training and environmental compliance.

Memorandum of Understanding (MOU) and Project Specific Agreement (PSA)

MDT signs contractually binding MOUs and PSAs with Tribal governments, which become effective during preconstruction. MDT maintains MOUs with Tribal governments to address planning, design and construction on Tribal Lands. Each project requires a PSA to address training positions, mineral and water sources or items unaddressed by the MOU. Field personnel must be familiar with requirements affecting MDT and Contractors. Environmental and hiring requirements, trainee stipulations and other conditions must be followed. MOUs and PSAs supersede other laws and regulations. Contact Legal Services with questions regarding MOUs and PSAs.

Pre-Bid Conferences

Prime Contractors bidding Tribal Land Projects must attend mandatory pre-bid conferences.

Occupational Safety and Health Act (OSHA)

Most injuries are due to unsafe work environments, which are often a product of work environment, work site conditions, equipment and material usage, or the work itself. Work environment changes can help eliminate unsafe physical conditions, and improve working conditions. Most construction accidents are caused by unsafe actions coupled with an attention lapse and inadequate training or experience. Construction sites are unpredictable, and employees must be alert and aware.

Safety Enforcement

Contract documents require Contractors to comply with, Section VIII of FHWA Form 1273, entitled SAFETY: ACCIDENT PREVENTION, for all Federal aid contracts. MDT project personnel monitor Contractor OSHA compliance, but cannot enforce or direct Contractors. MDT personnel observing unsafe practices must report incidents to the Project Manager.

OSHA Standards

OSHA “Safety and Health Standards for the Construction Industry” (29 CFR Part 1926) apply to construction sites, are available from the Office of Occupational Health and Safety within the MDT Human Resources Division, and outline construction site safety standards. District Occupational Safety and Health Specialists often assist field personnel to address health and safety issues. OSHA safety standards are segregated into 26 subparts A to Z, and applied according to construction type and safety activity.

Individual subparts are labeled with Federal standard prefix “1926”, and followed by a decimal point and section number. Every section also has a descriptive title. Every OSHA standards paragraph has an alphanumeric identifier to make specific safety provisions easy to find. More complicated OSHA sections are organized into additional sublevels. Nomenclature for “OSHA Standard 1926.57(c)(3)(iii)(B)” is explained below:

- 115: .57, OSHA Standards section number
- 116: (c), First sublevel labeled using lowercase letters
- 117: (3), First sublevels are subdivided into second sublevels, denoted by numerals
- 118: (iii), Secondary sublevels are further subdivided into third sublevels, labeled using lower case Roman numerals
- 119: (B), Third sublevels are divided into a fourth sublevel using upper case letters.

Hazardous Materials and Material Safety Data Sheets (MSDS)

MDT field personnel should know if material at the work site is hazardous. Contractors must make Material Safety Data Sheets available to workers. OSHA Section 1926.59 covers information regarding “right to know” job site requirements. The “Superfund Amendments and Reauthorization Act” (SARA) requires MSD Sheets be available if chemicals are on site in the following quantities:

- Greater than 10,000 pounds, or the threshold planning quantity (TPQ) for a hazardous substance.
- Greater than 500 pounds, or the TPQ for extremely hazardous substances.

Contractors must submit the MSDS or list of chemicals covered by the MSDS to Project Managers. Chemical manufacturers must send an MSDS with information describing physical and chemical properties, physical and health hazards, handling precautions, spill and clean up procedures, and emergency first aid procedures. An MSDS is required for each hazardous chemical at the workplace, and must be maintained at each project site. Incoming MSDS sheets must be reviewed by Project Managers.

Accidents

If hazardous materials are spilled, accidentally discharged or encountered, Project Managers must be notified. (Standard Specification Subsection 107.24). If an occurrence is unaddressed by contract documents, Project Managers should call 911, ensure workers are removed from contaminated areas, prevent further exposure to workers and call the DCE. Project Managers should have a copy of the US Department of Transportation “Emergency Response Guidebook” to help identify hazardous materials, potential dangers, and precautionary measures. Project Managers should isolate and seal off areas containing hazardous material before experts arrive to handle serious hazardous spills or exposures.

Work Suspension

Project Managers may halt work if operations are unsafe. See Standard Specification Subsections 104.02.2 and 105.01. Consider the following when deciding if work should halt:

- Is the unsafe condition away from main site activities, or can the hazard be isolated or barricaded until safe?
- Are worker activities jeopardizing safety, and is serious injury a risk?
- Could Contractor operations cause property damage or injury?
- Has a Contractor Superintendent reviewed the situation?
- What can be done to make the hazard temporarily safe? Can someone be assigned to monitor the hazard while people are at risk?
- Review OSHA standards, advice from safety experts and previous enforcement actions.

Work or production suspension due to minor safety infractions isn’t usually needed. An unsecured, infrequently used ladder in a remote job site area doesn’t require work suspension, but workers in a 10 ft deep trench without a trench box is a serious safety violation warranting immediate work suspension and a meeting with the Contractor. Most safety hazards fall between these extremes. Decisions balancing strict safety standard adherence with perceived injury risk are often difficult, but it is best to err on the side of safety, and document decision rationale. For work suspension guidance, Project Managers should contact the project DCE, DCOE, CES Reviewer, CES Engineer or MDT Legal Services.

Contractor Employee Safety

According to MDT Standard Specification and project contracts, Contractors are responsible for employee safety and OSHA regulatory compliance. If an MDT employee observes an unsafe situation, report the infraction to the individual involved and Project Manager. Document the notice and Contractor response in the DWR. To avoid liability, MDT personnel should not recommend corrective measures. If an issue persists, a supervisor notification should be followed by Project Manager written notification to the Superintendent. Record both notification and Contractor response in the project diary.

If a solution is not reached, the Project Manager may under Standard Specification Subsection 105.01.1 suspend work wholly or in part to correct unsafe working conditions. The Contractor Superintendent must then be notified to correct the situation. Contractors must follow OSHA regulations governing work methods. Project Managers must notify the DCE of uncorrected violations. The DCE must notify OSHA if an unsafe practice persists. If working conditions are assessed by an OSHA representative to be in violation, OSHA will inspect the job site per Standard Specification Subsection 107.01:

- If practices are unsafe by OSHA regulation, Contractors are responsible for damages, fines, penalties, and liabilities.
- Project Managers record the corrective action date with other information in the project diary.

MDT Employee Safety

Contractors must create safe work conditions for MDT and Contractor employees. MDT field employees must take a 10 hour basic OSHA training course. Supervisors must have a 40 hour construction safety course. Training may be scheduled through the MDT Occupational Safety and Health Office. MDT employees must demonstrate safe working practices by teaching safety awareness to rotational or new employees. Construction projects involve dangerous work situations. Always wear proper clothing, hard hat, approved high visibility vest, safety shoes, and additional personal protective equipment, (PPE) such as eye and hearing protection.

Heavy Equipment

- Ensure operators see you by making eye contact.
- Stay clear of equipment blind spots.
- Stay away from the rear of cranes and excavators.
- Never board moving equipment.
- Yield right-of-way to heavy equipment.
- Stay clear of equipment buckets.
- Stay clear of loads moving by crane.
- Stay back from haul units.
- Pay attention to hoisted loads, and be prepared to relocate.
- Do not face away from lifted piles or pile leads.
- Be aware of pinch points.

Trenches

- Never stand next to trench edges.
- Be aware of overhead dangers such as backhoe buckets or loads lowered into trenches.
- Never enter an unstable trench.
- Detect for gases that may have settled in trenches.
- Notify others you have entered a trench.
- Use Support Systems when needed:
- A stairway, ladder with rails extending a minimum of 3 feet (900 mm) above ground level (see OSHA Std. 29 CFR 1926.1053(b)(1)), or other safe means of

egress (ramp) must be provided if excavation is 4 feet (1.2 m) deep requiring more than 25 feet (7.5 m) lateral travel for workers.
- If a trench is 5 feet (1.5 m) or more deep without slopes or benches, an approved Support System must be provided and equipped with means of egress within the support system (see OSHA Std. 29 CFR 1926.650 and 1926.651).
- These are just a few dangers associated with trench work. See “OSHA trenching requirements” for additional information (OSHA Technical Manual, Section V: Chapter 2).

Crushers and Hot Plants
- Watch for heavy equipment and overhead hazards.
- Stay clear of moving parts on crushers and hot plants.
- Watch for falling rock.
- Be cautious around hot materials like bituminous asphalt and plant mix.
- Avoid hazardous chemicals.
- Stay clear from valves, fittings and couplings, as they can fail and spray hot, hazardous materials.
- Be aware of electrical connections.
- Watch for trip hazards.

Roadways
- Park vehicles in safe areas.
- Use vehicle warning lights in work zones.
- Look out for fellow workers.
- Look both ways before crossing traveled ways.

Hard Hats

Hard hats are mandatory:

- At highway construction or maintenance projects.
- At work activities during which jurisdictional authorities require hard hats outside vehicles working within highway ROW.
- At any project area where falling or flying objects could be present.

Safety Vests and High Visibility Clothing

Workers within the ROW or highway project boundaries must wear high visibility safety apparel. To comply with the 23 CFR 634 requirement for worker visibility, high visibility safety apparel must meet Performance Class 2 or 3 requirements of the ANSI/ISEA 107 publication entitled “American National Standard for High Visibility Safety Apparel and Headwear.” Fluorescent orange or fluorescent yellow-green clothing meeting ANSI/ISEA Performance Class 2 or 3 requirements, such as a shirt, sweatshirt or jacket furnished by the employee, with supervisor’s approval, may be worn as a substitute for MDT provided apparel. High visibility clothing and personal protective equipment must be monitored to ensure items retain qualities provided by the manufacturer.

Protective Footwear

Wear protective footwear in construction areas where vehicles or equipment are operating, and in areas where foot injury is possible. Protective footwear must comply with ASTM Standard F2413-05. Compliance determinations are based on OSHA Regulation 29 CFR 1910.136(a) and 29 CFR 1926.96.

Employment Related Legal Requirements

Federal aid projects have provisions governing Contractor employment practices regarding, EEO, DBE, Labor Compliance (Davis-Bacon wage rates, payrolls), and On the Job Training (OJT). The MDT Human Resources Division within the Civil Rights Bureau establishes and enforces MDT policies and Contractor employment requirements. The Civil Rights Bureau publication “Title VI Compliance Program” outlines employment regulations, training and MDT personnel responsibility to monitor Contractor activity. The MDT Civil Rights Manual covers EEO, Labor Compliance and DBE information.

Site Manager

MDT Site Manager Training Manual Section 7 requires Contractors to determine subcontract amounts contributing to DBE goals, verify payroll labor and wage rate compliance, and track trainee information. Site Manager and AASHTOware track DBE goal compliance for Contractor and Subcontractor(s). DBE subcontract information is entered into Site Manager via SiteXchange. Project Managers review Contractor information and request corrections as needed. Contractor payroll information verifies training, labor and wage rate compliance.

Disadvantaged Business Enterprise (DBE) Requirements

The MDT DBE program ensures certified women owned and disadvantaged businesses have opportunities to competitively bid MDT contracts. MDT seeks to reach construction DBE goals on a statewide basis. Contractors select a DBE from which to purchase needed materials. Project Manager DBE responsibilities include daily DBE reviews, equipment lease and rental agreement submission to DBE Program Staff, a CUF Report (federally funded projects) and Civil Rights Bureau notification if the following occur:

- significant DBE work item reduction
- DBE work performed by the prime Contractor
- DBE failure to work
- employee sharing between DBE and prime Contractor, or
- other factor outside “normal industry practice” by a DBE

CUF reports are prepared to ensure DBEs are legitimate. If a prime Contractor indicates a DBE is working on the project for DBE credit, MDT personnel must ensure the DBE is performing the work, or contact the DBE Program Manager within the Civil Rights Bureau. For more DBE information, see the MDT Disadvantaged Business Enterprises (DBE) Program Manual.

On the Job Training

Certain projects have government funded training provisions for construction occupations. Special provisions governing training programs are included within the contract. The “Title VI Compliance Program” publication covers training programs for Federal aid projects, most of which require on the job training for construction trade workers, which must be part of an MDT approved apprenticeship program. During construction, Project Managers verify trainees are enrolled in approved training, performing normal work and supervised by a journey level person of the same craft. Trainees are paid less than Davis-Bacon wage rates, and each hour a trainee works is partially paid by MDT.

Project special provisions establish minimum Contractor provided training hours, and stipulate the hourly rate at which MDT will subsidize training. Trainees must be placed on the project when work covered by the program begins. At least daily, the Project Manager or designee must observe work to ensure trainee is receiving required program training. If a Project Manager does not agree with Training Report information, take necessary corrective field action and have contractor representatives initial changes. Reports submitted to the Civil Rights Bureau must have a Project Manager signed explanatory memo accompanying the corrected Report. Send an unsigned Training Report to headquarters accompanied by a memo explaining why field corrections cannot be made.

Labor Compliance

Project Managers must ensure Contractors comply with Federal regulation governing work hours and conditions, payroll records, and wage posting information.

Spot Check Interviews

Spot check interviews must be conducted by Project Managers weekly the first month Contractor and Subcontractor are working, and monthly thereafter. An LC-1 form copy should be attached to corresponding payroll, and forwarded to the Civil Rights Bureau.

Certified Payrolls

MDT investigates certified payroll labor standard compliance during federal aid projects, but not during state funded projects. Project Managers may request certified Contractor payrolls. These investigations include confidential interviews with employees, payroll data and document examination, and fringe benefit payment. Contractors and Subcontractors must submit two copies of weekly certified payrolls to Project Managers within seven days following the pay period to verify:

- All project workers are shown on a payroll
- Employee names
- Employee work classifications
- Employee hourly wage rates
- Employee daily and weekly hours
- Authorized deductions
- Net wages

Project Managers should request supplemental payrolls when errors affecting individual earnings are discovered. Refer to the FHWA Labor Compliance Manual for specific requirements.

Davis-Bacon Wage Rates

Davis-Bacon wage rates are required for construction personnel. MDT conducts payroll verification to ensure correct rates are paid to employees and subcontractors. Off-site work or material fabrication outside Montana is not subject to Davis Bacon requirements.

Bulletin Board

Certain postings and notices are required for projects receiving Federal aid. Project Managers must differentiate between required business postings and those required on a construction project bulletin board, and ensure bulletin boards display EEO Required Bulletin Board Materials.

Additional recommended postings include Contractor EEO policy enforcement officer name and telephone number, emergency telephone numbers, and OSHA safety and security information postings. Contractors must furnish at least a 12 square foot bulletin board for required posters, which must be suitable for outdoor environments and accessible to employees during non-working hours.

Contractors and Subcontractors conducting mobile operations such as striping or traffic control may provide bulletin board information in a binder retained by a superintendent or foreman, if employee access is available.

Checklists

Appendix A contains EEO information checklists for field personnel including:

- EEO Documentation to Project File
- EEO Checklist for Bulletin Board Inspection
- EEO Checklist for Training Programs
  (See MDT Civil Rights Manual for information)

Permits, Licenses, and Taxes
Subsection 107.02, Standard Specifications

Permits referred to within Standard Specification Subsection 107.02 do not include environmental permits. Contracts include a project specific special provision listing requirements pursuant to Subsection 107.02. The Construction Administration Services (CAS) Bureau ensures Contractors attain required permits and licenses.

Local Requirements

Contractors must abide by local ordinances such as noise limitations, haul restrictions and permit fees. Most Montana cities require Contractors to obtain a permit to tap city waterlines. Permits associated with construction activities are Contractor responsibility. Permits unforeseen during bidding are MDT responsibility.

Motor Carrier Services (MCS) Division

The MCS Division protects State and Federal investment in the Montana highway system and ensures public safety by enforcing State and Federal commercial motor carrier laws and regulations. See the Montana Commercial Vehicle Size and Weight and Safety Trucking Handbook for information.

Standard Specification Subsection 107.02 allows MCS to:

- Issue Oversize/Overweight Permits required outside construction zones. See Subsection 107.H for load restriction and oversize vehicle information.
- Preconstruction conferences address subjects of concern to MCS and MDT construction staff, such as load restrictions, weight limits, special fuel usage, permits, licenses and taxes, and oversized load detours.
- MDT annually issues a construction memorandum entitled "Motor Carrier Services Construction Guide Update" to assist MCS during construction activities and provide uniform enforcement with respect to load restrictions, project diesel fuel, permits, licenses and taxes, and prevent damage to new projects.

Patented Devices, Materials, and Processes
Subsection 107.03, Standard Specifications

Restoring Surfaces Opened by Permit
Subsection 107.04, Standard Specifications

Federal Aid Participation
Subsection 107.05, Standard Specifications

The FHWA administers the federal aid program funding highway improvements nationwide, and ensures state DOTs comply with federal regulation during federal projects. The FHWA ensures State DOTs meet highway project engineering requirements, and maintains a Division Office within each State.

FHWA Onsite Inspection

Project Managers should accompany Federal officials during inspection to document FHWA interactions within the project diary. Project Managers should be familiar with federal project regulations.

FHWA/MDT Partnership Agreement

Projects not subject to full oversight are administered by MDT under a "Partnership Agreement", and not subject to review and approval during development. These projects are also called "state administered projects." Under this designation, MDT assumes previously administered FHWA inspection and monitoring duties during construction, such as change order approval. Full oversight projects require change orders, audits, reviews and final inspections to be discussed with or approved by FHWA during construction.

FHWA Form 1273

FHWA Form 1273 "Required Contract Provisions" is included within federal aid contracts to address nondiscrimination, payroll, minimum wage payment rates, fringe benefits, material certification, subcontracting and recordkeeping. Project personnel should refer to form 1273 for information before contacting headquarters. Form 1273 provision violations may legally invalidate a contract, and can result in Contractor or individual disbarment. MDT failure to enforce Form 1273 requirements may jeopardize federal funding.

Non-Participating or Ineligible Costs

Regulation 23 CFR, prevents the FHWA from participating in certain State DOT construction costs. "Non-participating" or ineligible costs include:

- Items not incorporated into the work, such as accepted materials MDT may use later
- Accounts Receivable (AR) for third party damage claims while Contractor is on the job
- Materials not meeting minimum MDT functionality
- Contractor maintenance activities
- Contractor legal fees
- Contract administration outside project specifications
- Liquidated damage waivers without adequate justification
- Unforeseen consultant errors covered by "errors and omissions" insurance
- Work in violation of a permit
- Enforcement action
- Steel or iron not meeting "Buy America" provisions and Standard Specification Subsection 106.09.

Non-participating or ineligible costs are determined during preconstruction. During construction, the CAS Bureau in coordination with the FHWA establishes MDT issue resolution policy on an individual project basis. Project Managers work with headquarters to identify potential risk to eligible costs before Contractors are paid.

Public Convenience and Safety
Subsection 107.06, Standard Specifications

Project Managers must ensure Contractors minimize public hazards and inconvenience. Contractors should contact adjacent property owners to discuss construction impacts. Urban contracts often require Contractors to conduct public advisory programs. If requested by the District Office, a special provision may be included requiring Contractors to develop an informational website and local public awareness campaign.

Emergency Notification

Emergencies may involve public safety, work accidents, hazardous materials, environmental issues, landslides, law enforcement participation, archeological sites or wildfires. Before construction, Project Managers prepare an emergency notification list posted at project offices (Table 107-1). Project specific lists identify office locations and emergency phone contacts. District Offices should be called first. DAs may prefer to be contacted personally. Contact the appropriate jurisdictional law enforcement office.

Promptly notify first responders if an incident closes a highway or requires rerouting to county roads, and advise local county officials as soon as possible. If a railroad is involved, notify the County Commission. If a highway must be closed due to safety concerns, contact jurisdictional law enforcement. An MDT Maintenance Section may need to install traffic control.

Accident Reporting

Employees must report vehicle accidents or personal injury as soon as possible and by the end of shift. Accidents Involving State Owned Equipment: Employees operating equipment involved in the accident must use the Montana Department of Administration (MDA) “Incident Report” form available on the MDT Intranet website. This report must be submitted to the District Office and District Shop or Equipment Superintendent, then sent to the MDT Office of Occupational Safety and Health within 10 working days.

TABLE 107-1
EMERGENCY NOTIFICATION LIST

District Construction Engineer/Supervisor	____________
District Construction Operations Engineer	____________
District Environmental Engineering Specialist	____________
District Construction Reviewer	____________
MDT Traffic Control Engineer	____________
MDT Local Maintenance Section	____________
MDT Environmental Services Bureau	444-7203
MDT Archeologist	444-0455
MDT Historic Preservation Office (SHPO)	444-6258
MDT Hazardous Waste Section	444-9204
Department of Environ. Quality (DEQ) Enforcement	444-0379
DEQ Underground Storage Tank Office	444-1416
State Disaster & Emergency Services	324-4777
Local Montana Highway Patrol (MHP) office	____________
Police/Sheriff	____________
	After hours phone
–	
Malmstrom Air Force Base	(406) 731-2580
County Disaster Coordinator	____________
	After-hours
–	
County Commission Office	____________
	After-hours phone
–	
Local Fire Department or Response Office	____________
Railroad Company Offices____________	____________
____________	____________
Utilities in project area:	

	Electrical	__________
–		
	Natural gas	__________
–		
	Telephone	__________
–		

Personal Injuries to State Employees: Employees must report injury to Project Managers immediately. District/Area/Headquarters reporting personnel must report employee injury using the Montana State Fund form “First Report of Injury and Occupational Disease, Supplement to First Report of Injury and Occupational Disease, and Supervisor’s Investigation Report”. This report must be submitted to the Montana State Fund within six days after injury notification.

Incidents Involving State Owned Equipment or Property: Use the Montana Department of Administration “Incident Report” form to report incidents involving MDT equipment or personnel.

Incidents Involving Private Equipment or Personnel: Use the Montana Department of Administration “Incident Report” form to report vehicle, property or other losses. Use this form if the State may be involved with litigation. If the incident involves a citizen claim, the “Citizen Incident Notification” form must be completed by the citizen. Both forms must be completed when a citizen claim is made.

“Incident Report” form must be completed for incidents involving MDT personnel or property. The report must also be completed for incidents in which the State may be liable. MDT field personnel must record information to the best of their ability, but are not required to contact participants unless an incident directly involves MDT personnel or equipment. Guidance for completing “Incident Report” and “Citizen Incident” forms is located on the MDT Intranet. Severe injuries requiring transportation to a medical facility and fatal crashes require completion of the “Construction Zone Crash Documentation Checklist”, as well as crash site video documentation. Contact the Construction Traffic Control Engineer for additional guidance. Photograph or video signage in place during the accident, and locate related features. Submit report copies to the DCE and Construction Traffic Control Engineer.

If an incident occurs during working hours, employees overseeing construction zones or maintenance areas must complete a “Report of Incident” form. If the incident occurs outside working hours, Project Managers or Maintenance Chiefs may obtain information through the highway patrol or sheriff’s office to complete the report. The form must be signed by field personnel and the DA, and sent to the MDT Occupational Safety and Health Office.

Project Managers must report information to the MDA, and include weather conditions, project signing, posted speed limits, sign installation dates, condition of the traveled way and hazard warnings. Immediate supervisors investigate personal injuries as well as vehicle and equipment accidents. Supervisors should complete the MDT “Supervisor’s Investigation Report” form available on the MDT intranet.

Liaisons with Local Businesses and Residents

Project Managers hold meetings with local business owners and neighborhood associations at business establishments or local community centers. Project Managers should invite Contractors, affected businesses and residents, and encourage Contractor representatives to explain schedules and answer questions. Contractors should be aware of community concerns about project progress and impacts.

After construction, Project Managers should contact businesses and residents to ensure cleanup and property damage issues are resolved. Significant involvement by individuals or groups is best followed up with a letter expressing appreciation for their participation.

Construction Site Protection

Standard Specification Subsection 107.06 ensures reasonable construction site safety after working hours. Inspectors must enforce temporary fencing requirements. During nonworking hours, people must be reasonably prevented from entering construction areas. Temporary fencing should prevent accidental entrance into hazardous areas, and serve as a warning not to enter. Contractors should take safety precautions like removing ladders, blocking openings, and locking equipment. Meet with Contractors before earthwork operations to discuss public safety.

Railway and Highway Provisions
Subsection 107.07, Standard Specifications

Project Managers should contact the Utilities Section within the Headquarters ROW Bureau regarding railroad associated construction issues. Agreements between MDT and the Railroad Company are contingent upon two cases:

- No Existing Highway Easement; When construction is required on railroad facilities not subject to a highway easement, or when property rights are acquired, a Construction and Maintenance Agreement is required, which is commonly referred to as a “Railroad Highway Agreement.” This Agreement between MDT and the railroad assigns work to either Railroad or Contractor.
- Existing Highway Easement; When construction work is required within an existing highway easement obtained from a railroad, a Flagging Agreement is usually adequate if an existing Construction and Maintenance Agreement or easement covers the work area.

Contracts include a detailed, project specific special provision governing railroad impacts. Contractors should contact the railroad “road master” when dealing with railroad crossings. If construction is adjacent to or within railroad ROW, Contractors must notify the railroad and comply with contract provisions governing insurance requirements, grade crossings, mitigation, schedule coordination, track clearance and railroad flagger usage. The Department will pay for railroad flagging when required, but if flagging costs are due to Contractor failure to provide necessary notice, costs will be charged to the Contractor Construction on railroad ROW requires personnel to attend railroad training. MDT and Contractor personnel performing work within railroad ROW must have railroad “Contractor Orientation Course” certification, the cost of which is incidental to railroad ROW work items. Railroad tracks within MDT project limits should be surveyed prior to construction to document preexisting track location and elevation.

Load Restrictions
Subsection 107.08, Standard Specifications

The MCS stipulates size and weight restrictions by which Contractors must abide. Load weights are provided by Contractor load tickets. Project Manager or field crew should review delivery tickets and report violations to the MCS Division.

Oversize Vehicles

- If oversize loads are detoured, Project Managers must notify the MCS Division. Oversize and overweight vehicle frequency increases during the construction season, so provide MCS with timely restriction notices.

- Ordinarily, size and weight restrictions are identified within MDT weekly road reports submitted by the District, but restrictions often change during construction. In such cases, notify MCS as soon as possible. Project Managers should notify MCS of unexpected situations, and situations addressed by Special Provisions.
- MDT issues annual over width permits up to 15 feet (4.5 m) wide, in addition to other daily permits. Advance notice must be given to MCS when requesting annual permits. Providing sufficient lead time helps detours function smoothly and reduces complaints.

Load Limits

Concrete Structures, Pavements and Bases

No loads are allowed until curing is complete. Legal loads are allowed only after curing, except when overloads are allowed by an MDT issued, Contractor obtained permit.

Gravel Surfaces

Legal loads are not enforced for gravel surfaces not at finish grade. Contractors must repair damage from loaded vehicles and reduce loads if damage occurs. Legal weight requirements apply when gravel base is at finished grade.

Existing Asphalt Surfaces Within and Outside Project Limits, Public Roads Used as Haul Roads, Frontage Roads

Legal loads must not be exceeded except where allowed by permit. Axle combinations and loads are subject to bridge formulas. Maximum legal load requirements are 20,000 lbs per single axle, and 34,000 lbs per tandem axle.

Property and Landscape Protection and Restoration
Subsection 107.10, Standard Specifications

Adjacent Landowner Dealings

Contractors may enter private agreements with adjacent landowners for items unaddressed by the contract, such as material sources, haul roads, or parking areas. Project Managers should:

- Not become involved in agreements between contractors and citizens.
- Report legal or regulatory violations to the appropriate agency, and inform the Contractor of the report.
- Ask landowners to contact law enforcement regarding Contractor trespass.
- Advise landowners to consult a lawyer regarding Contractor nonpayment, and contact Legal Services with questions regarding Department involvement.

Irrigation Systems

Highway construction activities often affect irrigation systems. Potential impacts are usually addressed during negotiations between the ROW Bureau and landowners during preconstruction. Agreements are addressed by an “MDT ROW Agreement” (ROW Form 28), incorporated into the contract, and usually require Contractors not to interfere with irrigation during certain time periods. Contractors should contact water users within the project area to make sure construction activities will not obstruct water usage. Negotiated agreements assign irrigation users specific responsibilities to address impacts to gates, boxes and, channels. Users sometimes seek to replace deteriorated components with newer, higher quality ones at public expense. In such cases, MDT often agrees to cover some improvement cost.

The ROW Bureau may learn during construction that a private irrigation structure is without any agreement. These cases risk a landowner damage claim or lawsuit. When landowners express concern about irrigation impacts, Project Managers should gather field information before making landowner commitments, and provide information to the DCE and Legal Services if necessary. Standard Specification Subsection 104.05.6 discusses contract requirements regarding irrigation maintenance and noninterference.

Environmental Protection
Subsection 107.11, Standard Specifications

Environmental Services Bureau

The Environmental Services Bureau (ESB) performs environmental analyses and coordination during preconstruction to initiate environmental commitments, mitigation measures and permit obligations during construction. The ESB compiles this information into a project environmental document. Environmental factors influencing construction include environmental permit requirements, wetland mitigation, archaeological and historical site documentation and mitigation, hazardous waste disposal and underground storage tank assessment. The ESB secures environmental permits for highway and bridge projects during preconstruction, based on expected impacts. Contractors must obtain permits for environmental construction impacts. The ESB may be involved during construction if project environmental impacts change, environmental complaints arise, or environmental issues require further analyses. Contact the ESB or DEES if changes could affect environmental mitigation measures or permit obligations.

Wetlands Unit

When notified by the ECCB that an offsite wetland mitigation project has been awarded for construction, the Wetlands Unit coordinates with the Project Manager, Construction Headquarters and Contractor to conduct periodic construction contract monitoring and oversight. If construction reviews identify needed corrective action to comply with final plans, the Wetlands Unit coordinates with the Project Manager to ensure construction conforms to final design.

Historian/Archeologist

During construction, an MDT historian and archeologist ensure cultural resource avoidance commitments are fulfilled, and document historic and archaeological resource and mitigation measures.

Hazardous Waste Section

Projects involving hazardous material remediation during construction require a Hazardous Waste Section Analyst or consultant to provide oversight and ensure Contractor compliance with special provisions.

Noise Analyst

Noise Analysts coordinate with Project Managers to ensure special provision compliance related to traffic noise abatement measures and construction noise.

MDT Construction Personnel

MDT construction personnel ensure adherence to environmental commitments, mitigation measures and permit obligations. Not doing so may cause MDT and/or Contractor to deal with fines, work suspensions, change orders, poor public relations, and damaged state and federal agency relationships.

Before construction, Project Managers must review environmental provisions, permits, approvals, authorizations and agreements between MDT, government agencies and property owners. Project Managers must make sure field personnel have environmental information at the work site. MDT ensures construction permits are obtained by the Contractor with copies kept onsite, and Contractors do not violate permit terms. "Onsite" means at the project field office, or within an onsite MDT vehicle with Project Manager or Inspector. A permit copy may also be placed on the Contractor bulletin board.

Violations

Violations must be immediately reported. Failure to report violations may subject MDT to serious fines, or individuals to civil fines or prosecution. If a permit violation is witnessed:

- Notify the Project Manager and document using photos or videos
- Make Diary or Work Report (DWR) entries
- Notify the Contractor
- Notify the DCE
- Notify DEES or the MDT Environmental Services Bureau

District Office

District Environmental Engineering Specialist (DEES)

The DEES addresses environmental issues, and regulatory compliance for District construction and maintenance programs. The DEES assist DCE, DCOE, EPMs and construction personnel to address environmental project compliance, and:

- Attend Preconstruction Conference meetings to answer questions, and provide information regarding environmental permits, regulations, conditions and special provisions.
- Review Contractor submittals and temporary facilities permitting. DEES personnel also track permit authorizations and conditions, consult with Project Managers to request clarification or amendments, and oversee implementation and compliance.
- Conduct site reviews for temporary facility permit compliance, storm water permits, environmental requirement compliance, and coordinate with Project Managers to conduct field reviews and meet with regulatory personnel to discuss construction permitting.
- Assist Project Managers in adhering to MPDES "General Permit for Storm Water Discharge Associated with Small Municipal Separate Storm Sewer System (MS4) Permit" requirements within municipal areas.

District Biologist and Botanist

District Biologists and Botanists work with DEES and construction personnel to:

- Conduct field reviews for reclamation and planting specification compliance.
- Inform construction staff of specification goals and objectives.
- Verify compliance with plant survival specifications.
- Coordinate with seeding contractors.
- Wildlife
- Threatened and endangered species
- Water resources and wetland mitigation

District Projects Engineer

District Engineers coordinate with the DEES and construction personnel to oversee:

- Permanent facilities meeting Clean Water Act, Section 404 Permit requirements
- Properties protected by Section 4(f) of the DOT Act, or Section 6(f) of the Land and Water Conservation Fund Act
- National and Montana Environmental Policy Act (NEPA/MEPA) environmental document compliance

Environmental Resource Agencies

State and Federal agencies may inspect field construction, withdraw participation or delay project work. Problems can be avoided through personal contact and working relationships with representatives at the project level. The ESB is available to consult with resource agencies regarding project issues. Project Managers should consult with the Bureau and DEES to coordinate resource agency communication. Before project initiation and when coordinating with environmental agencies, MDT construction staff should:

- Explain construction work tasks and scheduling, invite local representative to tour the site, and contact local agency representatives to share contact information.
- Periodically update local representatives regarding project progress.
- Answer questions promptly.
- Provide representatives with project documents relating to work quality or contract administration, as stipulated by Agreement or MOU.
- Understand environmental agency jurisdictional authority.
- Address unanticipated construction impacts using Agreement and MOU procedure.

Occasionally agencies may request actions unaddressed by an agreement or MOU or violating MDT policy. If an issue is beyond Project Manager authority or cannot be resolved in the field, refer agency representatives to the DCE.

Water Pollution and Siltation Requirements
Subsection 107.11.2, Standard Specifications

State and Federal environmental agencies administer, manage and monitor legal requirements governing water pollution and pertaining to construction activity or permanent facility impact. For compliance questions, contact the DEES.

Construction Dewatering (Short Form C)
Subsection 107.11.2(A), Standard Specifications

Montana Statute (MCA 75-5-101 "Water Quality") establishes DEQ authority to protect, maintain and improve water quality and potability for water supplies, wildlife, aquatic life, agriculture, industry, recreation and other uses, and provide programs for water pollution prevention, abatement and control. DEQ requires Contractors to obtain a "General Discharge Permit" before dewatering.

The Construction Dewatering (Short Form C) permit is necessary if Contractors dewater by pumping into a drainage. Contractors must obtain a DEQ permit if pumped water returns to a drainage basin. Water should be discharged to an upland area and filtered through vegetation, or pumped to an evaporation pond. Contractors must submit a “plan and authorization letter” copy to Project Managers before working, and carry out water testing.

Short Term Construction Authorization (318)
Subsection 107.11.2(B), Standard Specifications

Montana Statute MCA 75-5-318 “Short Term Water Quality Standards for Turbidity” establishes DEQ authority to issue 318 Authorizations for turbidity due to construction or enhancement project stream impacts. Permittee activities must be in accordance with prescribed conditions to protect water quality and minimize sedimentation.

These rules allow a variance from state standards for short term construction activities. Almost any construction activity discoloring water violates these standards, and requires a variance. Excavation for riprap keyways or channel changes usually require a variance pertaining to installation method. MDT does not apply for or obtain variances due to short application and processing time. Contractors must apply for and comply with water quality variance terms. Project Managers must obtain variance copies before allowing variance related work. If construction causes short term turbidity within State waters, a Short Term Exemption (318) permit from DEQ must be obtained. The “Increase in Turbidity” special provision must be included if a short term construction permit is necessary.

Section 404 Permit
Subsection 107.11.2(C), Standard Specifications

The US Army Corps of Engineers (USACOE) Clean Water Act Section 404 regulates dredged material and fill within US waters. As needed, MDT secures Section 404 Permits for permanent structures such as bridges, culverts or riprap within US waters. Preconstruction 404 permit conditions are incorporated into the contract by Special Provision.

Contractors must apply for a USACOE permit for temporary work within waters of the US, including road and bridge construction and approach fills. Contractors submit 404 applications through the Project Manager and DEES for application review and amendment recommendations. Approved permit authorizations are received and forwarded to Project Manager and Contractor. “Waters of the United States” include areas between the ordinary high water mark, and may include perennial, intermittent and ephemeral streams, lakes, ponds, irrigation ditches and wetlands. If a “water of the US” may be impacted, contact the DEES or ESB. Enforcement actions may include cease and desist orders, fines and criminal penalties.

Erosion and Sediment Control

The NPDES (Clean Water Act Section 402) authorizes the US EPA to regulate pollutant discharges subject to US EPA effluent limitations, water pollution prevention and control objectives. Installation and maintenance requirements include erosion and sediment control during construction, until revegetation.

Under the Administrative Rules of Montana (ARM), DEQ administers the MPDES “General Permit for Storm Water Discharges Associated with Construction Activity,” commonly known as “General Storm Water Permit” for areas outside Indian Reservation lands, for which the EPA administers permitting authority. A General Storm Water Permit is required for construction activities disturbing one acre or more or having a potential to discharge to State water.

NPDES/MPDES requires that best soil erosion and sediment control practices be applied to highway construction. MDT best management practices require comprehensive erosion control plans, and erosion control measure installation.

Montana Stream Protection Act

The Montana Stream Protection Act (SPA 124) requires MT FWP approval for projects affecting streams or tributaries, and requires FWP approval for highway plans during preconstruction. Montana State Statute establishes FWP authority to require SPA 124 Notification submission for projects affecting Montana streams or tributaries. FWP approval is often subject to conditions explaining work timing and methods, which are included as special provisions during bid letting. SPA 124 authorization notification obtained during preconstruction may not specify construction method(s) or temporary impact(s), as they are commonly unknown during permit application. Contractors must apply for authorization to temporarily impact a drainage or its tributaries, or to use construction methods installing permanent features. Contractors complete and submit SPA 124 applications to the DEES through Project Managers.

Flood Plains

Federal law governing flood plains is administered by local officials, usually county commissioners, with Montana DNRC oversight. A permit or approval is required for construction within flood plains, and obtained during preconstruction by MDT for permanent work. To comply with the Flood Plain Management Act, Contractors must obtain approval for temporary work facilities such as haul roads or work bridges.

Municipal Separate Storm Sewer Systems (MS4)

Polluted stormwater runoff flowing through Municipal Separate Storm Sewer Systems (MS4s) is often discharged untreated into water bodies. To prevent pollutants from entering an MS4, operators must obtain a NPDES permit, and develop stormwater management programs to reduce runoff contamination and pollutant discharge. An MS4 is a conveyance or system of conveyances:

- Owned by a state, city, town, or other public entity discharging to US waters.
- Collecting or conveying stormwater through storm drains, pipes, and ditches.
- Not in combination with a sewer.
- Not part of publicly owned treatment works, such as a sewage treatment plant.

In Montana, the DEQ designates areas to be regulated as MS4s, although local authorities may implement additional requirements or require permits within designated urban areas. Contractors must comply with these additional measures. Contract documents include a special provision regarding this requirement, but Contractors should contact the DEES with questions about MS4 permitted areas.

Environmental Complaints

External entities such as the Montana DEQ or the public may file complaints regarding environmental construction impacts. Dust, open burning, fuel spills and discharge to streams or water bodies may be cited. MDT Inspectors should identify environmental issues that could result in a complaint. When a complaint or an issue that could cause a complaint is identified, Project Managers should contact the DEES. MDT environmental personnel coordinate with Project Managers, DCE, and regulatory and agencies to discuss options for complaint mitigation, such as dust suppression, open burning limitations or emission control. Project Managers oversee corrective action(s) to resolve complaints and ensure regulatory compliance.

Environmental Impact Changes

The nature of construction may change due to seasonal construction, or additional construction activities, and may cause unanticipated impacts. If construction changes alter environmental impact, Project Managers notify the ESB, to:

- Coordinate with Project Managers to identify proposed construction changes and identify impacted environmental resources.
- Conduct field reviews to evaluate environmental impacts.
- Identify environmental actions to ensure compliance.
- Coordinate with Project Managers to minimize and mitigate unavoidable impacts.
- Coordinate with regulatory and resource agencies to address compliance.
- Advise Project Managers when environmental assessment is complete.

Air Quality
Subsection 107.11.3, Standard Specifications

Contractors must obtain air quality permits to crush aggregate and operate hot plants before these activities. The Montana DEQ requires public notice for permit applications, which may take months, so Contractors should apply for air quality permits as soon as possible. Permits are required for specific locations, and are not transferrable to other locations. Project Managers should request permit copies from Contractors prior to operations. All projects include a standard dust control special provision.

Noxious Weeds
Subsections 107.11.5 and 107.11.6, Standard Specifications

MDT includes a special provision with grading projects for noxious weed management (Subsection 107.11.5, Standard Specifications) and noxious weed control (Subsection 107.11.6, Standard Specifications).

Forest Protection
Subsection 107.12, Standard Specifications

Contractor and MDT personnel must have fire extinguishers available when working around dry vegetation and during periods of high fire danger.

Insurance Requirements
Subsection 107.13, Standard Specifications

Construction is not allowed until Contractors are fully insured. If insurance lapses, construction activities must stop until insurance is reinstated. Contractors must obtain and submit Owner and Contractor Protective (OCP) liability insurance at contract award for work on behalf of the State of Montana, the Department, its agents, employees and officers. The CAS Bureau tracks insurance expiration dates, but Project Managers should verify Contractor insurance, and coordinate with CAS to track expiration dates, especially when projects span multiple construction seasons. Notify the Project Manager of expired insurance, issue a stop work order and if necessary withhold payment until issue resolution. Work cannot take place within 25 feet (7.5 m) of railways on project routes until Contractors have obtained a railroad protective policy.

Third Party Beneficiary Clause
Subsection 107.14, Standard Specifications

Damage Claim Responsibility
Subsection 107.15, Standard Specifications

Damage claims against Contractors may be received by MDT Project Managers from public citizens, adjacent landowners, pedestrians, municipalities, utilities, or other Contractors. Vehicular damage claims should be submitted to Contractors for submission to the Contractor insurance carrier. Contractors opting to pay for repair should repair property damage to owner satisfaction, and provide a letter to the Project Manager from the owner resolving the claim. For unresolved damage claims, Contractors must submit a written report and repair estimate.

Opening Project Sections to Traffic
Subsection 107.16, Standard Specifications

Contractor Work Responsibility Subsection 107.17
Standard Specifications

Contractor Responsibility for Utility Property and Services
Subsection 107.18, Standard Specifications

Utility Locates are required for all projects. MDT locates Department owned utilities, but Contractors must locate remaining utilities. Utility companies are notified of construction, and invited to weekly progress meetings to coordinate relocations or new utility construction. Utilities may be discovered during construction.

Furnishing ROW
Subsection 107.19, Standard Specifications

Public Official Personal Liability
Subsection 107.20, Standard Specifications

No Waiver of Legal Rights
Subsection 107.21, Standard Specifications

Archeological and Historical Finding Protection
Subsection 107.22, Standard Specifications

Federal and state regulations require archaeological resource protection and mitigation during project construction. Take immediate action to preserve the site if prehistoric remains, dwelling sites or historic or cultural evidence is discovered. Contractor operations near the site must be stopped to avoid damage. Soon after site discovery, notify an MDT archaeologist to provide inspection and documentation. A Historian or Archaeologist will initiate field studies to evaluate site significance, and mitigative action. Within 48 hours of discovery, the State Historic Preservation Officer (SHPO) and/or Tribal Historic Preservation Officer (THPO), native tribes attaching religious or cultural significance to the site, and the Advisory Council on Historic Preservation (ACHP) are notified. This notification describes National Register of Historic Places (NRHP) site eligibility, as well as measures to avoid adverse effects. The SHPO/THPO, Indian tribe(s) and ACHP respond within 48 hours of notification. Artifact discovery on Tribal lands during construction requires examination by a Historian and/or Archaeologist to comply with Tribal regulation and obtain tribal concurrence regarding proposed action(s).

Underground Storage Tank Discovery
Subsection 107.23, Standard Specifications

Underground storage tanks (USTs) discovered during construction within project ROW, require Contractors to stop work near the UST and notify the Project Manager, who then notifies the ESB Hazardous Waste Section (HWS).

The HWS investigates the UST(s) and completes a Montana DEQ “Notification of Underground Storage Tanks” form, submits it to the DEQ and completes a DEQ “Closure Permit Application for Underground Storage Tanks.” After DEQ review and application approval, a permit is issued for UST removal. Upon receiving a UST Closure Permit from DEQ, the HWS hires a licensed tank removal contractor to remove the tank. The HWS provides UST removal oversight and notifies the Project Manager when tank removal is complete and construction can proceed.

Unknown Hazardous Material Discovery and Removal
Subsection 107.24, Standard Specifications

Contaminated Soil or Groundwater

If required by the ESB, contracts include a special provision addressing contaminated soil or groundwater encountered during construction. Contractors must stop work at contaminated locations and notify the Project Manager, who notifies the ESB Hazardous Waste Section (HWS) to evaluate contamination by conducting historic land use research, gathering information about the contaminated area, and conducting subsurface investigation to characterize contamination within MDT ROW. If contamination is not hazardous and does not involve petroleum contaminants, the HWS documents findings and provides a copy to the Project Manager advising that construction proceed. If contamination is hazardous and/or involves hydrocarbon products, the HWS notifies applicable regulatory agencies and works with the Contractor or separate environmental contractor to mitigate contamination according to a regulatory work plan. Contamination mitigation is only conducted in areas affected by project construction, and cleanup does not extend beyond project completion limits. When cleanup as required by regulatory agencies is completed, the HWS informs the Project Manager cleanup is complete and construction can continue.

Asbestos Inspection and Abatement

The Hazardous Waste Section within the Environmental Services Bureau identifies and addresses asbestos contamination before letting.

Lead Paint Removal

The Hazardous Waste Section is involved in lead based paint removal from MDT steel bridge structures. Before project initiation, the HWS collects paint samples to determine lead content and provides test results to the Project Manager. If lead paint is present, HWS coordinates with Construction to evaluate alternatives allowing lead based paint to remain. If feasible, Construction may leave lead paint to remain. If paint must be removed, the HWS includes a special provision requiring compliance with environmental regulation for removal, containment, collection, storage, and disposal. HWS may also coordinate with Construction headquarters to monitor prime Contractor work, ensure compliance with contract special provisions, and provide waste transport and disposal documentation to the Project Manager.

Access to Contractor Records
Subsection 107.25, Standard Specifications

CERCLA Claims and Liability
Subsection 107.26, Standard Specifications

Project Diesel Fuel
Subsection 107.27, Standard Specification

SECTION 108
PROSECUTION AND PROGRESS

Subcontracting or Contract Assignment
Subsection 108.01, Standard Specifications

A Subcontractor is any entity to which a Contractor subcontracts, assigns or disposes work. “Work” is furnishing all resources to complete the project, including labor, equipment and materials. Subcontracts are required for any person or entity on the project site for project work, unless that person or entity is paid by the Contractor or Subcontractor.

Objectives for Requiring Subcontracts

Legal Agreements with Subcontractors must:

- Meet FHWA Form 1273 requirements during Federal aid contracts.
- Allow MDT to ensure Contractors perform a minimum amount of prime contract work, as required by Standard Specification Subsection 108.01.
- Allow the Civil Rights Bureau to monitor Contractor DBE requirement compliance.
- Allow Project Managers to ensure Subcontractors only perform subcontracted work.
- Track workers against certified payrolls.

Subcontract Work Identification

A subcontractor is a person, firm, or supplier obligated to perform contract work using chosen work methods, except as restricted by contract documents. Labor and equipment are furnished and controlled by the Subcontractor under prime Contractor supervision include:

- Personnel under direct Subcontractor supervision, and included on Subcontractor payroll.
  Work requiring a subcontract may include:
- Contract items or contract item portions performed by an entity other than the prime Contractor.
- Crushing operations at a dedicated site.
- Operations on the project site.
- Change order work.
- Surveying if not performed by prime Contractor.
- Consultant services at the project site enlisted by the prime Contractor or Subcontractor.
- Work items covered by professional service contracts or purchase order.
  Resources not requiring subcontracts include:
- Commercially supplied materials
- Equipment rentals
- Haul truck owners and operators

Material Suppliers

Material suppliers deliver materials to the project site, but do not install or set materials in place. For example, a commercial asphalt plant supplying asphalt paving materials cannot laydown plant mix. Trucks may load the machine, and independent truckers may work for the material supplier, but either Contractor or Subcontractor must place and compact plant mix. The CAS Bureau provides clarification regarding subcontracting requirements.

Assignment or Contract Sub-letting

Change ordered, sub-Subcontracted or specialty work within the contract is not considered subcontracted. Subcontracts may not begin until evaluated by the Construction Administration Services (CAS) Bureau. Prime contract provisions relating to wage rates, labor laws, EEO, or training requirements must be included in any subcontract or sub-Subcontract.

Payroll Issues

The Civil Rights Bureau requires certified payroll submission, compliance with the Davis-Bacon wage rate and fringe benefits during federal aid projects. Project Managers should not confuse these requirements with MDT subcontract agreement policies governing subcontracts. Contact the Civil Rights Bureau for clarification.

Site Manager

AASHTOware and Site Manager track and document both prime and subcontracted construction work. The MDT Site Manager Training Manual Section No. 7 teaches users to view, modify and delete subcontract data.

Control Over Subcontracts

Subcontractors cannot be selected within SiteManager DWRs unless a work item has been subcontracted, which allows Project Managers to track subcontracted work. If a Subcontractor performs only a portion of the work item, the portion is noted within the subcontract item "Remarks."

DBE Requirements

DBE requirements are part of every MDT contract. The Civil Rights Bureau administers DBE program compliance, but the Bureau itself relies on MDT personnel, especially Project Managers, to track project performance and prevent DBE program violations. MDT Site Manager Training Manual Section 7 describes Project Manager inputs to Site Manager to monitor Contractor DBE compliance.

Notice to Proceed
Subsection 108.02, Standard Specifications

Post Award Activities

Standard Specification Subsection 103.02 discusses contract award and execution. The Engineering Construction Contracting Bureau (ECCB) submits executed contract copies, award letters, and insurance memos to the District Construction Engineer and Project Manager. Project Managers must ensure Contractor and Subcontractor do not begin permitted work until permits are obtained.

Site Manager Contract Activation

MDT Site Manager Training Manual Section 6 discusses contract activation. Shortly after award, Construction Administration Services (CAS) designates the project as "active", prompting Project Managers to perform contract activities.

Notice to Proceed (NTP) Date

When Contractors have satisfied bond and insurance requirements, the Engineering Construction Contracting Bureau (ECCB) transfers projects to the CAS Bureau, which sends the notice and date to proceed to Contractors immediately after award. The NTP date is approximately 20 working days after award. The NTP lists contract requirements per Standard Specification and ensures projects are properly initiated by emphasizing basic contractual requirements. Unless amended, the NTP date initiates contract time.

Notice to Proceed (NTP) Adjustments

No work may be performed within the ROW before the NTP date, including mobilization and traffic control installation. If Standard Specification Subsections 103.07, 108.01.2 and 108.03 requirements are met, work may begin sooner via change order, without affecting contract time. Contract start time for flex time contracts is the NTP date, unless Contractors choose to start work earlier. Contractors may select an earlier date as allowed by contract if Subsection 103.07, 108.01.2 and 108.03 requirements are met. If an earlier date is approved, Project Managers must notify the CAS Bureau to update NTP information.

Work Begin Date

"Begin Work Date" within Site Manager is the date a Contractor begins work within project limits. It cannot be earlier than the Notice to Proceed date, unless adjusted as above. This date is registered within SiteManager when the first work item is recorded on a DWR, at which time the system automatically sends an email to the distribution list indicating that project work has begun.

Contract Time Charge Initiation

Project time starts to accrue on the NTP date. As per Standard Specification Subsection 108.03.2, Contractors may request to start work before the NTP date.

Conditions Beyond Contractor Control

Standard Specification Subsection 108.02 states that contract time is not charged if work cannot begin on the NTP date for "reasons beyond Contractor control". Contract time determination applies to temporary facility permitting within project limits only. Contractor facility permitting outside project limits is outside the contract, and not considered in relation to contract time assessment. Project Managers must determine if Contractors have finished the permitting process in a timely, complete and competent manner. Change orders are usually not required for this situation, but information should be documented within Site Manager.

Work Prosecution
Subsection 108.03, Standard Specifications

Preconstruction Conference
Subsection 108.03.1, Standard Specifications

Subsection 108.03.1 requires preconstruction conferences be held between Contractor, Department and other interested parties. This conference is held for all contracts no later than 20 days after the NTP date, and must occur before work within project limits begins. Project Managers schedule and arrange a preconstruction conference with the Contractor when a contract is executed but before work begins.

Preconstruction Conference Attendees

Project Managers may invite representatives from the following entities to the preconstruction conference:

- Civil Rights Bureau
- MCS Division
- Railroad Companies
- Utility Companies
- FHWA
- Superintendent and Contractor necessary representatives.

- MDT Maintenance
- DEES
- MDT District or Area Lab Supervisor
- DCE
- CES Reviewer
- Local county and municipal government or Federal officials
- Tribal representative(s)
- Design Project Manager
- MDT Consultant Design Bureau
- Contractors working adjacent or nearby projects
- Project Inspectors
- District Administrator
- Construction Engineer and/or Headquarters Construction Program
- Law enforcement
- Business owners
- Other MDT Bureaus

Meeting Agenda

DCEs should prepare to discuss critical issues with Design Project Managers, summarize the project, review the contract to emphasize key project elements, and address Contractor questions or arrange to provide additional information.

Preconstruction Conference Checklist

Preconstruction conferences enhance coordination and communication. Use appendix A as a guide to conduct the conference.

Site Manager

MDT Site Manager Training Manual Section No. 7 discusses the Site Manager user interface and outlines conference procedure.

Project Schedules
Subsections 108.03.2 and 108.03.3, Standard Specifications

Project schedules are critical to project management. Contractors must submit schedules satisfying Standard Specification Subsection 108.03 requirements at or before the preconstruction conference. No work may begin within project limits until scheduling requirements are met. Scheduling may have significant impacts to MDT and the public, including:

- Labor and equipment construction costs to MDT
- Public traffic disruption and user costs
- Construction impacts to businesses and residences
- A negative reflection on MDT with delayed project completion.

Contract Time Types

MDT assigns contract time as “working days”, “calendar days” or by “date of completion”. MDT contract time determination procedures within Standard Specification Section 101 define contract time in detail.

Contract Time Determination

Contract time is estimated during project preconstruction. After design project managers coordinate with MDT units, local agencies, utilities, and railroads, “Board of Review” committee reviews, adjusts, and approves contract time as discussed within the “MDT Contract Time Determination Procedures”. Contract time determinations are made based on past production rates, job tasks and sequencing, and project specific issues. Contractors must submit a project schedule to MDT.

Activities Schedule Chart
Subsection 108.03.2, Standard Specifications

MDT contracts must have a critical path. Contractors must submit the following at or before the preconstruction conference:

- Activities Schedule Chart (ASC). A chronologically sequenced, time scaled bar chart showing significant project activity and duration relationships.
- Bar charts lacking necessary information are unacceptable. Contractors must resubmit an ASC reflecting contract limiting dates and events, such as concrete cutoff dates or irrigation timeframes. Project Managers must be able to clearly ascertain when specific work will transpire.
- Written Narrative (WN). A written description submitted with the ASC describing proposed work sequence, activity relationships and durations, and work methods. A WN must detail specific activity changes, including changes to original activity durations and change orders since the last ASC update, and enable Project Managers to anticipate personnel needs.

Critical Path Method (CPM)
Subsection 108.03.2 (B), Standard Specifications

MDT contracts may require a CPM schedule for complex projects, which must include:

- Critical Path. The activity sequence through the schedule to accommodate all task durations and produce a minimum project duration. Activities having zero float define the critical path.
- CPM. Planning and scheduling based on activity relationships and durations along the critical path.

MDT Procedures

The MDT website displays CPM information to help construction staff understand and review CPM scheduling. The site offers information pertaining to terminology and principles, activity definitions and durations, long duration sequencing, scheduling activities, critical path and float computation, contractor schedule reviews and updates, “look ahead” schedules, critical activity schedules and change order extensions.

MDT must review Contractor progress and demand realistic work schedules. Standard Specifications allow MDT to request an updated schedule if work has not progressed as indicated. MDT must ensure accurate schedules with required information. Contractors must resubmit inadequate schedules.

Initial MDT Review

MDT reviews Contractor scheduling for completeness and reasonability, but does not evaluate Contractor assumptions, production rates, labor or equipment. Project Managers must receive an initial schedule as required by the “Contractor Table of Submittals”, which requires an initial schedule be submitted 7 calendar days before the preconstruction conference. Project Managers reviewing schedules should refer to the MDT Critical Path Method (CPM) Scheduling Manual. Project Managers should meet with a Contractor Superintendent or Scheduler to request a schedule review.

Schedule Updates and Progress Payments

Monthly schedule updates must be submitted to reflect construction changes and meet the project completion date. Schedule reviews should reveal if a planned completion date is realistic. Project Managers should request corrective action if a scheduling updates indicate Contractor progress is lagging, and ensure field staff are familiar with and informed about critical path activity status. Whenever a Contractor is not working on a critical path activity, contract completion may be at risk. Schedules and written narratives help identify and evaluate delays, and updates may help avoid claims. Project Managers should document if and why Contractors are not working on critical path activities, and may suspend work if project scheduling does not accurately reflect the work. Late CPM or ASC schedule update submissions are assigned monthly deductions, in accordance with Standard Specification Table 108-1A.

Operation Limitations
Subsection 108.04, Standard Specifications

This subsection discusses public safety and convenience issues mentioned within Standard Specification Subsections 104.05 and 107.06. Special provisions may restrict working hours.

Worker Character

Standard Specification Subsection 108.05 grants MDT authority to remove Contractor personnel if work is improperly performed, or workers are intemperate, disorderly, or abusive. Project Managers assess whether Contractor personnel are trained and certified as required, but situations involving underqualified or uncertified Contractor employees should be reviewed by the DCE or Legal Services. If employee removal is necessary, submit a written request the problem employee be removed from the project. Project Managers may suspend work until a problem employee is removed. Factually document circumstances leading to the decision, and avoid voicing personal opinion.

MDT field personnel generally cannot require Contractors to use specific construction methods or equipment, unless allowed by the contract. For commonly used equipment, construction staff should:

- Verify Contractor has provided required equipment.
- Verify equipment is sufficient in terms of capacity and number to perform continuous and timely work.
- Verify Contractors maintain equipment to minimize breakdown delays.

Methods and Equipment

MDT staff must never operate or adjust Contractor equipment.
If Contractor equipment issues are observed, Inspectors should document information within the DWR “Contractor Equipment Tab.”

Project Managers assess daily contract time to help monitor Contractor progress and identify delays triggering liquidated damage assessment. Project Managers should issue a weekly report (Form CSB_108_2, Section 9, MDT Site Manager Training Manual) to Contractors documenting time assessment between April 16 and November 15 after the NTP. Project Managers often explain time charges within the report, and each day must be assessed as chargeable or not chargeable. Some work like chip seals and seeding may proceed during work suspension. In such cases, contract time assessment is issued on the last chargeable day, and stipulates when project time will resume.

Working Day Contracts
Subsection 108.07.3, Standard Specifications

Working days are judged individually and assessed against contract time, excepting days during which inclement weather or its aftermath prevents operations. A working day will not be assessed if work is suspended, or the work crew is dismissed due to inclement weather before four work hours transpire. Explain clearly in the work diary reasons for suspending project time. Do not cite “weather” without explaining how weather impeded the work. If inclement weather included high winds that made paint or vegetative mulch application impractical, note as such in the diary.

Working day charges when Contractors are absent from the project are evaluated by judging whether work activities could have taken place if the Contractor was present.

Calendar Day Contracts

Every calendar day is a “day,” except those designated otherwise, but weather must still be noted in the Diary.

Work Suspensions

Project Managers decide when to suspend and resume work. See Standard Specification Subsection 105.01 for situations during which work may be suspended. If suspension is necessary for reasons beyond Contractor control, Project Managers must document decision rationale within the DWR Info tab. When issuing a work suspension, Project Managers should cite a work resumption date. When work is suspended for reasons within Contractor control, project working days are charged. Noncompliant materials, failure to have materials available, inadequate manpower or equipment, or failure to comply with Project Manager directives constitute work suspensions “within Contractor control”. Work suspension notification in such cases must be issued in writing and notify the Contractor of deficiencies triggering the suspension. Time charges during work suspension for reasons within Contractor control are reported in Site Manager or AASHTOware.

When the reason for suspension no longer exists, a written resume work authorization is issued. Should the Contractor suspend work without Project Manager direction, contract time continues to accrue. Contractors are responsible for damage to the work during Contractor initiated suspensions. If work is suspended indefinitely, Contractors are required to protect the work by providing drainage, opening ditches, installing shoulder drains or taking Project Manager directed precautions. Contractors should store materials to avoid public hazard, damage and theft. MDT is not responsible for stored materials. Standard Specification Subsection 104.02.2 discusses the Contractor right to request additional compensation and/or contract time for work suspension considered unreasonable.

Contract Time Suspension

If time is suspended, Project Managers document nonchargeable days and suspension rationale within the Diary. Contractors may accomplish partial work such as stockpiling or emergency repairs during work suspension, but must continue to meet environmental requirements.

Final Acceptance Date

Final Acceptance is granted when Project Manager and Contractor agree punch list work is complete, and is the date physical contract work is complete. The Contractor "Certificate of Work Completion Form" (CSB 105_17_2) must be completed by Contractor and approved by Project Manager. Contract time charges are discontinued after the final acceptance date. Project Managers may suspend contract time when only punch list work items remain, depending on the quantity and magnitude of the items. If a Contractor does not submit the "Certificate of Work Complete" form in a timely manner, time assessment may continue.

Failure to Complete on Time
Subsection 108.08, Standard Specifications

Standard Specification Subsection 108.08 discusses the MDT right to assess liquidated damages against Contractors using more time than allowed to complete work. Liquidated damage assessment allows MDT to recover costs resulting from additional project completion time. The CAS Bureau evaluates and implements liquidated damages, often soliciting Project Manager opinions. Project Managers are required to assess contract time in accordance with contract terms, but may only alter contract time through change order.

Contractor Default
Subsection 108.09, Standard Specifications

Termination for Public Convenience
Subsection 108.10, Standard Specifications

Project Managers must issue written notice if a contract is terminated for public convenience, which must include an effective date and appropriate directives. Project Manager, DCE and DA will seek MDT Legal staff guidance when drafting written notice. All contract work is stopped, except work needing completion before termination.

Work the Project Manager deems necessary to secure the project for termination, and ensure safety, permanent traffic control, a passable roadway surface, and approach access must be completed.

Equipment must be removed from the site, and materials protected. Subcontractors and suppliers must be notified of contract termination, and that contracts or orders will only be carried by Project Manager written authorization. Project Manager is provided with a list of unused materials previously produced, purchased or ordered from suppliers, along with material storage locations and other requested information. The Project Manager may either:

- Request material invoices and pay Contractor invoice prices adjusted by materials in storage payments made to date, after which time MDT owns the material.
- Request the Contractor provide invoices for restocking fees covered by the Department.

Unused materials must be removed as directed, including materials not meeting contract requirements or without Departmental value. Inform contractors that termination cost submittals must comply with Standard Specification 108.10.2.

Payment

Payment at contract unit prices is made for completed work.

Equitable adjustment for partially completed work items and material disposal is paid under Standard Specification Subsection 109.05, which covers partial or terminated work payment. Payment is made for completed work units at contract bid prices. If Project Manager determines units are inappropriate for performed work, an agreed price may be used. If unit prices are not used, and no agreed price is used, Project Managers determine an equitable adjustment under Standard Specification Subsection 109.04.3. Payment is usually paid under contract unit prices by prorating partially completed lump sum work.

To cover direct costs based on a Contractor submitted written list of direct costs incurred to terminate work, excluding costs paid under completed work items. Total payment for any item cannot exceed the bid price or adjusted price by change order. To calculate payment for incomplete bid items, use the total item cost, less the unperformed work value, minus the amount already paid for completed portions. Total Contractor payment cannot exceed the contract price plus change order modifications, minus amounts paid by previous estimates. The Department does not cover anticipated profit losses for incomplete work items.

Project Managers may pay for unused materials ordered before termination by Paying Contractor invoice prices plus material storage payments to date, after which the Department owns the material, or by requesting the Contractor provide restocking invoices.

SECTION 109
MEASUREMENT AND PAYMENT

Quantity Measurement
Subsection 109.01, Standard Specifications

Work tasks are measured and paid in units referred to as a “work items”. Contract documents specify a measurement unit and task for each work item. Work items are measured by number, length, area, volume, weight or lump sum. Project Managers and Inspectors verify by measurement item quantities installed by the Contractor. Discrepancies often exist between estimated contract quantities and as-built quantities. If necessary, Project Managers should contact Design Project Managers to discuss work item quantities. Project Managers should request backup quantity information to determine planned quantities or investigate item discrepancies.

Measurement Methods

Contract specifications specify measurement methods used to determine work item quantities eligible for payment. Measurement methods usually measure key material unit quantities for each pay item, or measure completed work as a single unit. A change in measurement unit constitutes a contractual change, and requires a change order. Requests for measurement method changes should be in writing from the Contractor.

Measurement methods may or may not represent used material quantities. For example, structural backfill is measured based on the MDT Detailed Drawings, which show vertical fill limits adjacent to structures. In reality, excavations are sloped beside structures so backfill volumes always exceed measured payment amounts. Contractors may over excavate to place additional structural backfill. Additional quantities are documented for testing, but not for payment.

When detailed drawings are used to indicate specific item quantities, drawing quantities are used instead of in place field measurements. However, if items unique to a project differ obviously from a detailed drawing, quantities are measured. If plan quantities are unavailable, detailed drawing quantities and dimensions are used by default. Quantities on detailed drawings are typically generic. For generic items such as “right-turn only” arrows and signs, standard detailed drawing quantities work well.

The DCE should be contacted for clarification when item measurement or payment issues arise. Refer such issues to the CES Bureau if unresolvable at the District level.

Measurement Units

Always use measurement units (US Customary or metric) specified within the contract.

Measurement Accuracy

Accurate pay quantity measurement is an important Inspector task, as measurement inaccuracies may lead to Contractor under or overpayments. Measure and calculate contract item quantities to a degree of accuracy consistent with the contract item price. Project Managers must establish degrees of accuracy so item measurement and calculation is carried out uniformly. See Standard Specification Table 109-1A, Departmental “Pay Unit Rounding” criteria.

Site Manager and AASHTOware Documentation

MDT Site Manager Training Manual Section 2 discusses DWR viewing. DWRs record daily item quantities Project Managers can review for accuracy and acceptance. In Site Manager or AASHTOware, once Project Managers authorize a DWR, contract item quantities are incorporated into payment estimates.

MDT Site Manager Training Manual Sections 3 and 5 describe daily DWR creation and recording using three Site Manager applications:

- **DWR creation using a template**. Section 3 describes DWR template types based on bid item measurement. When available, Inspectors must use these templates for documenting pay quantities.
- **DWR using an accompanying spreadsheet**. Section 3 describes Site Manager usage for contract items lending themselves to spreadsheet calculation. Spreadsheets are specific to pay items, so variations are not allowed. Standardized spreadsheets must be used if a template is unavailable or supporting pay item documentation is needed.
- **Pipeline.** Section 5 describes the Site Manager pipeline process for automated quantity transfers from DWRs used for compiling progress estimates.

Pay quantity documentation is subject to audit and review, so must be complete, accurate, organized and understood by personnel unfamiliar with the project. Contract quantities must have written data to support payment. DWRs should include station, installation date and measurement method in tons, cubic yard, square yard, lump sum, pounds or by each.

Monthly Quantity Estimates

Pay estimates over $500 are issued by Project Managers based on approved work documentation and Project Manager completed work assessment. Project Manager and Contractor should be in agreement regarding estimate quantities, and Contractors may discuss quantity estimate calculations with Project Managers. Unless contract documents specify otherwise, pay estimate quantities are generated from measured, calculated and Project Manager approved quantities. Disagreements should be addressed promptly. Field personnel use DWRs within Site Manager or AASHTOware to track placed quantities based on field measurement, load tickets and survey information. Lump sum items require dates and work descriptions, as well as labor and equipment costs to complete the work.

Weighing Equipment
Subsection 109.01.1, Standard Specifications

For contract items involving bulk materials such as asphalt or mineral admixtures, payment is based on weight. Material is weighed on scales either owned or leased by Contractor or material supplier. When payment for material such as CAC is made on a weight basis, MDT provides a scale witness. For other bulk materials, MDT requires an Inspector to monitor Contractor payment weights. Inspectors must ensure scales are certified and operated correctly, accrued material amounts are tracked daily, and contractor weight tickets are correct.

Scale Accuracy and Calibration

Accurate weight measurement requires calibrated scales and known tare weight. Truck tare weights should confirmed twice daily, or as deemed necessary by the Project Manager. Scale approaches must be level and accommodate entire haul units. Platform scale surfaces and areas between scale frames must move freely to yield accurate readings

Scales

Truck scales must be certified by the Montana Bureau of Weights and Measures (BWM), or by a certified scale service within 12 months of recording weight, and the system must be sealed after adjustments and/or testing is completed. Scale setups and relocations must be licensed and certified by the BWM or certified scale service before scales are used. If MDT personnel feel scales are not accurate, stop weighing. The BWM or a certified scale service should inspect the system at Contractor request. Contractors must set up, certify, operate, maintain, adjust and repair scales.

Weighing

Load tickets should include project number, truck number, time, source, date, material type, waste or rejected material, and net weight. Written notes justifying rejected material should be on the load ticket, and initialed and dated by the Inspector.

QA item daily and accumulated item quantity totals are entered into the QA Suite. Non-QA items are recorded in the DWR. If QA Suite and progress estimate quantities do not match, the discrepancy must be Inspector documented. Weighing operation and tare weight spot checks should be made depending on material type and quantity weighed daily. Verification frequency is at Project Manager discretion.

Scope of Payment
Subsection 109.02, Standard Specifications

As necessary, field personnel should discuss payment method with the Contractor. For example, drainage work may be paid per linear foot to include all pipe trench excavation, shoring, granular backfill, trench backfill, pipe and other work items, some of which could also be paid for separately as structural backfill. Contractors do not receive payment for separate work items such as granular backfill because this cost is included within the price per trench foot. MDT pays monthly for completed work, but payment does not constitute acceptance. The Department has a right, until final acceptance (Standard Specification Subsection 105.15), to require corrective work after work payment.

Quantities shown within contract documents are estimates of work required to complete the contract, and in place quantities may differ from estimated quantities. Standard Specification Subsection 104.02 discusses unit price adjustments when quantities under or overrun estimated amounts, are deleted, or work is added. Underruns generally increase unit prices, whereas overruns lower unit prices. Whether contract items are "major" or "minor" may impact unit price adjustment.

Extra Work Payment
Subsections 109.04, 104.02.4 and 104.03, Standard Specifications

Project Managers may substantiate Contractor submitted prices by referring to "Contract Bid Tabs Summary" history located on the MDT Intranet, and "Weighted Average Unit Bid Prices" located on the MDT Internet under "Contracting/Consulting/Letting Info/Q&A Forum/Archived Bid.

Payment Method

Contractors are paid by:

Unit Prices within the bidding schedule, which establish unit item prices to pay for extra work. Unit prices are used when a construction material, such as cubic yards concrete, is calculated to pay the Contractor based on work quantified in advance. Detailed cost analysis and revised design details may be required.

Lump Sum Price pay for work as a single unit. Lump sum price is the total cost for all work associated with the work item, and includes material costs, labor, and equipment. Lump sum estimates are appropriate when adjustments to the original scope are unexpected or quantities are indefinite. Lump sum payment should be reserved for situations in which additional costs or quantities exceeding the original estimate are unlikely.

Force Accounts compensate Contractors for extra work based on hours worked, equipment usage and materials. Force account is more administratively complex than unit price or lump sum payment, and best used when:

- Clear and accurate work definition is difficult, making a change order difficult.
- Extra work must begin immediately.
- MDT and Contractors cannot agree on a unit or lump sum price.

Force Account Records

Force account payment is used when price negotiation for an extra work item is unsuccessful. The intent is to reimburse Contractors for work costs plus overhead and profit. Markups specified within Standard Specification Subsection 109.04.2 for equipment, materials and labor include profit and overhead. Project Managers estimate extra work cost, obtain force account approval, and make payment during the estimate time period during which work was carried out, but after payroll and supporting documentation is available.

The Department is authorized to direct work taking place under force account. Project Managers and Inspectors may control work performance, labor, material and equipment, and decide what else is covered under a force account. MDT directs the work only when the Contractor is 1) performing substandard work, 2) under equipped, or 3) not achieving reasonable production rates.

Project Managers must authorize labor, equipment and material usage daily, and direct Contractors to remove unauthorized equipment or labor from force account charges. Contractors retain supervisory control over labor and equipment during force account work.

MDT Site Manager Training Manual Section 4 describes force account tracking within Site Manager. Inspectors and Project Managers use the force account custom report (CSB_109_04) accessed in Oracle, and Equipment Rental Rate Determination Forms to enter force account quantities. After a Project Manager or authorized Field Office Person (FOP) creates a force account in Site Manager, Inspectors begin recording DWR work hours and material quantities. Site Manager force account functions include:

Equipment; This folder tab maintains an equipment list with usage rates.

Labor; This folder tab records force account workers and wage rates.

Materials; This folder tab records force account materials, invoice quantities and costs.

Summary; This folder tab calculates and displays total force account costs. Costs are adjusted by entering lump sum adjustments to the account, and entering fractional adjustments to labor, equipment and material costs.

Site Manager does not automatically include force account payments on progress estimates. To pay force account work, users must record force account item quantity as a change order item or "Miscellaneous Work" under Standard Specification Subsection 104.04. Installed items are included in progress estimates and paid with other contract items.

Payment Procedures

Use the following procedures to pay force account work:

Daily Force Account Work Statements. Force account work quantities must be recorded daily by MDT personnel and Contractor, and tracked within Site Manager or AASHTOware to generate a quantities report. Project Managers meet daily with Contractors to review quantities and share notes with the Contractor. Contractors do not need to sign and return the report. Force account information with rental rates and payroll information is provided to Contractors weekly or biweekly.

Materials are paid according to specification with 15 percent markup. Only materials incorporated into the work are paid.

Labor is paid according to specification including an 80% markup. If Contractors provide certified documentation showing a higher percentage needed to cover labor costs, this documentation is submitted to the Civil Rights Bureau. Only labor used exclusively for force account work is paid. Foremen onsite and managing the contract are not paid unless assigned exclusively to force account work. Only labor shown on certified payrolls is payable. If a contract does not require certified payrolls, a payroll must be submitted exclusively for force account work. Note that approved "wage rates" may include travel pay but not fringe benefits.

Equipment is paid according to MDT "Equipment Rental Rate Guidelines" and includes a 10 percent markup. Each District has one computer accessing equipment rental rates, but just one person can access it at a time. For equipment rental rates, contact the District Engineering Officer.

Equipment

When a specific equipment type is not listed within "Equipment Rental Rate Guidelines," a rental rate determination should be requested from the CAS Bureau. An equipment description should accompany the request, and include attachment descriptions.

Equipment standby time is paid at 50 percent of hourly bare rate, but may not exceed 8 hours per day or 40 hours per week. Round rental equipment payment to the half hour, but not less than 1 hour per day. Equipment required for but unavailable on the project is allowed reasonable mobilization expense, but not when equipment is used for other project work. Move-out expenses cannot exceed move-in costs. Contractors are paid transportation costs for equipment hauled to the worksite. Hauling unit rates are paid based upon equipment transit time. Expenses for commercially hauled equipment are paid at invoice price. Equipment hauled to the project is allowed a standby rate for transit time. Equipment moved to the project under its own power receives 75 percent of the hourly rate for move-in and move-out time. Commercial rental equipment may be authorized if a Contractor can't obtain required machinery, or if commercial equipment is less expensive than Contractor equipment mobilization. When commercial rental equipment usage is approved, a reasonable rate plus 10% is paid. The rate is agreed upon and approved by the District before equipment usage. This rate must be confirmed by Project Managers and the CAS Bureau, and documented via rental agency invoice.

Bond Premium

Contractors are reimbursed for performance bond increases due to extra work if documentation is submitted within 30 days of force account work. Premiums increases are computed using the total extra work cost.

Subcontracting Administrative Allowances
Subsection 109.04.2.G, Standard Specifications

MDT allows an administrative allowance for Subcontractor work performed via force account. Allowances are not allowed for work performed by the Prime Contractor.

Deleted or Terminated Work
Subsection 109.05, Standard Specifications

Some work items may not be completed or constructed due to design revision or a change request by local agencies. Contractors should be promptly notified in writing so material orders may be cancelled or amended. Costs for materials delivered prior to notification may be subject to restocking costs to return materials. Contractors must provide cost documentation.

Deleted or terminated work requires a change order. Project Managers may delete work by change order under Standard Specification Subsection 104.02.4, or terminate the contract in whole or part under Standard Specification Subsection 108.10. Partial contract termination is treated as a “deletion change order” paid under Standard Specification Subsection 109.05.

Partial Payments Subsection
109.06, Standard Specifications

Project Managers and Contractor superintendents should review completed work quantities before submitting estimates, and pay item disagreements must be resolved before the next progress estimate submission. In rare cases modified estimates may be submitted if resolution occurs early within the payment period, and considerable payment is involved. Prime Contractors are given a progress estimate copy, which prime Contractors may give to Subcontractors and materials suppliers upon request.

MDT Site Manager Training Manual Section 11 discusses progress estimates, final estimates and lump sum payments to Contractors. Estimates are generated by Project Managers, or FOP personnel develop estimates from DWRs and change orders within Site Manager. Site Manager administers estimate discrepancies, contract adjustments, and line item adjustments. Lump sum work carried out during separate estimate periods must be verified by the Project Manager and documented within DWRs to show paid percentages.

Stockpiled Materials
Subsection 109.07, Standard Specifications

Before stock piling material, Contractors submit a written payment request citing delivery receipts, invoices, material quantity, storage time, location and sufficient detail to justify requested costs. Project Managers may deny stockpiled material payment at commercial sources if material cannot be separated from other inventory. Material must be delivered to the project or Contractor yard before payment. Payment is made according to contract document unit prices. Stockpiled material payment does not constitute material acceptance. If material is lost, stolen, damaged, or incorporated into the project in a manner not meeting contract requirements, stockpiled material costs are correspondingly deducted from progress estimates. MDT Site Manager Training Manual Section 8 outlines procedures to calculate and issue stockpiled material payment.

Final Estimate Subsection
and 105.15, Standard Specifications

Site Manager Training Manual Section 11 outlines estimate calculation procedures. Project Managers prepare draft estimates, including edits, validations and calculations. Final estimate discrepancies may be due to incomplete material sampling, item overruns or major item overruns greater than 25% without a change order. Note that unlike progress estimates, final estimate discrepancies cannot be overridden, and must be resolved before a final estimate is approved.

Mobilization
Subsection 109.09, Standard Specifications

Mobilization to the project requires planning, coordination, permits and office utility connections. Insurance and bond requirements must be satisfied and acceptable to MDT prior to notice to proceed. Subcontractor mobilization is included within prime Contractor mobilization cost. Contractors must submit required contract documentation at the preconstruction conference. Incomplete documentation, such as incomplete schedules or safety plans, show poor Contractor preparation. Site Manager automatically calculates a mobilization value when estimates are generated.

Overpayments
Subsection 109.10, Standard Specifications

Fuel Price Adjustment
Subsection 109.11, Standard Specifications

To address fuel based product volatility, Standard Specification Subsection 109.11 adjusts contract fuel prices. Current fuel prices from the “Platt’s Oil-gram Price Report” should be used to prepare progress estimates. Fuel price adjustments do not apply to stockpiled material. Project Managers enter price adjustments into Site Manager using the Contract Adjustment (Fuel Price Adjustment) function.

SECTION 110
POST CONSTRUCTION

Project construction ends when MDT completes the contract finalization process.

Project Managers participate in post construction activities such as Post Construction Reviews (PCRs) and As-Built plan compilation.

Post Construction Reviews (PCRs)

The Construction Engineering Services (CES) Bureau conducts PCRs to determine how construction method and practice may be improved. During the review process, stakeholders review completed projects to identify which project methods worked well, construction problems needing future attention, and improvements to uniformity, cost effectiveness and change order prevention. The CES Bureau, District Construction Engineer and PM initiate PCRs based on project complexity, problem situations, risk to MDT and the need to gather information for future projects.

Formal PCR Report Procedures

Formal PCR reports involve functional units and other stakeholders who:

- review and discuss plans, specifications and constructability issues
- identify project enhancing processes and issues jeopardizing the project

PCR projects are typically large and complex, and involve new or innovative materials or processes. PCR information can improve future design, product quality, and cost efficiency. PCR meetings may be facilitated by the CES Bureau Constructability Review (CR) Section as part of the review process. Project Managers, construction crews, Contractors and Subcontractors, designers, MDT functional unit personnel, FHWA and other resource agency representatives ordinarily attend. PCR meetings cover special provisions, plans and issues identified through the Q&A forum, such as:

- Bid addendums
- Change orders
- Claims issues (PCRs are not conducted during active claims)
- Value analysis recommendations generated during project development
- Contractor value engineering proposals
- Constructability issues
- Maintenance issues
- New technology or construction processes
- Innovative solutions or methods
- Scheduling and completion time
- Lead person assignment for action items
- ROW agreement requirements

PCR reports are distributed to MDT personnel and saved to the CR Database. The CR Section addresses meeting action items. Solutions and ideas ascertained during item follow-up are included within the CR Database.

Construction Summary Report

SiteManager generates a construction summary report for every project to document construction information pertaining to milestone reports, subcontracts, change orders, plan discrepancies and claims.

As-Built Plans and Construction Records

As-built plans record project features as they are constructed and completed in the field, and are essential for maintenance, inspections, FHWA standards compliance, future improvement planning, facility retrofits or reconstruction. Construction Records may be reviewed by the public.

Definitions

As-Bid Plans are complete construction drawings for a project, including addendums, awarded and published by the Engineering Construction Contracting Bureau (ECCB). Engineering Project Managers (EPMs) designate one set for recording field (redline) plan changes.

Field Redline Plans record changes to as-bid plans, and document field conditions at project completion. Amendments or changes occurring during construction are notated using red ink, or by inserting pages and electronic annotation. EPMs and others also record changes and update field plans during construction.

As-Built Plans represent all planned or revised field work. EPMs ensure as-built plans completion. Technical support for as-built completion is provided by District Engineering Officers or Preconstruction Design Unit technicians.

Construction Record Drawings are final as-built plans stored on the as-built database and viewed by entities within and outside MDT.

District Engineering Officers (DEO) provide technical support to EPMs by converting field redline plans and other construction records into electronic as-builts, and transferring them to an as-built database for storage as “Construction Record Drawings”. EPMs may request assistance from preconstruction design units to complete as-built plans when the DEO is unavailable, or when significant revisions occurred. Preconstruction design units include the Road Design, Bridge, Traffic Safety, and Consultant Design units, which produce project engineering design and as-bid plans. DEOs may request technical support from specific bureaus or sections to complete As-Built plans.

As-Built Documentation within AASHTOWare

EPMs maintain an updated plan set during construction to document finished work as constructed. EPM and MDT inspectors maintain a project record for performed work and material used by the Contractor, adjusted according to authorized contract deviations. Throughout project implementation, revisions are documented using AASHTOWare.

During project construction, construction crews enter field notes, computations, DWR data, Change Orders and documentation references into AASHTOWare. As-Built Information is noted within the DWR and Diary for addition to field redline plans, or included as an attachment at project completion. AASHTOWare reports can be generated to list As-Built remarks. Construction Summary Reports and Final Progress Estimate Reports are submitted with field redline plans when construction is complete. During contract finalization, DEOs enter an “As-Built Plans Date” in AASHTOWare when As-Built plans are completed and stored on the database. This entry generates an automatic email to CAS indicating as-built plan completion.

Department of Environmental Quality (DEQ) Procedures

MDT must ensure ARM 17.38.101(10) provision compliance for projects including waste water or water delivery systems, which requires professional engineer (PE) approved as-built plan submission to the DEQ. The engineer signing As-Built plans must have been "in responsible charge" during construction, and could be the Project Manager, District Construction Engineer or District Engineering Officer. Sealed documents are first submitted to the Environmental Services Bureau, then to DEQ.

Field Redline Plan Guidelines

Redline plans should be drawn to scale, with explanatory and reference information documenting lines, grades, dimensions and features reflecting actual field construction. Redline plans should include bid document changes, permit work and extra work performed, including underground communication systems and utility information with accurate redline locations. Special emphasis should be given to items installed other than specified or by alternative procedures.

The EPM or other designated individual creates field redline plan packages, and confirms changes necessary during construction. EPMs designate one as-bid plan set for field redline documentation. Do not use this plan set for other purposes, or discard sheets from the field redline plan set, regardless of changes voiding prior information. Field redline plan sets may be a paper copy or an electronic pdf file published by the MDT Engineering Construction Contracting Bureau (ECCB).

Document as-bid plan revisions on the field redline plans. Revisions may include geometric, dimensional, or structural changes, or features such as approaches, fencing, MDT owned utilities (such as those in electrical plans), guardrail, striping, signage, and permanent erosion control.

Indicate even minor revisions on the field redline plans in red. If using 11x17 paper copies, use red ink or pencil. If using pdf plans, use software such as Adobe to electronically annotate plans. Provide sketches, photos, and notes to document field modifications. Write legibly, and do not include extraneous information, informal sketches, or work reports on the plan sheets.

Major Revisions are typically developed in cooperation with the Design Engineer of Record (Highways, Bridge, Safety or Consultant). Draw an "x" on the detail from corner to corner of sheets requiring major revision, and attach a new detail or sheet. If a revised sheet is needed, the new sheet must be certified by the Engineer, and attached to the field redline plans. Do not discard any plan sheet.

Document changes to road plans affecting typical sections, detail sheets, plan and profile sheets, electrical plans, signing plans and other features. Document final locations for pipes, culverts, catch basins, manholes, drop inlets, paved ditches, and rip rap, added or moved from plan location(s). Do not document changes to ADA curb ramp details if Construction Worksheets for ADA Ramp Documentation are provided. Document changes to signal pole locations as well as signal equipment additions or deletions. Include electronic signal plan drawings and a print out of final controller settings. Verify signage was built per plan. Red line and explain plan deviations. Only include information usable for future reference. Document bridge plan deviations and add information not shown on the as-bid plans including:

- General Layout – added or abandoned structures, rip rap modifications, utility attachment

- Footing Plans – seals, sub-excavations, backfill, added or abandoned structures
- Detail sheets – pile tip and finished structure elevations, shims, repairs or field modifications, reinforcement size changes, type and layout, and permanently incorporated construction aids such as telescoping drilled shafts, casings, shims, and retaining structures

Summary Sheet changes should include location information for installed fencing, retaining walls, culverts, or embankment protectors. Summary frame changes should also be indicated on plan, profile and detail sheets. Final quantity totals, including those for earthwork and surfacing, can be documented on As-Builts and with AASHTOWare reports.

Attach or reference shop drawings submitted by the contractor but not included within as-bid plans for items such as beams, joints, bearings, pipes or sign bridges. Attach or reference information requests, change orders, and supplemental agreements modifying as-bid plans. Include a list of these references and attachments on the Field Redline Plans Submittal Cover Sheet (Figure 110-1), and attach hard copies as needed to field redline plan sets.

EPMs sign the field redline plan submittal cover sheet, and transmit the redline plans package to the DEO when construction is complete. Before submitting the redline package, contact the DEO to discuss unique situations and how they were addressed and documented during construction.

The DEO creates and stores As-Built plans in accordance with the following guidelines:

- District Engineering Officers create As-Built plans using field redline plan information delivered by the EPM. When significant plan changes occurred during construction, EPMs should contact the Preconstruction Design Unit to ensure changes were approved. Using the following guidelines, create and store As-Built plans on the database as “Construction Record Documents”. These processes may change depending upon software changes.
- Locate ECCB published plans and attachments or major design revisions shown by the field redline plans package.
- Create an electronic copy for completing As-Built plans. Copy and rename reference files. Do not save As-Built changes to preconstruction design files.
- Save As-Built working documents in the proper directory.
- Complete As-Built corrections using current CADD standards.
- Collate As-Built plans and create an informational pdf file before copying the pdf file to the database for storage. The EPM or DEO retains and stores original field redline plans according to policy.
- DEOs enter an As-Built plan date in AASHTOWare under the “Select Information Times” when plans are completed and stored on the database. AASHTOware automatically generates an email to CAS indicating “As-Built plans complete.”

NBI Rating

MDT must document a baseline inventory rating after initial construction for bridges and structures subject to the National Bridge Inventory (NBI). Project Managers should contact district construction bridge inspectors to notify district personnel the structure is complete.

Montana Department of Transportation

Field Redline Submittal Cover Sheet

Project Number: ______________________________
Primary Type of Construction: ______________________________
Contractor: ______________________________
EPM: ______________________________
Letting Date: ______________________________
Completion Date: ______________________________
As-Builts Assigned to: (DEO, Preconstruction Design, other) ______________

Submittal Index

Sheet No. Description

AB1 Cover Sheet

AASHTOWare Progress Estimate Report (final)
AASHTOWare Construction Summary Report
Field Red Line Plans (designated copy)

- Typical Sections
- Summaries
- Details
- Plan and Profile
- Signing Plans
- Electrical Plans
- Bridge Plan
- Other

Sheets Revised or Replaced

Sheet No. Description, Revision Number, Date

(attach hard copy or identify electronic storage location)

Additional Sheets

Sheet No. Description, Type (addendum, change order, supplemental, etc), Date

(attach hard copy or identify electronic storage location)

Shop Drawings

Sheet No. Description, Date

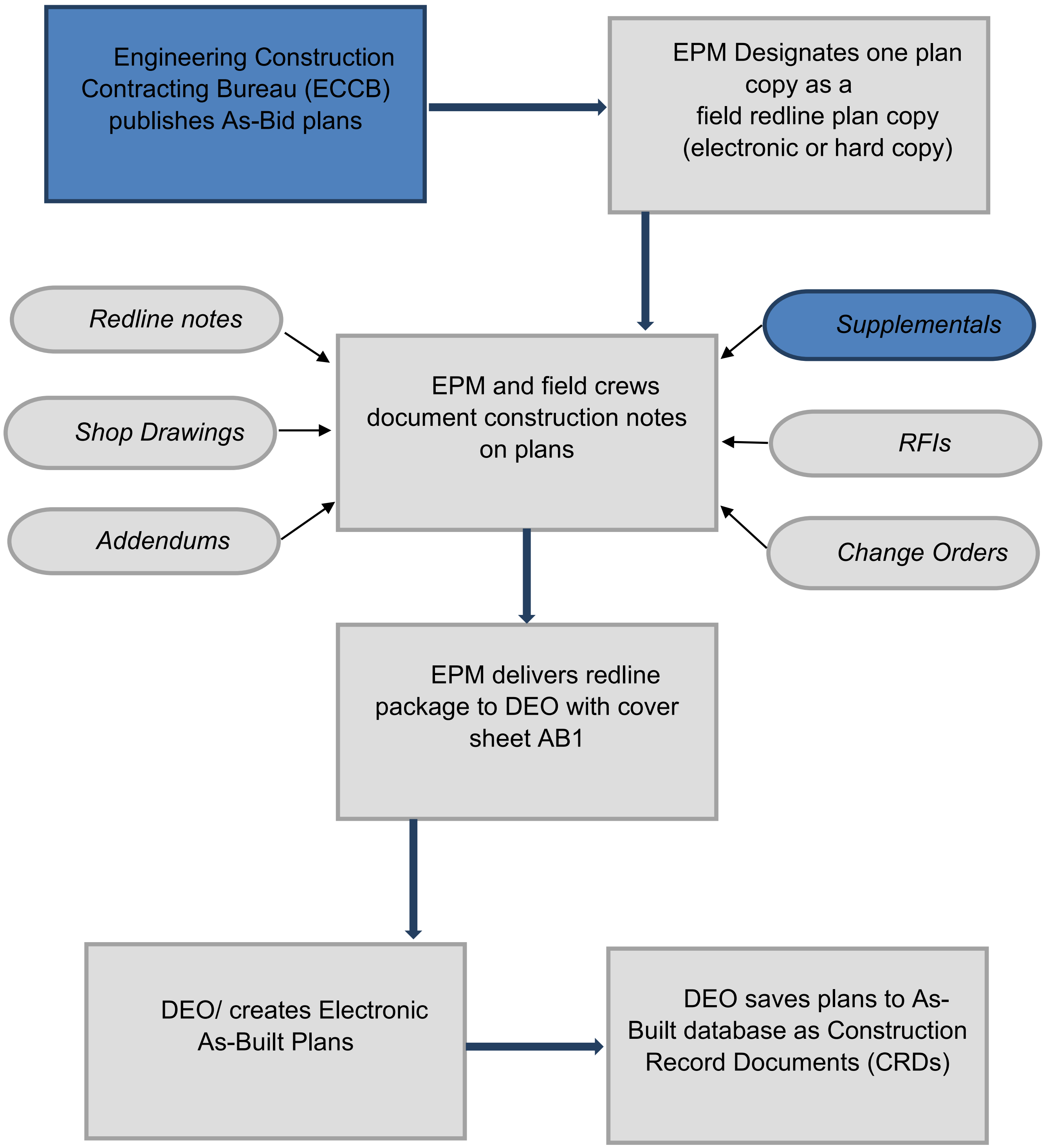
(attach hard copy or identify electronic storage location)

Other Attachments

Sheet No. Description, Date

(attach hard copy or identify electronic storage location)

Figure 110-1
As-Built Life Cycle Flowchart



SECTION 201
CLEARING AND GRUBBING

Subsection 201.01, Standard Specifications

Clearing and grubbing is typically paid as excavation and embankment unless a separate pay item is warranted, and is the first phase of major rehabilitation and reconstruction projects during which obstructions, vegetation and other materials are removed prior to earth work. Inspectors should ensure:

- Contractor clearing and grubbing activities are limited to within slope stake boundaries.
- Do not allow vegetation removal unless required for construction. The environmental document requires avoidance and minimization measures to limit construction impacts.
- Clearing and grubbing practices must adhere to MPDES/NPDES storm water permit requirements to minimize soil exposure and disturbance.
- ROW and needed easements must be established before construction. Work area boundaries, clearing limits and access routes must be clearly indicated to the Contractor.

Field Review

Project Managers and Contractors should visit the jobsite to discuss:

- Clearing limits
- Typical sections
- Soil profile(s)
- Drainage profiles (check that existing drainage is as shown, and proposed drainage does not flow from the ROW, and drainage changes will not affect private property
- Utilities, fences or other obstructions to be moved, protected or avoided
- Private property boundaries and restricted areas
- Vegetation, survey monuments, cultural or archaeological sites, and other features to be protected, preserved, or relocated
- Borrow sources and access roads
- Unusual conditions such as springs or seeps

Clearing procedures and schedule(s) should be discussed and documented within DWRs.

Coordination with Other Owners

All Right of Way (ROW) acquisitions are completed by the ROW Bureau and signed by landowners during project preconstruction. If the project, or project portion occupies land owned by a Tribe, National or State Forest, National Park, representatives for these organizations should be contacted by the Project Manager before construction.

Measurement and Payment

Measurement and payment methods must be clarified before work begins.

Construction Requirements
Subsection 201.03, Standard Specifications

The following Standard Specification subsections may significantly impact clearing and grubbing:

- Erosion Control and Stream Protection
  Standard Specification Section 208
- Archeological and Historical Finding Protection
  Standard Specification Subsection 107.22
- Hazardous Materials
  Standard Specification Subsections 107.23 and 107.24.

Clearing and Grubbing
S**ubsections 201.03.2, 201.03.3 and 201.03.4, Standard Specifications**

Equipment used for clearing and grubbing is at Contractor discretion, but equipment must perform work satisfactorily. Equipment usage or construction methods may be limited by site conditions or proximity. Grubbing must remove tree stumps and large roots from excavation and embankment areas to a depth preventing mixing with embankment soil. Heavily timbered areas and areas with undergrowth may require root removal after clearing.

Clearing and grubbing operations may be hazardous. Clearing equipment should be protected by a cab or cage. Damage to existing facilities must be avoided. Clearing timber demands extra care, precaution and proper felling equipment. Precautions should be taken to protect the public when clearing or grubbing takes place adjacent to roadways. Proper construction signing with flaggers and pilot cars helps accommodate traffic and enhances construction efficiency.

Removed Material Disposal
Subsection 201.03.5, Standard Specifications

Contractors may not dispose of materials within project limits without Project Manager approval, but do so outside State ROW. Project Managers should verify Contractors have secured written landowner permission and required permits for material disposal.

SECTION 202
STRUCTURE AND OBSTRUCTION REMOVAL

Construction Requirements
Subsection 202.03, Standard Specifications

Project Managers and Contractors should discuss obstruction removal methods, material salvage, storage and disposal.

Salvaged Material

Contract documents should identify removed or retained materials. Inspectors should verify Contractors adhere to contract provisions, but avoid directing the Contractor. Salvage material should be removed without damage, and may be stored at specified locations within project limits prior to removal. Contractors should submit a list of salvageable materials with location and condition descriptions to the Project Manager.

Wells

Wells within the proposed roadway prism must be abandoned in accordance with state law and Montana Administrative Rule. Wells are usually abandoned by the owner before construction. If a well has not been abandoned, MDT abandons the well using a licensed well driller. The Geotechnical section can identify certified drillers, and is licensed to abandon wells. The Environmental Services Hazardous Materials (HazMat) Section can also make monitoring well abandonment recommendations. Well abandonment prevents groundwater contamination and roadbed saturation.

Obstruction Existing Condition Documentation

Photo or video record existing conditions before work begins.

Measurement Method
Subsection 202.04, Standard Specifications

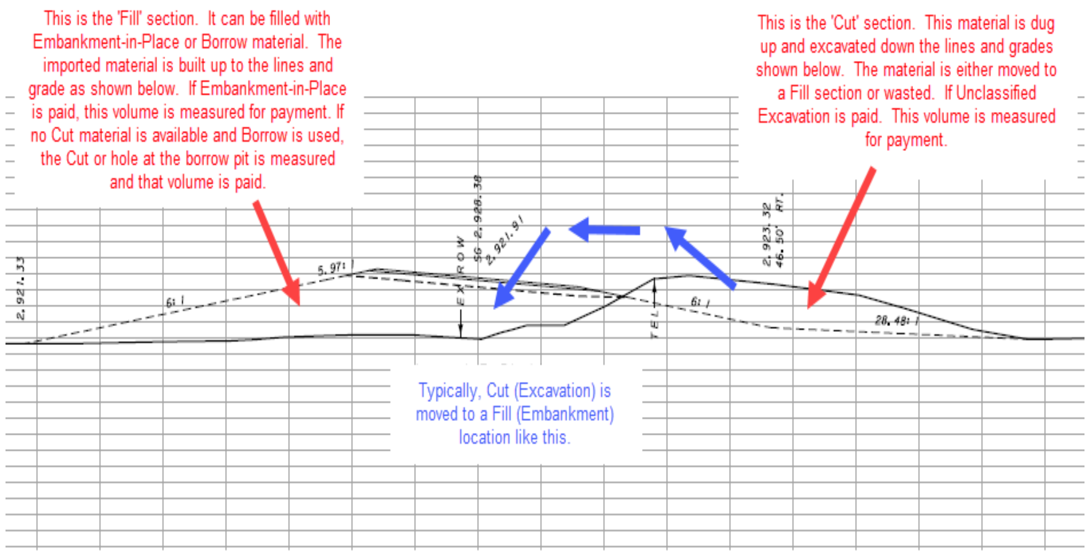
Payment Basis
Subsection 202.05, Standard Specifications

SECTION 203
EXCAVATION AND EMBANKMENT

Subsection 203.01, Standard Specifications

"Excavation" is material volume removed from cut sections to attain planned grade and cross section. Excavation activities include those needed to remove material from cut sections, such as loosening, digging, loading, hauling, placement and compaction. "Embankment" is the material volume moved to plan fill locations. MDT distinguishes between "excavation" projects and "embankment" projects, during project development.

"Embankment" projects typically have a total excavation volume exceeding 20,000 cubic yards (15,000 cubic meters). "Excavation jobs" are those with excavation quantity exceeding embankment quantity. Volume payment made for removed cut volume is referred to and paid under the "unclassified excavation" bid item. Smaller jobs are typically referred to as "embankment jobs", during which payment is made for placed embankment volumes shown on the plans. These volumes are shown below:



Excavation Type
Subsection 203.01, Standard Specifications
Unclassified Excavation

"Unclassified excavation" refers to excavated material with characteristics "unclassified" by the contract. Material of unknown composition or known to be unsuitable for construction is removed as specified under an "unclassified excavation" bid item. Most construction contracts have an "unclassified excavation" bid item. Suitable material may also be used if approved by the Project Manager.

Borrow Excavation

Borrow excavation is usually separated into unclassified borrow or special borrow. Borrow material sources may be obtained near the ROW or miles from the construction site, and are usually Contractor responsibility. Both unclassified borrow and unclassified excavation are earth volumes moved to the project. Unclassified borrow material is soil material suitable for embankment construction, whereas "special borrow" material must meet R-value, gradation or unit weight requirements. Special borrow is typically used to mitigate weak subgrades.

Contractors identify borrow sources by examining soil borings to confirm suitable material. A minimum R-value is unspecified for unclassified borrow. Clays and topsoil are generally unsuitable borrow. “Special borrow” must meet tested material requirements, and is usually used as the top two feet of subgrade or at bridge abutments and other structures.

Most central and eastern parts of the state including the Great Falls, Billings, and Glendive Districts, have fine grained unclassified borrow with lower R-values. Special borrow is specified according to AASHTO soil classification, with an A-1-a material assigned a maximum R-value of 30 for design purposes. Turnaround time for soil classification is much shorter than for R-value determination, which can be highly dependent on soil moisture and significantly varying test results.

Unclassified “Channel” Excavation

Construction may traverse waterways, channels, irrigation facilities or other water courses. Channels may require deepening, widening, realignment, or added drainage structures. Earth volumes moved to carry out these tasks is known as “channel excavation”, and listed as “Excavation-Unclassified Channel."

Street Excavation

Measurement and payment for city street excavation is a contract item referred to as “street” or “unclassified” excavation. Street excavation describes excavation and material removal within a specified cross section. Street excavation is refined work requiring precision and attention to utility locations, manholes, sewers and storm drains, so is more costly than unclassified excavation. Street Excavation removes embankment materials to plan elevation, and includes embankment between the back of sidewalks.

Muck Excavation

Muck excavation removes soil or organic matter unsuitable as foundation material from marshes, swamps and bogs over which embankment is constructed. Muck excavation removes unsuitable and typically water laden material so a stable embankment foundation can be constructed. Project Managers should contact Geotech to identify muck excavation material. Wet material may be suitable for embankment or foundation material if dried and recompacted. Project Managers should consult Geotech if dewatering may be needed.

If special equipment is needed and excavation is below embankment elevation, work may be measured and paid as ”muck excavation”, because materials are more costly to remove.

Sub-Excavation

Very few highways are constructed without encountering unsuitable materials such as coal, clay, silt or moist materials. In most cases, sub-excavation does not require special payment, is typically measured using field measurements, and paid under the existing bid item for unclassified excavation.

Dig-outs

Dig-outs are distinct from Sub-Excavation and have a unique bid item. Dig-out plan quantities and areas are typically associated with rehabilitation projects.

Construction Requirements
Subsection 203.03, Standard Specifications

Excavation and embankment grading operations are rapidly changing activities involving varied equipment working concurrently within the same area. Use extreme caution around equipment and maintain eye contact with operators before approaching equipment.

Project Managers may identify conditions requiring plan changes, needed construction procedures and daily Contractor coordination. Project Managers and Inspectors should monitor excavation and embankment activities like staking, quantity usage, balance point location and haul distances. Onsite excavation should be used for embankment before importing borrow material.

Excavated Materials

Project Managers should review soils studies and geotechnical information contained within District/Area Lab Soils Surveys, Geotechnical Section Subsurface Soils Reports and consultant soils data. Cuts may be examined to verify soil types. Unstable subgrades can be caused by high soil moisture, high water table, organic material or heaving soils.

Excavated material may be stockpiled on site, placed in embankment areas or removed. Project Managers should identify quality material within the ROW for embankment usage.

Equipment

Contractors typically select equipment best suited to excavated material type, grade and haul length. Crawler type tractors and scrapers are used for steep grades and short hauls, whereas higher speed wheeled tractors and scrapers are used for longer hauls. Trucks loaded by excavators or front end loaders are used when load limits are imposed or long haul distances are required.

Rollers are designed to compact a particular material, and must compact lift thickness to required density at optimum moisture content. Rolling unit coverage must match excavating and hauling equipment production rates. Contractor operations should haul no more excavation than can be compacted.

Topsoil Removal Placement

Top soil is stripped from excavation and embankment areas and stockpiled for placement over slopes, ditches, channel changes and other areas. Top soil is normally obtained within the ROW, and should be stockpiled at locations allow redistribution over finished slopes. Stockpiles must be stored in measurable volumes if Contractors expect topsoil payment.

Cut and Fill Transitions

Transition sections are often overlooked during moisture and density testing, so cut/fill transitions should be thoroughly inspected. Such areas develop sags as material densities vary from cut to fill areas. “Continuous benching” (Figure 203-1) may be used within cut and fill transition areas to prevent slip plane formation. Embankment and density inspection should accompany embankment processing and compaction in cut and fill transitions. Standard Specification Subsection 203.03.2.C discusses benching.

Cut to fill transitions should be over excavated before compaction to avoid sudden subgrade material density changes. Project Managers should consult Geotechnical if clays are discovered within transition areas. Swelling clays may damage pavement sections, and may require removal to prevent heaving.

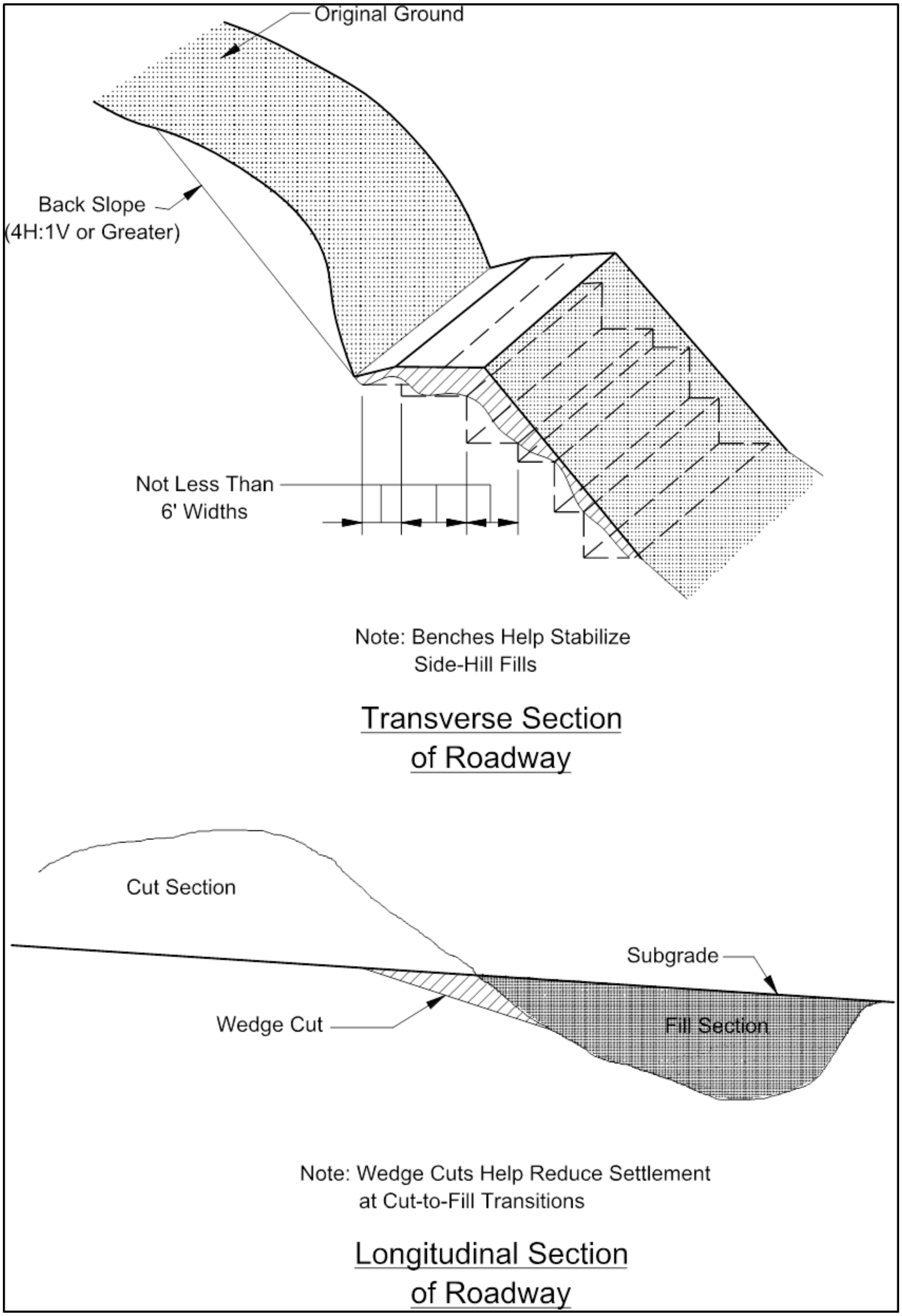


FIGURE 203-1

CONTINUOUS BENCHING WITHIN CUT AND FILL TRANSITIONS

Cut Section Subgrade

Cut section subgrades must be compacted through 8 inches (200 mm). Variable soil layers require mixing and compaction for uniform compaction. Backfilling with uniform material ensures uniform consolidation in cases involving hard and soft layers.
Cut section finished subgrades must be density tested. Subgrades are typically composed of varying materials which may expand differentially to cause roadway humps. Scarification, blending with a construction disc, and repeated compaction are required.

Standard Specification Subsection 203.03.1.C requires 6-inch (155 mm) excavation below subgrade when rock is encountered to provide a cushion between pavement and underlying rock. Low areas caused by rock removal should be backfilled with suitable material. Large rocks within top subgrade layers should be removed.

Excavation
Subsection 203.03.1, Standard Specifications

Roadway excavation removes suitable material for use as roadbed material. Excess or unsuitable material may be discarded. Disposal areas should be blended and contoured to produce stable side slopes after construction. Excavated material is often obtained from the roadway prism but may come from borrow sites.

Pre-wetting Excavation Areas

Excavation material often requires watering before removal. Pre-wetting uniformly distributes moisture and reduces needed machine mixing after material placement on the road bed. Pre-wet areas are scarified 2’ deep on 4’ centers along contour to provide moisture penetration, minimize runoff and control dust. Heavy clay soils should be sprinkled evenly and mixed on grade by using heavy discs or harrows to break dry clods before moisture application and mixing with discs, cultivators or rotary mixers.

Sandy soils and friable silty soils absorb water, and should be wet days or weeks before placement and compaction, depending on soil texture. Longer pre-wetting periods allow uniform and thorough soil water dispersion.

Unsuitable Versus Unstable Materials

Material not meeting embankment specifications must be discarded. Large rock, broken concrete and asphalt are unsuitable for embankment, unless material size requirements are met. Deleterious materials, such as mineral deposits and muck should be discarded outside the roadway prism. Discuss disposal areas with the Project Manager. Unsuitable material may be unidentified during preconstruction. Removal depth should be determined by the Project Manager. Wet soils are commonly unsuitable, but soil shear strength and workability may be improved using improved drainage or mechanical manipulation. Soils such as peat, mulch, some silts and expansive clay soils may be unusable as embankment, but can be used to flatten slopes or as top soil.

Unusable soils below cut section subgrades do not require sub-excavation, but when required, Geotech provides guidance to determine sub-excavation depth and backfill requirements. When unstable or wet areas are encountered, inspectors must not instruct the Contractor. Often over excavation aggravates unstable soils, and bridging over these areas is required. Geotechnical solutions are often considered instead of over excavating wet, unstable soil. Field personnel should discuss with Geotech alternatives to continuing excavation. Wet material may simply be replaced with dry material. Contractors should be encouraged to dry soils before over excavating, as wet material may become suitable if scarified and dried. Dry granular material can also be used to bridge smaller areas. Solutions such as lime application or Portland cement or kiln dust stabilization for heavy clays should be approved by Geotech.

Extremely wet areas may require geotextile fabrics and rock filters to allow water passage. Wrapping stabilization geotextile material around draining material preserves material drainage properties by preventing fines infiltration.

Excess Materials

Materials excavated from cut sections and placed within fill sections often have different volumes. Project Managers should compare construction quantities with preliminary quantity calculations soon after staking. Terrain and material availability may require material borrow and waste rather than balancing cut and fill volumes. Even without an excess material disposal provision, Contractors must arrange for disposal areas. Excess material may be used to flatten slopes, or construct turnouts and scenic viewpoints. Be aware roadway footprint increases may affect NPDES permitting, and disposal areas must maintain drainage. Minimize embankment erosion where excess material is used to flatten slopes.

Slopes

In-slopes, back-slopes and ditches are most aesthetic when edges are blended with natural topography. Rounding cut slope tops and ends is done most effectively when these areas are accessible. Slope instabilities should be discussed with the DCE and Geotech to ensure timely corrective measures. Cut slopes and ground surfaces near cut slopes should be inspected for distress during excavation.

Rock Blasting
Section 204, Standard Specifications

Embankments
Subsection 203.03.2, Standard Specifications

Embankment Foundation
Subsection 203.03.2.C, Standard Specifications

Lasting roadway smoothness depends upon embankment foundation preparation. Slippage planes, unstable material, irrigation water, seepage, springs or surface water retained by clay may be encountered. Localized heavy vegetation likely indicates water. Surface water should be removed, drained or mitigated before embankment placement.

Unless specified otherwise within the contract, embankment ground surface must be cleared of deleterious organic material and compacted to specified density. If weak or unstable soils are identified, Geotech may recommend leaving existing ground cover undisturbed, excepting larger vegetation. Subgrade is covered with geotextile and a bridging lift of minimally compacted material. Subsequent lifts must conform to Standard Specification Subsection 203.03.3 moisture density requirements. Temporary haul roads beneath roadway embankment may not require total compaction, but should be reworked and compacted from the bottom up, before embankment operations proceed.

Basic Construction Process

Check that embankment conforms to designed cross section(s), large roots and organic materials are removed, and drainage facilities shed embankment runoff. Contractors must maintain excavation and embankment drainage. Areas collecting or ponding water violate Standard Specification. Erosion control features must protect newly constructed slopes.

Moisture

Uniform compaction is more attainable within thin lifts. Uniformly distributed lift moisture facilitates proper compaction, provided lift thickness does not exceed roller capability. Begin compaction with moisture content near optimum. Material blending is required to obtain embankment consolidation. Aside from rock or gravel, embankment lifts must be worked with a tandem construction disc fully penetrating the lift to blend moisture into the soil. Clays require more discing and turning to blend in moisture than do lighter soils. Several light water applications are more effective than one heavy application, and allow soil moisture percolation and minimize rutting. Avoid overlapping or gaps between successive water truck passes. Water should be applied progressively and evenly.

Earth Embankment
Subsection 203.03.2.D, Standard Specifications Reference

Material quality control and usage are verified by Project Manager and Inspectors. Field personnel are ultimately responsible for verifying specified material and procedures are used, and specified results are obtained. Project Managers and Inspectors should understand compaction density testing, lift thickness measurement, maximum density and optimum moisture curves.

Rock Embankment
Subsection 203.03.2.E, Standard Specifications

Haul vehicles should dump rock near final locations. Dozers or other leveling equipment move rock into final position within the embankment. Coarse and fine materials can usually be distributed so voids are filled with smaller size material to maximize embankment density. Material should not be allowed to segregate by rolling or sloughing, as often happens when material is dumped over a slope. If end dumping is needed to bridge over poor foundation, material should be dumped over the layer being built, then moved ahead on as slight a slope as possible to natural grade, while maintaining a lift no thicker than required to support machinery at the slope. The top two feet (600 mm) of rock embankment below subgrade elevation should be constructed from finer material.

If rocks and boulders can be placed in uniform layers and rolled, rolling should take place using a grid or smooth wheel roller. When significant rock is present, moisture and density for the earthen portion are hard to measure. Large boulders should be broken and uniformly distributed throughout the fill. Large rock quantities should be placed along the fill slope toe, or used as rockfall barriers or riprap.

Embankment Placement Over Saturated Areas
Subsection 203.03.2.F, Standard Specifications

Special construction techniques may be needed to construct embankment over soft ground. At Project Manager direction, lifts may be thickened to support equipment, or end-dumping may be used in lieu of layered construction. Contractors must use construction methods to least disturb soft foundations while maintaining embankment compaction.

Swampy areas may be traversed by excavating and discarding structurally deficient material, or by placing embankment surcharge to displace unstable material at depth. Soft ground may be bridged using widely placed embankment with flatter side slopes. Soft areas are typically assigned specific construction methods, and must support planned embankment. Consult Geotech to verify questionable areas will support embankment.

Embankment Adjacent to Structures
Subsection 203.03.2, Standard Specifications

Piers, bents and culverts may be moved from alignment or subjected to stresses from improper backfilling. Backfill must be compacted uniformly in lifts placed equally around the structure to equalize pressure. Rocks, stones, frozen material, stumps, limbs and organic materials are unacceptable as structural backfill. Organics rot and leave voids conducive to water movement and settlement. Large rocks placed against structures concentrate stress to exert excessive pressures. Unacceptable material should be removed. Material abutting bridge end backwalls must be drainable with few fines. Hand operated mechanical tampers should be used alongside structures instead of heavier equipment to avoid structural damage. Backfill compaction inspection is especially needed at smaller confined areas adjacent to structures. Contractors must use equipment capable of compacting material in these areas. Roadway embankment compaction for bridge approach fills and structural backfill at bents and abutments requires coordination between road and bridge contractors, and should be discussed by Project Manager and Contractor at the preconstruction conference.

Moisture and Density Requirements
Subsection 203.03.3, Standard Specifications

Compaction and Density Control

Examine cut faces for soil information. Obtain soil boring information from preliminary soil surveys from the District Materials Supervisor or Geotechnical Section. These documents may also be included within contract documents. Soil type samples should be collected for moisture-density tests, and retained for construction reference. Testing must represent excavated and compacted soils. Preconstruction testing rarely represents full material variability. Inspectors must frequently monitor test results to ensure density tests are performed using appropriate soil characteristics.

Soil Types

Soil samples should be collected and labeled, so texture, gradation and color are evident. Inspectors should spend time in the District/Area Materials Lab to observe soil classification, liquid limit (LL) and plastic limit (PL) testing, and plasticity index (PI) calculations. Soil identification is not an exact science.

Guidance

Soil containing significant rock cannot be compaction tested, but must still be densified to produce a durable road bed. When compaction tests cannot be administered, refer to MDT Materials Manual MT-218, and note that field tests were not possible. Explain within the DWR how compaction acceptance is being made. Inspectors must use experience and judgment to determine if compaction is satisfactory when normal density requirements cannot be satisfied. In such cases, compaction or density must be approved by Project Managers. Good embankment construction practice, leveling equipment, correct lift thickness, and effective compaction equipment help ensure compaction. Often the first few lifts placed over soft material do not compact as well as subsequent layers. Because underlying densities affect upper lift densities, adjustments must be made to attain densities above soft areas. When densities cannot be obtained, soft material must be removed.

Where weak or unstable soils are identified, Geotech may recommend existing ground cover be undisturbed, covered by geotextile, and bridged with minimal compaction effort. Subsequent lifts must conform to Standard Specification Subsection

203.03.3 moisture and density requirements. Field moisture and density testing must be the determining factor by which to evaluate compaction. If test results contradict field observations, investigate the discrepancy. If embankment is firm but density tests indicate failing density, inspect the test area and repeat the test. Inspectors should review test procedures, check calculations, review comparison samples and check for faulty equipment. If the roadbed appears soft and yielding, but tests indicate moisture and density requirements are met, Inspectors should check other work phases.

Nuclear Gauges

Certified technicians must adhere to these safety guidelines:

- Keep unauthorized personnel away from nuclear gauges.
- Follow established operating procedure when using nuclear gauges.
- Ensure gauges are always within immediate operator control when not secured. Do not leave gauges unattended.
- Maintain nuclear gauges in the “SAFE” position when unused.
- Ensure nuclear gauges are stored in approved locations.
- Contact the Headquarters Materials Bureau, Nuclear Measurements Unit, for assistance.

MDT provides nuclear gauge operators dosimetry badges for processing and evaluation by a National Voluntary Laboratory Approved Processor (NVLAP) on a quarterly basis. Operators should wear badges when in close to gauges. Badge must: Be used by only one operator, worn near the center of the operator and oriented toward the gauge, not be left in a gauge box overnight, and not be stored within 30 ft (9 m) of nuclear gauges.

Damaged Gauge Procedure:

If a nuclear gauge is involved in a vehicular crash, lost, stolen, crushed, dropped from a moving vehicle, or significantly damaged:

- Stop activity around the device and remove personnel from the area.
- Do not move the gauge.
- Do not remove vehicles or equipment from the site. Immobilize equipment.
- Rope off a 30 ft x 30 ft (9 m x 9 m) area around the device, and place warning signs. The area may be smaller if necessary.
- Monitor the site.
- Contact the Project Manager and District Materials Lab so they can contact the Headquarters Materials Bureau. Refer to gauge Emergency Procedures.
- Call local Sheriff and/or Fire Department if Headquarters cannot be contacted, or if accident circumstances warrant such action.
- Complete an accident report form and document the event. Record pertinent details as soon as possible.
- Keep personnel away. Await instruction from and the arrival of the Helena Radiological Response Team

Moisture Control

Optimum moisture content specifies moisture control within clay and soils containing clay, but is applicable for other soil types as well. The Project Manager, with concurrence from the District Materials Lab, may accept moisture content not meeting specifications due to material characteristics. Compaction moisture requirements may be relaxed when:

Cut material composed of mixed clays and silts and deposited in fill, make optimum moisture determination difficult. Optimum for clay is much higher than for silt. In such situations, soil must be worked to distribute water. Observation and testing are used to ascertain moisture content.

Occasionally, soil containing diatomite (diatomaceous earth) or zeolite is encountered. Diatomite is a siliceous material made of fossilized remains of microscopic, one-celled algae called diatoms, typically associated with ancient lake bed deposits. Zeolites are minerals formed when volcanic rocks and ash layers react with alkaline groundwater. Both diatomite and zeolite material are low density, high porosity and surface area materials. Both are so absorptive moisture content in these soils indicates little for engineering applications. These soils often lead to long term soil instability.

Granular soil needs water for compaction, but the 2% water content can be relaxed with these non-swelling soils, although moisture content should not be reduced less than 4 percentage points below optimum.

Variations from 2% optimum moisture must be documented by test results, with a reason for the change listed on the test report.

Silty soils are sensitive to moisture changes. Because optimum moisture ranges may be narrow, processing silty soils to attain proper moisture content may be problematic. Correct moisture content must be determined by incrementally adding water, processing thoroughly, and repeating. Optimum moisture content within cohesive or plastic soils may be approximated by rolling soil into a tight 1.5” ball and applying pressure. If the ball shatters into several uniform fragments, soil is close to optimum moisture. If the ball flattens without breaking up, soil is over optimum. If the ball “weeps” when held for a few minutes, it is well over optimum. If soil is difficult to or cannot be balled, it is under optimum.

MDT prefers salvaging jobsite material for project usage. Material replacement is warranted when a Project Manager, with concurrence from CES Bureau and Geotechnical Section, concludes no reasonable alternatives remain.

Expansive Soils

Expansive soils occur frequently in Montana, so moisture control over expansive soils is important. If compacted below optimum moisture, maximum density may be obtained, but expansion may occur when water is introduced. If expansive soils are compacted wet, unit weights are low, and soils shrink with drying.

Compaction Summary Usage and Processing

Submit the original “Embankment and Excavation Compaction Summary of Test Data” form and “Surfacing Compaction Summary of Test Data” form to the Materials Bureau the DMS. The original form is signed by the Project Manager and forwarded to the DMS for review and signature, and a copy placed within the project file. The DMS submits original forms to the Materials Bureau, retains copies, and forwards to the CES Reviewer. Submit completed and uncompleted compaction summaries for each category (original ground, embankment, finish cut, culvert) weekly. Summaries should include acceptance tests meeting specification, test results not meeting specifications, and follow up “check tests.”

When compaction summaries are completed, Project Managers:

- Scan and file summaries within the share drive directory.

- Send an email and review link to the DMS and CES Reviewers, who review the summaries for accuracy.
- Submit original individual field test documentation to the Materials Bureau through the DMS prior to project closeout. Test copies must be retained within project files and District Labs. Original compaction summaries and individual field test forms are filed with the Materials Bureau.

Compaction Moisture Requirement Adjustment

Contractors may submit a written request to the Project Manager (PM) to compact soils at a lower moisture content in accordance with Standard Specification 203.03.3 when moisture content flexibility is needed and if project goals are not jeopardized. Engineering judgment is reserved for specific cases, and does not warrant granting “blanket approval” to lower moisture content. Project history has shown particular soil types to be more compactible when moisture content is under optimum. Soil types A-1-a, A-1-b and A-4 exhibit this characteristic. A-6 and A-7 soils should be rejected if moisture content is more than 2% under optimum.

To compact at lower than optimum moisture:

- Contractors submit a written request to the PM to include soils class and location using project stationing.
- PM reviews and discusses the proposal with DMS and District Geotech Engineer, who investigate the soil moisture relationship to determine if lower moisture content is detrimental to roadway serviceability.
- After denial or approval, PM sends a written response to the Contractor including stipulations, or the Materials Engineer approves or denies the request.
- Response letter copies are attached to initial compaction summaries and placed in project and lab files. Summaries should note compaction was accepted at a lower moisture content.

Slope Contouring and Finishing
Subsection 104.07, Standard Specifications

Slope finishing inspection takes place while major work items are in progress. Rounding and finishing backslopes should be done as cuts are incised, so removed material can be easily disposed of with available equipment. Clearing and grubbing debris should be removed when work is in progress with available equipment. These operations and cleanup should be performed during grading when areas are accessible to equipment.

Finished earthwork should be smooth and presentable in accordance with the contract. Rounded cut slopes are more aesthetic and reduce erosion. Ditch section ends within cut slopes should be flared away from embankment to avoid abrupt slope changes at cut and fill intersections, and provide drainage from cut sections. Rock projections or rocks partially embedded within cut slopes should be removed, so slopes can be contoured. Economic considerations usually make trimming rock slopes to exact cross sections impractical. Slopes should be left neat, presentable, and contoured to remove hazardous loose rock.

Earth work should be finished to neat and uniform lines at channel changes, ditches, inlet and outlet channels, and other features. Leave rocks in place or placed randomly within channels only if required by the contract. Remove stakes for slope, guardrail, culverts and other features. Debris should be removed from storm drains, culverts, ditches, drop inlets and fences. Frequent inspection should be made by Project Managers, and remaining tasks identified. Inspection observations can be presented to the Contractor. Do not wait until a project acceptance request before mentioning punch list details.

Roadway Maintenance During Construction
Subsection 203.03.5, Standard Specifications

Contractors must maintain highway facilities during construction until final acceptance, provide protective measures for installed or constructed work portions, cover maintenance and repair costs, and take corrective action when damage occurs during construction. Roadway surfaces must be free draining to provide efficient runoff. Drainage courses, ditches and culverts must freely drain to prevent saturated subgrade or water ponding on adjacent land. Water should be drained and subgrade aerated before subsequent material lifts are placed. MDT does not pay for corrective measures if damage was preventable by precautionary measure(s). If conditions exist beyond Contractor control, MDT may contribute to repair costs. Project Managers may direct special maintenance to benefit the public, but should confer with DCE and CES before initiating special maintenance work.

Topsoil Salvage and Placement Subsection 203.03.6, Standard Specifications

Topsoiled slopes should be finished to grade and left in rough condition to facilitate bonding and promote root growth. Topsoil is normally spread over completed cut and fill slopes by equipment moving perpendicular to contour. To minimize erosion, dozers should operate on slopes 3 to 1 or steeper at an angle of 45° or 90° to the roadway during final traverses. Dozer cleat marks impede flow direction, and help prevent channel development. Rocks larger than 4 inches (100 mm), brush, roots and foreign matter are removed from finished slopes. Clods and lumps are dispersed so topsoil is of uniform texture. Topsoil should be seeded as soon as possible to prevent erosion.

Balanced Project Borrow Volumes

Soil characteristics, shrink and swell factors, slope changes, sub-excavation, bridge locations and other factors, make projects with zero balances unlikely. Designers attempt to set alignment and grade so jobs are as balanced as possible using practical balance points within project limits. Preferred project grading minimizes excavation, but if projects are within three percent of excavation quantity, they are considered “balanced”. Grading summary frames usually stipulate that “borrow quantities are included in the cost of grading items”, although Contractors are not expected to include borrow costs exceeding known quantities. If plan quantities overrun due to project conditions, a change order may be arranged to eliminate costs associated with borrow item overruns.

Mass Diagram

Description

Excavated material distribution and waste or borrow quantities may be estimated using a mass diagram. When long hauls are necessary, fill material may be cheaper from borrow pits than from roadway cuts. When borrow material is obtained from offsite sources, cut section material may be wasted, rather than transported to distant fills. Mass diagrams graphically depict cumulative cut and fill volumes along stationing. Cut and fill volumes are adjusted for swell or shrinkage to form a line indicating volume accrual quantities. **(**Appendix D for mass diagram information)

Mass Diagram Usage

Mass diagrams generated during design are not included as contract documentation, but are required by construction personnel during excavation projects. Mass diagrams are available online for three months subsequent to letting. Soil shrink and swell data are needed to generate mass diagrams. Design personnel obtain as-built shrink and swell data from previous projects. Construction personnel may use Engineering Applications or MicroStation to generate as-built mass diagrams.

Shrink and Swell Factors

Contractors evaluate soil surveys, boring logs, and Geotechnical Reports to determine shrink/swell factors.

Measurement Method
Subsection 203.04, Standard Specifications

Measurement methods may be project specific and determined by Project Managers. Methods must be clear and easily applied. Earthwork quantities are not paid until earthwork type is completed. Work types include sloping, finishing, ditches, and topsoil placement. Compaction testing may take place after payment if the area required reworking due to weather, winter maintenance, or truck damage. As work items near completion, estimated quantities are computed or measured for final pay documentation to avoid overpayment. When earthwork quantities are finalized, overpayments or underpayments are applied within the next estimate.

Measurement Process

Earthwork pay quantity estimation methods used with monthly estimates are listed below in preferred order:

Unclassified Excavation

Calculate a completed earthwork percentage using computer earthwork runs. Include average length, width, and depth.

Borrow Site Measurement

Survey borrow sites monthly, and calculate completed earthwork via computer program. Include average length, width, and depth.

Special Borrow Neat Line

Computer calculation using “Typical Transition And Vertical Alignment” program cross sections, and length, width, and depth measurements.

Embankment In Place

Calculate a completed earthwork percentage using computer earthwork calculation. Include average length, width, and depth.

Muck Excavation and Sub-Excavation

Measure cross sections and measure average width and depth.

Payment Basis
Subsection 203.05, Standard Specifications

SECTION 204
BLASTING

Description Subsection
204.01, Standard Specifications

Material Subsection
204.02, Standard Specifications

Visually inspect stemming material and obtain a sample. Test stemming material for conformance with Standard Specification Subsection 204.02 gradation requirements. The material should resemble “pea gravel”. Fines and dust typically generated by drilling are unacceptable, and should not be used without a gradation test.

Construction Requirements
Subsection 204.03, Standard Specifications

Blasting operations must be in accordance with project plans and Standard Specification Section 204 submittal requirements. Master Blast Plan, Safety Plan, and other Plans required by the Contract must be submitted prior to blasting. Inspectors must verify subsection 204.03.5 safety requirements are followed.

When rock cannot be ripped, blasting is used to fracture rock for equipment handling. Large oversize rock indicates poor stemming practices or blast design. Blast design is the responsibility of the “Blaster-in-Charge” and the Blasting Consultant. Blasting areas are cleared of overburden, trees, and access roads constructed for blasthole drilling. Drill holes are spaced throughout the area for optimum fragmentation without damage to final cut slopes. Commonly used blasting terms are:

- **Burden:** The shortest distance from a free face to a primary hole, and selected by “Blaster-in-Charge” and Blasting Consultant.
- **Spacing:** Distance between holes measured perpendicular to burden, determined by Blaster-in-Charge and Blasting Consultant.
- **Powder Factor:** Explosive weight divided by rock volume impacted by the blast.
- Project special provisions include road closure times, timing restrictions, structural demolition, managed and special status species, and other blasting related provisions.
- Figure 204-1 lists items to be addressed before blasting.

Blasting Checklist :

- ☐ Know the blasting subcontractor.
- ☐ Is the contractor listed on the pre-qualified blasting contractor list? (204.03.1)
- ☐ Know the “Blaster-in-Charge (BIC)”.
- ☐ Know the project blasting consultant. (204.03.1)
- ☐ Blasting Consultant must have monitoring equipment required by Subsections 204.03.10 and 204.03.11.
- ☐ Calibration certifications must be current. (204.03.10.C)
- ☐ Verify a master blasting plan has been submitted. (204.03.3)
- ☐ Verify a safety plan has been submitted. (204.03.3)
- ☐ Has a road closure time been specified by special provision?
- ☐ Other additional required plans must be submitted.
- ☐ The blasting consultant must be onsite. (204.03.1)
- ☐ Blasting consultant must have performed pre-blast surveys. (204.03.10)
- ☐ Be familiar with blasting day protocol.
- ☐ Verify a blast plan (CSN-55) has been submitted. (204.03.3)
- ☐ Review memorandum received from the geotechnical bureau.
- ☐ Signage must be posted in accordance with the contract. (204.03.5)
- ☐ Blasting consultant has verified subsection 204.03.7 information.
- ☐ Blasting consultant has verified blast hole location and depth. (204.03.7)
- ☐ Blasting consultant has verified explosives and stemming are installed in accordance with the blast plan. (204.03.7)
- ☐ A pre-blast meeting has been held. (204.03.5)
- ☐ BIC and blasting consultant monitor blast areas for a period of 5 minutes after each blast. (204.03.5.C.2)
- ☐ Traffic is prevented from entering the blast area until the “all-clear” signal is given. (204.03.5.C.4)
- ☐ Verify daily drilling logs are received. (204.03.9)
- ☐ Blasting logs are received weekly. (204.03.9)

FIGURE 204 – 1

BLASTING CHECKLIST

Presplitting

Subsection 204.03.6, Standard Specifications

Blasting techniques may be specified to produce a smooth cut face. “Presplitting” is used with hard rock such as granite, basalt, hard shale, sandstone, limestone, and argillite, and uses a series of closely spaced parallel holes conforming to designed cut slope line and grade. Presplitting takes place before a primary blast to provide a pre-sheared face for the primary blast, and permits blast hole gases and energy to escape. Hole loading, firing sequence and hole spacing allow a relatively smooth plane between holes, without damaging back slopes outside excavation limits. Normal presplitting operations begin on a trial basis by using initial test blasts to assess rock faces. Blast area excavation is necessary for test blast rock face evaluation. Further drilling or blasting should not be take place before evaluation, after which adjustments may be made. Fracturing outside neat line may be corrected using powder charge reduction, hole spacing changes, powder charge spacing reduction or hold charge redistribution.

Safety and Public Notifications

Project Managers and Inspectors must be familiar with Contractor seismic monitoring equipment safety requirements, placement, monitoring and documentation, and impacts to structures. Video document and monitor wells before, during and after blasting or related grading activities. Blasting Consultant and “Blaster-in-Charge” are typically responsible for these duties. All individuals within blasting areas must be safety aware. Personal injury, shattered windows, flying boulders, and damage to railroads, forests and highways may occur due to poor blasting operations. Before blasting, Contractors must inform law enforcement, emergency response organizations, utility companies, local residents and area business owners. Contractors must post signage in accordance with MUTCD requirements, obtain necessary permits, and close the area. Public safety and convenience measures, as well as blasting notification to authorities is essential. Figure 204-2 illustrates blasting day protocol. Project Managers and blasting consultants should work with interested parties before blasting operations to develop specific protocols required by the master blasting plan.

Blasting Report (CSN 55)
Section 204, Standard Specifications

Form CSN-55 records blasting effects to construction, cut stability and appearance. It also provides information for future construction and design. Form CSN 55 is finally submitted to Geotech to review blasting consultant plans submitted by the Contractor. Contractors are required to hire a blasting consultant with drilling and blasting expertise, not to be a Contractor employee, explosive manufacturer or distributor. Blasting consultants professionally advise Contractors regarding blast design and public safety and convenience. Consult Geotech with questions regarding unexpected conditions requiring blasting.

WEEKSVILLE – WEST BLASTING DAY PROTOCOL

Day Prior to known Blast

MDT field Office releases E-mail update of future blast on Project Distribution list. Start 24 hour pre-blast warning on message board signs.

MDT will contact John Hood, MRL Rail Boss, 822-3120, Cell 370-4077. With 24-hour notice, longer "*work windows*" may be generated on the day of the blast. Inform RR Flagger of blast days each week.

Day of Blast

8 AM: Check with MRL Railroad Flagger on site for afternoon train schedules.

Pick tentative time to blast. Critical Blast by 1 pm, all other blasts by 3 pm.

Blasters loading holes.

Mid to Late Morning: Recheck for changes to the early morning train schedule.

Adjust scheduled blast time accordingly.

Blasters continue to load holes and set up for blast.

Meet One Hour Before Blast Time: Traffic flagger station nearest blast site.

Must-Convene Personnel: Blaster or Blast Consultant, Greg Rogers, Cell 370-7637

MDT Const. Representative, John Benda 826-5864, Cell 396-4766 or Kevin Todd,

Traffic Control Foremen, Shawn Hollenback, 239-1304, Cell 360-8351

MRL Railroad Flagman, MDT Geotech Larry Prinkki

PumCo Foreman, Brett Pumnea, Cell 239-4202 or Chad Pumnea, Cell 239-1158

FIGURE 204-2
EXAMPLE BLASTING DAY PROTOCOL

Contractors must submit a Master Blast Plan to MDT for review before blasting activities, and submit the plan to MDT for each blast. Plans must be submitted to Geotech for review. Submittals must include containment plans for Environmental Services Bureau review if blasting involves waterways or wetlands.

Measurement Method
Subsection 204.04, Standard Specifications

Payment Basis
Subsection 204.05, Standard Specifications

SECTION 206
DETOURS

Description
Subsection 206.01, Standard Specifications

Construction Requirements
Subsection 206.03, Standard Specifications

Verify proper traffic control is in place before detour construction. Review the Contractor TCP before detour construction begins. Do not allow contractors to grub areas identified as wetland or riparian areas. Vegetation in these areas should be cut flush to ground, and covered with a geotextile or separation material. Verify contractors construct detours to plan grade and alignment, or as approved by Project Manager. Detours may require guardrail due to slope changes or construction over a temporary structure. Contractors must submit NCHRP 350 Test Level – 1, or MASH crash test documentation prior to guardrail installation. Contractors must maintain safe and smooth detour surfaces. Notify the Project Manager of unmaintained detours.

Measurement Method
Subsection 206.04, Standard Specifications

Payment Basis
Subsection 206.05, Standard Specifications

SECTION 207
CULVERT AND TRENCH EXCAVATION

Description
Subsection, 207.01, Standard Specifications

Standard Specification Section 603 applies to culvert excavation and installation. Standard Specification Section 207 addresses culvert excavation for trenches with and without vertical walls.

Construction Requirements
Subsection 207.03, Standard Specifications

Before Excavation Contractors must consider:

- Marking existing underground utilities and structures
- OSHA trenching and confined space entry requirements
- Open trench/excavation protection including safety fence and barricades
- Notifying utility companies affected by trenching and pipe installation
- Existing utilities and structure protection
- Securing local permits
- Survey monument locations
- Inspectors should document whether Contractors address these items before excavation.

Safety

Shoring to protect personnel and work is Contractor responsibility. MDT representatives are not responsible for approving safety systems used with Contractor excavations. MDT Project Managers and Inspectors must abide by excavation safety measures and regulations. Consult the "MDT Employee Safety Policy and Procedure Manual", current OSHA trench excavation regulations or the Montana Department of Labor and Industry, Occupational Safety and Health Training Institute, Occupational Safety & Health Bureau, MOSHTI Course 109-OSHA "Trenching and Excavation 29 CFR 1926 - Subpart P." MDT employees must never enter trenches 5 feet (1.2 m) deep or deeper lacking proper slopes or adequate shoring. Contact the Project Manager with questions regarding Contractor shoring methods or trench safety.

OSHA Requirements

Trench safety and confined space entry are major safety concerns during pipe installation, for which OSHA has issued strict requirements. OSHA regulations Subpart P (29 CFR 1926.650 -652) addresses excavation safety. The first section of Subpart S (29 CFR 1926.800) applies to confined space entry. OSHA requirements apply to all trenches, although standards are more stringent for excavations 5 feet (1.5 m) and deeper. Figure 207-1 summarizes field safety assessment and safety investigation.

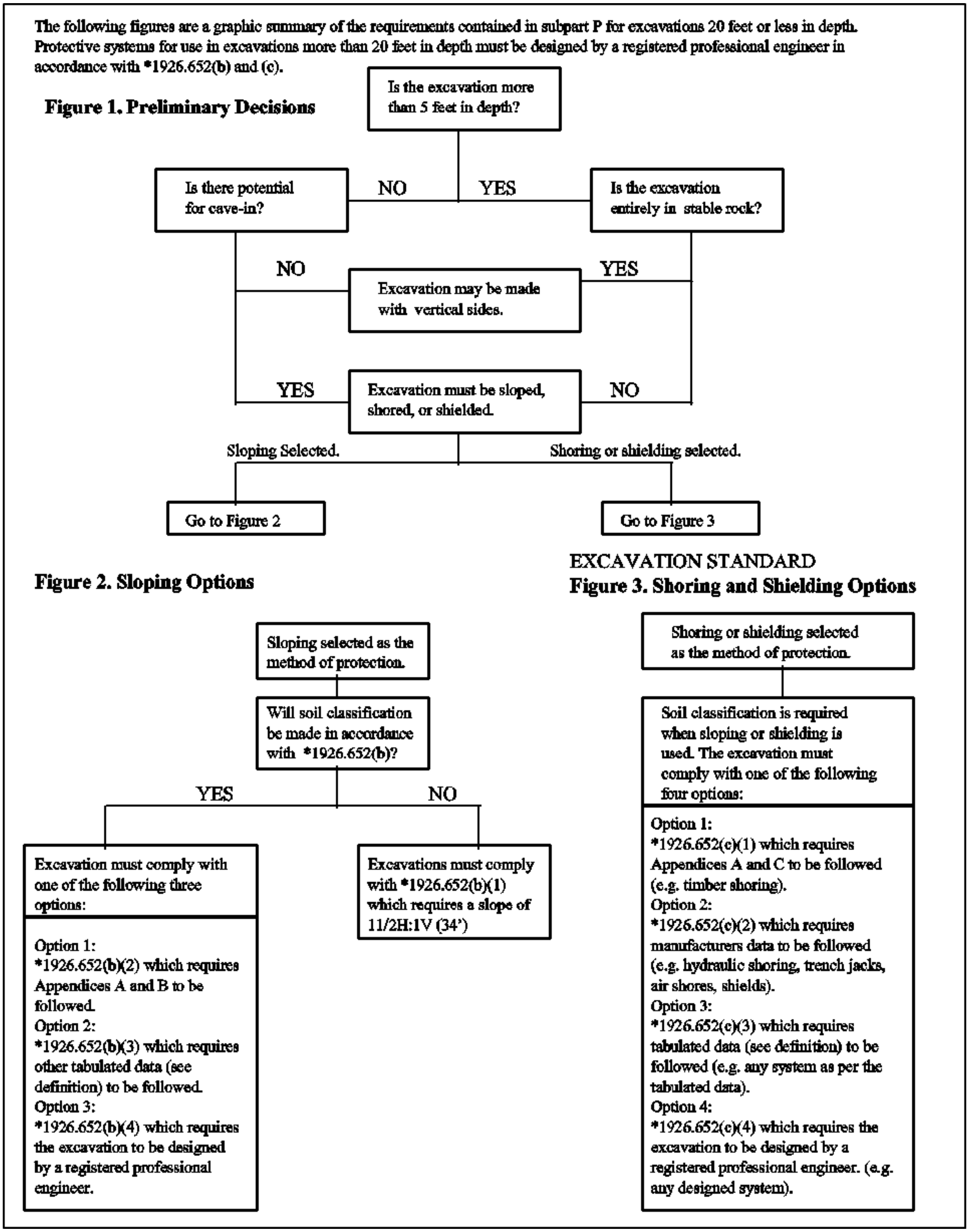


FIGURE 207-1; FIELD SAFETY ASSESSMENT

OSHA excavation safety standards:
Contractors must have a competent person on the job site, whose duties include:

- Soil classification and rock outcrop or formation identification
- Evaluation for collapses when excavations exceed 5 feet (1.5 m)
- Employee removal from hazardous conditions
- Daily excavation inspection
- Dewatering equipment monitoring
- Training and qualifications held by the Contractor designated "competent person" should be reviewed by Project Managers based on the OSHA definition of a "competent" person (see §1926.650(b)) as follows: "A worker able to identify existing and predictable hazards, or unsanitary, hazardous, or dangerous working conditions dangerous to employees, and having authorization to take prompt corrective measures."

Project Managers should verify individual qualifications relating to:

- Soil classification
- Trench protection system selection, installation and inspection
- Dewatering equipment installation and operation
- Toxic gas hazard recognition
- Monitoring and rescue equipment availability

Project Managers should verify "competent person" qualifications and training records, and may request Contractors provide a "competent person."
A "competent person" must oversee slope, shoring and shield design for trench depths greater than 20 feet (6.1 m), in accordance with §1926.652(b) and (c). A competent person must identify nearby structures unaffected by excavation.

Soils are classified as a stable rock or type A, B or C soil. Soil classification must include manual soil testing for gradation and strength, and visual assessment. Sloping, shoring and shielding requirements depend upon soil type.
The "competent person" also evaluates spoil pile stability.
For excavations less than 5 feet (1.5 m), Contractors must mitigate caving risks, by sloping, shielding or shoring trench walls.

Project Managers should verify Contractors have correctly identified soil and an appropriate trench slope. If Contractors use a trench shield, Project Managers must verify the shield is professional engineer certified for trench soils. Trench safety and OSHA compliance is Contractor responsibility. Project Managers must not allow State employees to enter unsafe trenches. Contractors must be notified that unless trench safety issues are addressed, work within the trench will not be paid. Air monitoring devices must be used in confined spaces to monitor oxygen and methane levels and identify explosive gases.

Certain gases are heavier than air, so oxygen levels in deep, narrow trenches must be measured to ensure ventilation. Manhole covers should be removed upstream and downstream of workers to guarantee fresh air movement. Forced air is required when natural drafts through a pipeline are inadequate. See §1926.800 of OSHA Subpart S for more details. Occupied trench areas must be inspected by an OSHA defined "competent person" before entry. If unsure about trench safety, have a "competent person" inspect the trench.

Foundation and Bedding

Contractors mitigate groundwater using water tight sheathing, trench drains, pumping or a well pumping systems. Dewatering often increases trench stability, but ground subsidence may accompany lowered water tables and affect nearby structures and pavements.

Inspectors should monitor trench width during excavation. Contract documents specify minimum trench widths and define “non-trench conditions” during pipe installation. Adequate width is needed for bedding material placement and compaction.

Examine and approve pipe subgrade before bedding placement. Subgrades free of soft or unstable material must evenly transfer loads placed on the pipe. Soft, yielding subgrades cause pipe shifting and settlement, whereas rocky subgrades concentrate point loads against the pipe and may cause cracking or deformation.

Culvert Foundation Preparation

Contractors may use sheepsfoot, vibratory or rubber tired rollers, or hand-operated compaction equipment to prepare culvert foundations. Contractors must obtain at least 95% maximum density for culvert foundation and embankment material placed around and over the pipe.

Soft Ground Conditions

Soft ground conditions are typically caused by wet organic silts or clays with little shear strength, and usually require sub-excavation, geotextile, or granular backfill and foundation. Verify bedding and foundation material complies with Standard Specification Subsections 701.04.1 and 701.04.2. Geotech normally conducts foundation investigation drilling for culverts 36 inches (900 mm) or larger. If soft soils are encountered, a special provision requiring foundation treatment is included in the plans. Contact Geotech if unanticipated soft soil conditions are encountered. Sometimes pipes can be moved to a stable location. Steel probes may be used to help locate firm material. If pipe cannot be moved to a firmer bottom, increase excavation by 2 to 4 feet (0.6 to 1.2 m). Stable foundations are usually rock or gravel with the top portion being a finer material. Failing pipe installations due to unstable foundations are expensive to repair, making foundation costs a good investment.

Silt, Fine Sand and Clay Soils

Some silts, fine sands and clays crack as they dry, enabling water to flow through these cracks. Water may flow around, and along pipes rather than through a pipe, a condition known as “piping.” Visually examine for potential piping and consult with the Maintenance Section as needed. Sub-excavation is usually not feasible. A cohesive soil seal with a cutoff wall at the pipe inlet may be necessary to prevent piping.

Alkaline and Acidic Soils

Alkaline and acidic soils corrode pipes, so soil and special borrow material should be tested for these properties during preliminary soil surveys. Retesting may be necessary with pipe relocation during design or construction. Heavy alkalinity is common in Montana, and usually a white deposit left where water concentrated and evaporated. Although not as common, acidity is associated with mine drainage, decomposing organic material, timbered mountain slopes and wetlands and marshes. Significant pipe corrosion is usually due to soil salts and sulfides. Samples tested by District, Area or Materials Bureau laboratories help identify corrosive soil properties and locations. Often laboratories have tested soils within specific project areas. Soil pH and resistivity determine if corrosion resistant pipes are required. Reinforced concrete pipe or corrugated metal pipe with bituminous or polymeric coating are typically used in areas with corrosive soils to enhance service life.

Rock Cuts and Embankments

When pipe excavation uncovers rock, shale or clay hard pan, Standard Specification requires these areas be sub-excavated 1 foot (300 mm) below grade, and backfilled with earth or gravel to produce a uniform foundation. If excavation reveals soft areas, sub-excavate to provide even support and avoid differential pipe settlement. Pipes placed under blasted or fractured rock embankment require special care to prevent pipe damage.

Pipe Bedding Aggregate

Bedding depth should be at least 10% of pipe height. Bedding evenly distributes pipe loading to avoid concentrated loads against the pipe walls. Bedding material type is designated within the contract, and placed as shown by MDT Detailed Drawings.

Bedding for corrugated metal pipe must be formed to the pipe bottom profile as specified by Detailed Drawings. The most practical method of constructing the bottom profile is to compact the bedding area to required density, then shape bedding to fit the pipe bottom. Obtain final Project Manager approval before pipe placement.

After rough grading and bed compaction, hubs can be set to control fine grading before pipe placement. Pipe bedding should be compacted to elevations specified within the Detailed Drawings, after which fine grading shapes the pipe bed to attain plan elevations. Hubs reference established invert elevations while accounting for pipe wall thickness. Before setting hubs, check drainage invert elevations with a level and tape at approximately 10-foot (3-m) intervals. Laser levels may also be used to set grade.

Flowable Fill Bedding

Flowable fill is aggregate bedding material mixed with cement and water mixture to enhance flowability, reduce voids under the pipe and eliminate compaction or vibratory consolidation. Inspectors may request vibrators usage if the mixture is not filling trench voids. Flowable fill may be required within narrow trenches where conventional compaction is impractical. Excessive cement makes flowable fill placement and future pipe removal difficult. Inspectors should monitor bedding for flowability and cement content. It is better to have too little cement, than to have unremovable fill when a pipe eventually needs maintenance.

Measurement Method
Subsection, 207.04, Standard Specifications

Unless specified, culvert and trench excavation quantities are not measured for payment, and shown within summary frames “for information only.”

Payment Basis
Subsection 207.05, Standard Specifications

SECTION 208
WATER POLLUTION CONTROL AND STREAM PRESERVATION

Subsection 208.01, Standard Specifications

Disturbance to vegetated areas during construction may cause soil erosion and create sediment. During grading and draining, Inspectors should ensure soil erosion and sedimentation are controlled. The following elements prevent water pollution, soil erosion and sedimentation:

- Stormwater construction and construction dewatering permits
- Short term construction turbidity waivers (318 authorizations)
- Temporary facilities
- Tribal resource permits
- Clean Water Act (Section 404 Permits)
- Section 10 permits
- Clean Water Act (Section 401 Certifications)
- Aquatic resource preservation
- Montana Stream Protection Act (SPA 124 Notifications)
- Municipal Separate Storm Sewer Systems (MS4) permits

Materials
Subsection 208.02, Standard Specifications

Construction Requirements
Subsection 208.03, Standard Specifications

Project Manager BMP Presentation

No MDT unit should direct Contractors. BMP issues should be presented by the Project Manager.

National Pollutant Discharge Elimination System (NPDES)

NPDES authorization, known as “Clean Water Act Section 402”, authorizes the Environmental Protection Agency (EPA) to regulate point source pollutant discharge subject to EPA effluent limitations to meet water pollution prevention and control objectives. In Montana, the EPA delegates permitting authority to the DEQ, except on Tribal lands, which remain under EPA and NPDES authority. DEQ rules are established under the Montana Water Quality Act. DEQ administers the Montana Pollutant Discharge Elimination System (MPDES) to issue a “General Permit for Storm Water Discharge Associated with Construction Activity,” commonly known as the “stormwater construction” permit. NPDES/MPDES stormwater construction permits require Best Management Practices (BMPs) to reduce pollution from disturbance activities. BMPs administered during MDT projects include erosion control plans, temporary and permanent erosion controls, sediment control measures, pollution prevention activities, and avoidance activities. Even when an NPDES or MPDES stormwater construction general permit is not required, FHWA rules still require BMPs to prevent sediment and pollution from leaving project sites.

Storm Water Pollution Prevention Plan (SWPPP)

SWPP Plans are a stormwater construction general permit condition, and must be submitted and obtained by permit holders indicated within the contract. Contractors often have a separate SWPPP for ground disturbance activities outside Department ROW, easements, material sites or designated contract areas. Permits may apply to staging and Contractor furnished material source areas. For areas within Department ROW, easements, material sites or other areas designated in the contract, MDT staff conducts periodic inspections. Ensure MDT project Inspectors use the "MDT SWPPP Inspection Report" (CSB208_03_6) when inspecting erosion and sediment control measures. Contractors may use any form complying with permit requirements. Additional erosion and sediment control information is available within the "MDT Erosion and Sediment Control Best Management Practices Manual."

Reporting Potential Noncompliance

This Subsection discusses MDT procedure for reporting noncompliance related to water pollution control regulation, authorization, permits or permit conditions. MDT project noncompliance must be reported, and potential violations should be documented using photographs, memos, correspondence and diaries. Noncompliance reporting must be conducted according to regulation, MDT guidance and permit conditions. Contractors must provide an emergency contact for events or violations occurring outside working hours. Project Managers or Maintenance Superintendents use this number if a major event requiring notification occurs. Noncompliance reports should be forwarded to the Environmental Services Bureau.

Contract Requirement Enforcement

Stormwater permit compliance is permit holder responsibility. Permit holders must weigh discharge risks against BMP installation and maintenance. Regardless of contractor risk management strategy, MDT must ensure projects are built according to contract documents, and in regulatory compliance. Compliance with environmental legal and permit conditions is required by permit holders. Erosion Control is a project bid item, for which MDT is responsible through oversight and documentation, in accordance with FHWA/MDT oversight agreements, and the Code of Federal Regulations (CFR).

Contractors are required to construct environmental mitigation features in accordance with MDT Detailed Drawings. If BMPs are improperly installed or maintained, or MDT does not receive timely inspection reports:

- Final inspection is not granted.
- Storm water discharge permits are not transferred
- BMP payments are not made.
- BMP total payment to date is deducted from the next estimate.
- Potential noncompliance is reported.
- Contract time may still be charged.
- Contract bond may remain in effect.

Measurement Method
Subsection 208.04, Standard Specifications

Payment Basis
Subsection 208.05, Standard Specifications

SECTION 209
STRUCTURE EXCAVATION

Construction Requirements
Subsection 209.03, Standard Specifications

Most soil types require shoring or ground sloping beyond contract neat lines to avoid caving. Trenching must conform to OSHA standards. Subgrade foundations under structures must be compacted across the entire bearing surface. Unsuitable material beneath footings must be replaced with specified structural backfill.

Measurement Method
Subsection 209.04, Standard Specifications

Payment Basis
Subsection 209.05, Standard Specifications

SECTION 210
EQUIPMENT USE

Description Subsection 210.01
Standard Specifications

Construction Requirements
Subsection 210.03, Standard Specifications

Equipment Operational Safety

MDT has no mechanism requiring Contractors to replace equipment, but if equipment defects affect operational safety, Inspectors should notify the operator. If the issue is uncorrected, the Superintendent is notified. If the issue remains uncorrected, inspectors may shut down an operation until correction. Inspectors must inform Project Managers of contractor communication. Contractors must provide safe and operational equipment in accordance with local, state and federal regulation.

MDT Field Office Services

Before moving field office construction trailers, take the following steps to ensure connectivity, network and phone connectivity, power, security, water and sewer service. These procedures do not apply to field testing trailers addressed through special provision.

Service Disconnection

Notify MDT ISD Systems and the MDT Radio Outlook distribution list personnel 30 days before disconnection. Provide contact information, physical address and network or DSL connections needing disconnection. Notify district office personnel of phone and fax numbers to be disconnected.

Disconnect and Reconnect at New Location or Reconnect Only

Confer with DOA, ITSD and MDT personnel 60 days in advance to discuss network and phone connectivity options, and select an optimal location meeting connectivity needs. Invite DOA, ITSD and MDT Networking Team Outlook distribution list members and District personnel.

When location is determined, notify ISD Systems and Outlook distribution lists 60 to 90 days before disconnection or reconnection. Provide contact information, physical disconnection address, network or DSL connections or disconnections, trailer relocation date, reconnection address, new location phone number, and network and DSL connections needing installation. Include use township / range legal description. Update new contact information.

Measurement Method
Subsection 210.04, Standard Specifications

Payment Basis
Subsection 210.05, Standard Specifications

SECTION 212
OBLITERATE ROADWAY

Description Subsection
212.01, Standard Specifications

Construction Requirements
Subsection 212.03, Standard Specifications

Existing plant mix and aggregate may be used as fill material within the road prism if material meets embankment requirements described in Subsection 203.03.2. Existing material must have 12 inches of cover.

Measurement Methods
Subsection 212.04, Standard Specifications

Payment Basis
Subsection 212.05, Standard Specifications

SECTION 300
GENERAL INFORMATION AND GUIDELINES

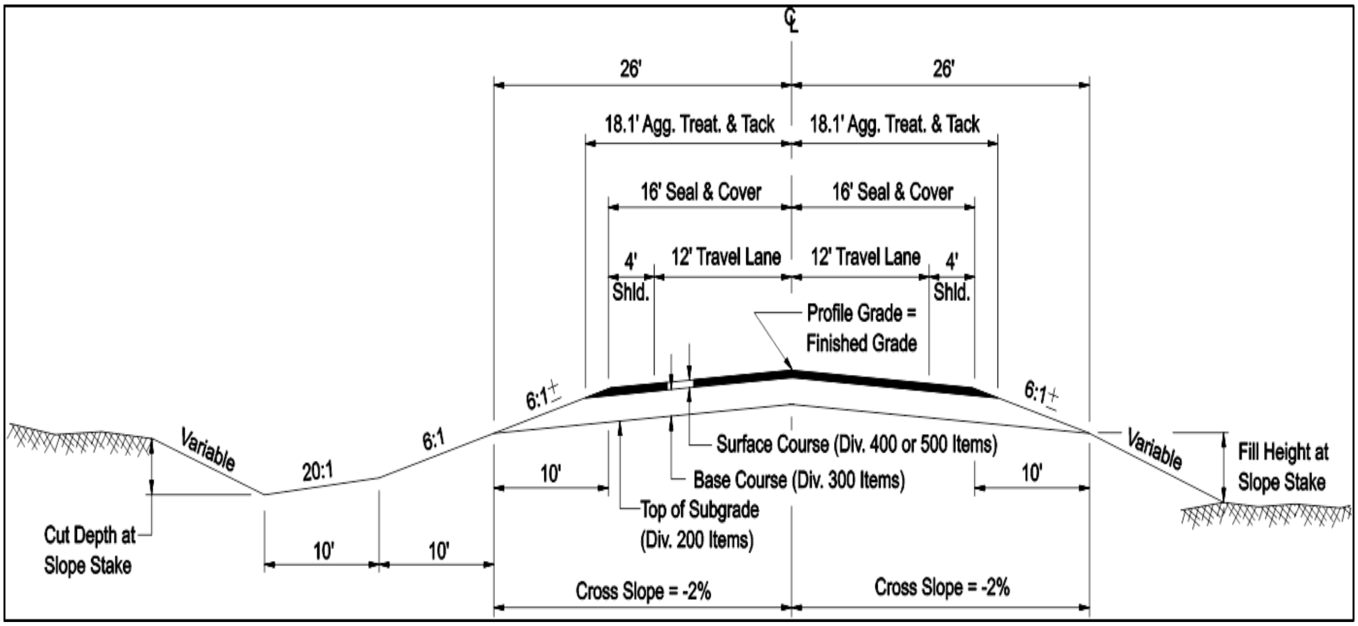
Section 300 provides Project Manager and Inspector guidance regarding aggregate surfacing construction and base course pay items. Inspectors should monitor subgrade movement before aggregate placement. Subgrade movement or pumping with equipment passage requires corrective action. Proof rolling may be used to verify subgrade integrity before aggregate placement. MDT may suggest contractors provide pneumatic tired equipment loaded to a specified axle load. If weak and yielding subgrade areas are observed, notify the Contractor of needed repair.

Before aggregate placement, verify subgrade surfaces are properly compacted, unrutted, not pumping, unfrozen, at grade and cross section and Project Manager approved.

Project Managers, Inspectors and material testers must sample as directed by the MDT Materials Manual minimum sampling size and frequency. Project Managers may also request additional samples. Material sampling and testing is discussed within the MDT Materials Manual, along with information regarding material forms and reports, material certification acceptance, sample identification, labeling and field calculations.

The Materials Bureau Pavement Analysis Section designs pavement structure using AASHTO pavement design methods. Pavement typical sections (Figure 300-1 below) are incorporated into the plans by the Road Design Section

Base course is placed directly on subgrade to ensure uniform load transfer from surface to subgrade, drainage under surface courses, uniform subgrade, stability against frost heave and minimal surface course stress and deflection. Base course type, thickness and material vary with design. Base courses are constructed of durable aggregate materials able to transfer loads from the surface course to the subgrade, and undergo higher stresses than subgrade. Typically, only one base course is required, but some sites may require an additional base course type. Grade or cross sectional variations over base course surfaces should not be corrected using surface course. Inspectors must document subgrade is constructed to plan elevation. Inspectors must verify subgrade repair or correction prior to base material placement. “Spot” and “sliver” fills are unacceptable, and often create areas failing to meet density. Base course lift thicknesses less than 8” may be placed as a single lift, whereas base courses thicker than 8” must be placed using multiple lifts. Inspectors should monitor base course surfaces for wet areas, soft spots, rutting, and grade and cross section variation. Project Managers must approve base course construction before work on an additional section begins.



℄
26'
26'
18.1' Agg. Treat. & Tack
18.1' Agg. Treat. & Tack
16' Seal & Cover
16' Seal & Cover
4' Shld.
12' Travel Lane
12' Travel Lane
4' Shld.
Profile Grade = Finished Grade
6:1±
6:1±
Variable
20:1
6:1
Variable
Surface Course (Div. 400 or 500 Items)
Base Course (Div. 300 Items)
Top of Subgrade (Div. 200 Items)
Fill Height at Slope Stake
Cut Depth at Slope Stake
10'
10'
10'
10'
Cross Slope = -2%
Cross Slope = -2%

Figure 300-1

SUBSECTION 301
AGGREGATE SURFACING

Descriptions
Subsection 301.01, Standard Specifications

Aggregate surfacing is most often used as base course under plant mix surfacing, but is also used as low volume rural road surfaces. Contractors must produce aggregate in accordance with Standard Specification Section 106. Inspectors sample aggregate directly from the roadway to ensure Standard Specification Section 701 requirements are met.

Materials
Subsection 301.02, Standard Specifications

Aggregate Surfacing Types
Subsection 301.02.1, Standard Specifications

Aggregate surfacing is most often used as base course under plant mix surfacing, but is also used as low volume rural road surfaces. Contractors must produce aggregate in accordance with Standard Specification Section 106. Inspectors sample aggregate directly from the roadway to ensure Standard Specification Section 701 requirements are met.

Aggregate Material
Subsections 301.02 and 301.03.1, Standard Specifications

Aggregate surfacing material types have unique applications, gradation and material property requirements. To avoid multiple stockpile sites, Contractors may propose:

- Aggregate material types from separate sites used within the same pavement structure.
- Aggregate surfacing material used as surface course for unpaved roads and ramps within project limits
- A single aggregate for shoulder gravel usage
- A single aggregate for traffic gravel and temporary riding surface
- Inspectors should monitor aggregate pay items.

Construction Requirements
Subsection 301.03, Standard Specifications

Sampling, Testing, and Acceptance
Subsection 105.03 and 301.03.01, Standard Specifications

Standard Specification Subsection 105.03.2 identifies contract items designated for QA acceptance, and includes Section 301 items except “Shoulder Gravel” and “Traffic Gravel”, which are not designated by Standard Specification Subsection 105.03.2 as Quality Assurance items.

Aggregate QA Testing
Subsection 105.03.2, Standard Specifications

Quality Assurance samples are collected by inspectors from aggregate lifts prior to compaction. If aggregate gradation does not meet specification, Project Managers inform the Contractor. Inspectors may collect additional gradation samples to ensure segregation is not occurring. Although Contractor quality control tests at the crusher may show satisfactory results, placed material may not meet specification. Inspectors should realize that segregation and conditions such as excess moisture or clumping may be undetected by random sampling.

Quality Incentive Allowances (Standard Specification Subsection 105.03.3) require Contractors to submit Forms CB30-CBC5A or CB30-CBC6A before placing a second aggregate lot. If multiple aggregate sources are used, forms should be submitted for each source before a second lot is placed. If Form CB30-CBC5A or CB30-CBC6A is submitted after first lot completion, the target aggregate gradation will be applied retroactively to the first lot for quality incentive assessment. Failure to submit Form CB30-CBC5A or CB30-CBC6A within the specified timeframe is cause for waiving a quality incentive, after which aggregate will be evaluated in accordance with Standard Specification. Gradation targets should be selected early during laydown.

Defective Material
Subsections 105.03.1 and 105.03.2, Standard Specifications

Standard Specification Subsection 105.03.2 allows obviously defective material to be rejected regardless of sampling sequence or location within a lot. MDT is not required to accept defective material because random sampling did not detect defective material. Subsection 105.03.1 states “when a contract item does not meet contract requirements resulting in work inadequate to serve the design purpose, remove and replace or correct the work by and at Contractor expense.” Inspectors must notify Project Managers of work not meeting contract requirements. Project Managers notify Contractors of needed corrective action.

Corrective Action

When sampling and testing indicate uncompliant material, additional testing may isolate the problem. Prudent Contractors realize excessive aggregate handling causes segregation. Project Managers should discuss project specifics and failures with Construction Engineering Services and Materials to determine if a material will serve the intended function during a reduced service life. Project Managers may remove defective material if it will not serve the intended purpose, or apply a deduction commensurate with lost value. If material will fulfill primary function over a reduced life, a deduction to account for extra repair costs and shorter design life is appropriate. Price reductions must be processed via change order.

Equipment
Subsection 301.03.2, Standard Specifications

Inspectors should ensure aggregate segregation is prevented. Segregation is a separation of fines from coarse fractions to produce inconsistent density. Over handling aggregate material causes segregation, and may degrade softer material. Acceptance sampling and testing is performed at the placement site. Contractor quality control plans should include quality checks at the production site.

End Dumping Operations

Stockpiled materials are most often delivered by end dump trucks and leveling equipment. Dumping aggregate over stockpile slopes should be avoided to prevent segregation. Aggregate should also be dumped at or near the placement site to minimize maneuvering and spreading, which encourages segregation.

Stockpile Operations

Typically dozers or loaders are used to shape and level stockpiled material. Excessive material movement introduces segregation. Good communication regarding gradation concerns at the stockpile prevents uncompliant material from being delivered to the project.

Crushed Aggregate Course
Subsection 301.03.4, Standard Specifications

Crushed Aggregate Course (CAC) is a base course material, as opposed to a specific aggregate type.

Aggregate Placement
Subsection 301.03.5, Standard Specifications

Inspect for soft subgrade areas before aggregate placement. If pumping or yielding is observed with construction equipment loading, Inspectors should notify the Project Manager that repairs are needed. Aggregate should be spread at correct thickness per volume or weight per station to attain specified thickness. Although thickness is contractor responsibility, Inspectors should perform a rough check by noting the distance over which loads are distributed. Prepare a spreadsheet tracking aggregate quantity per station. As placement progresses, calculated aggregate volumes can be compared to Contractor records. Significant variations warrant investigation. Aggregate surfacing lifts must be compacted to correct depth to prevent soft spots. Randomly inspect and test lift thickness.

Observe watering and compaction to ensure a uniformly dense lift. Record station and lift for placed material. Account for soft area correction and material rejection. Compacted aggregate surfacing lift thickness must not exceed 8 inches (205 mm).

Contractors must construct the section to alignment and grade, with control measured in accordance with Standard Specification Subsections 105.08.5 and 105.08.6. Project Managers perform grade checks when the section is completed. Contractors may reshape, lightly scarify, or trim and finish roll the material to comply with plans. Inspectors check finished grade by the close of each day after section completion.

Pugmill Mixing Operations
Subsection 301.03.5, Standard Specifications

Pugmill mixing ensures uniform gradation and moisture distribution. Standard Specifications require pugmill mixing unless otherwise specified by the contract. Inspectors must verify contractors add no more water to pugmills than specified. Document additional water, and note CAC areas having additional water applied. Excess water may segregate and saturate previously placed gravel. Monitor heavily watered areas before paving begins.

Aggregate Compaction
Subsection 301.03.5.D, Standard Specifications

Density tests are randomly conducted in accordance with MT-416, using MT-210, MT-212, MT-215, MT-218 and MT-230. Ten tests are completed every 2000 feet (610 m) along full placement width, the average of which must be compacted to 98% target density. Contractors must recompact failing sections. Inspectors record passing and failing test result locations, and regularly provide information to the Contractor. Project Managers submit a copy of the “Embankment and Excavation Compaction Summary of Test Data Form” and the “Surfacing Compaction Summary of Test Data Form” to the CES Reviewer and headquarters Materials Bureau. Original forms remain within District files. Inspector compaction summaries are reviewed by the CES and Materials Bureau weekly to promptly address issues, and filed within the Materials Bureau. Notify Project Manager if a failing section continues to fail.

Aggregate Cure

Final CAC lifts must cure for 72 hours until moisture content is 2% or more below optimum moisture, or a maximum of 5% final moisture content, whichever is lower. These criteria must be met prior to aggregate treatment or paving. This specification prevents paving over saturated and unstable gravels, but may be waived by the Project Manager. Project Managers inspect CAC to ensure a stable surface without soft areas. Change orders must be written to waive this cure requirement.

Measurement Method

Subsection 301.04, Standard Specifications

Aggregate measurement by volume or weight is specified by the contract. The Department measures aggregate surfacing volumetrically. Record surfacing aggregate location and quantity, and additionally surfacing placement. Volumetric quantity measurements are compiled according to Standard Specification Subsection 109.01, and may incorporate plan dimensions and roadway or stockpile volumes, as determined by the Project Manager. Record daily aggregate volumes within the DWR. Payment is made per volume unit price. Record these items within the DWR during aggregate placement:

- Surfacing thickness
- Placed and accepted aggregate locations and quantity
- Surface smoothness tolerance
- Irregularities and soft area corrections
- Materials needing corrective action

MDT may specify areas where aggregate is measured by weight. This determination is made by designers, and indicated within the contract. Contractors provide individual truck load weight tickets. Inspectors record, compute and check quantities, then sign and date each sheet. Ineligible quantities, such as corrective work quantities exceeding those specified or approved, are not paid.

Payment Basis

Subsection 301.05, Standard Specifications

SECTION 302
BITUMINOUS PAVEMENT PULVERIZATION

Subsection 302.01, Standard Specifications

Bituminous pavement pulverization mixes existing plant mix with underlying base course to form a new base, use existing material and correct base course deficiencies. Pulverization can delay reflective cracking and provide a fast, inexpensive, durable alternative to rehabilitating pavements otherwise requiring major repair or reconstruction.

Materials
Subsection 302.02, Standard Specifications

Construction Requirements
Subsection 302.03, Standard Specifications

Pulverization
Subsections 302.03.1 and 302.03.2, Standard Specifications

Pulverized material must be less than 2”. Oversize piece removal may require additional pulverization.

Mixing with Additional Aggregate
Subsection 302.03.3, Standard Specifications

Pulverized material may be mixed with virgin aggregate at a ratio depending upon gradation requirements, moisture content and material volumes needed to construct the surfacing typical. When needed, virgin CAC is pug-milled with pulverized material to produce a uniform pulverized plant mix and virgin CAC mixture. Pulverization may also blend only existing plant mix and underlying base. Additional CAC is added as needed to increase structural thickness.

Compaction
Subsection 302.03.4, Standard Specifications

Compaction should immediately follow mixing and placement to prevent moisture loss. Pulverizing materials in place often creates an inconsistent material having varying plant mix, base course and moisture percentages. Project Managers determine if a new target density is required, based on Standard Specification Subsection 302.03.4 requirements. Nuclear density testing may be inaccurate due to varying pulverized asphalt percentages.

In place pulverized plant mix normally exhibits variable CAC to pulverized plant mix ratios. MT-219 should be used to develop target density. Oven dried moisture tests are used to determine moisture content and correct nuclear gauge moisture readings.

Measurement Method
Subsection 302.04, Standard Specifications

Pulverization is measured and paid by unit area. Crushed Aggregate Course (CAC) is measured and paid by volume or weight. Record these pavement pulverization items within DWRs:

- Treatment depth and thickness
- Pulverization location and quantity

- Additional crushed aggregate course
- Errors or irregularities needing correction
- Corrective action to sections not meeting density requirements
- Contractor employees shifts
- Contractor equipment usage durations
- Weather conditions

Ensure MDT personnel who record, compute and check quantities sign and date sheets for which they had involvement. Ineligible corrective work quantities or those exceeding specified or approved quantities are not compensable.

Payment Basis
Subsection 302.05, Standard Specifications

SECTION 303
STOCKPILED SURFACING AGGREGATE

Description
Subsection 303.01, Standard Specifications

Standard Specification Section 303 addresses crushing and stockpiling specifically for future construction or use by MDT maintenance. Contractors must locate, stage and secure stockpiles outside MDT ROW, and secure permits or clearances. Stockpiled aggregate material is typically Contractor tested.

Materials
Subsection 303.02, Standard Specifications

Aggregate Stockpiling Method
Subsection 303.03, Standard Specifications

Measurement Method
Subsection 303.04, Standard Specifications

Payment Basis
Subsection 303.05, Standard Specifications

SECTION 304
CEMENT TREATED BASE (CTB)

Description
Subsection 304.01, Standard Specifications

Cement Treated Base (CTB) is a mechanically mixed pavement base containing crushed aggregate, fine aggregate, cement, fly ash and water. CTB provides a stable base for surface course placement and anchoring dowel bar baskets before pouring PCCP. CTB also provides structural enhancement, minimizes aggregate usage, and enhances erosion pumping resistance.

Materials
Subsection 304.02, Standard Specifications

The Materials Bureau oversees CTB compressive strength, durability, and uniformity. Inspectors should review compressive strength requirements and Contractor mix designs for compliance. Mix design correction should occur during mix design review. During start up production, both Contractor and QA staff should monitor target gradation and cement content to achieve compressive strength. Compressive tests are performed 7 days after placement, and test sections may be required to allow corrective changes.

Construction Requirements
Subsection 304.03, Standard Specifications

CTB uniformity prevents base deterioration and traffic loading failure. Cement content changes often create inconsistent bearing strength. CTB compaction must be uniform and QA testing results compared to Contractor QC results. Standard Specifications specify CTB compressive strength. 7 and 28 day compressive strength tests are performed in accordance with MT-216.

CTB Subgrade Preparation
Subsections 204.03.1 and 304.03.4, Standard Specifications

Subgrade must meet moisture and density requirements before CTB placement. Dry and loose subgrades require reworking to meet Standard Specification Subsection 204.03.1 requirements.

CTB Mixing and Placement
Subsection 304.03.5, Standard Specifications

CTB is best mixed at a central plant to ensure consistent and uniform material ratios. Check scale systems and meters for specified calibration. Check water to cement ratio and gradation percentages for compliance with mix targets established by the Project Manager. Accurate and calibrated scaling and metering systems are critical to mixing. Plants must control cement content as specified, and Inspectors should spot check weighing devices while cement is blown into the silo. Cement hydration begins when water is added, so Inspectors should note CTB time delays and haul times within DWRs. Standard Specification Subsection 304.03.7 requires compaction completion within two hours after mixing. The length of each placement section should ensure timely compaction. Notify plant inspectors if undesirable moisture content changes occur. Dry mixes are difficult to work, and may lower CTB density, compressive strength and durability, whereas wet mixes may segregate to lose strength and durability. Standard Specification Subsection 304.03.3

stipulates minimum ambient and ground temperatures for CTB mixing and placement. Inspectors should monitor weather forecasts before CTB placement.

CTB Compaction
Subsection 304.03.7, Standard Specifications

Compaction rolling immediately increases density by reducing voids. Rolling begins along the CTB edge, and moves toward centerline, except on superelevated curves, where rolling proceeds from lower to upper margins. Especially observe compaction along margins where compaction is difficult and segregation may occur. If CTB has set, surface irregularity correction requires removing the upper compacted lift. Grade, cross section and lift thickness must be checked while CTB is loose or lightly compacted in accordance with Standard Specification Subsection 105.08.1. Notify materials bureau personnel for testing in accordance with MT-108, MT-216 and MT-202. The bureau also reviews CTB cement content and seven day compressive strength.

Construction Joints
Subsection 304.03.9, Standard Specifications

Contractors terminate CTB lifts with a ramp after each work day, and remove it before placement the next day.

Curing Operations
Subsections 304.03.10 and 304.03.11, Standard Specifications

Note bituminous material type, application rate and elapsed time after finishing. Excess asphalt binder may create a slip plane over CTB. After finishing and compaction, an asphalt film should completely seal surface voids to prevent moisture loss and enable curing. Excessive sealer should be avoided, and sealer must cure before allowing traffic.

Surface Smoothness and Thickness Requirements
Subsections 304.03.13 and 105.08, Standard Specifications

Check CTB finished grade and obtain Project Manager approval. Areas outside tolerance must be corrected. Note rutting, equipment imprints, roller marks and loose or segregated material. Notify the Project Manager to identify corrective measures.

Cutting and Trimming
Subsection 304.03.14, Standard Specifications

Contractors usually cut and trim CTB during placement and compaction. Trimmings must be removed as directed. Cuttings used to fill depressions during curing will not bond and loosen with traffic loading.

Measurement Method
Subsection 304.04, Standard Specifications

Payment Basis
Subsection 304.05, Standard Specifications

SECTION 306
PCCP CRACK AND SEAT REHAB

Description

Hot mix asphalt is often placed over existing PCCP to rehabilitate concrete pavements, but can be costly and time consuming. Overlays may reflectively crack with horizontal and vertical movement at cracks and joints. Horizontal movement by expansion and contraction is due to temperature variation, but length changes may also occur with moisture changes. Vertical movement is usually caused by loading and indicates inadequate base, voids beneath slabs, frost action and poor subgrade soils.

PCCP “cracking and seating” prepares PCCP before a plant mix overlay to reduce reflective cracking. During the crack and seat process, concrete pavement is fractured into pieces approximately 3 feet square then rolled to seat the material. Cracking reduces slab size to minimize movement at original joints and cracks. Existing asphalt overlays or patching should be removed prior to cracking.

Existing PCCP Conditions

The crack and seat process must not damage underground utilities, drainage facilities, bridge approach slabs or decks. Do not permit cracking within 5 feet (1.5 m) of structures and subsurface utilities. Verify utility company coordination prior to cracking. Undisturbed PCCP slabs adjacent to cracking and seating should be isolated using a full depth saw joint. Screens or partitions must be placed to protect adjacent traffic.

Cracking Operation

Verify cracking produces clean vertical fractures. Cracking should not cause surface spalling along cracks, excessive pavement or base shattering, or undesirable cracking. Cracked slabs should not exceed 3 feet (1 m). Do not allow cracking equipment to impact within 1 foot (0.3 m) of an adjacent break line, joint or PCCP edge. Verify full depth cracking by using water or coring. Ensure bonds between reinforcing steel and concrete is being broken.

Concrete Seating

Concrete seating firmly seats each concrete slab piece to increase load carrying capacity. Without seating, fractured concrete may deflect to cause reflective cracking through asphalt overlays. Typically two passes by a heavy pneumatic tire roller seats fractured concrete, although other equipment may be effective. Proof roll using a loaded tandem axle dump truck after compaction to determine stability within a cracked section after seating.

SECTION 401
PLANT MIX PAVEMENT

Description
Subsection 401.01, Standard Specifications

Plant mix pavement should be stable, dense, flex under repeated loading and have a smooth skid resistant surface. MDT Standard Special Provisions typically present project specific plant mix surfacing requirements.

Flexible pavement types are classified as low ESAL (18,000 lb Equivalent Single Axle Load) or high ESAL loadings. Plant mix discussed in Standard Specification Section 401 are mixed by heating asphalt and aggregate in a central mixing plant. Plant mix pavements require careful attention to asphalt and aggregate ratios, voids, moisture content, mixing temperature and other properties to consistently produce specified plant mix. Lower ESAL pavements, or road mix asphalt pavements, are constructed by applying liquid asphalt to unheated aggregate at the site, a windrow for mixing, or a pugmill. Bituminous pavements are discussed in Standard Specification Section 406.

Specific MDT Plant Mix Types

Plant mix types specified within MDT projects include:

- **Grade S Volumetric** plant mix is standard for projects requiring over 2000 tons, although may also be used with projects requiring less than 2000 tons. The specification for Grade S mix is an end result specification.
- **Commercial Mix** is used when plant mix quantity is less than 2000 tons. Below this tonnage onsite plants are not cost effective.
- **Warm Mix** is mixed, produced and placed at temperatures 50 to 100 F cooler than conventional plant mix. Temperature reductions cut fuel consumption and decrease greenhouse gas production. Benefits include improved compaction, longer haul alternatives and lower allowable paving temperatures.
- **⅜-Inch Grade S Plant Mix Wearing Course** serves as a chip seal and provides additional pavement structure. ⅜-inch Grade S wearing course negates the need for chip sealing by providing the same functional benefits. Thin mill and fill operations are often planned when wearing courses begin to fail. Wearing course is measured and paid by the ton, without separate payment for asphalt cement, hydrated lime, fillers, additives and tack. When ⅜-inch Grade S wearing course is used, interim striping is unneeded, as permanent striping can be applied immediately.
- **Plant Mix Seal Wearing Course** provides the same benefits as a chip seal where chip usage is problematic. Plant Mix Seal is measured and paid by the ton, with separate payment for bituminous binder by the gallon or ton, and hydrated lime by the ton. Tack is incidental to plant mix seal course payment.
- **Micro-surfacing** is a polymer modified, asphalt emulsion based, densely graded, cold mixed, quickly curing surfacing material applied as a semi liquid using specialized equipment. Micro-surfacing chemically changes from a semi liquid material to a dense material able to carry normal traffic an hour after application, but does not bridge or correct failed asphalt surfaces. Failed surfaces must be corrected first.

Materials
Subsection 401.02, Standard Specifications

Project Managers should ensure plant Inspectors collect and review invoices and shipping bills for plant mix materials such as asphalt, tack, or hydrated lime to verify correct project material delivery.

Aggregate
Subsection 401.02.1, Standard Specifications

Plant mix pavement aggregate is specified by gradation. Grade S is used statewide. See Standard Specification Table 701-16 for aggregate design requirements.

Bitumen
Subsection 401.02.2, Standard Specifications

Project Managers should verify HMA grade and binder compliance, HMA and binder sample collection and witnessing, binder and hydrated lime compliance certificates and correct mixing and compaction temperatures.

Mineral Filler
Subsection 401.02.4, Standard Specifications

Mineral fillers meeting Standard Specification Subsection 713.06 modifiers improve aggregate gradation within very clean materials. Mineral fillers are included within gradation calculations only if added to the cold feed. Fly ash and other mineral fillers are not paid for separately.

Additives
Subsection 401.02.5, Standard Specifications

Hydrated lime is an additive which prevents aggregate stripping by moisture and traffic. Lime is not included in aggregate gradation tests for mix design purposes, but remains present in aggregate samples after burn testing.

Construction Requirements
Subsection 401.03, Standard Specifications

Inspectors must not direct or control Contractor equipment or methods, but should observe Contractor activities. If a problem is noted, notify the Project Manager, discuss the issue with the Contractor, and document the situation within the DWR.

Inspectors should be equipped with notebook, heat gun, string lines, straight edges, tape measures, or smart level, have a working knowledge of Contractor equipment, be able to visually inspect equipment functionality, and ensure construction crews produce a quality product.

Pre-Paving Procedures and Planning

Inspectors should review the following items before paving:

- Yield
- Planned tonnage
- Typical surfacing section dimensions
- Plant mix properties impacting pavement service life, such as temperature variation, segregation, compaction, joints, traffic control and laydown methods.

Before paving, Inspectors, Project Managers and Contractors should discuss the following:

- Hot mix plant and paving operations
- Work sequencing
- Quality control
- Equipment
- Equipment failure contingency plans
- Test results reported to the Contractor
- Testing responsibilities
- Grade control
- Project areas requiring special treatment
- Sampling protocols
- Cold joint construction
- Weather impacts to paving
- Traffic control and temporary striping

Subgrade and Base Verification

Standard Specification Section 204 discusses subgrade preparation, while Division 300 addresses base course. Subgrade preparation and placement, compaction and base course aggregate trimming must be closely controlled. Elevation irregularities within foundation courses are incorporated into upper lifts, so inspectors should verify subgrade and base elevation before paving. Pavement must not be placed over soft or segregated areas, surface smoothness must be within specification tolerance, and roadways must be shaped to designed crown or superelevation. Night inspection using low angle illumination (headlights) may reveal smoothness irregularities unseen during daylight.

Base courses moving under normal loads are unstable, and require correction through aeration, compaction, replacement, prime coat, and cement or lime treatment. Ensure CAC cures in accordance with Standard Specification Subsection 301.03.5F. Aggregate reshaping may be necessary before aggregate treatment due to irregularities caused by traffic or work methods. Project Manager, Inspector and Contractor should discuss damaged area repair before paving, and contingencies must be in place to avoid paving delays. A bituminous prime or tack coat may be needed, as specified by Standard Specification Section 407.

Quality Control and Quality Assurance

MDT accepts most plant mix pavement materials on a QA basis. Standard Specification Subsection 105.3.2 discusses MDT QA practice applying to QA items. Contractors provide Quality Control (QC) by producing specified materials and identifying deficient materials before incorporation into the work. Contractors use QC sampling and testing to evaluate product quality. Although MDT field staff cannot direct Contractors, quality control issues cannot be ignored, and should be documented within DWRs. Contractors often review MDT QA test results and their own QC before making operational changes, although MDT QA processes do not substitute for Contractor QC.

Common Construction Problems

Improper paving equipment or operation may produce:

- Short, choppy waves caused by poorly adjusted tracks or drive chains, truck braking while dumping mix into the paver, or excessive paving machine speed
- Surfaces with long waves caused by allowing the screed to settle during paver stops, mix quantity variation in the auger box ahead of the screed, premature rolling, travel speed or frequent screed adjustment. Pavers should remain in motion during placement.
- Open plant mix surfaces caused by improper screed adjustment, rough or worn screed plates, or excessive speed.
- Varying surface textures due to improper mixing, overheating, segregation, or a worn or damaged screed plate.
- Surface bleeding caused by excessive asphalt, and irregularly mixed or excessive moisture. Small bubbles on coarse aggregate, plant mix slumps in truck beds, or bubbles behind the paver indicate excessive moisture.
- Irregular rough spots caused by idle rollers on fresh surfaces, abrupt roller stops, or trucks backing to the paver.

Paving Inspector Checklist

- Equipment should be in good repair and proper adjustment.
- Be sure traffic control provisions are well organized and incorporate specified signage and layout. Verify a Traffic Control Plan has been submitted and accepted.
- Verify paver centerline control is set properly.
- Confirm base material has been documented and accepted.
- Check longitudinal and transverse joints for smoothness and appearance. Do not let longitudinal joints coincide with wheel paths.
- Frequently check mix temperature.
- Inspect the new mat for uniform texture.
- Observe the rolling operation and verify the sequence is correct for conditions, proper methods are being used, and rollers operate at reasonable speeds. Check the mat for plan thickness and verify needed adjustments are made.
- Frequently check spread, and record daily truckload numbers. Check yield hourly, and check spread relative to planned project yield. Communicate with the plant inspector about daily totals to reconcile discrepancies.
- Ensure lights, barricades, and signs are placed correctly. Remove or cover unneeded signs. Verify temporary striping is in place. Document observations and conditions within DWRs.

Mixture Composition
Subsection 401.03.1, Standard Specifications

Mix designs extend service life by correctly proportioning and controlling mix properties to enhance longevity. Contractor stockpile material percentages used for plant mix production must be submitted to the Materials Bureau. MDT does not establish job mix formulas or targets, but job mix designs must represent stockpiled crushed aggregate materials. Laboratory mix designs are adjusted after field production begins.

Grade S Plant Mix

Project Managers and Inspectors should be familiar with Grade S plant mix composition requirements. Superpave mixture designs (Grade S) depend on aggregate and volumetric properties. Mix designs should have an aggregate skeleton and sufficient air voids to resist deformation, and enough asphalt binder to resist fatigue and premature binder aging.

Sufficient void space is needed for asphalt binder, but with enough aggregate contact to carry traffic loading. Superpave specifications require adequate VMA without weakening aggregate structure. Some air voids between coated aggregate particles are necessary for continued compaction under traffic. Allowable air voids in laboratory specimens is 2 -4% for most surface courses. Plant mix durability is a function of air voids. Lower voids indicate a less permeable mix, while excessive air voids allow air and water intrusion. Insufficient air voids may flush asphalt to the surface. Job specifications usually require 7% air voids.

Plant mix is described using the following ratios:

- Percent Voids Total Mix (VTM). Voids unoccupied by aggregate or asphalt, expressed as a percentage of total volume. This value provides an indication of whether mix can be adequately field compacted. VTM is the most important criterion influencing field compaction and pavement longevity.
- Voids Filled with Asphalt (VFA) is the void percentage filled with asphalt in compacted pavement, and is also referred to as the “asphalt void ratio”. VFA is a measure of relative durability.
- Voids in Mineral Aggregate (VMA) refers to air void spaces between aggregate particles, including those filled with asphalt. VMA is the space available to accommodate asphalt and air within compacted mixtures.
- Dust to Asphalt Ratio. Lowering dust content maximizes VMA, as more voids are available.
- Dust content is from mineral filler. If dust originates predominately from one aggregate stockpile, Contractors may reduce mineral filler from that stockpile. If screenings are the only manufactured fines added to the mix, they may need washing. Bag house fines are added during mix design if fines will be added to the field mix to reduce VMA. Including bag house fines in the mix makes the design more accurate. Contractors may field adjust gradations to correct or optimize volumetric properties. For calculation purposes, Inspectors should refer to MT-332 within MDT Materials Manual Section 11.2.

Mix Design Approval

Contractors must notify district or area labs when submitting mix design samples. District or area lab personnel receive aggregate samples for Departmental use. Lab personnel transport these samples to district or area labs, and dry and retain them until a Contractor mix design is received. When samples and a complete mix design have been received by the Department, the mix design lab has 30 calendar days after submission to review contractor mix design. Mix design and Department samples are then submitted to the Materials Bureau for Hamburg testing. If results pass, the mix design is approved. If Hamburg results fail, a new mix design must be submitted. MDT administers Hamburg testing after initial targets are set for acceptance, and may again sample mix during production to verify previous Hamburg results.

Field Role

Mix designs are adjusted to ensure workability and minimize bleeding. Plant mix surfaces normally become smoother with usage, but excess asphalt causes flushing and/or rutting. Mix designs determine void, stability and density values, but plant mix must be field controlled using “Marshall Tests” when “Rice Method” density cores are specified. Inspectors must visually inspect plant mix to ensure quality. Project Managers may require Contractors to adjust asphalt content, but changes exceeding 0.3% must be Materials Bureau approved. The Materials Bureau is available to explain mix design changes and assist field staff.

Asphalt Content

Asphalt content is an end result specification, so MDT only recommends changes during production. Unless Contractors produce plant mix outside specification, MDT has little authority to require changes. Volumetric projects require Contractors are responsible for asphalt content changes, bin splits and roller patterns.

Asphalt Mixing Plant Inspection
Subsection 401.03.2, Standard Specifications

Contractors are required to notify MDT when plants are calibrated. Inspectors should become familiar with plant features, and examine for safety and function. Mixing and production should not begin until mechanical deficiencies and unsafe conditions have been corrected. Field laboratories should be located in full view and upwind of plant operations. Project Managers should ensure lab personnel have job mix formula copies, standard specifications, special provisions and a list of produced mixtures. Laboratories should be equipped with testing equipment. Power and water are both Contractor supplied, as are stove and oven fuels. Power supply must be operable two days before paving.

Roadway Equipment
Subsection 401.03.2 (F), Standard Specifications

Contractor equipment should be observed for condition, power, defects and excessive wear in bearings and linkages. Deficiencies must be corrected before paving to avoid delays. Inform Project Managers and Contractors of deficiencies, and document within the DWR. Paving is a mobile operation that changes unexpectedly. Exercise extreme caution near equipment to avoid being caught between or struck by moving equipment. Maintain eye contact with equipment operators and truck drivers before approaching equipment.

Inspectors should become familiar with paver capabilities. Adjustment details for paver types are shown in equipment manufacturer handbooks. Paving machines with loose controls cause jerky or erratic screed operation, and should have approximately 1/16 - 1/8 inch (1.5 to 3 mm) more crown along the leading screed edge than the trailing edge to prevent the screed from dragging material. Automatic screeds employ a grade reference device, a pendulum or grid type sensor, and raise and lower screed pull arms. Manual thickness adjustments are used for correcting screed position if deviations become apparent. Two grade reference devices are used to provide cross slope and longitudinal grade control. Cross slope is controlled by a transverse beam mounted above and connecting the forward portion of the screed arms. Longitudinal grade control is provided by an external reference device, such as a string or wire line, long ski, floating beam, sonic sensor or 10 ft joint matching ski. String lines and wire lines must be properly tensioned to prevent sagging. Skis exceeding 40 feet must be straight. Spring loaded shoes on floating beams must move freely so the beam can reflect average grade. When matching grade to adjacent pavements or curb, a ski less than 10 feet is used.

Most paving starts using manual screed controls. Automatic control is used after the screed attack angle is stabilized at desired operating speed. Common practice is to begin and end spreading at slower speeds, because manual control may be necessary approaching a terminal point. When using slope control sensors, changes within superelevated sections are carried out by adjusting slope settings as the paver moves through the transition. Values for super-elevations must be marked at 25 ft intervals before paving, because adjustments must be made before reaching the next reference point. When changing superelevation is not staked, better results may be obtained using manual thickness controls until superelevation is constant. Automatic screed control sensitivity is essential, but an overly sensitive grade sensor produces false control signals and causes a wavy surface. An insensitive grade sensor fails to detect grade changes quickly enough. Sensitivity must be adjusted so referencing device movement does not signal correction.

Be sure auger extensions match screed width. Do not allow screed extension without auger extension, or a cooler mix may be placed at longitudinal joints and shoulder slopes. Auger extensions ensure uniform mix placement over the mat width, and must be installed before paving, so planned paving width should be known in advance. Verify paving width with the superintendent before hot plant start up to provide for needed auger extensions

Be sure a notched wedge paving shoe is attached to the side abutting the joint. Contractors must ensure paving equipment meets the following requirements:

- Pneumatic tires are inflated at correctly.
- Drive chains are adjusted.
- Screed plates have proper crown and tilt adjustment.
- Screed heaters are functioning.
- Screed extensions are in the same plane, and flush with screed bottom.
- Screed surfaces are in good condition, and screed vibrators function properly.
- Auger extensions are added with screed extensions.

Roller Inspection Checklist:

- Steel roller drums are smooth without flat spots, ridges or grooves.
- Pneumatic tires are smooth, of equal size, ply and inflation.
- Vibratory rollers travel at speeds preventing corrugations or wash boarding. Vibratory mechanisms are off when rollers are stationary. Breakdown or intermediate rollers do not stop while on hot plant mix.
- Vibratory roller amplitude and frequency are properly set.
- Rollers start, stop and reverse smoothly.
- Rollers have cleaning devices.
- Drum sprinklers are functional.

Trucks

Contractors should provide enough hauling vehicles for continuous paving, and assign haul truck numbers before hauling. Release agent should be applied to truck beds to prevent asphalt accumulation, and may contain lime water, soap, detergent or a solution of similar materials. Diesel fuel, gasoline and oils are not permitted. Insulated truck beds help prevent plant mix heat loss during hauls, and tarped loads protect mix from dust or rain.

Plant Mix Production, Testing and Acceptance
Subsection 401.03.3, Standard Specifications

During plant mix surfacing projects, MDT uses Quality Assurance (QA) specifications defining lot size and tests per lot. Acceptance is determined by averaging work portion test results, or lots. Grade S mix provisions do not include aggregate gradation as criteria for price incentives or reductions. Plant mix properties are evaluated according to specification conformance only.

QA specifications are “end result specifications”, meaning MDT does not direct Contractors regarding stockpile percentages or aggregate production items. Contractors produce aggregate meeting specifications at the point of bituminization.

Aggregate testing during aggregate production is Contractor responsibility.
QA specifications are not an option for Contractors to accept price reductions in lieu of producing unspecified material, and continued unspecified material production is prohibited. Obviously defective material may be rejected despite sampling sequence or location within a lot. Lots are evaluated for acceptance when all test results are available. Single failing tests do not necessarily indicate a problem, as multiple test results are averaged for lot acceptance. Report test results to mix plant personnel when available. Inspectors are not to recommend corrective action called for by test results. Evaluation form copies are given to Contractors when completed, checked and reviewed by Project Manager.

Sample locations are selected via random number generation in accordance with MT-416. Although material lot sizes vary, density lot sizes are normally 3,000 tons. Five samples are selected and tested, or one sample per 600 tons. Initial Grade S Volumetric “start-up” lots are typically 3,000 tons, depending when a Contractor sets initial plant mix targets. Subsequent lot sizes are typically 5,000 tons, or one sample every 1,000 tons. Sample locations are selected before lot production, and should not be communicated to Contractors. If MDT Materials Manual testing procedures are not followed, test results may be challenged, especially when price reductions are at stake. Contractors often rely on MDT QA test results, although quality control (QC) is ultimately Contractor responsibility.

Surface Conditions, Weather Limitations and Paving Dates
Subsection 401.03.6, Standard Specifications

Project Managers may suspend paving operations if conditions could adversely affect plant mix quality. Project Managers should discuss with Contractors weather conditions legitimating shutdown. Contractors must stop paving before adverse conditions affect the existing surface. Not wanting to shut down a hot plant, Contractors often continue to pave when rain begins to fall, but paving should stop with rainfall. Trucks at or enroute to the paver should not empty or continue placing remaining mix. Document the reasons for shutdown within the Daily Work Report (DWR).

Traffic and Roadway Structures Protection
Subsection 401.03.9, Standard Specifications

Traffic control is vital to safety. Project Managers must be familiar with Traffic Control Plans and operational Special Provisions. Dust along unpaved shoulders during paving is a hazard. Paving areas may require additional nighttime precaution. Flaggers, pilot cars, barricades, pavement delineators, warning signs, flashing lights or other MUTCD traffic control devices must be selected before work begins. Devices delineating special hazards should be reviewed by the Construction Traffic Control Engineer. Appropriate barricades, warning signs and traffic control equipment must be plainly visible before paving. See Standard Specification Section 618 for additional work zone traffic control information.

Plant Mix Placement and Finishing
Subsection 401.03.10, Standard Specifications

MDT constructs 20 year typical pavement sections as designed, regardless of quantity over or underruns. Contractors establish spreading rates, while Inspectors ensure correct depth and yield. Yield is calculated daily using truck load weights to compare tonnage delivered to the job site with planned station quantities. Computing periodic plant mix placement tonnage helps prevent large under or overruns.

Plant mix may be windrowed before the paving machine, mechanically placed in the hopper, or dumped directly into the hopper from a truck. Windrowing material ahead of the paver allows a more continuous operation, although mix material windrowed too far ahead of the paver may cool rapidly, in which case windrowed mix temperature should be monitored with a heat gun and mix inspected for clumping. Prevent cool or clumped mix from being placed. Pavers are most effective when operating continuously, as starts and stops increase surface irregularities. Although screed adjustment may be operating properly, factors such as temperature, screed weight, plant mix quantity before the screed, screed weight and feed rate influence mat thickness. A leveling course may be included to address surface warping or rutting before surfacing. When a leveling course is not needed, an isolation lift may be included to thermally isolate existing crack sealant before plant mix placement. Plans indicate isolation lift plant mix and asphalt cement quantities.

Joint Construction
Subsection 401.03.11, Standard Specifications

Poorly constructed or pronounced transverse and longitudinal joints reduce roadway service life. Contractors must carefully construct plant mix to concrete joints, so compacted plant mix is slightly higher than adjacent concrete. Vertical joints must be tacked before placing adjacent courses.

Longitudinal Joints

Plant mix longitudinal joints must be laterally offset at least 6 inches from adjacent upper and lower lift joints to prevent water and debris from entering the joint. In accordance with Figure 401-1, joints are constructed having a vertical edge at least maximum aggregate size, or more than ½ compacted lift thickness. The joint should then taper over a slope less than 4H:1V, and the sloped joint portion uniformly compacted behind the paver.

Hot side lifts overlap 1 -1.5 inches onto the cold lift. Overlapped plant mix should be compacted without raking, with the first roller pass on the hot side 6 to 12 inches from the joint. Compact the remaining 6 -12 inch width of hot material with the second pass by overlapping the roller pass onto the cold side. Contracts may also direct Contractors to extract 6 inch diameter joint cores.

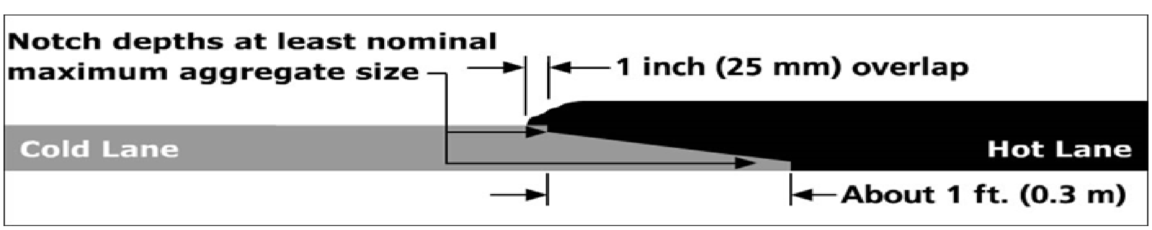


FIGURE 401-1 NOTCHED WEDGE JOINT

Tapered 4:1 to 6:1 longitudinal joints are required. Sloped joint usage eliminates vertical joint faces. Develop a plan with the contractor to minimize traffic along longitudinal joints. See MDT Report entitled "2009-2010 Plant Mix Longitudinal Joint Density Research Evaluation" for longitudinal joint placement information.

Transverse Joints

Contractors use various transverse joint construction methods, but not all provide a smooth ride. Transverse joints are constructed by discontinuing plant mix lifts through full depth, or by using a bulkhead. Bulkheads should be checked with a straightedge before joint completion. Bulkheads used in low stability mixes often shove when rolled, and may require a new joint. When paving resumes, the joint face should be sprayed or painted with asphalt before fresh material is paved against it. Paver screeds should be heated, and depth set so compaction provides a smooth transition from new to older material. Fresh joints should be compacted using normal and cross rolling. Transverse joints are usually hand constructed, most commonly by ending the lift with a temporary hand worked vertical face covered with roofing paper. To accommodate interim traffic, a plant mix ramp is constructed over a 50:1 slope for roadways and bridge ends under traffic. To resume paving, roofing paper is removed to clean and tack the joint.

Compaction Control Testing and Acceptance Testing
Subsection 401.03.12, Standard Specifications

Compaction

Review contract Special Provisions and Supplemental Specifications for roller pattern requirements. Compaction is Contractor responsibility. Compaction is paramount to surfacing longevity, and often offsets other plant mix deficiencies to ensure a durable pavement. Plant mix achieves a critical effective void range when compacted as specified. Too much or little compaction can diminish pavement performance. Compaction rolling should start soon after material has been placed. Roller drums should be moist with only enough water to avoid material tracking, and move at a slow uniform speed, with drive wheel nearest the paver. Rollers should reverse smoothly. If rolling causes material displacement, affected areas must be loosened and restored to original grade before re-compaction. Heavy equipment should never be stationary on warm finished surfaces. Rolling patterns should deliver uniform lane coverage and compaction. Rolling patterns depend on roller characteristics.

Testing

Cores must be cut through full lift thickness, and be collected after rolling completion. If not, Project Managers may stop paving until issues are resolved. Address improperly collected cores on an individual basis. MDT Inspectors should mark cores locations and ensure the Contractor extracts cores close to the mark. Trimming loose gravel from the first plant mix lift over gravel surfacing is allowed to a depth approved by the Project Manager. Grade S Volumetric Commercial Plant Mix Special Provisions address these issues.

Project Managers must retain failing cores for 14 days after paving, or 14 days after 30,000 tons of plant mix surfacing has been produced since test acceptable results were provided to the Contractor, or project paving has been suspended for the construction season. Passing cores must be retained at least seven calendar days after test results are given to the Contractor. Core testing requests must be made only after including request justification. Retain cores until issue resolution, and store to ensure physical integrity. Use original test results for QA calculations, unless retesting invalidates initial results. Failure to retain cores or cores damaged after initial testing does not invalidate original test results.

Compaction Problems

Compaction may be unattainable due to an underlying unstable surface, existing pavement variability, stiff mix, or an over rolled mix. Other factors affecting compaction are:

- air temperature and wind speed
- mix and underlying pavement temperature during compaction
- lift thickness
- graded mixes having fine or rounded aggregate
- compaction equipment type, number and characteristics
- compaction sequencing and timing
- equipment speed, tire inflation, vibratory frequency and amplitude
- underlying material
- plant production rate

Surface Tolerances
Subsection 401.03.14, Standard Specifications

The following guidelines govern surface International Roughness Index (IRI) surface data referred to by the MDT “Ride Specification for Flexible Pavement” special provision:

- IRI data determining ride classification is gathered by District Labs before letting.Pavement Management data may be used if IRI data is unavailable.
- District personnel assign a “ride category” by completing the “District Project Estimate Questionnaire” administered by the Engineering and Construction Contracting Bureau (ECCB).
- IRI data classifying projects and determining pay adjustment factors are measured within eight months of letting by a District Lab or the Pavement Analysis Section.
- New pre-paving IRI measurement should not be made after project letting. Original measurements may be verified if IRI measurement was made more than a year before paving and ride reassessment is requested, or if Contractors request remeasurement and Project Managers believe current existing ride classification may differ from contract IRI. IRI measurements do not typically change significantly within a year.
- Pre-paving IRI should never be run for roadways affected by frost heaving.
- If a project IRI classification differs from pre-paving IRI measured after project letting, a change order must be written to reflect new project classification.
- The ride specification special provision does not apply to all plant mix pavements or pavement areas. Areas not assessed an IRI are governed by surface tolerance Standard Specification Subsection 401.03.14. Surface smoothness information for bridge ends is found within the MDT “Bridge End Ride Concerns and Best Practices” report.

Rumble Strips
Subsection 401.03.15, Standard Specifications

Rumble strip installation milling creates shallow concave depressions, which are sealed using asphalt emulsion to repel moisture. Milling provides a consistent depression pattern and depth, to provide a rumbling warning to errant motorists. Observe grinding pattern dimension and alignment, and milling equipment variability.

Measurement Method
Subsection 401.04, Standard Specifications

Maintain an asphalt quantity record to help determine unused asphalt. Also document total daily asphalt quantity delivered plus unused remaining asphalt at shift end. See example worksheets within the “MDT Hot Plant Inspection Manual.”

Payment Basis
Subsection 401.05, Standard Specifications

SECTION 402
BITUMINOUS MATERIALS

Description
Subsection 402.01, Standard Specifications

Bituminous material may be referred to as “neat” and unmodified, or “polymer modified” asphalt cements, liquid asphalts. These materials are available in varying grades and contract specified. Bituminous material type usage depends upon aggregate gradation, mixing temperature, and traffic requirements. Mix should harden after curing, and support traffic without bleeding or instability. Bituminous materials are adhesive, waterproof, durable and flexible. Viscosity is measured to assess material flow characteristics in response to temperature.

Materials
Subsection 402.02, Standard Specifications

Asphalt Binder

The term “asphalt binder” refers to the asphalt in plant mix binding aggregate particles together. “Asphalt cement” typically refers to asphalt binders characterized using viscosity and penetration values. “Performance Graded Asphalt Binder (PGAB)” properties are identical to those of asphalt cement, but binder selection is based upon environmental factors like climate, temperature and traffic loading. Consider the following performance graded binder designated “PG 64-28”:

- “PG” indicates “Performance Grade.”
- “64” indicates physical properties meeting high temperature requirements up to 64°C (147°F), and represents the average 7-day consecutive maximum design temperature.
- “-28” indicates physical properties meeting low temperature requirements down to -28°C (-18°F), and represents a minimum single day design temperature.

Emulsified Asphalt

Emulsified asphalt is a mixture of asphalt, water and emulsifying agent for plant pavement applications such as tack coats. Asphalt emulsions are liquid at ambient temperature, although emulsion components separate with time.

Cutback Asphalt

“Cutback” asphalt is a blend of asphalt material and petroleum solvents used typically as an asphalt prime coat on subgrade. Cutbacks are liquid at ambient temperature, and lose volatiles by evaporation.

Construction Requirements
Subsection 402.03, Standard Specifications

Contractors must:

- Ensure hauling and storage containers are clean to avoid contamination
- Check storage tanks and coils regularly for damage and leaks
- Ensure a calibrated thermometer is used to obtain temperature readings

- Regularly record tank material temperature
- Ensure temperature is maintained below material flash point
- Not take temperature readings near heating coils or tank bottoms
- Use correct temperature-volume conversion factors to calculate quantities

Sampling and Testing
Subsection 402.03.2 and 402.03.4, Standard Specifications

Asphalt binder is sampled by Contractors and witnessed by Inspectors. The Materials Bureau conducts acceptance testing. Tank volumes are measured using contractor provided calibration charts. If multiple projects use common tanks, measurement before and after each work day is necessary to ascertain individual project usage. Binder test results are available to Project Managers by contacting the Materials Bureau or accessing the appropriate database. Project Managers should promptly forward failing binder test results to Contractors.

Asphalt Binder Acceptance
Subsection 402.03.5, Standard Specifications

Acceptance testing is performed by the Materials Bureau in Helena.
Price reductions are imposed for asphalt test results outside tolerance. The QA computer program documents deductions, and determines if removal and replacement is warranted. Monetary deductions are calculated manually, and entered into monthly progress estimates as line item adjustments.

Bituminous Material Alternate Type or Grade
Subsection 402.03.7, Standard Specifications

Alternates binders equal or superior to specified material are considered by the Materials Bureau. Contractors pay the difference for the higher grade product, and changes are documented in the contract via no cost change order.

Measurement Method
Subsection 402.04, Standard Specifications

Payment Basis
Subsection 402.05, Standard Specifications

SECTION 403
CRACK SEALING

Description
Subsection 403.01, Standard Specifications

Crack sealing prevents incompressible material and water intrusion into pavements, but does not deter reflective cracking. Leveling courses or isolation lifts placed prior to overlays may cause crack sealant to expand to produce bumps in finished plant mix surfaces. Crack sealing is typically done by MDT Maintenance prior to overlays.

Materials
Subsection 403.02, Standard Specifications

Compliance certification must accompany asphalt sealant material before usage.

Construction Requirements
Subsection 403.03, Standard Specifications

Routing
Subsection 403.03.2, Standard Specifications

Inspectors should verify crack routing dimensions are in accordance with the contract, and spot check cleaned crack depths.

Cleaning
Subsection 403.03.3, Standard Specifications

Inspectors should verify:

- Debris is blown from cracks and off the roadway
- Crack sidewalls are clean
- Cracks are dry. Contractors should apply heat to remove moisture
- Crack cleaning takes place just immediately before sealing to prevent debris from redepositing into cleaned cracks
- Contractors route existing crack length

Sealing
Subsection 403.03.4, Standard Specifications

Verify sealant is heated to manufacturer recommended application temperature, and safe heating temperature is not exceeded. Periodically check sealant temperature.

Weather Limitations
Subsection 403.03.5, Standard Specifications

Ambient and/or surface temperature must be in accordance with Standard Specification Subsection 403.03.5. Sealant application must not begin if crack surfaces are wet, and should stop if rain is imminent.

Equipment Considerations

Hot Sealant Heaters

- Heating systems are thermostatically controlled.
- Temperature gauges are calibrated.
- Proper wand tips are used.
- Squeegees and shaping tools are clean, in good condition and seal cracks effectively.

Crack Cutting and Cleaning Equipment

- Crack cutters or routers are in working order.
- Router configuration is adjusted to required width and depth.
- Cutting tools have no missing, chipped, rounded or broken teeth.

Common Crack Sealing Problems and Solutions

If sealant does not adhere to crack surfaces, Contractors should:

- Reclean or dry cracks as needed
- Allow cracks to dry
- Allow temperature to rise or use heat lance if ambient temperatures are cool
- Blot with sand or apply bond breaker if sealant pulls from cracks under traffic during high temperatures

Sealant should not drain from cracks along superelevated curves during sealing.

Measurement Method
Subsection 403.04, Standard Specifications

Payment Basis
Subsection 403.01, Standard Specifications

SECTION 407
TACK COAT

Description
Subsection 407.01, Standard Specifications

Prime Coat

Prime coats protect and stabilize base surfaces to provide a uniform and firm platform for the next course. Prime coats bond loose particles, waterproof base surfaces, and provide adhesion between base and subsequent courses.

Tack Coat

Tack coats are light asphalt emulsion applications to primed or stabilized base immediately prior to plant mix overlays to prevent shear between courses.

Emulsified Asphalt Treated Aggregate (EATA)

EATA is crushed aggregate blended with CSS-1 emulsified asphalt. EATA improves temporary riding surfaces, particularly during winter shut downs. EATA also improves gravel section serviceability, reduces road dust and the need for dust control products, provides a smooth temporary riding surface, reduces winter and construction maintenance and provides a firm smooth paving surface to ensure a quality initial PMS lift.

Materials
Subsection 407.02, Standard Specifications

Tack coats are typically diluted and slow setting asphalt emulsions which flow uniformly from distributors at ambient temperatures.

Prime Coat Construction Requirements
Subsection 407.03, Standard Specifications

Base Course

Base surfaces must be smooth, at grade and slightly damp without surface water during prime coat application. Water application one to two hours before prime coat application ensures deeper asphalt penetration. Before prime coat application, base should be checked for compaction and cross sectional tolerance. Prime coat is not a substitute for maintaining base or subgrade condition.

Usage

Prime coats must penetrate base material to function properly, and cure before overlay placement. Cutbacks generally cure longer than asphalt emulsions.

Prime Curing Time

Prime coats must cure completely. Uncured prime can cause more base movement than construction loading on an unprimed base. Volatiles from uncured prime may also degrade plant mix. No more prime should be applied than can be absorbed by the base in 24 hours. Blotter material should be used to absorb excess prime, but loose blotter must be removed before paving to ensure bonding between base and overlay. Do not allow traffic over primed surfaces until fully cured. Prime coats may take days to properly cure and withstand construction traffic, and cure more quickly during hot weather. Emulsified products may only require 24 hours to cure, while cutbacks require up to three days.

Tack Coat

Exposed non-plant mix contact surfaces such as PCC curbs should always be tacked. Contractors should protect adjacent facilities, construction and passing traffic during tack coat application. Inspectors should accommodate needed public access into construction zones.

Application

Lighter tack application rates are preferred, as heavy application may cause pavement slippage and flushing. Excessive tack lubricates slippage planes, and adversely affects mix properties. Insufficient tack coat may also cause pavement slippage and debonding.

Uniform application by hand spray or distributor truck is necessary. If a tack coat is streaked, the equipment or material being applied may be faulty. Distributor trucks should apply tack uniformly across the spray bar width. If tack distribution is irregular, inspectors should notify the Project Manager, who will inform the Contractor. Adjustments should ensure uniform tack distribution before work resumes. Tack application far ahead of the paver can leave tack too dry to bond with overlaid plant mix. Tacked surfaces carrying traffic may require reapplication. If emulsified tack is not being allowed to cure, stop paving. Emulsion moisture must evaporate before paving. When a tack “double shot” is applied to longitudinal joints and other surfaces, the first shot must be allowed to break before the second is applied. Do not allow contractors to apply tack at rates exceeding recommended rates. Inspectors should verify:

- Tacked surfaces are clean and free of dust
- Uniform tack application
- Correct application rate
- Haul truck tires are free of debris
- Contractors take steps to minimize tracking

Measurement Method
Subsection 407.04, Standard Specifications

Payment Basis
Subsection 407.05, Standard Specifications

SECTION 409
SEAL COAT

Description
Subsection 409.01, Standard Specifications

Seal coats are bituminous coats immediately covered by aggregate over existing pavement surfaces. Seal coats increase pavement life and enhance safety by:

- Preventing moisture intrusion
- Reducing air circulation throughout the mat to reduce oxidation
- Increasing skid resistance
- Rejuvenating weathered surfaces
- Delaying raveling
- Increasing head light reflection for better nighttime visibility
- Reducing vehicle tire spray under wet conditions

Materials
Subsection 409.02, Standard Specifications

Construction Requirements
Subsection 409.03, Standard Specifications

Seal Coat Distributing Equipment

MDT seal coat warranty based specifications do not require specific equipment usage. Application rates are uniform when self-propelled aggregate spreaders maintain uniform speed. Distribution rates determine the area each aggregate truck load covers. Aggregate trucks should arrive to the spreader opposite the spreading direction to avoid turns on freshly placed surfaces. Trucks must turn around at designated locations before returning to the stockpile. Before spreaders are loaded, Inspectors should verify uniform scalping screen openings, and not allow large material to block spreader gates. Contractors should test operate gates before loading spreaders. Each spreader gate should open and close simultaneously.

Contractors should ensure nozzles are clean and angled in the same direction. Clogged or misaligned nozzles cause irregular application. Nozzles should be of equal type and size, at the proper angle and elevation to ensure even distribution, and without excessive dripping when nozzles close. Plant mix spreaders should closely follow distributor trucks through steep grades or sharp curves to prevent binder drainage. Trucks should maintain constant speed while spraying. Longitudinal and transverse spray margins should be without overlap or skips. Building paper may be used at transverse joints where spray trucks stop or start.

Trucks should avoid asphalt lacking aggregate, speeds over 15 mph, and repeatedly driving over wheel tracks over fresh seal coats. Turning and braking on new seal coats and staging multiple trucks behind spreaders should be avoided. Spreader boxes should not be emptied between loads.

Seal Coat Bituminous Material Application

Bituminous emulsion is applied via distributor truck after the roadway is swept clean. Emulsion application rate may exceed the mix design rate if the surface is a dry pavement surface, newly micro milled surface, or new pavement with coarse surface texture. Application rate may be decreased if the surface is asphalt rich or without voids.

A test application section must be evaluated prior to full production. Test sections help determine emulsion amounts absorbed by particular surfaces. Check spray nozzle size, type and angle. Make sure nozzles are not plugged, and an even application distribution is observed.

Seal Coat Cover Material

Visually inspect the cover seal. Aggregate should not be stacked, with space the size of a pinhead between aggregate. When emulsions are used, cover material should be in place as recommended by the manufacturer, to avoid loosening. Cover must be applied before emulsion turns black with curing, after which cover aggregate does not adhere well. Quality chip seals embed average size particles approximately half particle thickness after rolling. Excessive application rates totally embed particles to create a flushed, bleeding surface. Insufficient application rates fail to adequately bind particles, causing cover loss.

Application rates ensuring proper embedment depend upon surface porosity, absorption and firmness. Contractor submitted application rates help avoid bleeding and raveling, but may require adjustment, depending upon the project surface. Bleeding is asphalt surface flushing partially or entirely submerging cover aggregate, usually caused by excessive application rates, whereas intermittent bleeding is usually caused by pavement surface variations. New chip seal wheel paths turn black shortly after work is completed. This condition, known as “tracking,” is not bleeding or flushing, as tracking discoloration does not diminish seal coat integrity, and wears off under traffic. Inspectors must closely observe seal coat operations at intersections, median crossovers, and interchange gores. Rolling difficulties at these locations are problematic for chip retention. Fast spreader speeds allow aggregate to roll when applied, which causes bituminous material buildup on top of aggregate particles. Excessive aggregate may cause excess chips to act as wedges during rolling, and weaken chip bonding to produce fly rock when opened to traffic. Inspectors should continually check seal coats to verify cover material is adequately embedded, and surfaces are completely covered. Examine the seal immediately after rolling, and again after curing.

Seal Coat Rolling

Rolling seats aggregate to resist traffic stress, and is most effective immediately after chip spreading but before emulsion breaks or asphalt cools. Asphalt cement cools to pavement temperature in less than a minute, making immediate roller passes behind the spreader essential. Completed seal coats intervals should be examined after rolling. Aggregate should be properly embedded without excessive asphalt, and surfaces should have a “salt and pepper” appearance. When bituminous material has hardened, rolling should be discontinued, as rolling after setting can dislodge cover aggregate.

Seal Coat Joints

Project Managers and Contractors should agree on shutdown criteria when rain is impending, and agree on a definition of “dry” pavement before resuming work. Longitudinal joints should follow center line and be clear of wheel paths. Rough transverse joints can be avoided by starting and stopping spreaders on building paper. Paper is placed across the lane so the forward edge is at the desired joint location. The distributor should travel at a speed needed for the desired application rate, and spray over the paper delivering a full, uniform application. Aggregate distribution should be applied across transverse joints to guarantee coverage across the joint.

Handwork

Handwork is often needed to remove spilled aggregate, which should be removed before rolling. Oversized aggregate must be removed, and areas aggregate deficient areas must receive aggregate before rolling. Oversized aggregate is cause for shutdown. Hand sprayers, extra aggregate and labor should be available behind the spreader to expedite handwork and minimize delay before rolling.

Traffic Control

For safety and inspection reasons, seal coat operations must stop one half hour before sunset. Most seal coats cover two lane roadways and require pilot cars and flaggers.

Loose Cover Material Removal

Except in urban settings, power brooms typically remove excess cover, but should not remove embedded aggregate, Surplus cover material should be removed from paved surfaces and along curbed project lengths. Brooming must not cause damage or inconvenience to residents and businesses. Contractors may use street sweepers in urban areas with accompanying dust control. Hot weather brooming is limited to cooler hours to avoid chip loss. Inspectors must verify brooming does not cause chip loss.

Final Sweep and Broom

Final project sweeping must take place within 5 calendar days before epoxy paint application. Inspect the project before striping, and inform the Project Manager of planned painting and sweeping. Project Managers must visit the project to verify excess chip removal. If chip loss is not occurring, and pavement is clean and free of debris, Project Managers inform Contractors final sweeping is unneeded, and write a change order rescinding the “final sweeping” work item.

Seal and Cover Inspection Guidelines

Seal and covers are fast operations. Extreme caution must be taken around equipment. Maintain eye contact with equipment operators and truck drivers before approaching equipment. Inspectors should verify:

- Cover material is not contaminated during loading, and without oversize material.
- Cover material is placed immediately behind the asphalt distributor. Emulsified asphalt chips should be wet but free of running water.
- Weather and surface temperature are as recommended by the manufacturer.
- Surfaces are cleaned and prepared.
- Surface absorptive surface properties have been inspected, and asphalt application rates are appropriate for surface conditions.
- Asphalt distributor and spreader box deliver a uniform application. Spray bar position and pattern are correct, nozzles are functioning, and wind is not affecting application.
- Test sections have been used to determine application rate.
- Inspector worksheets are completed to document bituminous material location and application rate. This information is valuable during warranty periods.
- Asphalt splash on curbs, handrails and traffic is prevented.
- Contractor is using building paper or other material to ensure smooth transitions to adjacent surfaces.
- Haul trucks back to the spreader along staggered wheel paths.
- Rollers are close behind the aggregate spreader.
- Haul units do not damage fresh seals with excessive speed, sudden braking or sharp turns.

Warranty
Subsection 409.03.8, Standard Specifications

Seal coats are administered and accepted under warranty. Inspectors must work with contractors during placement, and periodically inspect seal coats during the warranty period, with at least one inspection before winter weather conditions. Notify Project Manager of warranty deficiencies before the Project Manager conducts a final Inspection, and provide contractors written notice of warranty satisfaction. During inspection and warranty monitoring. Inspectors should refer to the MDT “Seal Coat Warranty Administration Guide.”

Measurement Method
Subsection 409.04, Standard Specifications

Payment Basis
Subsection 409.05, Standard Specifications

SECTION 410
BITUMINOUS SURFACE TREATMENT

Bituminous Surface Treatments (BST) provide a protective cover to resist abrasion, provide a low cost, all weather surface and reduce dust. BSTs are most commonly used over gravel roadway surfaces never having been treated with a BST or plant mix surface. BST applications are different than a seal coat (Section 409), and commonly referred to as “single shot” or “double shot” applications.

Materials
Subsection 410.02, Standard Specifications

Construction Requirements
Subsection 410.03, Standard Specifications

Measurement Method
Subsection 410.04, Standard Specifications

Payment Basis
Subsection 410.05, Standard Specifications

SECTION 411
COLD MILLING

Description

Cold milling removes pavement to a specified depth, grade and cross section.

Materials
Subsection 411.02, Standard Specifications

Construction Requirements
Subsection 411.03, Standard Specifications

Cold Milling Machines

Milling machines vary from small milling machines able to mill around manholes and valves to high capacity machines milling 16 feet wide and 12 inches deep in one pass. Tracked milling machines are operated with front or rear steering for maneuverability around tight turns. Front loading milling machines require only the milled lane be closed to traffic.

Safety

Stay clear of milling machines and never walk behind or in front of milling operations unless the machine has stopped and the drum is stationary. Milling machines may move forward quickly if failures occur.

Inspection

Inspectors must ensure planned mill depth. Milled surfaces should be uniform with a cross hatched appearance and free of irregularities exceeding ¼ inch. Surfaces exhibiting irregular patterns and depths indicate worn mill teeth needing replacement, in which case Inspectors should inform Contractors a surface is outside tolerance. Project Managers may have an area milled again.

Operational Sequence

Contracts specify operational sequences on a project specific basis. A 24 hour duration is usually stipulated between cold milling and subsequent paving. Contract documents normally permit milling one lane at a time.

Measurement Method
Subsection 411.04, Standard Specifications

Payment Basis
Subsection 411.05, Standard Specifications

SECTION 501
PORTLAND CEMENT CONCRETE PAVEMENT (PCCP)

Description
Subsection 501.01, Standard Specifications

Concrete pavement must be structurally sound and durable to withstand traffic, moisture and temperature changes, and variable soil conditions. Smoothness requirements are typically more stringent than for plant mix surfaces. Paving Inspectors should be familiar with contract provisions. PCCP construction is highly mechanized and requires a thorough knowledge of equipment, methods, and materials. Concrete paving operations are continuously moving operations requiring safety awareness by all workers. Take extreme caution near equipment. Maintain eye contact with operators before approaching equipment.

Materials
Subsection 501.02, Standard Specifications

Project Managers should collect and review PCCP material certifications to verify correct materials and track quantities.

Concrete
Subsection 501.02.1 and Section 551, Standard Specifications

Standard Specification Section 551 covers hydraulic cement material requirements.

Tie Bars and Dowels
Subsections 501.02.3 and 501.02.4, Standard Specifications

Dowels are typically 18 -24 inch stainless steel bars installed across concrete joints to prevent movement and faulting between adjacent slabs. Dowel bar type and spacing are contract specified. Bars must be certified to comply with “Buy America” provisions within Standard Specification Section 106.09. Epoxy coated dowels also require a coating certification. Compliance certificates are submitted to the materials bureau using Form 406.

Expansion Joint Filler and Sealant
Subsection 501.02.5, Standard Specifications

MDT joint fillers and sealants include hot sealants and silicon, which must be compatible with routed joint dimensions. Approved expansion joint filler material and sealant are listed on the QPL. Unlisted material must be sampled and tested before project usage, and compliance certificates submitted.

Construction Requirements
Subsection 501.03, Standard Specifications

MDT Inspector Role

MDT Inspectors should avoid directing or controlling Contractor work, but must observe and document Contractor construction activities and methods. If a potentially significant problem is evident, notify the Project Manager, discuss the issue with the Contractor, and document the situation in the DWR. Inspectors should be equipped with notebooks, thermometers, string lines, straight edges, tape measures, smart levels and other tools needed to provide oversight. Inspectors should also have a working knowledge of Contractor construction methods and equipment, so by visual inspection equipment can be verified to be in good mechanical condition and proper adjustment.

Contractor Discussions

Project Managers, Contractors and Inspectors meet before paving to discuss:

- Concrete mix design
- Plant and paving operations
- Quality Control
- Work sequencing
- Quality control methods
- Work sequencing
- Quality control methods
- Project decision making authority
- Equipment and contingency plans for failures
- Test result reporting to the Contractor
- Contractor and MDT testing responsibilities
- Roadway grade control
- Project areas requiring special treatment
- Random sampling methods
- Joint construction
- Weather impacts to paving
- Traffic control

Subgrade and Base Assessment

PCCP must be placed over stable, compacted base and subgrade, or placed over bituminous surfacing, lean concrete, aggregate surfacing or cement treated base. Aggregate base allows excellent drainage, but may yield to construction equipment loading, and may require soft areas to be repaired before concrete placement. After dowel bar baskets are installed, problems are difficult to address. Plant mix subgrade is more stable, and weather does not delay concrete paving after a rain. Paver tracks should be level, stable and maintain a consistent surface to allow continuous operation over properly graded subgrade. Inspect for base surface defects and specified strength before allowing concrete placement. Keeping base and subgrade moist helps keep concrete from drying too quickly to cause shrinkage problems.
Standard Specification Subsection 301.03.5 covers pavement subgrade preparation. Subgrade preparation, placement, compaction, and base aggregate trimming must be closely controlled. Foundation course deficiencies transmit to subsequent layers, so Inspectors should carefully inspect subgrade and base before paving. Base courses unstable under normal loads may need aeration, re-compaction, replacement, a prime coat, or cement or lime treatment. Such areas should not be paved until base problem correction.

Aggregate surface reshaping may be necessary before priming to correct surface irregularities. Project Managers, Inspectors and Contractors should discuss damaged area repair before paving. Bituminous prime or tack coats may be used to stabilize base aggregates.

Quality Control and Quality Assurance

MDT accepts concrete materials on a QA basis. Contractors are responsible for Quality Control procedures needed to meet material specification and identify deficient materials. Contractors select Quality Control (QC) sampling and testing methods to evaluate quality. Although MDT field staff cannot direct Contractors, quality control issues must be addressed and noted. Contractors commonly use MDT QA test results as QC, but MDT QA processes do not substitute for Contractor QC procedure.

Documentation

The following items should be periodically checked and documented in the DWR:

- Thickness
- Concrete air content
- Concrete temperature
- Concrete slump
- Edge slump during slip form paving
- Offset distance
- Tining depth
- Vibrator frequency
- Cure application rate
- Rebar placement and alignment
- Air temperature
- Concrete delivery time
- Saw cut timing
- Weather changes during pours

Pre-Paving Conference
Subsection 501.03.2, Standard Specifications

Before paving, Project Managers meet with Contractor supervisory personnel and MDT inspection staff to discuss material sources and handling, concrete plant site, paving equipment and methods, scheduling, specifications and concrete mix design.

This conference is also a forum to discuss problems and expectations before work begins. Project Managers prepare a meeting summary and submit copies to Contractor and DCE.

Paving Plan

Special Provisions require Contractors to submit concrete placement and curing plans to Project Managers 15 working days before paving, which should include:

- Paving layout drawing(s) showing the beginning, end, length, width, thickness and area of each pass, hand placement areas, and joint locations. PCCP width, thickness, joint location, tapers and breaks must meet contract specification. Hand placement areas should only be planned for areas inaccessible to paving machines.
- Discussion regarding cure times, expected production rates, and operation times can be helpful. Review crew size, equipment production rates, temperature specifications, allowable cure times, haul rates, batching capacity and traffic control requirements.
- A list of equipment including manufacturer specifications for equipment such as pavers, vibrators and finishing equipment.
- Discussion regarding stockpiling and batching procedure, aggregate storage to prevent contamination, aggregate moisture monitoring, batching procedures, mixing time and specified water content. A contractor representative is

authorized to make mix adjustments, and a plan is agreed upon for handling rejected concrete.

- A traffic control plan discussing work execution during peak traffic and at ingress and egress points. This plan should also address concrete protection during curing.
- A staging plan showing how paving will take place while maintaining traffic. This plan may be integrated into traffic control plans or paving layout drawings, but requires careful attention by Contractor and MDT inspection staff to minimize traffic disruptions.
- Texturing and curing method strategies.
- Sawing and sealing procedures indicating joint location, equipment usage, and joint cutting, cleaning and sealing, according to manufacturer installation requirements. Project Managers forward contractor joint layout to the CES Bureau for review.
- Detailed staking plan showing subgrade control stake spacing and offset, and the method for setting an accurate wire line before paving.

Maintaining Continuous Paving

Project Managers and Contractors should discuss circumstances during which MDT will not allow paving to begin or be halted. PCCP paving involves expensive equipment and significant labor, so work shutdowns often create disputes between Contractors and MDT field personnel. Pre-paving conferences often help avoid conflict.

No definitive rules indicate when to halt paving. This decision should take into account specific circumstances, and Contractor ability to rectify the problem. The following factors significantly affect PCCP quality:

- Non-conformant material
- Contractor strategies conflicting with proposed procedure
- Faulty equipment
- Weather
- Safety
- Insufficient lighting
- Finishing and sawing changes

Departmental Inspection Crew Introduction

Pre-paving conferences also outline personnel duties and responsibilities, and establish a decision making hierarchy. Clearly describe expectations, assignment to and schedules for each inspection role. Inspectors should observe:

- Dowel bar placement
- Aggregate and cement proportions
- Aggregate gradation
- Mix water content
- Concrete segregation prevention
- Finishing equipment adequacy
- Equipment operators and finishers
- Curing
- Sawing and jointing

- Concrete saw cut timing

Project Managers assign Inspectors to an operational area. Establish an issue escalation procedure to be used by Inspectors and the Contractor. Discuss scheduling, shift staggering and concrete cylinder delivery on no work days.

Equipment
Subsection 501.03.1, Standard Specifications

Paving equipment condition and operation is Contractor responsibility.

Before concrete work, Contractors should check plant production, as well as paver and hauling unit capacity and to ensure a uniform placement rate. Note mechanical issues within the DWR.

Batching Plant Equipment

Hoppers and bins should be level and loaded for 24 hours before calibration. Bins should be loaded to avoid segregation, contamination or material intermingling. Weighing hoppers should contain batches without overflow from the lower hopper.

Weighing unit components such as knife edges, shackles and weighing arms must be free of avoidable friction, in good condition, protected from falling or adherent material, and accessible for inspection. Attachments restricting movement to weighing mechanisms should be noted. Scales should be checked regularly to ensure material quantities. Zero balancing should be verified twice daily when the weighing hopper is empty. Water discharged into the drum may be checked against the gauge reading by disconnecting the water line, diverting flow into a container, and weighing discharge quantity at various settings.

Concrete Production, Testing and Acceptance
Subsections 105.03.2 and 501.03.5, Standard Specifications

A quality assurance specification is used with most PCC paving, which accepts material by averaging test results for work portions defined as "lots". Depending on work quality, Contractors may receive a price adjustment on a lot basis. Standard specifications identify lot sizes and test numbers to be taken within each lot. Lots are evaluated for acceptance when all lot test results are available, so one failing test does not necessarily signify a problem. Inform plant foremen of test results as they become available. Inspectors should not recommend corrective action for failing test results. An evaluation form copy is given to Contractors after Project Manager completion, checking and review.

Often as paving ends, small concrete quantities are needed for single panel or closure pours. In these cases, small quantities may be combined into a single larger quantity lot.

Follow Materials Manual testing and handling procedures. Do not transport concrete cylinders until eight hours after setting. During this period, store field cured cylinders as near as possible to the sampling environment. These cylinders are used only to determine when PCCP may be opened to traffic. Protect cylinder surfaces from the elements. Labeling coolers or boxes in bright orange with "DO NOT MOVE" helps prevent removal. Do not move cylinders during curing, which may alter test results, and notify the Project Manager if cylinders are moved.

Slip Form Concrete Placement and Finishing
Subsection 501.03.8, Standard Specifications

Slip-form concrete paving machines spread, consolidate and finish concrete while riding on side forms. The machine operates on a prepared base of sufficient width to fully accommodate the tracks. Surface grade is controlled using a tightly stretched guide wire. Other equipment used with slip form paving are texturing devices, curing machinery and hand tools.

Slip-form pavers must be stable to prevent deviation from line and grade. Form faces must be in good condition to minimize concrete dragging and displacement. The slip form must be long enough to provide support until lateral concrete margins are self-supporting.

Equipment

Inspectors should be familiar with equipment, and ensure equipment is assembled according to manufacturer recommendation, and operated accordingly. To ensure proper assembly and preparation include:

- Verify the main pan is flat side to side by checking with a straight edge or string line. Follow manufacturer instruction if adjustments are needed.
- Tamper bars should be in the lowest position, with the bar bottom even with the main pan bottom.
- Adjust vibrator elevations so vibrator tips are centered within the concrete slab. Steel mesh or dowels may require vibrators to be positioned above center.
- When adjusting the machine to line, the frame should be parallel to the string line guide.

Pavement Base

Profile and cross section uniformity and base surface consistency are critical to maintaining thickness. Because concrete pavement bases are frequently used as Contractor equipment routes, base damage assessment before concreting is essential. Pavement base travel by batch trucks and mixers may accumulate dust and contaminants, which must be addressed before concrete placement.

Concrete Paving Operation

Slip form concrete paving should be continuous. Frequent paver stops and starts affect concrete smoothness. Too few delivery trucks or recurring batch plant problems may cause return time and supply irregularities.

Concrete distribution ahead of slip-form pavers is important. Front loading pavers are equipped with augers. Strike off devices require adequate and evenly distributed material ahead of the paver at all times.

If vibration waves cannot be seen in fresh concrete around the spud, vibrators are likely not working. Vibration frequency can be checked with a frequency indicator, whereas amplitude can be adjusted to match paver speed, which is directly related to concrete consistency.

Control Guide Wires

Guide wires control pavement surface grade, which can be no more true to grade and cross section than the accuracy to which control wire has been set and maintained. This wire should be checked against survey stakes for alignment and grade. A final wire check and adjustment should be made immediately before paving, by sighting along the wire to detect and line and grade irregularities.

If a guide wire has been hit or moved, inform the Contractor immediately so grade can be checked. Wire control lines should be present on both sides of the paver when not paving against an existing vertical surface.

Slip Form Paver Spreading and Finishing

Slip form machines receive concrete on the subgrade and between paver side forms, or via receiving hopper. Hoppers laterally distribute fresh concrete to the screed. Concrete discharged into hoppers should fall less than five feet to avoid segregation. Hopper conveyors must be adjustable to prevent excessive concrete drops. When concrete is placed on subgrade in front of slip-form pavers, provide a uniform concrete quantity for the strike off blade. Dry concrete causes pavers to rise above design elevation.

Slip formed pavement is finished using a tube finisher, which removes surface irregularities and seals the surface. Water should be minimally applied as a fog or mist, during a single finishing pass in accordance with Standard Specification Subsection 501.03.

Slip Form Edge Slump

An early and helpful indicator of PCC paving quality is edge slump variation. Excessive edge slump causes water ponding over longitudinal joints. Paving machines must produce an edge within tolerance. Avoid continual edge finishing and repair. Contractors should have extra form sections to repair slumping edges.

Concrete Placement and Finishing - Stationary Side Form Method
Subsection 501.03.8B, Standard Specifications

Stationary side forms are placed ahead of the paver. Mechanical spreaders with a helical screw or a blade ride the forms and spread concrete. The blade travels back and forth between the forms, whereas screw movement is rotational.

The main screed is located behind the blade or screw to strike off and partially consolidate concrete. Screed elevation is usually set higher than finish elevation so after consolidation the final surface is at correct elevation. Excess mix should move ahead of the spreader to avoid starving the screed. Screed elevation is adjusted to create super-elevations or cross slopes. Gradual screed adjustments ensure a finished surface without abrupt elevation changes.

Finishing screed elevation and cross slope are determined using a straightedge laid across the pavement and side forms after the final pass. The concrete surface should be above this plane enough to provide for slump and subsidence during finishing. Tamper bars should penetrate approximately 0.03 feet into fresh concrete at the bottom of the stroke. Two passes of the tamping-screeding finisher are adequate to tamp and shape the surface. Some cases do require additional passes. Excess mix carried on the rear screed should be a few inches high and uniform across the screed during the final pass. Tamping-screeding finishers should be equipped with scrapers at each wheel to prevent mix accumulation between the finishers and form tops.

Finishing Concrete

Surface irregularities remaining after spreading and screeding must be corrected while concrete is still plastic and workable. Initial float finisher passes should follow immediately after the tamping-screeding finisher.

Over finishing concrete when free water is present should be minimal. Floating and screeding with excess water present leaches cement from the matrix, lowering surface strength, abrasion resistance and durability.

Adding finishing water to concrete surfaces is prohibited. Sprinkling finished concrete surfaces with water using a broom or brush to produce a more workable surface weakens concrete. Floating difficulties are most often caused by delayed finishing.

Concrete Form Setting and Alignment

Contractors must place and maintain forms in good condition. This Subsection covers practices Contractors should follow.

Ensure concrete forms meet required dimensions and material supporting capabilities, are clean, oiled and straight, and have perpendicular faces with locking devices. Test with a 10' straightedge before use, and verify variations along top surfaces or vertical faces are no more than ⅛-inch.

Forms should rest on a firm foundation throughout the entire form length. Forms should not be lifted to proper grade before pins are locked, as settlement will eventually occur at these locations. Locking devices must be properly fastened. Ensure correct distances between forms and from centerline. A consistent grade at correct elevation must be maintained. Properly set and trued forms allow a continuous concreting operation.

Subgrade should be moist before concrete is placed, to reduce cracking caused by rapid moisture loss. Sprinkling just ahead of paving is acceptable, but thoroughly wetting subgrade a few hours before concreting is more effective by allowing deeper water penetration.

Concrete Form Removal

Weather and temperature are important in determining form removal timeframe. Concrete must be hardened enough to prevent spalling or other damage. Honeycombed surfaces must be patched and pavement edges allowed to cure.

Concrete Texturing and Tining
Subsection 501.03.8.D, Standard Specifications

Texturing cuts grooves into the surface far enough apart to retain material between grooves. Grooves must be cut while concrete is plastic, but before texturing will tear or ravel the surface. Contractors should ensure tines are evenly spaced and free of hardened concrete. Shallow grooves wear prematurely, and do not provide drainage needed to prevent hydroplaning. Excessively deep tining weakens surfaces and wears excessively.

Concrete slump, ambient temperature and wind influence tined surface finishing.

Curing
Subsection 501.03.11, Standard Specifications

Concrete curing ensures durability. Concrete surfaces must be covered while curing to retain moisture and reduce drying stress. Rapid moisture loss causes shrinkage cracking and reduced strength. When finishing is complete and the surface will not be marred, the entire pavement should be sealed before surface drying to avoid shrinkage cracking.

Curing Membrane

Standard Specifications merely require curing Portland Cement Concrete Pavement (PCCP) using a "membrane". Alternative methods must be MDT approved. Membrane curing methods apply liquid membrane curing compound to the entire concrete surface. Curing surfaces should be moist when compound is applied using an even coat. Complete curing seal coverage is vital to pavement service life.

Curing compound application rates should be checked several times daily by calculating coverage area versus curing compound usage, and noting in the DWR.

If curing membrane is applied during windy conditions, use a burlap drape to completely cover the surface and prevent water loss. If curing membrane application is delayed, water mist the surface until membrane application. Concrete must retain adequate moisture to avoid shrinkage cracking.

Joints
Subsection 501.03.13, Standard Specifications

Joints allow concrete to relieve internal stresses. Without joints, concrete pavements fracture randomly where stresses exceeds concrete strength. Concrete longevity depends significantly upon joint placement and subsequent performance. Most concrete pavement failures begin with joint failures, not inadequate structural capacity. Pavement distresses due to joint failure include faulting, pumping, spalling, corner breaks, and mid-panel cracking.

Concrete Joints

Transverse construction joints are placed at the end of a run and when paving is interrupted for more than one hour. Joints are also necessary where adjacent lanes are placed separately.

When multiple lanes are placed concurrently, longitudinal joint tie bars are placed by the paving machine, and should be placed while concrete is plastic.

Construction and weakened plane joints must be sawed.

Smooth epoxy coated dowels provide load transfer over longitudinal construction joints and allow joint movement. Epoxy helps prevent dowel bar corrosion.

Joint placement within monolithically poured curb and gutter must line up with roadway joints.

Contractor Responsibilities

Joint details should be discussed at the pre-paving conference before work begins (Subsection 501.C.2). Review items should include:

- Proper joint sawing
- Contractor sawing plan, and the need to keep an extra concrete saw on site during sawing operations
- Construction joint spacing
- Joint construction around openings and other appurtenances such as manholes.
- Matching transverse joints with adjacent lanes

Inspectors should work with Contractors to address joint construction, but with Project Manager involvement. Joint layout may need changes due to manhole location, curb approach or other features. In most cases, Inspectors are responsible for such decisions.

Dowel Bars

Dowel are typically required for transverse joint reinforcement, and placed during paving to transfer loads between slabs across joints. Dowel assembly centerlines are laid out and marked so assembly locations can be recorded. Assemblies are held in position using metal stakes or pins left in the pavement. Small wires binding assemblies together during fabrication and shipment should be cut after placement. If dowel baskets are dislodged or unsecured during concrete placement, stop cutting shipping support wires. Dowels should move freely with a dowel cap or sleeve, and coated with a bond breaker. Review plan dowel bar details.

Watch for dowel bar basket movement as the paver moves over dowel bars during PCCP placement and vibration. Stress to Contractors that each dowel bar be properly aligned and parallel to centerline. Dowel bars skewed to centerline jeopardize pavement structural integrity. Never place dowel bars perpendicular to skewed transverse joints. Proper dowel bar pinning should be discussed at the preconstruction meeting. Inspectors should notify Contractors immediately if dowel bars are not located properly.

Tie Bars

Tie bars located along longitudinal joints prevent slab separation and movement, and provide load transfer across joints.

Tie bars installed across centerline should be parallel to the surface and at a right angle to centerline. Keyways used with multiple lane paving must be held in proper position against form faces. Keyways are used only in PCC pavements 10 inches or thicker. Tie bars or hook dowels must be correctly spaced and securely fastened. Do not coat tie bars with bond breaker.

Saw Timing

Contractors determine when to saw joints. Inspectors should ensure that timing is appropriate, and realize that saw cut timing varies between projects.

Discourage Contractors from sawing according to a predetermined schedule, as changing temperatures, humidity and wind speed alter optimum sawing conditions. If a crack opens at a joint during sawing, stop sawing to prevent a second crack from causing spalling between cracks.

Because they relieve early drying-shrinkage stresses, initial contraction joints must be cut as soon as concrete has hardened enough to support sawing equipment. Clean, neat saw cuts generally indicate the sawing process is late. Minor raveling indicates sawing time is correct. Excessive raveling at top edges of saw cuts and mortar washing from cut faces while sawing indicate cutting is too early. If sawing is unable to keep pace with concrete curing, early cracking will be evident at initial set. In most cases, this situation can be addressed by sawing every other or every third joint, then sawing skipped joints.

Saw Types

Conventional saws are single-blade, water cooled, walk-behind saws requiring continuous water supply, and at least two workers. Sawing should occur 4 - 12 hours after paving, to ¼ - ⅓ slab thickness.

Early entry saws, or “soft cut” saws, are lighter than conventional sawing equipment, to allow earlier sawing, often as soon as concrete can support workers. Shallower saw cuts take advantage of significant surficial moisture and temperature changes to help initiate cracking below the cut. Early entry sawing can begin 1 to 4 hours after concrete placement, depending on weather conditions and mix characteristics. Because pavement is sawed earlier, sawing depth to initiate cracking can be reduced to a minimum 1 inch depth. If corner spalling occurs, stop sawing approximately ½ to ¾ inch from the slab edge to prevent corner spalling and edge breakout.

Single vs Double Cut Joint Width

Figure 501-1 shows a single and double saw cut for transverse and longitudinal joints. MDT currently uses single saw cuts. Contract documents ordinarily contain joint dimensions and layout.

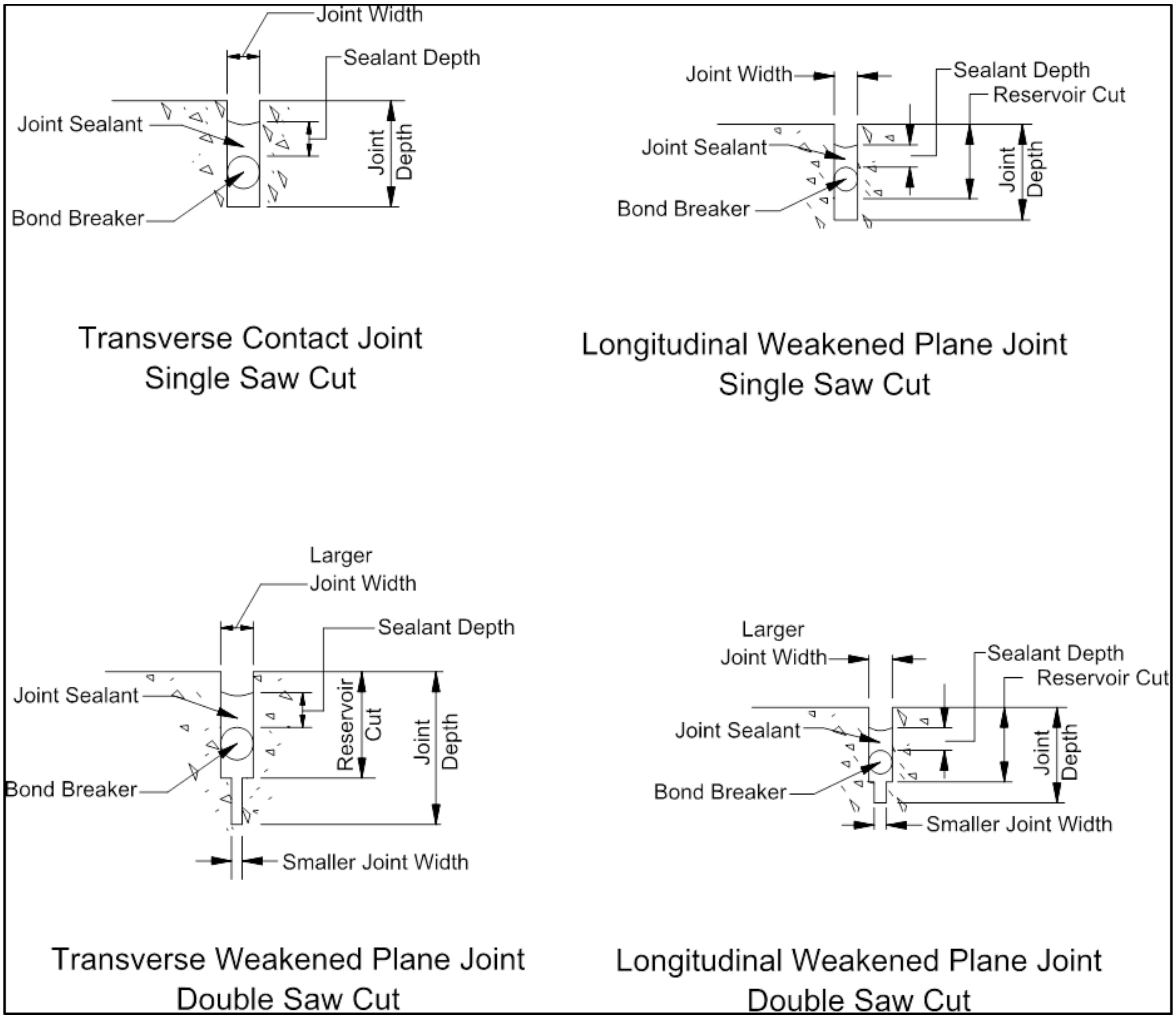


FIGURE 501- 1
SINGLE VS DOUBLE SAW CUT JOINTS

Joint Sealant

Joint sealant prevents water and incompressible materials from entering the joint to reduce moisture related distresses such as pumping and faulting. Incompressible materials block expansion, and lead to joint spalling and buckling.

Joint sealant must be compatible with joint cut dimensions. Contract documents usually stipulate joint sealant type, but Contractors may request an alternative sealant compatible with the joint. Sawed joints should be cleaned and filled with sealant as soon as possible. Grinding is completed prior to joint sealing.

Key inspection items include:

- Joint cutting depth.
- Joints are sandblasted to ensure sealant to joint wall surface bonding
- Sealant is applied only to clean joints

PCCP Surface Smoothness Test
Subsection 501.03.14, Standard Specifications

PCCP sections exceeding 300 feet are smoothness tested using a laser profiler. Areas needing grinding to meet smoothness specifications are isolated and marked along stationing. Use a straight edge to define smoothness irregularity boundaries.

Mitigating Spalls and Cracks
Subsection 501.03.15, Standard Specifications

Large concrete slabs crack with shrinkage. Sawed joints cause cracking to occur at joints where concrete thickness has been reduced, although concrete may still crack outside the sawed joint. Random cracking may be due to nonuniform water/cement ratios, segregation, improper curing, or latent joint sawing. Procedures outlined in Standard Specification Subsection 501.03.15 must be followed to ensure durable pavement.

After concrete has cured Inspectors should crack survey PCCP to depict crack location, orientation and length on a diagram provided to the Contractor. A crack repair plan is then submitted for Project Manager review.

Crack repair depends upon crack orientation and location. Transverse cracks are usually repaired by routing and sealing, except when dowel bar reinforced. The crack is epoxy injected and deepened. Longitudinal cracks not falling within wheel paths can also be routed and sealed. Repair for longitudinal cracks falling within wheel path is often ineffective, in which case Project Managers may require slab replacement.

Opening PCCP to Traffic
Subsection 501.03.16, Standard Specifications

A flex beam, maturity meter or concrete cylinder compressive strength test may be used to determine when PCCP is opened to traffic. Opening to traffic does not imply final acceptance, which is based on 28-day lot acceptance for concrete compressive strength requirements (Standard Specification Subsection 551.03.7.C). Contractors may use the maturity meter, flex beam or concrete cylinder method to determine when pavement can be opened to traffic. Flex beams or concrete test cylinders must be used to corroborate maturity meter performance curves, and field cured at the concrete placement site. Maturity meters nondestructively monitor concrete strength, and measure mix temperature to provide a quick flexural strength estimate. Maturity meter systems include sacrificial sensors placed in the concrete to measure temperature and calculate maturity. Handheld readers then download sensor data.

Weather and Night Limitations
Subsection 501.03.18, Standard Specifications

Cold Weather Concreting

In accordance with Standard Specification, concrete operations must stop when air temperature falls below 40°F (4°C), and not resume until air temperature reaches 35°F (2°C) and is rising. Concrete cannot be placed on frozen subgrade or contain frozen aggregate or material containing frost.

Standard Specification Subsection 552.03.8 covers cold weather concreting requirements. If cold weather PCC paving is used, Project Managers and Contractors should discuss cold weather preparations.

Hot Weather Concreting

Hot, dry, windy conditions encourage rapid surface drying and temperature changes, as well as high concrete temperatures during early hardening stages. These conditions dehydrate concrete faster than moisture can be replaced by normal bleeding, and create shrinkage cracks. Mix water and aggregate stockpiles may be cooled to lower concrete temperature. Forms may also be cooled by sprinkling water or dragging wet burlap over them before concrete placement. Under some conditions wet burlap must be used for 24 hours.

Nighttime Limitations

Night concreting operations require lighting systems for concrete proportioning, transportation, placement, finishing and inspection. Concreting should not be conducted when light conditions reduce workmanship or Departmental inspection capability.

Rain Protection
Subsections 501.03.9 and 501.03.10, Standard Specifications

Before paving, Inspectors should verify Contractors have sufficient curing protective material such as burlap or polyethylene sheeting in case of rain. Sudden showers during paving or immediately after finishing require concrete to be covered so cement does not wash from the surface. Concrete mixing and placement must stop during rain events. The pavement surface must be damage inspected, and the Contractor advised if corrective action or removal is necessary (Standard Specification Subsection 501.03.10). Contractors should not trowel or tool water from concrete. Finish work while excessive surface water is present forces more water to the surface, and changes the water/cement ratio to cause spalling and other distresses.

Batch Plant Inspection Items:

- Aggregate production, handling and stockpiling
- Plant equipment operation handbooks
- Equipment calibrations and checks observed versus documented
- Cement certifications received versus recorded
- Air agent and admixtures approvals verified and recorded
- Inspected scale weight settings
- Mix design adjusted for aggregate moisture changes
- Recorded versus observed batch weights
- Unit weight test results for individual batches
- Daily batch production records
- Periodically inspected plant components and performance pertaining to mixers, weigh bins, admixture dispensers, water meters, drum revolution counter and mixing time
- Aggregate batch handling practices inspected
- Returning haul units inspected for undischarged concrete
- DWRs with recorded instructions to Contractor, unusual events, start and stop times, and lost time due to breakdown, weather and Contractor forces
- Aggregate samples obtained and tested as required

Concrete Slab Inspection Tasks:

- Coordinate inspection and testing activities
- Review paving equipment handbooks

- Inspect paving and hauling equipment for specification compliance
- Inspect base condition and string line ahead of paver
- Check concrete slump in accordance with specifications
- Verify vibrators are in place and operating; vibration should stop if paver stops
- Verify dowel bars are at proper depth and alignment
- Verify tie bars are spaced and placed at correct depth
- Inspect concrete behind paver for excessive moisture
- Verify concrete behind the paver is smooth and without voids
- Ensure tube finisher follows closely behind paver
- Ensure water added to the surface is only a fine fog or mist
- Texturing is performed as soon as possible and does not tear surface
- Ensure curing compound is applied evenly
- Check construction joints with straightedge
- Record starting and ending stations daily
- Oversee slump, entrained air, cylinder, test beam and unit weight testing
- Verify plastic joint strips are installed properly
- Document lost time, weather conditions, and wasted concrete

Sawing Inspection

- Check saw cut depth and width
- Note excessive raveling, concrete washing or tearing and random cracking
- Joints are completely cleaned
- Curing compound removed by sawing is replaced

Joint Seal Inspection

- Joint is completely clean and surface dry
- Verify lab approvals and joint material certifications
- Check pavement temperature
- Check sealant temperature for compliance with manufacturer recommended heating and application temperature
- Joints are filled to proper depth and excess sealant removed
- Record daily beginning and ending stations

Measurement Method
Subsection 501.04, Standard Specifications

Payment Basis
Subsection 501.05, Standard Specifications

SECTION 551
HYDRAULIC CEMENT CONCRETE

Materials Subsection 551.02, Standard Specifications

Commercial Sources

Concrete is typically purchased from a commercial ready mix source. Lab personnel annually sample aggregate, cement and water used by the source. Sources developed for specific projects must be sampled and tested before approval.

Slump

An important indicator for obtaining smooth and durable concrete is uniform concrete slump, an empirical test measuring workability. Stiffer batches can cause high spots and surface tearing unable to be fixed with hand finishing. Slumps appreciably higher than optimum may cause excessive shrinkage and low spots. Slump uniformity is attained through aggregate grading, moisture content, ingredient proportioning, concrete mixing and frequent testing.

Slump is a comparative tool, but quality judgements cannot be made from slump tests alone. A significant slump change indicates more investigation or inspection is needed. Small slump variations are likely due to typical concrete variability.

Moisture

Concrete consistency cannot be maintained without uniform aggregate moisture from batch to batch. Aggregates from multiple sources may contribute to poor moisture control. Excessive aggregate moisture may impact water/cement ratios to affect concrete strength and durability. Discuss these issues with Contractors before batching and placing concrete. Maintaining coarse and medium aggregate at a saturated surface dry (SSD) condition helps ensure stockpile moisture uniformity. Watering keeps aggregate stockpiles at or near SSD levels during warmer months.

Inform Contractors not to add water to concrete after mixing. Inspectors should track water volumes added to the mix, and closely monitor concrete temperatures during hot and cold weather for specification compliance. During hot weather, concrete temperatures should not exceed limits. Hot concrete is prone to shrinkage cracking, which diminishes durability and longevity.

Fineness Modulus (FM)

Fineness modulus (FM) is an empirical figure obtained by adding total sample aggregate percentages retained on each of a specified sieve series, and dividing the sum by 100. Smaller values indicate finer aggregate and higher values coarser aggregate.

Fine aggregate affects many concrete properties, including workability and finishing. Coarse sand or fine sand produces poor concrete mix. Coarse sand concrete mixes are prone to bleeding and segregation. Fine sand mixes require more water for concrete workability, the mix is prone to segregation, and may require higher cement content. High cement content high-strength concrete is usually mixed with coarse sand and an FM around 2.8 to bring about workability with high compressive strength. Manufactured sands usually require more fines than natural sands for equal workability, which may be addressed using chemical admixtures.

Small aggregate gradation changes affect FM, so concrete aggregate samples may meet gradation requirements without meeting FM requirements. Concrete aggregate failing to meet FM requirements should be investigated.

Admixtures are classified as:

- Retarding Admixtures slow cement hydration and setting time. Retarders are used with large concrete masses during hot weather conditions to slow the effects of higher temperatures on set time. Retarders are also used when concrete is trucked long distances beyond Standard Specification time limitations.
- Accelerating Admixtures shorten concrete setting time to allow cold weather placement, early form removal, early finishing and early load application. Accelerators must be chosen carefully as they may increase drying shrinkage.
- Water Reducing Admixtures reduce the water required to produce concrete of equal slump, or increase concrete slump at equal water content. Water reducers may also influence initial set time, aid pumping or provide higher strength sooner.
- Air Entraining Admixtures produce air bubbles in concrete to enhance freeze-thaw durability. Although some strength loss accompanies air entrainment, it can be overcome by reducing the water to cement ratio.
- Bonding Admixtures intensify bonding between fresh and set concrete.
- Concrete mixes may be compromised by adding supplemental materials to balance admixture side effects. Understanding admixture effects for specific jobs requires expertise. Admixtures should be added during batching to ensure adequate mixing. The Materials Bureau Concrete Supervisor can approve exceptions for which additional admixtures are added onsite to make adjustments to variable job specific conditions, or for which specific conditions require adding admixture.

Water/Cement Ratio

Water to cement ratio (w/c) is the prime factor determining mix durability and maximum strength. Low w/c ratios impede workability. Chemical admixtures can increase workability while maintaining lower w/c ratios to increase concrete strength.

Mix Delivery Verification

Verify truck delivery tickets indicate the correct concrete mix. Check batched water volumes, w/c, revolution counters and water meters for conformance. Record added mix water and additional mixing time. Recalculate w/c to account for additional water.

Construction Requirements and Quality Control Assurance
Subsection 551.03, Standard Specifications

MDT accepts hydraulic cement materials on a QA basis. Standard Specification Subsection 105.03.2 discusses MDT QA practice applying to QA items.
Contractor quality control procedures should verify materials meet specifications before permanent usage. Contractors commonly use MDT QA test results to make operational changes, but MDT QA processes do not substitute for Contractor QC procedure.

Controlled Low Strength Material (CLSM)
Subsection 551.03.2.E, Standard Specifications

CLSM (flowable fill) is a flowable, cementitious slurry used as backfill. Flowable fill sets as a solid, is self-leveling and requires no compaction or vibration to yield maximum density. CLSM can substitute for concrete, compacted soils or sand to fill around pipes in utility trenches or fill voids. Flowable fill should not be considered a substitute for concrete or a compacted soil cement. CLSM is also referred to as flowable fill, flowable mortar, lean mix backfill, lean fill, controlled density fill, unshrinkable fill, flowable fly ash, hydraulic cement, low strength slurry backfill, flowable backfill and flowable grout. Flowable fill backfill is used with sewer and utility trenches, building excavations, bridge abutments, conduit trenches, retaining walls, abandoned wells, sewers, manholes and underground storage tanks.

Plans typically specify excavatable or non-excavatable flowable fill. “Excavatable” indicates material removable by using a hand shovel. “Non-excavatable” is material removable with an excavating machine.

CLSM Placement with Culverts and Utilities

When using flowable fill with culvert installation Contractors should:

- Ensure against flotation movement, and plug form holes to prevent flowable fill loss during placement
- Avoid rapid placement on and around thin walled culverts to avoid deformation during placement
- Avoid resting culverts or utility components on surfaces harder than flowable fill, such as concrete blocks, rocks or steel during placement. Point loads may cause pipe deformation. Place steel plates over trenches if traffic will pass over the fill within 24 hours
- Start at one end and pour along both sides evenly as until movement or flotation risk is low

CLSM Usage at Bridge Ends

Unspecified flowable fill usage at bridge ends may impact bridge substructures. Consult the Bridge Bureau if flowable fill backfill is considered.

Contractors should place flowable fill slowly to prevent damage to pile caps, backwalls or wingwalls. Expansion joints may be necessary between bridge ends and flowable fill. A drainage plan may be needed under flowable fill at bridge ends. Contractors are responsible for flowable fill shrinkage after curing, which may influence finished grade.

Batching Plant Equipment
Subsection 551.03.3, Standard Specifications

Hopper bins should be level and loaded at least 24 hours before calibration to avoid segregation or contamination. Weighing hoppers should empty completely and contain the entire batch being weighed without overflow. Scales, load cells, meters and pump operations must be verified by the Bureau of Weights and Measures, with certification documentation visible at the plant. Working scale components, such as knife edges, shackles, and weighing arms must move freely, be in good condition, protected from falling or adherent material, and inspection accessible. Scale and weigh hopper attachments should not restrict free movement of weighing mechanism components, or cause inaccurate weight measurement. Scales should be checked regularly. Zero balancing should be verified twice daily. Water volumes discharged into the mixing drum may be checked against gauge readings by disconnecting the water line, diverting flow into a container and weighing discharged quantities at various settings.

Pneumatically Applied Mortar

Pneumatically applied mortar (shotcrete) is cement, water and sand conveyed through a compressed air hose and ejected at high velocity. The mixture is relatively dry and self-supporting even when applied on vertical or overhead surfaces. Shotcrete is applied in successive applications. Equipment manufacturers use other names, such as gunite, sprayed concrete, sprayed concrete and air blown mortar to describe pneumatically applied mortar. Pneumatically applied mortar can be applied to varying surfaces, profiles and slopes, and is commonly used as protective coating for structural steel, masonry, rock, and concrete beams.

Pneumatic Concrete Application Process

Pneumatic mortar is applied via dry or wet mix processes. The dry mix process mixes cement and damp sand in a mechanical feeder, and forces mix through a discharge nozzle. Water is introduced through a second hose at the discharge nozzle. Wet mixing thoroughly mixes sand, cement and water, and pumps the mixture into delivery equipment chambers for later discharge through a nozzle.

Concrete Aggregate Optimization
Subsections 551.03.8(B)(1)(d) and 701.01.3, Standard Specifications

The Department prefers optimized aggregate gradations for concrete mix design usage, which usually requires using multiple bins. Optimized aggregate gradations generate higher performance and cost effective concrete by reducing cement and water usage, avoiding segregation and maintaining workability. Concrete strength, long term performance and workability are enhanced.

Concrete mix design submittals must meet Standard Specification Table 701-5 gradation requirements. The Materials Bureau approves mix designs based on combined aggregate optimization charts, but Inspectors still must field sample mix designs. Special provisions may require Contractors to develop and submit optimization charts with mix designs, and state whether an optimized aggregate gradation is used.

Curing Concrete
Subsection 551.03.7, Standard Specifications

Concrete curing seals the surface to retain hydration moisture and allow excess water to exit. Surficial moisture loss weakens concrete, making it subject to cracking and reduced durability. Excessive moisture, generally applied to fresh concrete during finishing, can produce a weak concrete surface layer due to high surficial water/cement ratios. When finishing operations are complete and surface marring will not occur, the entire surface should be cured. Curing compound must be applied promptly to avoid surficial shrinkage cracking.

Water Curing

Apply water to concrete surfaces using a water atomizer or fogger immediately after finishing. Continue to apply water with an atomizer until concrete has set, then apply a curing medium such as burlap, and keep moist.

Impervious Membrane Curing

The membrane method requires spraying moist concrete with an even coat of liquid curing compound. Ensure all surfaces receive curing compound at the rate specified. A continuous seal is vital to long term concrete durability. Curing compound application rate should be checked several times daily. Compare curing compound usage amounts to calculated amounts at the required application rate, and note discrepancies.

If curing membrane is applied during windy conditions, a shielding barrier should be used to prevent compound loss. If curing membrane application is delayed, a water mist should be applied until curing membrane is applied. Concrete must retain hydration moisture to avoid shrinkage cracking.

Compounds should be agitated before use. Standard Specifications do not require agitation, but Project Managers may. Use propellers and air agitation to maintain compound integrity. Rolling compound barrels is not an acceptable mixing practice. Thoroughly mix compound daily, and apply curing compound when standing water is no longer present.

Measurement Method
Subsection 551.04, Standard Specifications

Payment Basis
Subsection 551.05, Standard Specifications

SECTION 552
CONCRETE STRUCTURES

Description
Subsection 552.01, Standard Specifications

Structures must support wind forces, soil and water pressures and carry intended traffic loading. MDT builds structures made primarily of steel or concrete. Structural steel is ASTM designated steel having material properties intended for structural applications such as buildings and bridges. Structural steel is high grade and strength, and designed to yield before failure. (Standard Specification Section 556).

Structural concrete contains steel reinforcement, and meets higher quality standards than concrete found in sidewalks or driveways. Unless otherwise approved, MDT contracts require structural steel members, reinforcing bars or high strength wires or strands incorporated into permanent work to meet domestic steel or “Buy America” provisions outlined within Standard Specification Subsection 106.09.

Structural Concrete Types

Reinforced concrete is concrete with steel reinforcement. Concrete is strong in compression but weak in tension. Reinforcement carries tensile loads induced by concrete movement or shrinkage, as well as shear stress loading.

Prestressed concrete contains pretensioned steel wire or strand reinforcement, which by imparting a compressive load within the concrete, allows structures to carry greater tensile loading. Steel strands are tensioned before or after concrete placement. Prestressed concrete requires less reinforcement as smaller tensile stresses develop within the concrete cross section, making thinner and lighter structural concrete members possible. See Standard Specification Section 553.

Inspection Importance

Inspectors and Project Managers should understand how structures are intended to perform. Discussions with designers can clarify why particular special provisions and details are needed. Understanding structural design concepts helps identify key inspection elements. Concrete structure inspection must be thorough. Failures can lead to injury, death or property damage. Inspectors must interpret bridge construction specifications, project plans and details. Consult Project Managers, designers, and CES Bridge Reviewers as needed.

Headquarters Coordination

During construction, CES or Bridge Bureau personnel address questions regarding plans, shop drawing reviews and design details.

Materials
Subsection 552.02, Standard Specifications

Construction Requirements
Subsection 552.03, Standard Specifications

Standard Specification Section 552 applies to all concrete structures

Falsework and Forms
Subsection 552.03.2 and 552.03.3, Standard Specifications

Project Managers and Inspectors must understand the distinction between falsework and forms. Forms contain concrete until it has time to harden into a desired shape, resist lateral pressure exerted by fresh concrete, and can be used to impart surface texture.

Falsework carries concrete and formwork loads, and supports concrete filled forms until concrete supports itself. Formwork is used to construct:

- Catch basins and manholes
- Abutment walls and spread footings
- Retaining walls and sound barriers
- Bridge bent columns
- Box culvert bottom slabs and side walls
- Cast in place girders
- Falsework is used to construct:
- Bridge decks; plywood acts as formwork and falsework
- Deck overhangs where sheathing acts as formwork and falsework
- Exterior cast in place girders
- Bent caps beams
- Abutment wing walls
- Box culvert top slabs
- Shoring systems for cast in place box girder bridges

Bridge falsework typically includes steel and timber. Stringers, joists and cap beams may be steel I-beams, while shoring, decking, bracing, corbels, sills and wedges are often timber.

Working drawings and falsework plans for public travel facilities must be signed by a Montana licensed professional engineer (PE) before submittal to Project Managers. Contractors must check and approve working drawings submitted to Project Managers.

Falsework Construction

When falsework drawings have been Contractor reviewed and approved, Project Managers should send copies to Inspectors and CES Bridge Reviewers. Inspectors ensure falsework is in accordance with approved drawings, observe falsework construction, work to eliminate defects and hazards, alert Project Managers to plan deviations, and document information within Daily Work Reports (DWR).

Falsework failures and are most often caused by:

- Inadequate bracing
- Improperly constructed falsework
- Inferior material
- Out of plumb vertical members
- Unstable soils under mudsills
- Vibration due to construction traffic or concrete placement
- Rapid concrete placement or uneven structural loading
- Premature stripping and shoring removal

Additional features to monitor are:

- Footings and Mudsills
- Soil type as identified by approved falsework drawings
- Soil is firm, stable and in uniform contact with mudsill
- Mudsill top surface is level
- Mudsill and footings are scour protected and properly drained
- Mudsills or footings are set back from slope edges as specified

Piling features and characteristics to monitor are:

- Pile placement within specified tolerances
- Piles are driven to allowable bearing values
- Pile caps are properly set and leveled for uniform pile bearing

Timber falsework member characteristics to monitor are:

- Timber is free of defects such as splits, open knots, or rot
- Timber is cured to prevent warping and shrinkage
- Members are in full contact with adjacent members
- Member size, spacing, length and grade are as specified
- Diagonal bracing is installed as shown by drawings
- Connections and hardware are checked for tightness
- Members are plumb and level
- Camber is provided when required to offset dead load deflection
- Bearing connection crushing distress

Structural steel falsework member characteristics to monitor are:

- Salvaged beams and other steel shapes are examined for section loss, web penetrations, rivet or bolt holes and local deformation affecting load capacity. If member condition is questionable, contact the Project Manager and Contractor.
- Column or pile bents are plumb and beams are level
- Member size and spacing conform to shop drawings
- Bracing is per drawings, especially on beam compression flanges
- Bolted connections are properly tightened and bolted
- Welded connections are certified
- Splices are located as specified
- Allowances made for jacking structural members are located under a hinge

Manufactured steel shoring assemblies should be monitored for:

- Manufacturer recommended usage
- Base plates, shore heads, extensions or adjusting screw legs are in firm contact with foundation or support
- Correctly spaced shoring tower assemblies
- Specified bracing
- Screw leg extensions within limits or adequately braced and snug to tower frame
- Plumb tower frames
- Top U-heads fully contact joists or ledges, and hardwood wedges are snug
- Section loss, kinks, broken welds, damaged cross-bracing lugs or bent members
- Closed locking devices
- Guy wires adequately attached to towers and ground support
- Allowances for jacking structural members are located under a hinge
- Falsework Protection
- Barrier and crash attenuator location, length and number
- Warning and clearance sign installation

- Safety beam height and offset
- Horizontal clearances between shores and barrier
- properly bolted or mechanically connected
- Falsework members adjacent to barriers are
- Falsework bracing and bolted joint connections
- Lane widths beneath falsework
- Signing, striping, barrier and barricade traffic control plan compliance

Tattletales

Contractors install “tattletales” to indicate settlement during deck and pier cap concrete placement. Tattletales are attached to form bottoms at various locations, and extended to a reference mark observed by a person near the structure. Place a reference mark on a stake driven into the ground. The ground reference stake indicates vertical falsework movement, which can be checked against calculated deflection.

Bridges

Excessive falsework deflections can:

- Cause sagging below finish elevation
- Produce bulging hardened concrete
- Impose adverse forces to the structure
- Cause concrete overruns

Safety

Bridge construction is dangerous and not all hazards are obvious. OSHA issues concrete construction safety standards applying to Contractors, but MDT field staff must also follow Montana Department of Labor and Industry standards. The MDT Office of Safety and Occupational Health provides further information.

Project Managers and Inspectors should discuss bridge construction safety including:

- Trip, fall and impalement hazards
- Required fall protection equipment
- Fall protection equipment availability and usage
- Heavy equipment safety
- Formwork and falsework climbing procedure
- Hand rail, ladder, stairway and platform requirements and standards
- Required personal protective equipment
- Accident and near accident reporting
- Deviations from established procedure or regulation reporting to Project Managers and documentation to DWR

Form Construction

Finished concrete appearance depends upon form facing, carpentry accuracy, form strength, and falsework. Inspectors should verify:

- Forms hold concrete without shifting, leaking, or deflecting
- Forms impart intended shape and dimension to concrete, at correct elevation and location
- Concrete surfaces exhibit planned appearance

Mortar Tightness

Mortar tightness depends upon concrete slump, temperature, vibration duration and form pressure, and is important for the following reasons:

- Leaking mortar may develop voids around rebar
- Leaking mortar causes an uneven surface appearance
- Mortar loss weakens concrete
- Mortar is a pollutant
- Form joints may leak during concrete vibration. Contractors should not curtail vibration to reduce form leakage

Fluid Pressure

Forms must be constructed to withstand lateral pressures and live loads induced by vibration and construction activity. Horizontal form pressure is high when concrete is placed rapidly. Slower placement allows lower lifts to partially set before top lifts are placed, which lowers horizontal pressures against bottom forms. Placement rate should avoid bulging or failing side forms. Bulging diminishes concrete appearance, while form failures jeopardize safety. Inspectors and Contractors should communicate about maximum pour rates.

Bridge Deck Falsework Removal
Subsection 552.03.10, Standard Specifications

Falsework must only be removed when concrete supports its weight without cracking or deflection, and resists prolonged deformation from sustained loading (creep). Concrete may creep under its own weight with falsework removal. Inspectors must adhere to Standard Specification cure durations despite early high strength cylinder breaks.

Concrete Placement
Subsection 552.03.4, Standard Specifications

Inspectors must inspect structural concrete forms, falsework and steel reinforcement prior to placement. Inspection times vary from a few minutes for a concrete catch basin to hours for a large bridge deck. Inspectors and Contractors should discuss pour schedule, steel placement, steel and formwork inspection, and traffic and safety issues. Contractors may want to make up for delays by shortening inspection time. Inspectors should not be pressured to accept substandard work. Frequently perform form and steel inspections to catch errors early**.** Meet with Contractors daily to discuss quality issues and progress Point out and document recurring incompliance**.** Keep Contractors informed of inspection time requirements**.** Adjust inspection schedules if Contractors experience delay

Escalate chronic, unresolvable, and incompliant situations. Adjust daily work hours to accommodate activity inspections. Discuss project plans with Contractors to verify inspection details are noted and areas causing complications are identified.

Build field relationships based on cooperation and courtesy, and be willing to help interpret plans and specifications. Although Contractors may rush inspection, do not shorten inspection time. Communicate with Contractors despite conflict. Perform inspections earlier than required and share information regarding defects. Do not compromise specifications to meet timeframes. Avoid directing Contractor work.

Construction Joints
Subsection 552.03.6, Standard Specifications

Construction joints terminate concrete pours at planned locations. For structures too large for a single pour, construction joints end the concrete pour while maintaining structural continuity and load transfer strength across the joint. Construction joints are constructed using a form where the pour is terminated. Usually rebar protrudes through the form, and a key is formed into the joint face. The joint is then cleaned using sand or water blasting before the next pour. Inspectors should examine construction joints for correct location and orientation, concrete placement procedures, proper cleaning and smoothness. Construction joints (cold joints) may be necessary during pour interruptions, or if pour rate is too slow to keep concrete being placed in contact with previously placed fresh concrete. Structural loads and stresses may cause construction joint cracking or separation. Contractors may remove a defective construction joint and construct a new one at a better location.

Steel Reinforcement Placement

Reinforced concrete performs best when reinforcement is in continuous contact with concrete. Because both reinforcement and concrete carry loading, complete contact between the two elements provides uniform stress transfer. Voids around reinforcement cause abnormally high concrete stresses, leading to poor load transfer to steel, premature cracking and steel corrosion. Inspectors must verify concrete consolidation around reinforcing steel to avoid air void development. Verify specified cover over reinforcing steel. Spot check these items:

- Bar size and grade
- Concrete cover and bar clearance
- Spacing, length and tie number and location
- Bar splicing
- Chair height
- Damaged epoxy coating repairs
- Bar cleanliness

Pumping Concrete
Subsection 552.03.4, Standard Specifications

Contract documents may dictate placement sequence. Otherwise Project Managers should require continuous concrete placement throughout structural sections or between planned joints to avoid extra joints.

Concrete Vibration
Subsection 552.03.4, Standard Specifications

Standard Specifications require structural concrete to be internally vibrated. External form vibrators are prohibited unless otherwise approved by Standard Specification Subsection 552.03.4. Vibration helps concrete envelop and bond to reinforcement, fill voids and make concrete more waterproof and durable. Concrete vibrators work concrete under and around closely spaced reinforcement, and should be run by trained and experienced personnel. Vibrators should not be stationary longer than a few seconds. When the surface surrounding the vibrator has settled, it should be pulled out slowly and inserted slowly into a new area. Excessive vibration causes segregation and increases lateral form pressure. Contractors should operate vibrators in accordance with manufacturer recommendation.

Concrete should not be deposited then moved with a vibrator. If concrete flow movement is unavoidable, use shovels to move concrete to minimize aggregate settling.

Bridge screeds should be equipped with vibrators. “Bidwells” and other commercially available screeds may be equipped with vibrators mounted in front of the rollers. Vibrators must clear top reinforcing steel mats while consolidating the bridge deck.

Foundation Construction and Bridge Foundation Elements
Subsection 552.03.1 and Section 209, Standard Specifications

- “Drilled Shafts” are deep circular holes filled with reinforced concrete transferring loads to soil and bedrock.
- “Pile Foundations” are reinforced concrete pads or footings placed over steel piling.
- “Spread Footings” are reinforced concrete structures placed on undisturbed soil.
- “Abutments” are concrete walls at each bridge end of and supporting the bridge. superstructure. Integral abutments are end bents extending into the abutment.
- “Bents” are reinforced concrete or steel frame supporting the superstructure. Piers refer to specific intermediate supports or columns.
- “Wingwalls” are concrete wall adjacent to an abutment acting to retain fill beneath bridge approaches.

Soil Boring Logs

Bridge foundations transfer loads to the soil. Safe load carrying capacity is determined using subsurface information collected by the Geotechnical Bureau:

- Soil boring and geotechnical design during preconstruction
- Soil boring information for use with contract documents
- Soils examination during construction
- Necessary foundation adjustment

Soil boring logs contain:

- Soil boring location relative to bridge substructure
- Surface elevation
- Ground water elevation
- Soil type change elevations
- Standard Penetration Test blow counts
- Graphical representation of encountered material

- Encountered material narrative
- Blow counts and interpretive information

Bearing capacity is determined by soil type, shear strength and water table depth. Soil or rock type is determined using samples from the bore hole bottom. Standard Penetration Test (SPT) blow count shown on bore logs is the number of blows required to drive a sampling tube 6 inches with a 140 lb (65 kg) hammer dropped 30 inches (750 mm). Blow count values indicate soil strength.

Because soil conditions often change within a few feet, bore log information is specific to a particular boring at a particular time. Water table levels may also vary from levels noted during construction. Avoid interpreting soil logs for contractors. Foundation construction is frequently a source of contractor claims, which often allege misleading bore log information. A detailed record of materials encountered during construction is helpful in preventing claims.

Structure Excavation
Section 209, Standard Specifications

The first step in foundation construction is excavating to base footing elevation, for which the contract item “structure excavation” is provided. (see Standard Specification Section 209). Some contracts define “Structure Excavation” as incidental work.

Foundation excavations must be sloped or shored in accordance with OSHA standards. Department personnel are prohibited from entering excavations not sloped or braced according to these standards.

Pay limits for “structure excavation” are defined by Standard Specification Section 209. Excavation outside these limits for OSHA compliance, construction ease or other reasons is not measured for payment. In some cases, excavation must not take place outside specified limits for environmental or other reasons. Structure excavation is usually done with a backhoe or clamshell bucket. Spread footings must be placed on undisturbed material. Before reaching plan grade, bucket teeth should be removed to prevent material disturbance below the footing, with the last few inches excavated by hand. Contractors must pay over excavation expenses.

Because moisture can alter soil bearing capacity, foundation excavations must be protected from precipitation and run-off. Excavations must be backfilled as soon as possible in accordance with the contract.

Standard Specification Section 209 references two structural excavation types. Dry and shallow wet excavations are designated “Type I” structure excavation, while deep wet excavations are designated “Type II”. Type I includes necessary shoring, cribbing, pumping, draining, bailing and other work including backfilling. Type II structure excavation includes the same items except shoring and cribs, which are paid as separate lump sum items. Contractors may extend footing depth to 3 feet below plan elevation at contract unit prices.

Wet Excavations

Often excavations require dewatering before foundation placement. Open excavations and cofferdams are usually employed for wet excavations. Environmental constraints virtually eliminate open excavations in or near streams. In wet granular material, excavations are often large. Water volumes entering excavations often exceed pumping capacity, so cofferdams are needed. Wet excavation bottoms should be large enough to create a sump and channel water from the foundation area. Carefully examine footing areas for “sand boils”, where water percolates through underlying soil. If concrete is placed over them, boils extend up through fresh concrete and weaken the footing.

Plastic sheeting should be placed under the concrete to seal sand boils. Concrete should be placed beginning at the point furthest from the sump and continue to the sump. Subsequent lifts are placed on concrete rather than in water. Dewatering must continue until all concrete has initially set. Concrete should not be deposited in deep or flowing water using an open bucket.

Water percolating through wet excavation bottoms can reduce or destroy soil bearing capacity. This is usually a problem during cofferdam dewatering, but can be encountered in deep open excavations. Soundings should be taken before and after dewatering if sand boils are expected. Pumping a hole dry and allowing it to fill several times adversely effects foundation materials, and should not be permitted.

Cofferdams

Cofferdams are temporary sheet piling and bracing enclosures built in water to allow an enclosed area to be pumped dry to create a foundation work space. Cofferdams are used where water and soil conditions make open excavation impractical, unsafe or environmentally unsound. Cofferdam design and details are largely Contractor proposed. The Department is concerned about Inspector safety and having the cofferdam protect the work. For this reason, Standard Specification Subsection 209.03.3 requires Contractors to submit cofferdam drawings before construction. Drawings are submitted to Project Managers for comment, and forwarded to the Geotechnical and Bridge Bureaus for comment. The CES Bureau reviews drawings to verify adequate dimensions. Unless design assumptions and calculations are included, loads and stresses are not calculated for cofferdam members. Cofferdam member sizes are compared to similar cofferdams under like conditions. If a proposed method may not perform well, conditional design approval is given. Cofferdams must ensure safe and acceptable work completion. MDT approval only covers submitted cofferdam design. Notify the CES Bureau if dimensions change significantly or support size or spacing are reduced. Contractors may propose leaving a strut or other cofferdam member embedded within the permanent structure. This is generally permissible with written authorization from the CES Bureau or Designer.

Unsealed Cofferdams

Water is removed from unsealed cofferdams without sealing the enclosure bottom. Piping or bottom blow-in may occur when an unsealed cofferdam is pumped, due to interior and exterior water pressure differences. Sheet piles must be driven well below the footing bottom to prevent blow-in or piping. Footings need to be driven much deeper in loose sandy soils. Rocks and boulders sometimes prevent sheet piles from being driven below the footing to prevent blow-in. A decision to dewater will often be made by the Contractor anyway. Excessive pressure and upward water movement through the cofferdam bottom diminishes soil bearing capacity, often producing a “quick condition.”

In cases involving spread footings, soundings should be taken before pumping by using a long rebar to monitor dewatering. Pumping should be halted if water boils are seen. Seek assistance from Geotech if necessary. Contractors are responsible for corrective measures preventing foundation bearing capacity losses. Bottom blow-in is not as much of a risk when piles are driven.

Sealed Cofferdams

Concrete plugs block water movement through sealed cofferdam bottoms. Without piling, water pressure at the bottom is offset by seal weight, which in most cases is a seal height 0.4 times the water depth from the footing bottom. This thickness can be reduced by bonding the seal to the sheet piles. Plan seal thickness is specified in relation to past results under normal conditions. Contractors may increase seal thickness, but must include additional shoring and cribbing costs. Payment is not made for additional excavation, concrete or other work. Seal concrete must also resist water pressure before cofferdam dewatering.

Concrete Seal Placement with Tremie

Cofferdam seals are placed under water. Placement with a tremie or concrete pump is required. A tremie is a water tight pipe equipped with a hopper and a means to seal the bottom. Standard Specification Subsection 552.03.5 covers tremie construction.

Tremie tubes must be kept filled with concrete at all times. The tremie is raised slightly until concrete begins to flow at a rate regulated by raising or lowering the tremie. The discharge end must be embedded in concrete or water will enter the tube. Concrete placement should stop immediately if water enters the tremie. The tremie must be raised, the end sealed with a “pig,” lowered and filled with concrete as done initially. Although tremies ideally should not move laterally, they must be maneuvered around struts and other obstructions. Movement should be minimized to avoid concrete mixing with water.

Concrete Seals

During pumped cofferdam seal placement, concrete flow is pressurized. The tremie end must still be sealed and kept beneath the concrete surface. Concrete must always be in the hopper to prevent air pockets within the line, and the pump discharge must be kept within the concrete during pumping. Cofferdams must not be pumped during seal placement to avoid water flow through the seal. Cofferdams should have a port to equilibrate interior and exterior water levels.

Cofferdam Seal Problems

Avoid disturbing the concrete seal until it has set. Dowel bars extending into the seal must be located and securely tied in place before pouring seal concrete. Interlocking sheet piles ensure an effective cofferdam, and sheets must be driven evenly to maintain interlock. Sheets may split if large rocks or boulders are encountered while driving. Changing water depth may indicate a developing “sand boil” or “blow-in.”

Shoring and Bracing

Shoring and bracing, or “cribbing”, is used in shallow excavations where sloping trench walls to OSHA standards is impractical. Cribbing is simply a braced wall. Wooden walls are used more often for bracing than for cofferdams. Stresses to shoring and bracing can increase suddenly and drastically with precipitation. Soil cracking outside shoring and bracing signifies increased loading.

Cofferdam Safety

Cofferdams are subject to large loads but as temporary structures may not be designed and constructed with safety factors normally attributed to permanent structures. Use extra caution when entering or working in cofferdams. Cofferdams must be carefully inspected before entering to perform inspection. Carefully observe bracing and look for excessive bending, buckling or other distresses. Pay particular attention to wood bracing subject to sudden failure. Rapid exit options must be in place. MDT personnel are not required to enter unsafe cofferdams, as Contractors are required to provide safe facilities. Do not perform inspection work until conditions are safe. Discuss cofferdam safety disputes with the Project Manager.

Work Bridges

Work bridges are temporary and used to access work areas. High lines, cableways or temporary work access structures are also considered work bridges. Work bridges are usually constructed in or near water courses and subject to environmental regulation. Contractors must acquire environmental permits before constructing work bridges.

Spread Footings

Spread footings are reinforced concrete mats distributing structural loads over foundation soil to prevent excessive soil pressures. Footing size determines the magnitude of stress loading to the soil. Soil load capacities used to calculate footing size is ascertained using geotechnical analysis and testing. Structures supported by improperly constructed spread footings may settle. Footings must be constructed on undisturbed soil or engineered fill material. The last few inches of excavation should be removed by hand to expose undisturbed ground. Contractors must correct material disturbance or over excavation below plan elevation.

Spread Footing Construction Inspection

Spread footing inspection requires material logging during excavation, and sounding tests. In dry open excavations, material can be logged by examining excavation walls. Material removed from cofferdams or wet holes must be observed during excavation. Footing locations should be excavated nearly to grade. When unsuitable material is encountered, excavate to near plan elevation, sound the excavation and have Geotech advise. Do not excavate below plan elevation unless notified to do so. In some cases excavation below plan elevation outside the footing area may help identify underlying material. Sounding below the footing with a long rod may help gather information.

Drilled Shafts

Drilled shafts are included in the contract via Special Provision. Depending on contract requirements, Special Provisions may require Contractors to provide work experience documentation for drilled shaft workers. Provisions may also require Contractors to provide Foreman and Superintendent work experience documentation.

Description

Drilled shafts are deep circular foundations constructed by placing concrete in a drilled hole acting as a form. Shafts transfer axial structural loads to soils and bedrock by:

- Skin friction between the shaft wall and adjacent rock or soil.
- End bearing shafts transmitting loads to bedrock or soil.
- End bearing and skin friction.

Unlike driven piles (Standard Specification Section 559), drilled shafts are susceptible to poor construction techniques, and require more detailed inspection.

Drilled Shaft Installation Plan

Contractors must submit a Drilled Shaft Installation Plan describing equipment, tools and methods. Installation details depend upon site conditions and shaft complexity. Plans should address shaft excavation, excavation cleaning, casing installation and removal and concrete placement method. Plans should also refer to minimum requirements within the Drilled Shaft Special Provision, and provide MDT an opportunity to identify risks unidentified by the Contractor. Submitted plans must demonstrate to the Department a capability to complete the work.

Installation plans ensure drilling contractors are prepared, and minimize Departmental risk associated with defective shafts. These Plans give Project Managers an opportunity to verify Contractor work conforms with the contract and minimizes project risk, before work begins. Installation Plans must be reviewed by Project Manager, CES Bridge Reviewer and Geotechnical Section.

Pre-Drilling Meeting

Project Managers meet with Contractors before drilled shaft construction to discuss:

- Contractor Installation Plan details
- Contract pay limits and measurement methods
- Inspection and Contractor inspection assistance
- Contingencies for caving, groundwater, utilities, boulders and obstructions
- Safety precautions

After the meeting, Project Manager and Inspector should clearly understand the Construction Plan, and Contractors should understand Departmental inspection procedure.

Equipment and Materials

Inspectors should be familiar with Contractor equipment used to construct shafts, and should consult other MDT personnel for assistance. Inspectors should:

- Compare Contractor equipment to Drilled Shaft Installation Plan equipment
- Document equipment onsite within the Daily Work Report
- Document operating equipment
- Document equipment condition

Inspectors should ensure Contractors provide certification and approval for:

- Reinforcing steel
- Mechanical rebar splices
- Casing and coating
- Concrete mix design
- Welding methods

Excavation

Excavation to drilled shaft top elevation requires space for the drill rig and concrete placement equipment. End bent embankments are placed and compacted before drilled shaft excavation, during which Inspectors should observe and record soil type and depth. Inspectors should review boring logs and contract requirements for shaft bottom elevations. Penetration into bedrock may be required. Where drilled shafts continue into bedrock, Inspectors should measure shaft depth and document bedrock top elevation(s) shown on bore logs. Verify and record required penetration into bedrock using the “drilled shaft log”. If bedrock depth is not at planned elevation, contact the Project Manager to have Geotech evaluate the need for additional drilling.

Safety

Utilities must be staked before drilling. Contractor and Project Manager should identify underground and overhead utility conflicts, as vertical space is needed to construct deep drilled shafts. Drill rigs and cranes need space to lift 100 ft rebar cages and tremies. Power lines may be shut down while shafts are installed, and power companies may mark power lines to help judge clearance. Underground utilities must be located before drilling. If caving exposes a utility, verify the utility is supported and free of the shaft during concrete placement. Certain soil types may collapse during drilling. Project Managers may suspend work (Standard Specification Subsection 105.01) until the area around the shaft is safe. Safety casings may be placed to protect workers. OSHA Subpart "P" applies to drilled shaft excavations. Fall protection around the shaft must be provided. Unattended shaft excavations must be covered. Fencing may also be required.

Shaft Drilling

Suitable material excavated from drilled shafts may be used for fill and embankment. Drilling methods affect drilled shaft cost and inspection requirements. Three shaft drilling methods are used:

Dry Method

The dry method is the quickest, cheapest and easiest method to construct drilled shafts. The drilled hole remains dry until a rebar cage is placed and concrete poured, although temporary casing may be required. Project Managers should consult Geotech when contractors request eliminating temporary casing.

Casing Methods

Temporary Casing Method

Unstable soils are often encountered during drilled shaft construction, and may heave, compress, or collapse. Contracts may require temporary casing to prevent sidewall sloughing and caving before concrete placement, unless temporary casing is deemed unnecessary. Temporary smooth rolled steel casing prevents shafts from caving during excavation and concrete placement, and also serves as a safety barrier around the excavation. Casing is driven while an auger drills inside and ahead of the casing. Casing is driven into the hole until stable soil or shaft tip elevation is reached. If contracts allow, drilling slurry keeps the hole open beneath the casing until stable soil is reached.

The casing must be retracted while concrete is still workable, so space left by the casing and unstable soil is filled. Slump must be monitored when casing is pulled. If casing retraction is delayed, concrete may begin to set and prevent casing removal. Concrete may also come up with the casing, lifting and twisting the rebar cage. Voids along the shaft may also go unfilled. Any of these outcomes may impair drilled shaft integrity. Inspectors should collect sufficient concrete samples from the first concrete load to measure and record hourly slump during placement and monitor concrete set time. Contractors may use concrete plasticizers and retarders to provide additional time for casing removal. Even with sufficient concrete head in the casing and adequate slump, Contractors must use care during casing removal. Inspectors should monitor casing removal for upward concrete movement or rebar cage racking. Use a level with a target placed on the cage to measure movement.

Permanent Casing Method

Permanent casing reduces skin friction between the shaft and surrounding soil, remains a permanent foundation component, and is part of shaft design and structure.

Typical Construction Problems

Inspectors should document and request corrective action for unclean casings with adherent concrete, improperly sealed casings, poor concrete control or tremie malfunction.

Synthetic Drilled Shaft Construction

Synthetic slurry construction methods may be an alternative to or used with temporary casing, and rely on mineral or synthetic slurry to maintain shaft wall stability. The process is slow and requires intensive inspection. Slurry must be cleaned and recirculated into the shaft to maintain slurry elevation as the auger is removed from the hole to prevent sudden pressure changes. Slurry is a pollutant, and must be disposed of properly. A variation of the slurry method is the wet drilling method, in which drilling occurs under water, with water stabilizing the shaft. MDT does not allow using only water if shaft stability is at risk. When wet or slurry methods are used, Contractors must use temporary casing to stabilize the shaft.

Soil Identification

Geotech may visit construction sites to log soils during boring. Drilled shaft Inspectors record soil type and depth and other observations. Inspectors note groundwater or caving conditions. Significant soil type deviations, stratum changes or conditions differing from boring logs are reviewed by Geotech to identify shaft design changes, such as shaft lengthening to address unexpected soil or rock conditions. Changes are made in coordination with the Project Manager.

Depending upon work experience, Inspectors may record soil logs, but onsite Geotechnical personnel should preferentially complete soil logs. Geotech also identifies rock formations and bedrock during drilling. Notify Geotech if unanticipated conditions are encountered.

Boulders and Other Obstructions

Boulders are difficult to remove from drilled shafts, but grab buckets, boulder rooters, and hammers can break or remove boulders. Boulder removal is time consuming and expensive, so shafts are usually widened so boulders can be move upward through auger flights. Shaft widening is acceptable if adjacent shafts or underground utilities are unimpacted. Project Manager may immediately stop drilling when:

- Surface soils may cave and safety measures are not in place
- Workers at open shafts lack fall protection
- Soil caving jeopardizes adjacent shafts and worker safety
- Contractor drills deeper than necessary
- Additional time is needed to evaluate site conditions
- Shafts do not meet location, plumbness, width, depth, rebar configuration, or slurry treatment specifications

Shafts are designed to a planned bottom tip elevation based on geotechnical findings. Actual conditions vary, and may require bedrock penetration. Project Managers should notify Geotech or the onsite Geotech Engineer regarding material changes. Contractors may be notified to deepen the shaft to penetrate desired strata. Contractors are required to clean the shaft bottom leaving only 1 inch loose material. Contractors should not deepen drilled shafts due to loose bottom material.

Inspection

Drilled shaft construction is an expensive operation. Minimize Contractor delay while ensuring contract requirements are met. Cooperation between inspectors and drilling Contractors is the most effective way to meet these goals. Key inspection activities like verifying hole depth, width, plumbness, and concrete depth require Contractors to interrupt production for Inspector measurement and documentation. Let Contractors know inspection activities may interrupt drilling and slow production. Work together to minimize conflict. Drilling should not begin if operational issues are unresolved. Bring unresolved issues to the attention of the DCE. Inspection participation by the drilling Contractor can help ensure meaningful inspection. Experienced drill rig operators and drilling Contractors can inform Inspectors about subsurface shaft conditions while drilling.

Drilled Shaft Inspection Report

Inspector and Contractor complete a Drilled Shaft Inspection Report for each shaft, which must include soil identification results and drilling difficulty information. If drilling is slow due to boulders, document this difficulty. Also note drilling tools with worn cutting teeth or edges impeding progress.

Construction methods affect drilled shaft load carrying capabilities. Inspector reports are important documentation if shaft integrity is an issue. In addition to Drilled Shaft Inspection Report completion, shaft integrity testing results (cross-hole sonic logging) should be attached.

Shaft Cleanout

Cleaning the drill hole removes loose material from the shaft bottom just before the cage is set and concrete poured. Inspectors must approve drilled shafts before concrete placement. Inspect hole bottoms with mirror or a light. Bottoms should be flat and uniform. Sounding with a weighted tape measure often provides helpful information. When the hole contains water, cleanliness must be verified by sounding.

Check the hole center, which is usually the cleanest, then check shaft sides. Lifting and dropping a sounding device should produce equal results everywhere if the bottom is firm, flat and uniform. If there is any doubt, err on the side of over cleaning the shaft. Inspectors should be aware of clays smearing against excavation walls and adhering to shaft walls to act as a lubricant between concrete and soil. If shaft sides are slickened, Contractors should ream the hole to roughen sides.

Integrity Testing Using Cross Hole Sonic Logging (CSL)

Contractors are required to assist with drilled shaft excavation inspection for correct depth, plumbness and diameter. The shaft must be safe for inspection. CSL measures concrete density by emitting ultrasonic pulses measured by an adjacent receiving tube. Sound travels faster in and loses energy passing through less dense material. Concrete integrity is assessed by detecting voids. The CES Bureau performs drilled shaft CSL testing. Department owned equipment enables MDT to test and retest shafts. At a minimum, CSL testing should be performed:

- On at least one shaft per bent and the first constructed shaft
- When Project Managers suspect a defective shaft, based on construction observation, mix problems or other reasons
- On the first shaft constructed after using an altered procedure

CSL tube placement extends to the shaft bottom, which is the most important portion of the shaft. Ensure CSL tubes are filled with antifreeze before concrete placement, and temporary tube caps are fastened to prevent debris from entering. After CSL testing and analyses are complete and the shaft is accepted, Contractors must level CSL tubes with the shaft top, remove fluid to within 4 inches (100 mm) of the tube top and permanently cap tubes.

Reinforcing Steel

Steel products such as steel members, reinforcement and wire incorporated into permanent work must meet domestic steel “Buy America” provisions mandated by Standard Specification Subsection 106.09.

Rebar Cages

Contract documents show drilled shaft steel reinforcement details, although MDT does not require rebar shop drawings for entire shafts. Inspectors should compare Contractor work with contract documents. Bar splice changes and changes to longitudinal bar terminations at cage tops or bottoms should be brought to the attention of the Project Manager. Spiral or hoop bar hooks should allow tremie tubes to move freely through the rebar cage without obstruction.

Cage fabrication usually occurs at the project site. Cages are built on the ground, giving Inspectors ample time to observe fabrication. Check rebar cages for proper:

- Bar size, grade, spacing, length, width, and clearance
- Lap lengths for hoops, spirals and straight bars
- Length and width
- Lifting stability
- Inspection tube placement

For safety or constructability reasons, Contractors may substitute mechanical couplers for lap splices, but if plans show couplers, they cannot be substituted for by lap splices.

Inspectors must use manufacturer instructions while inspecting rebar splices, and ensure spiral bars, hoops, splices, terminations and welding within rebar cages are compliant. When cages are lifted, check for twisted or distorted bars. Stress concentrations may develop in a drilled shaft if distorted cages are used, so cages should be examined while lowered into the hole. If bending affects straightness, spiral pitch, bar spacing, or cage shape and diameter, the cage should be lifted from the hole to replace bent bars.

Centering Devices

Long lasting and durable drilled shafts require rebar cages surrounded by adequate concrete cover. Centering devices keep cages aligned within shafts until concrete placement. Centering devices prevent cages from hitting excavation walls and dislodging loose material into the hole

Cage Stiffeners

Rebar cages are built horizontally, then lifted into vertical position for placement. Because cages are long, slender and flimsy, lifting cages to a vertical position may distort the cage. To prevent distortion, Contractors may place temporary stiffeners interior or exterior to the cage. Inspectors should check for special provision bracing requirements. Interior stiffeners are removed as cages are lowered into the shaft, but still may interfere with concrete placement. Exterior stiffeners can allow moisture intrusion from surrounding soils, and promote rebar cage corrosion.

Concrete Placement

If segregation and strength loss can be prevented, fluid concrete has these advantages:

- Completely covers steel reinforcement without vibration
- Fills surface voids along excavation walls
- Exerts enormous pressures against excavation walls

With shafts as deep as 130 feet, vibrators seldom vibrate deeply around the rebar cage. High slump concrete eliminates this problem. Irregular surfaces between excavation walls and concrete is desirable for skin friction drilled shafts. Fluid concrete fills voids along excavation walls to enhance skin friction, and exerts hydrostatic pressure against excavation walls. Drilled shaft concrete placement rates do not have an upper limit. Contractors should pour shafts quickly. Hydrostatic pressures push concrete against excavation walls to fill surface voids and compact wall surface material. Remove loose material from excavation walls above concrete as it rises. Material falling on the concrete surface floats until pour completion. Unsegregated fluid concrete with long set times is ideal for drilled shafts. Ensure fluidity by administering slump tests and checking concrete mixing times on concrete delivery tickets. The Materials Bureau may approve admixtures enhancing slump.

Concrete placement must take place within 24 hours after shaft excavation, have at least 5 ft of fluid concrete above casing bottom or water table during casing removal.

Dry Excavation Concrete Placement

Inspectors must approve shafts before steel or concrete placement. Inspect shafts frequently to ensure caving or concrete contamination is absent. After cleaning and Inspector approval, Contractors should place rebar cages and pour drilled shafts immediately to minimize debris contaminating the shaft. Loose sand, silt and filter cake float on the concrete surface as concrete rises to the shaft top. Pouring must continue until contaminated concrete is expelled from the shaft.

Placement Under Water

Underwater concrete must be placed the day excavation is completed to minimize soil collapse risk. Tremies place concrete on the shaft bottom, and keep concrete from mixing with water or slurry. Tremies cannot be aluminum, which reacts adversely with fresh concrete. A tremie valve, sealable cap or plug prevents water and slurry from entering.

TABLE 552-1
DRILLED SHAFT INSPECTION CHECKLIST

Contractor & Equipment Arrive On-Site	Yes	No	N/A
1. Did Contractor submit a Drilled Shaft Installation Plan?	☐	☐	☐
2. Has a Drilled Shaft Installation Plan been approved?	☐	☐	☐
3. Was the Contractor mix design approved?	☐	☐	☐
4. Has the Contractor run a trial mix and slump loss test for this shaft mix design?	☐	☐	☐
5. If concrete placement time will exceed two hours, has the Contractor performed a satisfactory slump loss test for the extended time period?	☐	☐	☐
6. If a blended mineral-polymer or polymer slurry is proposed, has an approved Slurry Management Plan been submitted?	☐	☐	☐
7. Is the Contractor prepared to take soil samples or rock cores at the shaft bottom in accordance with the contract?	☐	☐	☐
8. Has site preparation been completed in accordance with the contract?	☐	☐	☐
9. Does the Contractor have a qualified diver and safety diver for cofferdam inspections?	☐	☐	☐
10. Does the Contractor have equipment and tools required by the Drilled Shaft Installation Plan?	☐	☐	☐
11. Is casing size in accordance with the contract?	☐	☐	☐
12. Does the Contractor have needed equipment to mix a manufactured slurry?	☐	☐	☐
13. Does the Contractor have an operational de-sander on site if needed?	☐	☐	☐
14. Does the Contractor tremie meet contract requirements?	☐	☐	☐
15. Are required drilled shaft forms available to be completed during shaft construction?	☐	☐	☐
Trial Shaft			
16. Is a trial shaft away from production shafts as stipulated by the contract?	☐	☐	☐
17. Has the Contractor completed a test hole in accordance with the contract?	☐	☐	☐
18. Did the Contractor truncate the shaft 2 feet (0.6 m) below grade?	☐	☐	☐
19. Has the Contractor revised shaft construction technique and equipment?	☐	☐	☐
Shaft Excavation & Cleaning			
20. Is shaft construction at the correct location within spatial tolerance?	☐	☐	☐
21. Has the Contractor set a bench mark so shaft elevations can be verified?	☐	☐	☐
22. Has the Contractor taken a core in accordance with the contract?	☐	☐	☐
23. If a core hole was drilled, was a form completed and a log maintained?	☐	☐	☐
24. Can slurry tests and reports be generated in accordance with the contract?	☐	☐	☐
25. Is slurry level being properly maintained?	☐	☐	☐
26. Are slurry test types and numbers being run?	☐	☐	☐
27. Are Soil/Rock Excavation forms being completed?	☐	☐	☐
28. Does permanent casing meet contract specifications?	☐	☐	☐
29. Does temporary casing meet contract specifications?	☐	☐	☐
30. Does required safety belting meet contract specifications?	☐	☐	☐
31. Is the Contractor maintaining an excavation log?	☐	☐	☐
32. Is the shaft within vertical alignment tolerance?	☐	☐	☐
33. Is the shaft at proper depth?	☐	☐	☐
34. Is shaft excavation meeting specified time limits?	☐	☐	☐
35. Was shaft reaming performed in accordance with the contract?	☐	☐	☐
36. Does the shaft bottom meet contract requirements?	☐	☐	☐
37. Have all needed forms been completed?	☐	☐	☐
Reinforcing Cage			
38. Ensure that iron and steel incorporated into permanent work and required documentation meet Domestic Material (Buy America) requirements within Standard Specifications Subsection 106.09..	☐	☐	☐
39. Is rebar sized and configured in accordance with the contract?	☐	☐	☐
40. Is rebar tied in accordance with the contract?	☐	☐	☐

Contractor & Equipment Arrive On-Site	Yes	No	N/A
41. Does the Contractor have proper steel cage spacers?	☐	☐	☐
42. Does the steel cage have the correct number of spacers?	☐	☐	☐
43. Is splicing in accordance with the contract?	☐	☐	☐
44. Is the steel cage secured against settling and floating during concrete placement?	☐	☐	☐
45. Is the steel cage top elevation correct?	☐	☐	☐
Concrete Operations			
46. Are contingency plans in place for equipment failures?	☐	☐	☐
47. Has slurry (both manufactured & natural) been tested before concrete placement in accordance with the contract?	☐	☐	☐
48. If required, was casing removed?	☐	☐	☐
49. Was the tremie discharge end submerged within the concrete with enough concrete head above it during placement?	☐	☐	☐
50. Did free-fall placement (dry shaft only), take place in accordance with the contract?	☐	☐	☐
51. Did placement conclude within the specified time limit?	☐	☐	☐
52. Have concrete placement and volume forms been completed?	☐	☐	☐
53. During placement, did the Contractor overflow the shaft until uncontaminated concrete was extruded?	☐	☐	☐
54. Were concrete acceptance tests performed properly?	☐	☐	☐
Post Installation			
55. Were shafts constructed in water protected for seven days or until required concrete strength was reached?	☐	☐	☐
56. Has casing been removed to the correct elevation?	☐	☐	☐
57. Is the shaft within construction tolerances?	☐	☐	☐
58. Has the Drilled Shaft Log been completed?	☐	☐	☐
59. Have pay items been documented?	☐	☐	☐
Notes/Comments			

TABLE 552-1

DRILLED SHAFT INSPECTION CHECKLIST

Approved Job Information	Daily Essentials
☐ Project Plans & Specifications with Revisions ☐ Special Provisions ☐ Drilled Shaft Installation Plan Testing Equipment ☐ Sampler ☐ Sand Content Testing Equipment ☐ Mud Density Test Equipment ☐ Viscosity Test Equipment Blank Forms ☐ Drilled Shaft Soil/Rock Excavation Log ☐ Drilled Shaft Rock Core Log ☐ Drilled Shaft Inspection Log ☐ Concrete Placement Log ☐ Concrete Volume Form ☐ Drilled Shaft Log ☐ Drilled Shaft Construction & Pay Summary	☐ Hard Hat ☐ Boots ☐ Ear & Eye Protection ☐ Pen/Pencil (with spare) ☐ 12′ Tape (Preferably 25′) ☐ 150′ Tape ☐ Builder's Square ☐ Life Jacket and High Visibility Vest or Reflective Jacket ☐ Watch ☐ Calculator ☐ Camera ☐ Scale ☐ Level ☐ Weighted Tape (100′) ☐ Plumb Bob

TABLE 552-2

DRILLED SHAFT INSPECTION EQUIPMENT CHECKLIST

(cont)

Deck Construction
Subsection 552.03.4.E, Standard Specifications

Bridge Inspectors must be familiar with and understand bridge deck construction methods, equipment, testing and inspection. Most deck construction problems are difficult to correct after concrete sets. Thorough inspection will likely identify and prevent problems.

Pre-Placement Bridge Deck Meeting

Bridge Special Provisions require Project Managers to meet with Contractors before bridge deck pours to describe concrete placement, consolidation, finishing, texturing and curing. This meeting ensures both Contractor and MDT personnel clearly understand pour and inspection procedure(s). Contractor and MDT personnel should be familiar with:

- Contractor pour sequence, construction joint location by span and station, concrete placement width and quantity, placement time, placement direction, screed orientation, and screed grade control method.
- Vibrating, finishing, floating, tining, misting and curing equipment
- Curing material types
- Crew experience and assignment
- Inspection staffing, procedure and timing
- Rebar placement and scheduling
- Material sampling, testing and certification

- Plant operation, inspection and concrete deliveries
- Traffic control
- Safety hazards and protective equipment
- Personnel access ladders and walkways
- Contingencies for plant failures, pump breakdown, screed malfunction and weather
- Night illumination requirements

Bridge deck pre-placement meetings address specifications and the placement process to ensure a quality bridge deck. Also discuss Table 552-3 items at the bridge deck pre-placement meeting.

TABLE 552-3
BRIDGE DECK PLACEMENT MEETING

1. Weather Conditions
    a. Temperature restrictions
    b. Anticipated TemperatureS
2. Placement Time and Duration
    a. Start time
    b. Anticipated completion time
3. Concrete
    a. Supplier
    b. Mix approval
    c. Any special considerations?
4. MDT QA Sampling & Testing
    a. Samples from point of placement
    b. Frequency
    c. Air content spec?
    d. Slump expectations
5. Concrete Handling & Finishing
    a. Any special consideration?
        i. silica fume, retarders, plasticizers
    b. Placement methods and equipment
    c. Hand finishing areas
    d. Screed should provide the finish, bull floating undesirable
    e. Any detail work, dowels to insert, etc.
6. Fogging
    a. Equipment
        i. type is correct
        ii. sufficient for anticipated conditions
    b. Ahead of the screed
    c. Behind the screed prior to burlap placement
    d. After burlap placement
7. Wet Cure
    a. Wet burlap
        i. burlap spec.
        ii. presoak burlap, 24 hours
        iii. catwalk for application
        iv. setup at beginning of placement
        v. placement within 15 minutes of screeding & as close as possible
    b. Soaker hoses
        i. placement
        ii. water source
    c. Plastic cover
        i. material, clear polyethylene sheeting
        ii. placement
        iii. ensure that soaker hoses not impeded
    d. Monitoring and maintenance
8. Contingency Plans
    a. Equipment failure such as pump breakdown

Pour Sequence

Certain bridge deck portions are poured before others. Pour sequences are outlined within the contract documents, and Project Managers must ensure Contractors strictly follow pour sequences. Contractors may propose alternative sequences, but Designers must approve changes. Some pour sequences place concrete at midspan areas before placing concrete over piers to allow reinforcing steel over piers to move as the bridge deflects. If concrete over piers is poured first, rebar will lock into place as concrete hardens, causing concrete over the piers to fracture in response to deflection caused by midspan pours.

Deck pour sequences also control dead load deflections, as loads placed anywhere along a continuous span influences deflection in other spans. Placement load sequence must be controlled to attain final deflections. Pour location, length and sequence is considered to calculate final deflection. Plans often indicate a pour direction in addition to length and sequence. Pour lengths are constrained by theoretical deflection and maximum pour length. Pour sequences must be followed exactly unless otherwise approved. Adverse girder stresses and deflections may otherwise result.

Sequence pours require bulkheads running transversely to the deck, which are usually wooden, straight and adequately braced. Plastic foam usage is discouraged because foam adheres to concrete. Sequence pour joints often fail smoothness criteria, so bulkhead tops are cut or ground to grade.

Form Grade and Reinforcing Bar Clearance Checks

Standard Specification Subsection 552.03.11.1 requires a finishing machine to check form grade and reinforcement cover. Contractors must notify Project Managers when bridge decks are ready for a trial run with a mechanical paving machine, or “Bid-Well”. This machine requires a detailed setup to ensure concrete depth and clearance are maintained. Trial runs are made, during which adjustments are made for grade and depth. Distances between the screed bottom and the top of reinforcement steel and the top of deck forms are measured. Check form grades by shooting elevation with a surveying level or against measurements from the trial machine run. Measure overhang deflection by positioning the roller or float over a tenth point and measuring from the beam top. This distance should equal the “D” depth used for setting forms. Detect incorrect interior bay form adjustments by measuring from forms to the roller. This distance should equal slab thickness.

Whether or not the discrepancy is produced by the machine or forms can be determined by measuring from the tenth point on the girder adjacent to the rollers. If this measurement checks with the “D” for that point, and if the distance from the beam top to the rollers checks with the “D” on exterior girders, then forms are in error.

Deck form grade controls reinforcement steel position. Obtaining proper concrete cover over the top rebar mat requires form tops to be at grade. Inadequate cover may lead to deck deterioration. Calculated elevations must take into account plan dead load deflections. Inspectors must determine if the Contractor has assumed a form “crush” value when setting form elevations. This small value is sometimes added to account for form compression under concrete weight. Values of ¼ or ⅜ inch are typical. MDT inspection must incorporate Contractor “crush” adjustment value(s) when checking form elevations against specified tolerances.

Before placement, reinforcement cover can be checked by attaching a filler equal to plan cover thickness to the bottom of the finishing machine strike-off. The strike-off is then operated over the slab area to check cover thickness during the trial run. Special

Provision may require reinforcement cover to be measured via Ground Penetrating Radar (GPR) after placement.

Bridge Deck Forms

Deck slab forms support wet concrete, reinforcement steel and construction loads. Overhanging forms must support finishing machines, work bridges and finishers. Wooden wedge usage behind overhang bracket legs to maintain form position is discouraged. Wooden wedges may crush, and can impede grade maintenance by screed machines during placement. If the screed machine is supported by an overhang, bracket spacing must not allow supporting members between brackets to deflect, as deflections will be reflected in the deck surface.

Plywood is generally used as forms. Plywood should be sound with clean edges and fit tightly together. Plug plywood holes with foam, corks or wooden plugs only. Do not use metal patches. Corners and edges should be filleted or chamfered where overhangs contact the outside of exterior beams.

The joint between overhanging forms and prestressed beams is a common problem area. Overhanging forms must be tight against beams during placement to prevent mortar loss and honeycombing. Superstructure deck forms must allow final adjustment during a screed test run. Form hangers must not be welded to steel girders. Welding form hangers or screed supports to reinforcing steel is prohibited.

Contractors may be requested to furnish form system details for approval, especially if forms appear inadequate, or if a form system is unfamiliar. Forward these details to the Construction Engineering Services Bureau for review.

Falsework for Cast-In-Place Construction

Falsework for cast-in-place, flat slab and girder structures requires special attention due to the loads they support, which may include the entire superstructure. Maintain falsework support during placement and throughout the cure period. Falsework foundations are usually either “temporary piling” or “mudsills”. Piling is driven to attain bearing needed capacity. Mudsills are used where soil conditions provide adequate bearing capacity. Areas supporting mudsills must be well compacted. Consider the effects of frost, rain or other moisture on soil bearing capacity. Structures can be damaged if runoff causes falsework settlement during curing. Mudsills located close to the surface in clay or silt soils may settle if exposed to moisture. Resolve falsework foundation bearing capacity issues prior to erection.

“Tattletales” are devices installed to monitor form subsidence during concrete placement and critical curing stages, and should be attached near support beam mid points. Inspectors monitoring tattletales or falsework supported deck slabs should be aware sudden failure is possible. Falsework design approval does not exempt Contractors from providing safe and satisfactory concrete results.

Reinforcing Steel

Section 555 and Subsection 552.03, Standard Specifications

Unless otherwise approved before work begins, steel products such as structural steel, steel reinforcement, and high strength steel wire permanently incorporated into the work must meet Standard Specification Subsection 106.09 domestic steel “Buy America” provisions.

Reinforcement bar location within a slab is critical. Bars not located according to plan location may not carry stress effectively. Premature deterioration may result if bars are located without adequate cover. Standard Specification Subsection 555.03.3 requires separation between upper and lower steel mats within a deck slab. Supports must be perpendicular to centerline for slab structures, and always be under main reinforcement, which is closely spaced with heavier bars.

Bar support height determines bar location within the slab. Most upper bar supports are manufactured in ¼ inch height increments. Often nominal height calculated from plan cover and slab thickness will be an odd 1/8 inch rounded to the next lower ¼-inch nominal height to determine correct bar support height. Check bar support height when supports arrive on the project. A ± ⅛ inch manufacturing tolerance applies to bar supports, but supports with incorrect nominal height should not be used. Supports distorted to correct improper height are unacceptable.

Periodically inspect bars for size, spacing, tie interval, support height and clearance. Intermittent inspections eliminate costly corrective work after bars are tied in place. Final inspection is mandatory after bar placement to verify bar size, count, spacing, ties, form clearances and condition. Do not place concrete until reinforcement is inspected and approved. Bars must be free of oil, grease, mud, dust, dry concrete, frost or loose rust when concrete is placed. Bars extending from diaphragms and backwalls often become coated with concrete during placement at these locations. These bars should be cleaned before concrete sets. Bars within curbs and barriers usually extend from slabs. These bars should not be walked upon, or support walk bridges or equipment. Protect bars from curing compound.

To control deflection, contracts require reinforcement to be in place for entire continuous span girders before any concrete is placed. Bent and loose bars, and failed supports must be repaired before concrete placement. Suspend placement if cover is insufficient.

Guard Angles and Expansion Joints
Subsection 552.03.12 Standard Specifications

Guard angles and expansion joints must be installed to proper elevation, slope and joint opening before deck placement.

Guard Angles

Guard angles are bolted on the end bulkhead form. End bulkheads are vertical, so guard angles must be shimmed to match grade and superelevation. Check guard angle grade against deck form grade, and recheck during the screed trial run. Guard angle slopes may not match drum or float slopes due to screed rail dead load deflection. Heavy traffic at bridge ends during concrete placement can displace guard angles. If heavy traffic is expected, require additional bolts to maintain proper position.

Paving notches are provided by offsetting and widening the upper backwall on some structures. Inadequately braced forms may rotate during placement to alter guard angle grade and elevation.

Expansion Joints

Expansion joints are located between bridge end bents and superstructures, bridge sections, bridge decks and approach slabs, and approach slabs and end bents. By providing a small gap between structures or structural members, expansion joints accommodate movement between adjacent structural members to prevent creep and shrinkage stresses from cracking structures. Ensure expansion joints have correct depth, length, and gap width, and that obstructions do not prevent joint contraction and expansion

The MDT preferred expansion joint is the “strip seal” joint, although other types such as silicone, rubber sealant, finger plates, and modular seals are used. At the joint surface, a compressible material prevents rocks, nails and incompressible materials from entering. Joint sealant prevents water intrusion.

Verify the following to ensure enduring deck joints:

- Guard angles on each side of the joint are recessed to avoid bumps or dips
- Existing adjacent concrete is coated with approved adhesive
- Concrete consolidation under guard angles is sufficient
- Angle bolts are loose to allow movement after concrete has set
- Temperature is monitored to ensure proper construction

Deck Finishing Machines
Subsection 552.03.11 Standard Specifications

Setting up, adjusting and operating the finishing machine ("bid-well") is contractor responsibility. Inspectors should never make machine adjustments. Close inspection is required to ensure machines produce an acceptable deck slab. Understanding machine operation features and adjustments is necessary for inspection.

Deck finishing machines use a frame supported at both ends. Machine supports have wheeled adjustable legs which travel along rails. Adjustments at these points control the framework height above the screed rail. Adjusting all four legs changes deck slab thickness. Adjustment to two legs on the same side changes tapering thickness from side to side.

The strike-off device is suspended from a carriage mounted on wheels and traveling on rails attached to the framework. Adjustable carriage rails allow proper cross section, while framework adjustments provide intended crown. The strike-off device can be adjusted to operate parallel to centerline when the framework is skewed.

A strike-off skewed to the carriage requires trial and error adjustment. Using a guard angle or bulkhead as a guide, the strike-off will screed the proper cross section.

Operation

The drum or float should be in contact with concrete for nearly the full length. Drum type machines leave surface voids if the trailing drum end is high. The drum should push a slight concrete wave during each pass, composed predominantly of fines, cement and water moving to the deck margin while the cutting pass takes place. This material should be distributed over unfinished concrete ahead of the screed or removed. Do not use this material to fill curb areas.

If the trailing edge is too low, the slab will develop a ridge or groove. Similar problems may be encountered with float-type machines, but may be corrected by raising or lowering the trailing portion of the framework by adjusting support wheels. If only trailing wheels are adjusted, no change will be made to grade or deck thickness. Drum rotation speed should not cause surface tears or finishing mortar depletion.

Travel rate affects finishing. Single drum machines only cut in one direction, with the drum leading edge rotating up and away from the machine. Extra concrete may be placed ahead of the drum to fill low spots.

Screed height adjustments to match guard angles or alter slab thickness should be made gradually to maintain an even surface. Thickness adjustments must be made at both leading and trailing points. Maintain adequate distance between placement operations and the finishing machine so it is not bumped by equipment. Machine augers strike off and move excess concrete forward. Overloaded augers may pull the strike off device downward. Personnel must be available to rake away excess or add concrete to maintain concrete volumes ahead of the auger. Observe drum machine operation for vibrations producing ridges and a rough slab, which may require hand floating.

Screed pipes should be regularly checked for deflection, cleanliness and proper support. Concrete, electric cords, or tools resting on screed pipes may produce high spots or cause the machine to leave the track. Clean pipes ahead of the machine that become covered with concrete during placement. Do not use the machine as a work bridge or truck. Extra loading may cause frame deflection and surface deviation.

Skewed and Complex Bridges

Significant skew, horizontal alignment transition and vertical curvature often cause bridge deck finishing complications and decks with poor ride qualities. These factors and measures to mitigate them are discussed below.

Skew

Subsection 552.03.11.1, Standard Specifications

Finishing machines must place concrete parallel to skew on prestressed and steel spans skewed past 15 degrees. Deck side girders support finishing machines, while strike-off component positioning is controlled by exterior girder position. Girders are subject to varying dead load deflection along beam length during placement. Finishing machine placement parallel to centerline on skewed bridges causes varying dead load deflection at endpoints. Points along the beam deflect as the machine moves along the deck, and strike-off positions relative to forms change as the machine moves along the deck. Concrete placement and finishing parallel to skew eliminates complications, as beams points are loaded equally and undergo equal deflection. Strike-off position relative to deck forming remains constant.

Horizontal Alignment Transitions

Bridges located on spiral or run-off sections develop a “broken-back” section between full superelevation and normal crown, making deck finishing complicated when this point falls on the deck. This situation requires transverse carriage rail adjustment on the finishing machine. Adjustments must be made incrementally as the machine advances. Adjusting to “broken-back” sections is relatively easy when a crown adjustment point is at the section break. Designers usually provide straight-line, right-angle deck sections to eliminate placement complications with broken-back sections.

Bridges skewed over 15° within a super elevation transition create a complicated situation. Sections along radial lines will be straight but skew sections may be broken. The magnitude of the break depends on skew, superelevation, spiral length and run-off length. The easiest way to identify a problem is plot skew sections using a large vertical scale. Transverse machine rails must be adjusted if plotted sections show significant linear deviation from a straight line, in which case individual bolt adjustment is probably necessary.

Skewed Bridge with Normal Crown

Transverse screed carriage rail adjustment for normal crown on skew is different than for right angle structures, as the screed carriage wheel axis is skewed to roadway centerline, and carriage wheels do not concurrently cross the break point. The simplest way to adjust carriage rails is to use a guard angle or bulkhead set to grade. Rails are adjusted so rollers follow grade. The section over the crown often requires trial and error adjustment. Exactly matching sharp breaks in normal crowns isn’t usually possible but can be approximated. Use the leading roller edge to adjust the front rail, and the trailing roller edge to adjust the rear rail.

Concrete Mix
Section 551, Standard Specifications

Standard Specification Section 551 covers MDT Portland cement concrete methods and requirements pertaining to concrete bridge decks.

Air Content

Air content fluctuations are common but difficult to control. Air content is influenced by placement method, temperature, slump, mixing speed, aggregate gradation, batching sequence and other factors. Low air content is not a serious problem for substructures, but exposed deck concrete must contain sufficient air to maintain durability. Air tests should be performed in accordance with the MDT Materials Manual during placement to ensure adequate air content. Chace air indicators are used to cross check pressure meter tests. With practice, Chace indicator tests are faster than pressure tests, but should not replace standard pressure tests. Erratic air content may is caused by a variety of issues.

Handling and moving fresh concrete effects air content, particularly during pumping. A trap bend at the pump discharge line helps retain entrained air. Mixer efficiency variations affect air entrainment obtained from air entraining agents. Air test results from different trucks may indicate the need to vary dosages for individual trucks. Worn mixers may not entrain air as they originally did. Higher mixing speeds generate higher air content.

Concrete should be at desired placement consistency before testing air entrainment. Air agent dosage changes based on varying slump tests produce erratic results. Air content and air agent dosage amounts are usually linearly related, so large air agent increases without corresponding air content increases indicate a problem. Situations involving dosage increases 2 to 3 times above manufacturer recommended levels deserve analysis.

Given special circumstances, low jobsite air content may be corrected by adding air entraining agent after Materials Bureau approval. Mix air entraining agents with a small amount of water before adding to the mixer, which should rotate at least 20 revolutions after adding. Air agent must be available onsite.

Slump

Slump is strongly correlated with air content. High slump concrete is unacceptable in most situations, and should be Materials Bureau approved and monitored for segregation during placement. Segregating concrete should not be placed. Hard to place and consolidate low slump concrete develops rock pockets and honeycombing, which can be mitigated by adding admixture or water. Admixtures may delay set time and cause air content changes. Water addition may decrease strength or alter air content. Workable slump may be difficult to attain without exceeding maximum water content when mix water is absorbed by aggregate, which happens when aggregate is dryer than “saturated surface dry” conditions during hot weather. Wet coarse aggregate piles 8 to 12 hours before use to maintain Standard Surface Dry (SSD) conditions during hot dry conditions. Concrete having water/cement ratios exceeding approved levels should not be placed.

Concrete Placement
Subsections 551.03.5 and 552.03.4, Standard Specifications

Deck concrete is commonly pumped during placement, with air, slump and cylinder QA samples taken from the discharge line. Take supplemental quality control samples at the truck. Maintain slump within specified limits at the discharge point. If slump cannot be maintained, pump approval for that particular pump is void.

Place concrete as closely as possible to final position. Placement direction should be parallel to and approximately 5 - 10 feet ahead of the finishing machine. Production, placement and finishing rates should match.

Durable concrete requires thorough and consistently applied vibration during placement. An adequate number of properly sized vibrators must keep pace with placement and finishing operations. Forms and reinforcement must be dampened immediately before placement to cool rebar and prevent forms from absorbing water. Concrete ahead of the finishing machine must never be sprayed with water to adjust consistency. Water must be added prior to placement.

Finishing Operations
Subsection 552.03.11, Standard Specifications

Inspectors and Contractors should emphasize deck joint smoothness, especially during precast girder bridge construction requiring pour sequences. Identify surface irregularities using a straight edge, paying close attention to gutter lines over flat grades to ensure longitudinal drainage. Machine finishing is described within Subsection 552.C.6.10. Some hand finishing usually must be done after finishing machine passage, but should be minimized to maintain surface durability. Adding finishing water weakens concrete surfaces and reduces durability, but may be necessary in small amounts. Apply water as a fog or mist, but never as a stream from a hose, or via a brush or drip process. Excessive water application may legitimate rejecting affected deck portions.

Most finishing machines require hand work adjacent to curbed areas, which must be evaluated transversely and longitudinally using a straightedge to ensure drainage. Mortar left by the machine in these areas must be discarded or moved ahead, but should not be placed in the curb area.

Curing and Protection
Subsection 551.03.7, Standard Specifications

In most cases MDT utilizes a 14-day water cure specification, but may specify a curing compound. Plastic shrinkage cracking occurs when surfaces dry before concrete sets, and can be avoided by nighttime or morning pours during hot weather, and avoiding windy conditions. Cracking can also be prevented using curing compound application and surface dampening with moistened burlap.

Deck Slab Concrete Pours and Cold Weather Protection
Subsection 551.03.6, Standard Specifications

Contracts may include a cold weather concreting Special Provision to protect slabs, which are relatively thin with large surface areas. Durability may be jeopardized by inadequate cold weather protection for recently poured slabs. Contractors must maintain curing temperatures by housing and heating concrete as specified. Materials for housing and heating must be on hand at the site before cold weather pours begin. Contractors must make arrangements to house and heat during no work days during curing in the event of weather changes. During curing be aware that:

- Heaters consume oxygen in confined spaces, and heater by-products and burner fuels may initiate concrete reactions.

- Embedded sensors, thermometers and thermocouples may be required.
- Precautions should be taken to minimize fire hazard.

Surface Smoothness
Subsection 552.03.11.6, Standard Specifications

Straight edging to evaluate smoothness should be done soon after the 14 day water curing period. Inspectors should complete straight edging, and Contractors should complete grinding and repair work before deck grooving. Special Provisions allow a 3⁄16 inch deviation over 10 feet parallel to centerline to maintain a smooth profile without irregularities felt by drivers. Small imperfections such as burlap wrinkle marks or finishing ridges do not diminish ride, and are acceptable. Gouges, footprints, soaker hose or finishing screed marks may be unacceptable under Special Provisions or contract documents.

Straightedges are held parallel to centerline and moved in 3 - 4 foot increments curb to curb. Repeat this process every five feet along the deck. Locating high and low points with a 10 foot straightedge may be difficult, so string-lining 20 30 foot distances may be more helpful. In difficult cases, plotting points using a large vertical scale may be helpful. Two people are usually required to observe and document deviations. Surface variations are measured independently of texturing depth. Tining leaves a rougher surface than broom finishing or saw grooving. Grooving makes straight edging more difficult, and requires judgment to assess surface irregularities. High and low points should be marked by Inspectors, but intervals needing correction should not be marked in the field. After high and low points are marked, Contractors must decide how much correction is required, and mark areas for correction. Star wheel rotary grinders are commonly used to reduce higher spots. Diamond cutting blade grinders are much faster for large corrections, and many are equipped to produce specified surface smoothness. “Bush hammering” to remove high points destroys aggregate to mortar bonding, and is prohibited.

Thin fills for low deck slab areas are difficult to apply and usually delaminate. Enduring patches demand good surface preparation, which should include removing weak upper concrete surfaces via sand blasting. Sound low area fill areas by striking sharply with a hammer after curing, and replace hollow sounding patches. Decks must be given a final straightedge check after corrections.

Bridge Decks Seals

Because deicing salt usage causes deck deterioration, MDT requires epoxy coated rebar and special deck concrete construction, and may require a silane or “High Molecular Weight Methacrylate” (HMWM) bridge deck sealer.

Structural Construction Tolerances

Standard Specification Section 564 Table 564-1 lists allowable elevational and dimensional tolerances based on national standards and industry practice. Work not exactly matching plan dimension but within tolerance is assumed not to adversely affect structures. Work portions outside tolerance limits may still be acceptable, and correction may not be required. Project Managers should contact a CES Bureau Bridge Reviewer or the Bridge Bureau for recommendations. Special provisions require Contractors to submit corrective action plans for detrimental effects to structures.

Measurement Method
Subsection 552.04, Standard Specifications

Payment Basis
Subsection 552.05, Standard Specifications

SECTION 553
PRESTRESSED CONCRETE MEMBERS

Description
Subsection 553.01, Standard Specifications

MDT commonly uses prestressed concrete girders for bridge spans exceeding allowable lengths for reinforced cast-in-place concrete slabs, and uses a variety of cross sectional shapes for prestressed, precast concrete I-girders. Prestressed concrete construction is specialized work and requires experienced crews. Prestressed structural concrete carries greater loads than would be carried by merely adding more reinforcement. The idea is to prevent tensile stresses that crack concrete. Higher compression stress induced within the concrete allows members to carry higher tensile stress before being in tension.

Tensioning

Concrete is prestressed using pre-tensioning or post-tensioning. Precast concrete girders are pretensioned, while cast-in-place box girders are post-tensioned. Pre-tensioning uses internal steel strands to induce prestresses. Strands are initially stretched to a specified stress, after which concrete is poured into the form containing the strands. When released, strands inside the member attempt to relax and shorten, but bonding between concrete and the strands imparts compressive stresses within the member.

Post-tensioning uses plastic or aluminum ducts through concrete members with anchors at each end. Concrete is poured to fill the ducts containing steel strands running through the ducts. After concrete outside the ducts reaches design strength, strands are pulled at one end while anchored at the other to induce compressive stresses along the member. Grout is then injected into the ducts and concrete poured around the anchors. When grout cures, the strand is bonded within the concrete member to impart compressive stress.

Materials
Subsection 553.02, Standard Specifications

Unless otherwise approved before work begins, steel products such as structural members, reinforcement, and high-strength wires, bars, or strands incorporated into permanent work must comply with domestic steel or “Buy America” Standard Specification Subsection 106.09.

Plant Inspection

The MDT Materials Manual (MT-111) outlines fabricator plant inspection procedures for prestressed, precast concrete beams. Prestressed Concrete Institute (PCI) or the National Precast Concrete Association (NPCA) plant certification is required for these products. Standard Specification Subsection 553.03.1 exempts new manufacturing plants having the same ownership as an existing PCI or NPCA certified plant, subject to Subsection 553.03.1 requirements.

Each prestressed member in conformance with specification is marked with a “Circle M” stamp before shipment from the plant, indicating fabrication procedures, material quality and workmanship are satisfactory, and the member was completed at the plant. If a “Circle M” is not present, a member is incomplete, requires corrective work, or the Inspector was not present when the member shipped. If deficiencies are identified, Plant Inspectors notify the Physical Testing Engineer, Bridge Bureau and Project Manager of concerns, and determine if corrective action is feasible. The prestressing plant is responsible for submitting proposed corrective action for Department review and approval. If corrective action is incomplete, the product is not marked with a “Circle M”. Plant Inspectors record concerns using the “Prestress Beam — Final Plant Inspection Check List” (Form 48-A), and transmit information to the field with the Prestressed Beam Report Lab (Form 48).

Field Inspection

At the construction site Inspectors review documents provided by the Fabrication Plant Inspector to ensure correct item delivery and assess product condition before shipment. Field Inspectors visually inspect deliveries to ensure precast beams have been undamaged during handling. Contractors are responsible for damage incurred during beam storage and handling. Inspectors check for:

- Correct dimensions and material specification compliance
- Spalls, dents, chips
- Exterior beam cracking
- Fabrication dates stamped on precast beams
- Beam identification marks indicating the lot production number shown on the Compliance Certificate

Final material acceptance is made in the field. Notify Physical Testing Engineer, Bridge Bureau, CES Bureau, Project Manager, and Contractor of field deficiencies, and determine if corrective action is appropriate. Do not allow Contractors to incorporate deficient products until corrective alternatives have been reviewed, approved, and completed. Contractors must submit a written repair procedure for approval by Project Manager and CES Reviewer.

Construction Requirements
Subsection 553.03, Standard Specifications

Shop Drawings
Subsection 553.03.2, Standard Specifications

Contractors must submit shop drawings for prestressed concrete members showing prestressed strand locations, and detailing hardware securing or anchoring strands within the member. Once received, Project Managers submit shop drawings to the Bridge Bureau for review, comment, and approval.

Precast Prestressed Girder Transportation and Storage
Subsection 553.03.16, Standard Specifications

Transporting and erecting precast prestressed girders are Contractor responsibilities. MCS permits are required to transport girders over Montana highways. Municipalities and county governments may require additional transport permitting. Concrete anchor devices are used for lifting members, which should always rest in an upright position on blocks just as when installed. Inspectors observe handling, but Contractors are responsible for handling. Handling damage must be documented by Inspectors and communicated to Project Managers. Exercise extreme caution during beam handling and placement.

Girders that tip or roll are usually damaged. If a beam tips on its side or flips, dead loading may reverse designed prestress forces.

Erection Plan

Contract documents include an erection plan for prestressed, precast concrete girders. Plan details depend on project complexity, skew, etc. MDT Structures Manual Chapter 5 covers erection plans. When required, contractors must approve, sign and submit an Erection Plan, stamped “Approved for Construction”. In some cases, a Pre-Erection Meeting between MDT and the Contractor is held. Contractors should submit erection plans a week before the meeting. Project Managers must submit plans to the CES and Bridge Bureau for review. Erection plans are reviewed but not approved by MDT. Falsework drawings must be in accordance with Standard Specification Subsection 552.03.2.

Erection plans and procedures must satisfy contract requirements, ensure safety, stability, damage prevention to work and surroundings, and achieve final geometry. Contractors must provide a complete erection plan with licensed Professional Engineer signature and seal, and plans for falsework, temporary bracing, guy wires and other items. Erection plans should provide the following details:

- Falsework, struts, bracing, tie cables, material properties and specifications for temporary works, bolt torque requirements prior to girder release from cranes, connection details and attachments to other components.
- Operational and procedural sequences, including a schedule with work item completion times.
- Minimum load and lift capacity chart, outrigger size and crane reactions.
- Calculated girder loads and weights, lifting points and devices, spreaders and lifting cable angles.
- Girder stresses at critical points along girder length during erection to ensure girder structural integrity and stability during installation. Lifting point stresses must provide bracing as required by analysis.
- Crane locations, girder deliveries, and crane and outrigger locations relative to structures.
- Drawings, notes, manufacturer recommendations, and calculations showing details, assumptions and dimensions.
- A reference to the Contractor Traffic Control Plan regarding girder erection.
- Contractor measures in case of inclement weather, equipment failure, delivery interruption, and slow production.

Contractors should safely erect precast, prestressed concrete members to prevent structural damage, and temporarily anchor primary members such as beams and girders during erection, to prevent overturning and buckling. Struts, bracing, tie cables and other temporary restraints should be considered falsework, and must resist loads imposed during construction stages. A pre-erection Meeting one week before erection is good practice. Project Managers, Contractors and erection Subcontractors should attend. Erection Subcontractors must demonstrate knowledge and familiarity with erected components, orientation within the structure, and girder shop drawings. Girder fabricators should attend the meeting to make sure subcontractors understand piece marking.

When bridges span public traffic, contractors should inspect girders before allowing traffic under girders. Contractors should inspect erected girders and permanent and temporary bridge elements daily until deck concrete has attained compressive strength.

Temporary struts, bracing, tie cables, devices and excess material must be removed when the structure is completed.

Post-Tensioned Concrete Elements

MDT rarely designs or constructs post-tensioned concrete elements such as girders and pier caps. Contract documents usually require Contractors to secure certified post-tensioning consultants to work with Project Managers during concrete member construction.

Measurement Method
Subsection 553.04, Standard Specifications

Payment Basis
Subsection 553.05, Standard Specifications

SECTION 554
PRECAST CONCRETE PRODUCTS

Subsection 554.01, Standard Specifications
MDT requirements for the following precast concrete products are further explained within:

- Subsection 609.03 precast concrete curbs
- Section 605 concrete barrier rail
- Section 611 concrete cattle guard bases

Materials
Subsection 554.02, Standard Specifications
Unless otherwise approved before work begins, contracts require steel products such as structural members, reinforcement, high-strength wires, bars, or strands incorporated into permanent work to meet Standard Specification Subsection 106.09 domestic steel "Buy America" provisions.

Plant Inspection
The MDT Materials Manual (MT-110) covers MDT fabricator plant inspection for certified manufacturers of precast concrete pipe, manholes, box culverts and other items. Plants meeting certified requirements are listed on the QPL. Products manufactured at a Department certified plant will not be marked as inspected. For uncertified plants, the Materials Bureau evaluates the plant quality control program, and assigns an MDT required inspection level at the plant to ensure quality assurance. Uncertified precast concrete item manufacturers must notify MDT when producing products so inspection arrangements can be made. Products produced by MDT uncertified plants must be marked inspected, unless communications between Project Manager and Plant Inspector have specified other arrangements. Fabrication plant Inspectors prepare documents such as inspection reports or photos for items shipped to the construction site in order to document inspection and identify items. Documentation should note defects deemed acceptable.

Field Inspection
Inspectors should examine fabrication plant Inspector documentation to ensure correct item delivery and verify product condition prior to shipping. Inspectors visually inspect precast concrete items to ensure items are undamaged during handling. Contractors should unload, store and handle all precast concrete items. Inspect for:

- Correct dimensions and material specifications
- Spalls, dents or chips
- Interior and exterior cracking
- Fabrication date and "Circle M" stamped on precast concrete items

- Item identification marks indicating lot or production number on the compliance certificate

If fabrication date or identification marks are not present on the compliance certificate, Contractors must provide documentation verifying listed items are considered for measurement and payment.

Final material acceptance is granted in the field. If products are of insufficient quality and repairs are unfeasible, paint an orange "X" adjacent to the plant product identification stamp, and inform the Contractor the Department has rejected the material. If repairs are feasible, identify where repairs are necessary, and communicate deficiencies to the Contractor. Contractors are responsible for developing corrective action plans. Project Managers handle corrective action communication and documentation. Products with known deficiencies are not incorporated until repairs have been made.

Construction Requirements
Subsection 554.03, Standard Specifications

As Standard Specification Subsection 554.03.1 requires, Contractors must submit fabrication drawings and design calculations for precast concrete products to the Project Manager. If necessary, after submitting documentation to the Construction Engineering Services Bureau for review, Project Managers approve fabrication drawings.

Measurement Method
Subsection 554.04, Standard Specifications

Payment Basis
Subsection 554.05, Standard Specifications

SECTION 555
REINFORCING STEEL

Description Subsection 555.01, Standard Specifications

Concrete is a steel reinforced mixture of aggregate, sand, cement and admixtures. Concrete is strong in compression but weak in tension, and cracks with shrinkage and sustained loading. Concrete without reinforcement is brittle, and breaks suddenly. Steel is 100 times stronger in tension than concrete, 6 times stiffer and stretches 17 times more than concrete before failing, and provides concrete with tensile strength, stiffness and ductility, making it an efficient, durable, versatile, and safe building material.

Materials
Subsection 555.02, Standard Specifications

Unless otherwise approved before work begins, contracts require steel products such as structural members, reinforcing bars, high-strength wires, bars, or strands incorporated into permanent work to meet domestic steel Standard Specification Subsection 106.09 “Buy America” provisions.

Reinforcement arriving earlier than needed should be stored to prevent bending, rusting, oil, grease or foreign material accumulation. Epoxy coated rebar must be covered to prevent ultraviolet damage. Check reinforcing steel before placement within structures to verify it is free of dirt, scale, paint, oil or contaminants which prevent bonding between steel and concrete. Reject heavily rusted and pitted steel. Steel bars and welded wire mesh reinforcement must be certified as conforming to specifications before concrete embedment. Materials Manual MT-414 covers steel acceptance requirements including:

- Required documentation
- Random sampling
- Domestic materials (Standard Specification Subsection 106.09)
- Noncompliant steel
- Standard weight, diameter, and number designation

Construction Requirements
Subsection 555.03, Standard Specifications

Reinforcing steel bears impact, shear and bending forces applied to concrete, and must be inspected carefully. Form clearance, bar size, lapping, specified bend, steel ties and supports are critical. Changes to these elements may change structural performance. Project Managers must ensure reinforcing steel is:

- Correct grade and type
- Correct size, shape, and length
- Placed at specified location and spacing
- Placed in correct number
- Tied and spliced properly
- Clean with specified concrete cover

Reinforcing Steel Changes in the Field

Contractors may request changes to rebar specifications and design regarding:

- bar relocation
- bar bending changes
- bar size, grade, or type substitution
- bar cutting or torching
- bar welding
- alternate splice details and locations

Requests changing bar location, size, shape, type, grade, length or splice location may impact structural behavior and longevity, and must be designer approved.

Bending, Heating and Cutting Bars
Subsection 555.03.2, Standard Specifications

Verify bar size and length, and bend dimensions. After rebar placement, make and document a final inspection. Contractors may want to field bend bars to simplify reinforcement installation, or to improve access. During situations requiring deviation from standard procedure, Inspectors coordinate with a Departmental Steel Fabrication Specialist to determine if changes are practical, and develop a specific inspection protocol. Grade 40 (Grade 280) bars smaller than #8 (#25) may be manually bent to provide access, and re-bent to final shape. Only bend bars twice to avoid fatigue failure.

Contractors may only bend Grade 40 (Grade 280) #8 (#25) and larger bars, and bars made from Grade 60 (Grade 420) steel once. These bars cannot be bent to provide access, or bent temporarily to accommodate construction activity. If bars are bent once in the shop, further field bending is not allowed. Repeated bending weakens fatigues steel. Heating steel for bending is also unacceptable. If not controlled and closely monitored, heating changes steel physical properties. Do not allow bars hindering steel or concrete placement to be cut without Project Manager approval. Cutting and splicing bars after removal is not acceptable. If bars must be spliced, splice type and location should be discussed with and approved by designers beforehand. Rebar should not be cut where steel stresses are high, or where length is insufficient for subsequent splicing.

Rusty, Oily and Dirty Rebar
Subsection 555.03.3, Standard Specifications

Rust is not detrimental unless it flakes from bars or significantly reduces cross sectional area. Oil, dirt, and loose mortar reduce steel to concrete bonding, so rebar should be cleaned of contaminants. Verify bars are oil free. Petroleum based solvent such as naphtha, gasoline or diesel fuel may be used to remove oils, or Contractors may use a torch to remove oil. If small, isolated mortar amounts are bonded to steel, and vigorous wire brushing cannot easily remove it, mortar is acceptable. Bars protruding from concrete and exposed to weather for long time periods must be rust protected. Contractors must remove such preventative coating when concrete work begins.

Rebar Cover and Clearance
Subsection 555.03.3, Standard Specifications

Reinforcement clearance must allow concrete to completely surround bars. If bars are spaced too closely, air voids may develop where concrete cannot inflow between bars, and weakening concrete locally. Stress concentrations develop in surrounding concrete as stresses ordinarily carried by missing concrete are conveyed to adjacent concrete. Areas between bars may also lack aggregate. Rebar congestion may be a problem where longitudinal bars are lap spliced and where column to cap beam rebar intersect.

Laps and Splices

Rebar is often specified in lengths too long for delivery as a single piece, requiring pieces to be spliced onsite. Contract documents usually designate splices for each location.

Lap Splices

Lap splices are most common, and formed by overlapping bars at a specified length before tying. “Lap length”, is specified by the contract, and transfers loads between bars. Lap length may be longer than specified, but never shorter. Inadequate lap may cause concrete cracking around the lap, or even failure, depending on location. Lap splices are placed where concrete stresses are lowest. Inspectors must ensure contractors lap rebar as specified. Designers must approve splice relocations. High bending and tensile stress locations require continuous bars or mechanical splices, as lap splices may cause concrete cover and clearance complications. Lap splice spacing must allow concrete flow between splices, and may be staggered to increase space at splice locations.

Mechanical Rebar Connectors

Mechanical rebar connectors (couplers) are proprietary rebar splicing mechanisms used to reduce rebar congestion in densely reinforced areas. Special provisions usually address mechanical rebar connector usage, and may disallow mechanical rebar connectors for certain splices. Refer to manufacturer recommendations when installing mechanically connected splices, and verify Contractors follow manufacturer recommendations.

Epoxy Coated Reinforcement

Carefully observe epoxy coated rebar handing. Standard Specification 555.03.1 addresses epoxy coated rebar protection. Scratches, nicks and marks must be minimized. Do not allow contractors to legitimate mishandling rebar by intending to repair epoxy coating.

Reinforcement Steel Inspection

When checking rebar compliance before concrete placement, verify:

- bar size, distribution, and grade
- concrete cover and bar clearance
- bar spacing, length, and ties
- bar splices
- chair height
- epoxy condition and bar cleanliness
- lap length for hoops, spirals, and straight bars
- length and width
- lifting stability
- inspection tube placement

Inspection may begin but not finished until all steel is in place. Contractors must allow and account for inspection times when planning concrete placement.

Measurement Method
Subsection 555.04, Standard Specifications

Payment Basis
Subsection 555.05, Standard Specifications

SECTION 556
STEEL STRUCTURES

Description
Subsection 556.01, Standard Specifications

Standard Specification Section 556 deals primarily with steel bridge construction. MDT uses two steel bridge types constructed using composite steel welded plate girders or factory rolled beam girders.

Composite Steel Welded Plate Girders

MDT uses plate girder superstructures for spans over 150 ft, horizontal curves or where vertical clearances are needed for ice and debris passage. Figure 556-1 shows a typical steel girder detail:

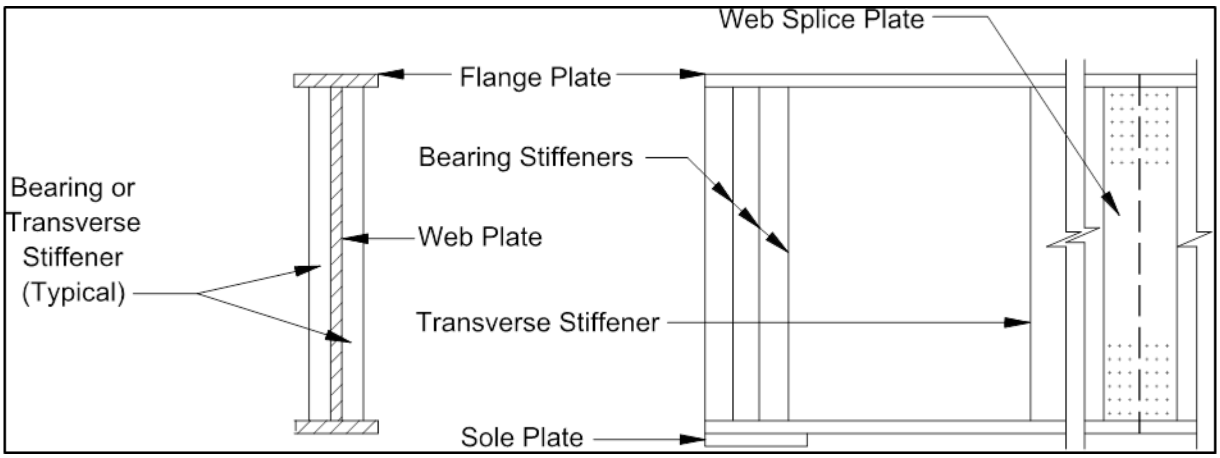


Figure 556-1

COMPOSITE STEEL WELDED PLATE GIRDER DETAIL

Steel plate girders optimize fabrication, weight and erection cost savings. Plate girder top flanges are typically thinner than bottom flanges. Sections vary in thickness along bridge length to reduce material and welded flange fabrication costs. The most economical location for flange transitions is at a field splice. Field splice plate designs vary depending upon bridge design geometry and girder web or flange location. Typically bridge designers vary only flange thicknesses within field sections. Plate girder webs are typically deeper and thinner than rolled beam webs. Bridge designers may increase web thickness to minimize stiffeners and reduce cost. To avoid buckling, diaphragms provide compression flange stability. Diaphragms also vary depending upon bridge design geometry, and provide stability and load transfer between girders.

Rolled Girders

Factory rolled girders use symmetric cross sections with equally dimensioned top and bottom flanges with relatively thick webs. Bridge design does not optimize cross sections for weight savings, but doing so may be cost effective given reduced fabrication and erection costs. Thick webs may also reduce the need for web stiffeners. Rolled girder superstructures are typically cost effective for spans less than 130 ft (40 m).

Materials

Subsection 556.02, Standard Specifications

Buy America

Contract documents require steel products such as structural members, reinforcing bars, bolts, nuts, and washers incorporated into permanent work to meet Standard Specification Subsection 106.09 domestic steel "Buy America" provisions.

Structural Steel

Plant Inspection

Standard Specification Subsection 556.03 discusses MDT steel structure construction and fabrication requirements. Plant Inspectors notify the Physical Testing Engineer, Bridge Bureau, and Project Manager of deficiencies to determine if corrective action is feasible. Fabricators must submit proposed corrective action for Departmental review and approval.

Field Inspection

Contractors must unload steel to minimize damage by using slings and wood blocks to prevent flange damage. Steel members must never be dropped. Contact the MDT Materials Bureau Steel Fabrication Specialist for assistance with welding or structural steel inspection, bolting and erection. Upon arrival Inspectors should examine Fabrication Plant Inspector documentation to ensure correct item delivery, and review noted product condition before shipment. Upon delivery visually ensure structural steel has not been damaged during transit. Contractors are responsible for damage during shipping, storage and handling.

Fabrication Inspectors identify and accept steel members, and notify Project Managers of further investigation if needed. Fabrication Inspectors collect item documentation but for reasons may not accept project items inspected and sampled later. Unless notified otherwise by a Fabrication Inspector, Inspectors inspect steel members, plates, bolts, nuts, washers and hardware for:

- shipping documents citing steel quantity, shape and type
- complete certification and material description, including grade, test results and lot or heat number
- markings indicating steel type and grade
- dimensional compliance

Inspectors must verify proper material arrival when final material acceptance is granted in the field. If needed, notify the Physical Testing Engineer, Bridge Bureau, CES Bureau, Project Manager, and Contractor to review corrective measures. Do not allow Contractors to incorporate deficient products until corrections are approved. Contractors must submit a written repair plan for Project Manager and CES Bridge Reviewer approval. Inspectors and Project Managers should contact the MDT Materials Bureau Steel Fabrication Specialist for structural steel welding, bolting, erection and inspection assistance.

High Strength Bolts

AASHTO and ASTM recognize three structural bolt types. ASTM A307 bolts are normal-strength bolts used for a variety of applications from light fixtures to cattle guard assemblies, but are not used for steel superstructures. Other bolt types designated "high-strength". AASHTO M164 bolts have a maximum allowable tensile strength more than double A307 bolt strengths. AASHTO M253 bolts have a strength approximately

20% higher than AASHTO M164 bolts. While MDT does not use M253 high strength bolts, Inspectors must be aware contracts may specify these bolt types. Contractors must protect, lubricate, and clean high strength bolts before installation to limit friction between bolts, nuts and connection plates.

Construction Requirements
Subsection 556.03, Standard Specifications

Girder fabrication and structural assembly may occur prior to shipment, after which Inspectors oversee prefabricated product erection and final assembly.

Fabrication Assembly

Contractors are required to provide shop fabrication or field erection information to construct steel superstructures. MDT personnel are not responsible for shop fabrication. During inspection, fabrication plant Inspectors must reference Subsection 556.03.1 "Pre-qualification", which ensures contractors use AISC quality certification program qualified metal fabricators for items in the above Subsection. Subsection 556.03.2 "Fabrication Drawings" submitted by contractors to Project Managers, are then submitted to the Bridge Bureau for review, comment and approval. Plant Inspectors ensure steel shop fabrication meets fabrication drawing requirements. Steel structures such as sign structures, light poles and bridges require fabrication drawings showing how each steel member is fabricated, connected, and assembled.

Fabrication Plant Inspectors verify Subsection 556.03.3 "Mill and Shop Inspection" compliance. The following apply to shop fabrication and field erection work:

- Subsection 556.03.7 Bolts and Bolted Connections
- Subsection 556.03.9 Welded Stud Shear Connectors
- Subsection 556.03.11 Assembling Steel
- Section 624 Welding
- Subsection 556.03.4 Storage and Material Handling

Member marking occurs in the shop, and is critical to structural assembly. Contractors should transport and handle members in an upright position, place girders upright on supports, support long members to prevent deflection, and brace deep members to prevent overturning.

Bolted Connections
Subsection 556.03.8, Standard Specifications

MDT uses tension bolt plate connections to transfer loads to structural members. These connections are referred to as slip critical joints, and use bolts, nuts and washers to prevent sliding. Tension bolt connections handle stress reversals, impacts, vibrations and extreme stress changes.

Tensioning Bolted Connections (see Bolting Handbook)

Contractors must tension bolts to at least 70 % minimum yield strength to prevent connection plates from slipping. Inspectors must closely monitor and document the tightening process, and should check at least 10% of connection bolts for proper tensioning. If a single bolt fails, the entire connection must be retightened and checked. The structure must be fully assembled and in place before final tensioning. Four methods are available for bolt tensioning:

Turn-of-Nut methods require turning nuts a specified number of turns after reaching a “snug tight” condition. Nut rotations needed to tension the bolt depend upon bolt length, slope of the connection plate faces, and washer type.

Calibrated Torque Wrenches are used to determine bolt tensioning, which relates to the torque required to turn the bolt. Friction may develop between the nut and the bolt, and require additional torque to achieve specified tension. Friction depends upon temperature, moisture and bolt condition.

Direct Tension Indicator (DTI) Contracts may specify DTI tensioning via Bridge Special Provision. Collapsible washers indicate when specified bolt tension is reached. Washers are placed under the bolt head and collapse when bolts achieve tension. This method most accurately determines bolt tension, but Inspectors should work with Steel Fabrication Specialists to verify washers collapse at required tension. Ensure washers are installed in accordance with manufacturer recommendation.

Tension Control (Twist Off) methods assume bolt tension directly relates to the torque needed to turn the nut. Specialized bolt assemblies and wrenches achieve tension by shearing the spline at desired torque. Contracts may specify tension control tensioning using a bridge Special Provision. Friction between the nut and the bolt requires greater torque to achieve tension, and depends upon temperature, moisture and bolt condition. Inspectors should work with Steel Fabrication Specialists to test Tension Control assemblies.

Bolt Tensioning Inspection and Documentation

Document the following within the DWR:

- when and where hardware samples were taken for material testing
- which bolts attained tension
- method used to achieve required tension
- bolt tensioning sequence and torque readings
- bolt lubrication if ordered by Inspector
- corrective action to assemble the connection, like changing bolt length or hole reaming

Erection

Subsections 556.03.11 and 556.03.14, Standard Specifications

Erection and assembly inspection ensures Contractors follow erection drawings and contract documentation. Fabrication drawings show structural component connections and assembly sequence.

Inspectors must ensure Contractors erect and assemble structures in accordance with the contract. Components should not be bent, over-stressed, cut, punched, drilled or damaged to expedite erection. Pay close attention to steel connections. Field connection inspection ensures structural performance, safety and predictability.

Pre-Erection

Holding a Pre-Erection Conference before erection is good practice. Steel erection involves lifting equipment, safety hazards, traffic control, and documentation. Project Manager, Contractor and erection Subcontractor should attend. Before erection, Contractors should locate bearing centerlines on substructure units. Inspectors should check bearing areas to ensure flat surfaces will provide uniform steel contact at correct elevation. If concrete surfaces in contact with bearing pads are rough or irregular, concrete must be ground to provide uniform bearing. Contractor and Inspector should review Standard Specification Subsection 105.8.2 regarding bridge surveys.

Erection Plan

Contract documents often include an erection plan specifically for steel girders, the details of which depend on project complexity and geometric characteristics. MDT Structures Manual Ch 5 discusses steel girder erection plan sheets. Contractors must approve, sign and submit an erection plan to be stamped “Approved for Construction”. Project Managers must submit plans to the CES and Bridge Bureaus for review, but not approval. Falsework drawings must conform to and be submitted in accordance with Standard Specification Subsection 552.03.2. erection plans must address:

- Falsework, struts, bracing, tie cables, material properties specifications for temporary works, bolt torque requirements prior to crane girder release, connection details, and attachment to other structural components
- Procedure and operational sequence, including a schedule showing work item completion times
- Maximum lift capacity charts, outrigger size and crane reactions
- Assumed load and girder weights, lift points, lifting devices, spreaders and lifting cable angles
- Crane locations, girder delivery trucks, and crane outrigger locations relative to other structures such as retaining walls, wingwalls, utilities
- Drawings, notes, manufacturer recommendations, and calculations showing details, assumptions and dimensions
- A specific reference to the Contractor Traffic Control Plan [TCP] addressing girder erection in accordance with Standard Specification Section 618
- Contingency plans addressing inclement weather, equipment failure, delivery interruption, and slowed production

Assembly

Contractors must safely erect girders to prevent structural damage, and temporarily brace primary members to prevent overturning or buckling. Struts, bracing, tie cables and temporary restraints should be designed to resist construction loads. Contractors must:

- Position members as shown by erection drawings by checking match marks or member identification
- Keep contact and bearing surfaces free of rust, loose scale, dirt, oil and grease
- Maintain girder splice contact surfaces and main truss bolt connections free of paint or lacquer
- Connect steel members with minimal strain or distortion. If bolt holes are misaligned, properly position using drift pins. If holes fail to line up, Contractors may redrill holes with Project Manager and Designer approval
- Fabrication uncorrected by a slight amount of drifting, drilling or reaming is cause for material rejection. Do not permit heavy sledging or flame cutting to align components
- The Bridge Bureau must approve heating steel members to facilitate bending and installation. Steel heating must be controlled under predetermined conditions
- Check girder top elevations to ensure Contractors make needed slab adjustments

- Contractors must remove temporary struts, bracing, tie cables, and extra material upon structural completion.

Erection Checklist

Figure 556-1 is an erection checklist from the AASHTO/NSBA steel bridge collaboration publication entitled “Steel Bridge Erection Guide.”

PART 1 Drawing

PLAN:

- ☐ A scaled work area plan view showing supporting structures, roads, railroads, waterways, utilities, adjacent structures, framing plan with member shipping marks matching those on fabrication drawings, and field splice locations.
- ☐ Temporary support, falsework, and holding crane locations
- ☐ Crane position locations and pick radii

  Elevation view of crane and member ☐
  Included ☐ Not Applicable

  Crane Support Method: barges, mats ☐
  Included ☐ Not Applicable
- ☐ Member delivery location and orientation

DETAILS:

- ☐ Detail showing rigging size, capacity and gravitational center for each pick
- ☐ Falsework and temporary support sizes and capacities
- ☐ Crane capacity chart indicating crane type, radius lifting capacities, counterweight requirements, and boom length
- ☐ Pick weight chart indicating member weight plus rigging and attachments
- ☐ Erection sequences for primary and secondary members using the “individual piece tie down method”, and connection methods for diaphragms, lateral bracing, and field splices.

PART 2 Calculations

- ☐ Load capacity and stability calculations for temporary supports such as falsework, tie downs, lifting beams and spreader beams.
- ☐ Calculations indicating temporary crane support capacity
- ☐ Member integrity and stability calculations prior to bridge completion
- ☐ Calculations indicating structural integrity of bolted primary splices after external support release
- ☐ Calculations to substantiate abutment and retaining wall structural integrity accounting for crane surcharge.

PART 3 Associated Data

- ☐ Manufacturer cut sheets for riggings such as beam clamps, slings, wire rope, shackles, turnbuckles, chains, straps, and engineered falsework.
- ☐ Other review entities, such as railroads, US Army Corps of Engineers

FIGURE 556-1

ERECTION PROCEDURE CHECKLIST

PART 1 Pre-Erection

☐ Erection Procedure – approved

☐ Site Preparation – access roads, crane pads, level crane mats are placed on firm ground, bearing pedestals, anchor bolts, survey, falsework foundation pads, noted obstacles

☐ Personnel
- foreman
- crane operators
- current welder certification and qualifications
- completed training

☐ Lifting Equipment
- current and scheduled crane inspection
- lifting devices and rigging certification and inspection

☐ Bolted Connections
- check bolt quality, size, length and certification
- tensioning method during installation
- skidmore machine calibration and certification
- impact wrench condition, size, and capacity
- torque wrench calibration and certification

☐ Welded Connections
- approved welding specifications (WPS)
- welding equipment
- welding consumables including proper storage, drying ovens

☐ Safety and fall protection including nets, lifeline lanyards, platforms, scaffolds, lifts, floats, and emergency boat

☐ Coordination with railroads, local agencies, and emergency services

PART 2 Erector Responsibility

☐ Provide to Inspectors before erection:
- framing plan, erection procedure
- crane operator qualifications
- welder certifications
- crane inspection certification
- crane mats on flat, level, firm ground
- Skidmore-Wilhelm and torque wrench calibrations and certifications
- bolt manufacturer certifications
- welding specifications

☐ Provided to Inspector during erection:
- access to work via ladders, lifts, scaffolds, or platforms
- torque wrenches
- Skidmore-Wilhelm calibrator
- temperature indicating crayons

FIGURE 556-2
ERECTION INSPECTION CHECKLIST

PART 3 Contractor Responsibility

The following are Contractor responsibility, but may be beneficial in the project file for reference.

☐ Check crane operator, welder and personnel certifications
☐ Check equipment certifications
☐ Check fall protection requirements and safety installation
☐ Check crane radii
☐ Temporary supports installed per erection procedure
☐ Check assembly marks for proper location and orientation
☐ Check bolt and pin minimum numbers installed before crane and temporary support release
☐ Monitor bolt installation procedure
☐ Check field weld size and geometry, consumables, and variables per WPS and NDT results
☐ Check bearing alignment and adjustment

FIGURE 556-2
ERECTION INSPECTION CHECKLIST
(Cont)

Measurement Method
Subsection 557.04, Standard Specifications

Payment Basis
Subsection 557.05, Standard Specifications

SECTION 557
STEEL BRIDGE RAILING

Description
Subsection 557.01, Standard Specifications

MDT specifies two steel bridge railing types:

- Texas 101 Rail (T101) is a rail system used to modify existing bridge rails on low volume route bridges. T101 enhances snow removal, is lower cost, lower weight and provides better visibility. See MDT Bridge Standard Drawings T101 design details. Inspectors must be aware of variations between structures, and be familiar with contract structural modifications.

- Wyoming Curb-Mounted Two-Tube Rail (W740)/W830) is 29-inch (740-mm) or 32¾-inch (830-mm) steel bridge rail used in special circumstances only, such as areas prone to drifting. See MDT Bridge Standard Drawings for W740/W830 design details.

Materials
Subsection 557.02, Standard Specifications

Plant Inspection

MDT reserves the right to inspect fabrication plants. Plant Inspectors or representatives inspect steel bridge rail components at the plant, and send an inspection report to the Project Manager listing rail manufacturer, heat number, base metal, brand name and rail thickness. Manufacturers also furnish an inventory of rail shipped to the job. Contractors furnish Project Managers with compliance certificates and Form 406, which lists mill test results, heat numbers and manufacturing origin, and must be received before installation and progress payments.

Buy America

In accordance with Standard Specification Subsection 106.09, Contractors must complete Form 406 to certify steel and iron materials for products incorporated into the work have been domestically melted, manufactured, and galvanized.

Field Inspection

Inspector material acceptance is granted visually and upon manufacturer certification and mill test report receipt. Contractors must provide mill test reports documenting heat numbers, material grade, origin and physical property compliance.

Following are guidelines for Inspector steel bridge rail evaluation:

- Check for galvanization damage, especially if materials have been stockpiled, and for field cutting or drilling. Require repairs or replacement based on coating damage. Contact Project Managers for assistance approving and accepting galvanization and coatings.
- Check rail sections for burrs, twists, bends, misaligned holes and uncoated areas. Verify sections are correct type, shape, length and curvature. Require damaged section replacement.
- Check steel posts for bends, twists, uncoated areas, misaligned holes and damaged ends. Verify posts are proper type and weight. Check length, cross-sectional dimension, hole diameter and template for compliance.
- Ensure fastening hardware is correct for the system. Do not permit bolt cutting.

Construction Requirements
Subsection 557.03, Standard Specifications

Manufacturer Documentation
Subsections 557.03.1 and 556.03.2, Standard Specifications
Fabrication drawings include:

- Drawings showing dimensions, steel grade and product information for rail sections, posts, anchors, bolts and hardware required for installation
- Installation instructions
- Manufacturer certification the system meets NCHRP 350 and AASHTO MASH requirements.

Rail Alignment

Steel bridge rail plates must expand and contract without loosening posts. Rail elements should have a smooth, continuous appearance, with the rail top horizontally and vertically aligned with the roadway. Upstream rail sections must lap over downstream sections.

Field Cut Bolt Holes

MDT prohibits cutting torches to make bolt holes. Heat weakens metal, and may allow bolt heads to pull through under impact. Drilling or punching are acceptable for making bolt holes in the field. Ensure metal plates do not warp when bolt holes are punched.

Measurement Method
Subsection 557.04, Standard Specifications

Payment Basis
Subsection 557.05, Standard Specifications

SECTION 558
DRILLED SHAFTS

Description
Subsection 558.01, Standard Specifications

Materials
Subsection 558.02, Standard Specifications

Construction Requirements
Subsection 558.03, Standard Specifications

- Refer to the MDT drilled shaft inspection training guide.
- Bridge Reviewers perform Cross hole Sonic Logging (CSL) testing for drilled shafts and assist with inspection. Provide a drilled shaft submittal copy to the reviewer, and notify them when drilling will begin.

Measurement Method
Subsection 558.04, Standard Specifications

Payment Basis
Subsection 558.05, Standard Specifications

SECTION 559
PILING

Description
Subsection 559.01, Standard Specifications

Piles are steel cylinders driven into the ground and known as “deep foundations”. Deep foundations are required when surficial soils will not support structural loading. Piles are also used when soil beneath structures could become loose or wash away. Piles are arranged in groups. ”Piling” refers to a group of piles.

Friction vs Bearing Force

Friction piles rely on friction between the pile and adjacent soil to transmit loading to the soil. End bearing piles bear on bedrock or hard strata, and transmit loading to hard strata. Although friction develops between any pile and adjacent soil, hard material at the pile tip carries most loading.

Types

The Geotechnical Section and Bridge Bureau design and select pile types:

- Steel Pipe Piles may be designed as bearing piles, friction piles or a combination of the two. Typical diameters are 16 - 20 inches. Steel pipe piles are filled with concrete and driven with conical or closed end driving points.
- Steel H-Piles are used when piles will bear on rock. Typical size is HP 12, although HP 14 is sometimes used.
- Fluted steel piles are only used in deep, soft materials.
- MDT rarely uses monotube piles or prestressed concrete piles.

Materials
Subsection 559.02, Standard Specifications

Buy America

Unless otherwise approved, contract documents require steel and iron product material permanently incorporated into the work to meet domestic steel “Buy America” provisions specified by Standard Specification Subsection 106.09. Manufacturer certification must accompany Form No. 406 (Mill Test Reports), and confirm piles were melted and manufactured in the United States.

Structural Steel

Plant Inspection

MDT may assign a plant Inspector to inspect steel piling at the mill. If deficiencies are identified, Inspectors notify the Physical Testing Engineer, Bridge Bureau and Project Manager to determine if corrective action is feasible. Manufacturers then submit proposed correction(s) for Department approval.

Field Inspection

Contractors should notify Project Managers before pile shipment. Steel piling must be undamaged during handling. Upon arrival, examine mill test reports from the Plant Inspector and Contractor to ensure correct item delivery. Field Inspectors visually inspect steel piling for damage. Contractors must ship, store and handle piling. Field Inspectors should review:

- Mill Test Reports to ensure domestic material
- Certified Material Test Reports listing heat numbers, chemical and physical test results, and mechanical test properties

- Pile dimensions, grade, weight/foot, and heat number to verify Certifications
- MDT Form 406 to each Mill Test Report packet, and send the Materials Bureau and construction office a copy
- Steel piling for compliance with maximum camber (strong axis) and sweep (weak axis), according to Standard Specification Subsection 559.02.1
- Piling for deformities
- Pile length and conical driving points for pipe piling, or cutting shoes for H-piling, conform to contract documents

Final acceptance is granted in the field. If deficiencies are identified, notify the Project Manager who will notify the Physical Testing Engineer, Bridge Bureau, Construction Engineering Services Bureau and Contractor of concerns to determine corrective action. Contractors must submit written proposed repair plans for approval by Project Manager and CES Bridge Reviewer. Do not allow contractors to incorporate deficient products until corrective action is reviewed, approved, and completed.

Construction Requirements
Subsection 559.03, Standard Specifications

Equipment
Subsections 559.03.1 and 559.03.2, Standard Specifications

Pile Hammers

The single action open ended diesel hammers are commonly used in Montana, and consists of an open cylinder and piston operating as a single cylinder engine. The piston drops under gravity and is lifted by combustion. Hammer energy is rated by piston weight and fall distance. Contractors occasionally use closed end or double action diesel hammers, which develop energy by compressing air during the upstroke. This hammer applies compressed air and gravity to power the piston. Hammer energy is indicated by upper chamber pressure readings. Pile hammer manufacturers furnish pressure gauges and charts showing impact energy at given pressures. Gauges, fittings, and hoses must be in accordance with manufacturer instruction. Check pile driving equipment upon delivery. Inspectors and pile driving contractors should ensure:

- equipment is MDT approved and meets job requirements
- leads are sturdy, smooth and straight
- the hammer falls freely
- hammer driving head blocks are not badly worn

Pile Driving Equipment Evaluation

MDT Standard Specification Subsection 559.03.2 requires MDT evaluate and approve pile driving equipment. Contractors submit hammer and driving system details to Project Managers, who forward details to the Geotechnical Section, which has 14 days to review and approve Contractor proposed equipment. The Geotechnical Section ascertains whether the hammer will drive piles to required capacities without overstressing piles. If not, MDT will require the Contractor to limit hammer stroke, propose a different hammer or demonstrate through Pile Driving Analyzer (PDA) testing the drive system does not overstress the pile.

Pile Capacity and Geotechnical Section Responsibilities
Subsection 559.03.3, Standard Specifications

Geotechnical Section Coordination

The Geotechnical Section evaluates pile driving resistance by conducting static load tests during driving.

Pile Driving Evaluation

The Geotechnical Section confirms pile capacities by evaluating driving records, reviewing Pile Driving Analyzer (PDA) results, and overseeing load testing. MDT Inspectors monitor pile installation. Project geotechnical specialists review driving data, confirm pile tip elevation, and verify blow counts. Two methods determine if capacity requirements are met when a PDA test is not performed:

- Wave Equation Analyses. After hammer approval, the Geotechnical Section provides a Pile Driving Inspector Chart for required ultimate capacity during driving, which provides hammer stroke height versus hammer blow count. If a PDA test is used, the Geotechnical Section still provides hammer approval, but PDA results and Case Pile Wave Analysis Program (CAPWAP) analyses are used to evaluate pile acceptance.
- Dynamic Formula. The Geotechnical Section does not determine ultimate pile capacity during construction based on the dynamic (Gates) formula, but the formula is used to check wave equation analyses.
- Project Managers contact the Geotechnical Section if final pile tip elevation is greater than 1 foot (300 mm) from the planned tip elevation, or if capacity is not achieved at design tip elevation. Geotechnical specialists should review original design parameters to evaluate the effects of altering tip elevation.

Pile Driving Analyzer (PDA) Testing and Evaluation

Project geotechnical specialists determine if PDA tests are necessary when pile installation begins. This determination takes into account subsurface variability, pile number, previous or similar pile driving records, soil characteristics and cost considerations.

PDA tests measure pile capacity after initial driving (EOID) and when restrike (BOR) begins. PDA results may indicate a different hammer system should be used. Although contract documents specify PDA testing requirements, PDAs may be conducted if specified pile capacities are unmet. In most cases, Contractors hire a PDA testing MDT certified consultant to provide testing. The first pile within a group PDA tested during production pile driving. After PDA data are collected and a Case Pile Wave Analysis Program (CAPWAP) analysis performed, Inspectors forward data and dynamic testing results to the Geotechnical Section for confirmation that minimum capacities are met, and driving stresses do not exceed allowable values. If EOID is inadequate, contact a geotechnical specialist to determine whether driving should continue. PDA testing is sometimes carried out after pile driving begins if capacities are not reached at design tip elevation, pile damage is suspected, or driving system revaluation is necessary due to equipment changes.

When conducting a PDA after production pile driving begins, Contractors must perform a CAPWAP analysis based on PDA measurements. CAPWAP analysis procedures plot a tip versus side resistance distribution, and displacement occurring with each hammer blow.

Static Pile Load Testing

The Geotechnical Section occasionally specifies pile load tests and coordinates load tests, which provide reliable pile capacity estimates. Static load test types are:

Proof Tests load piles with two times the design load to confirm pile settlement will be less than a calculated safety factor applied load. During proof testing, pile head load and displacement are recorded. Fully Instrumented Pile Load Tests determine pile load and displacement distribution during the loading sequence. Strain gauges and displacement measuring devices monitor load and displacement. Tests record load and pile head displacement. Fully instrumented tests are normally loaded to failure, and may include various loading and unloading sequences.

Load tests are most often contract required and specify loading, instrumentation and monitoring. Geotechnical specialists develop a load test plan, provide oversight during testing, and confirm the load test meets contract intent. Geotechnical specialists interpret results, compare calculated capacities to field capacities, and evaluate friction resistance and tip bearing capacity.

Test Piles

Contracts may require test piles where soil borings indicate unusual conditions. MDT uses test pile information to calculate pile length and ensure final load carrying capacity. Contractors must excavate to plan grade, and pre-bore as specified at planned pile location with equipment to be used for service pile driving. Test piles are driven to tip elevation and ultimate capacity without damage to the pile. Driving should continue to tip elevation even if capacity is acquired, to ensure lateral stability. If calculated design capacity exceeds field capacity near tip elevation, sufficient pile length should remain to continue driving after splicing. When test pile is not required, Project Managers review penetration records, bearing value and pile length for the first few piles. Report discrepancies between plan requirements and field test results to the Geotechnical Section, and provide driving logs.

Location and Alignment
Subsection 559.03.4, Standard Specifications

Before pile driving begins ensure footing bottom elevation is excavated to plan grade. Set a benchmark in a convenient, safe, location to check cut-off elevation. Check pile layout immediately prior to driving. Check pre-bore hole depth and diameter within a few tenths of a foot against those shown on plans. Pile tips must be correctly aligned before driving. Check vertical piles for alignment by sighting against a plumb line. Recheck alignment periodically and more frequently during initial driving while correction is possible. Inspect piling for damage during driving before concrete cap placement. Discuss contractor strategies to maintain pile alignment and tolerance. Contractors often use templates to properly locate and align piles. Contractors may brace pile templates, drive smaller piles to secure templates and move boulders from pile locations.

Service Piles
Subsection 559.03.5, Standard Specifications

Contractors must drive service piles to specified tip elevations and pile capacity. Before pile driving begins, be prepared to determine pile length, driven pile length, driven pile tip elevation, driven ultimate pile capacity and pile acceptance.

Safety
Pile driving is loud and dangerous. Abide by these safety precautions:

- Wear hard hat, steel toed boots, and safety vest
- Use ear plugs and ear muffs
- Dress for weather
- Wear expendable clothing
- Keep away from falling objects

Pile Marking
Number each pile and keep accurate driving records by marking piles before driving. Identify piles and driving lengths by marking piles by the foot, and writing cumulative driven length on piles every 5 ft. Mark spliced sections as usual, continuing to mark driven depth beyond the weld.

Recording Devices and Tools
Pile driving inspection and documentation require a measuring tape, level, watch, soapstone or paint for marking, contract documents, pile driving inspection chart, and hammer chart provided by Contractor.

Ultimate Pile Capacity
Ultimate pile capacity is higher than anticipated loading to account for loading and soil property variations. Piles must resist vertical and horizontal loading. Small piles may support factored vertical loads of 80 tons; whereas larger piles may support 200 tons of factored loading. Two measurements are recorded simultaneously to determine ultimate driven pile capacity:

- Hammer blows per minute. Time between ram strikes is related to piston rebound height. Blows per minute are used to determine average stroke length. Striking force is approximated using piston weight and stroke length.
- Hammer blows per foot or inch. This information is necessary to determine energy delivery rate, work done to the pile and resistance loading carried by the pile.
- “Expected driven resistance” is calculated using the dynamic formula. Dynamic formula results usually differ from PDA or wave equation results. The Geotechnical Section provides a chart for determining driven pile acceptance based on wave equation analyses.

Recording Data
Two or three individuals are needed to document and record pile driving data. Using a saximeter or paper and pencil, one records blows per minute during driving. A second Inspector records blows per foot for every foot driven. Be ready to count blows per inch when driving approaches 100 blows per foot, as piles can be damaged operating near ultimate pile capacity, and near hammer refusal. Refer to the MDT Pile Driving Chart, and plot blows per minute or per foot or inch, and determine driven pile capacity relative to ultimate pile capacity.

CES Bridge Reviewers may provide an informational spreadsheet augmenting the MDT Geotechnical Pile Driving Inspector Chart. Spreadsheets show ultimate pile capacity in kilonewtons using the Gates Formula at any elevation during the drive. Project

Managers furnish the MDT Geotechnical Section with a pile driving record for inclusion on the Pile Driving Log Form.

If a pile tip is near plan elevation, but has not developed ultimate pile capacity, Contractors are to stop driving so the Project Manager can notify the Geotechnical Section. Contractors should prepare to wait 24 -0 72 hours before resuming work. In some cases, wait times may exceed 72 hours. The Project Manager should forward re-strike ultimate pile capacity information to the Geotechnical Section to determine if the pile may “set-up” to meet required capacity during re-striking.

Splices

Pile driving Contractors should order pile lengths and plan driving sequences to minimize splicing. Project Managers may meet with Contractors before pile ordering to discuss pile lengths and driving sequences to minimize waste and splicing. If splicing is necessary, handling holes may be drilled to handle new sections during welding, during which time “flame cutting” holes is prohibited. Standard Specification Subsection 559.03.5 requires Contractors to drive service piles continuously unless the Department requires re-driving. Waiting a few hours during splicing is an acceptable exception to continuous driving, as is waiting to purchase and ship additional pile.

Pile Tip Elevation

Inspectors determine if pile is driven to specified pile tip elevation. If the contractor has not driven the furnished pile length minus plan embedment, the pile tip is likely not at design tip elevation, which is shown on end bent and intermediate bent sheets. Inspector or Project Manager must contact the Geotechnical Section if plan and field tip elevations differ by more than 1 ft. The MDT Geotechnical Section may approve a service pile at design pile tip elevation but short of planned ultimate pile capacity during driving, or recommend a re-strike. The section may also instruct the contractor weld a pile extension and resume driving. A tip elevation above design elevation may be approved, if ultimate pile capacity is met.

Pile Driving Problems

The CES Bureau must approve “maximum stroke” driving procedures. Pile driving without damage for 2 ft or less at 10 blows per 1/4 inch is not considered hard driving. ”Hard-driving” procedures usually require means aside from an approved pile hammer. Occasionally, piles encounter a shallow hard layer, and require careful driving. Most hammer energy is dissipated overcoming skin friction resistance, but resistance at the tip when driving through shallow hard layers may cause enough tip damage in just two or three blows to destroy pile capacity.

Pile Driving Inspection

Inspectors may suspend driving to realign the pile, truncate a deformed head, align the hammer and leads with the pile, or brace pile supporting leads. Contractors should not use excessive force to realign a deeply driven pile. Suspend driving if the hammer is not operating with required energy levels during final driving stages. Piles drive differently, making experience and judgment important. Seek assistance with unfamiliar driving situations.

Truncating Piles
Subsection 559.03.6, Standard Specifications

Piling groups must be truncated at equal elevation, and deburred so the concrete cap bears fully on the piling. Record pile cut off lengths, and do not allow piles to be cut until Geotechnical Section acceptance is granted.

Concrete Filled Steel Pipe Piles

Contractors provide light for inspection. Mirrors may be used to reflect sunlight into the pile casing. Dropping a rock into the casing may reveal water or mud in the casing, or a firm bottom. If casing water is present during concrete placement, Contractors must tremie concrete to solid material inside the pile. Tremies must be embedded in concrete during placement.

Measurement Method
Subsection 559.04, Standard Specifications

Payment Basis
Subsection 559.05, Standard Specifications

SECTION 561
BRIDGE DECK MILLING

Description
Subsection 561.01, Standard Specifications

Materials
Subsection 561.02, Standard Specifications

Construction Requirements
Subsection 561.03, Standard Specifications

Refer to the inspection guide for bridge deck milling procedures and materials.

Measurement Method
Subsection 561.04, Standard Specifications

Payment Basis
Subsection 561.05, Standard Specifications

SECTION 562
BRIDGE DECK REPAIR

Description
Subsection 562.01, Standard Specifications

Materials
Subsection 562.02, Standard Specifications

Construction Requirements
Subsection 562.03, Standard Specifications

Refer to the bridge deck repair procedures and material inspection guide.

Measurement Method
Subsection 562.04, Standard Specifications

Payment Basis
Subsection 562.05, Standard Specifications

SECTION 563
MODIFIED CONCRETE OVERLAY

Description
Subsection 563.01, Standard Specifications

Materials
Subsection 563.02, Standard Specifications

Construction Requirements
Subsection 563.03, Standard Specifications

Refer to the modified concrete overlay inspection training guide.

Measurement Method
Subsection 563.04, Standard Specifications

Payment Basis
Subsection 563.05, Standard Specifications

SECTION 564
STRUCTURAL TOLERANCE

Description
Subsection 564.01, Standard Specifications

Construction Requirements
Subsection 564.03, Standard Specifications

Although standard specifications stipulate minimum tolerances, contractors are required to adhere to stricter connection tolerances. Contracts may include plan notes or special provisions governing tolerances for particular items. If a constructed item does not meet tolerance, contact the designer and bridge reviewer.

Measurement Method
Subsection 564.04, Standard Specifications

Payment Basis
Subsection 564.05, Standard Specifications

SECTION 565
BEARING DEVICES

Description
Subsection 565.01, Standard Specifications

Materials
Subsection 565.01, Standard Specifications

Construction Requirements
Subsection 565.03, Standard Specifications

Refer to the bearing device and joint inspection guide.

Measurement Method
Subsection 565.04, Standard Specifications

Payment Basis
Subsection 565.05, Standard Specification

SECTION 601
WATER SERVICE LINES

Description
Subsection 601.01, Standard Specifications

MDT projects may include municipal water line replacement, relocation and adjustment, and may be specified for weigh stations, rest areas and irrigation systems.

Materials
Subsection 601.02, Standard Specifications

Materials not listed on the QPL must be submitted with material data sheets.

Construction Requirements
Subsection 601.03, Standard Specifications

Underground Utility Construction

Metal water service line installation may need to meet Montana Public Works Standard Specification requirements in addition to MDT specifications. Contractors must coordinate existing overhead and underground utility work, including work not within the contract.

Potholing

Local governments require project utility locates. Potholing may be required to verify subsurface material location, depth, and condition. Municipalities may request extra work from MDT Contractors to resolve utility conflicts. Local governments often coordinate with Contractors to plan, schedule and perform work. MDT may require a change order, for which the CAS Bureau will set up funding and payment accounts. Project Managers must agree work will not interfere with MDT project objectives. Potholing is normally a contractor function, and only qualifies as extra work when unforeseen utilities are encountered. Potholing equipment safely and effectively locates underground utilities using high pressure water to expose utilities and capture excavation spoils.

Project Managers must verify pipe joints are constructed as approved. Pipes must be uniformly supported and aligned correctly. Typically alignment deviation is limited to 4in/100 ft, with thrust blocks reinforcing sharp pipe bends. Prior to backfilling, water systems must be pressure tested to isolate and repair leaks.

Measurement Method
Subsection 601.04, Standard Specifications

Contractors may work for local agencies under a local agency agreement. Inspectors should review the contract to identify special local agency requirements pertaining to pavements, gravel sections or backfill material.

Payment Basis
Subsection 601.05, Standard Specifications

SECTION 602
REMOVE AND RELAY PIPE CULVERT

Description
Subsection 602.01, Standard Specifications

Pipe culvert removal and relay is sometimes used to relocate culverts in good condition. A previous project may have installed a culvert, but roadway widening may require culvert relocation. Section 602 outlines pipe salvage for relocation or for MDT maintenance work.

Materials
Subsection 602.02, Standard Specifications

Construction Requirements
Subsection 602.03, Standard Specifications

Removal and Backfill

Contractors select culvert removal methods. Photo document culvert condition before and after removal, and verify pipe is undamaged during removal.

Pipe Culvert Relay

Ensure bedding and compaction requirements are met and mortar or preformed gasket material is removed from pipe joints. Cracked and broken concrete must be addressed.

Pavement Restoration and Maintenance

Pavement repair patching may be included in the unit price for pipe culvert relay if contract documents include patching details. If patching is paid under another item, work limits may be determined and paid by the Project Manager according to placed quantity.

Measurement Method
Subsection 602.04, Standard Specifications

Payment Basis
Subsection 602.05, Standard Specifications

SECTION 603
CULVERTS, STORM DRAINS, SANITARY SEWERS, STOCKPASSES AND UNDERPASSES

Description
Subsection 603.01, Standard Specifications

Roadway drainage is essential to highway function and durability. Standard Specification Section 603 covers drainage structure construction.

Materials
Subsection 603.02, Standard Specifications
Plant Inspection
Precast Concrete Items

The MDT Materials Manual (MT-110) covers MDT fabrication plant inspection procedure for certified and uncertified precast concrete pipe, manhole, and box culvert manufacturers. Plants meeting certification requirements are listed on the QPL. The Materials Bureau evaluates quality control programs for uncertified plants, and assigns MDT inspection at the plant. Fabrication plant Inspectors prepare inspection reports and photos for items shipped to construction sites, with documentation noting acceptable product defects. Reinforced concrete pipe added by change order requires additional Fabrication Plant Inspector inspection coordination.

Corrugated Metal Pipe (CMP)

MDT Fabrication Plant Inspectors randomly inspect corrugated metal pipe at the plant. Inspection reports are forwarded to Project Managers, and list manufacturer, heat number, base metal, brand name and pipe thickness. Manufacturers provide a list of pipe materials shipped to the job site. Contractors must furnish Project Managers with Compliance Certificates and Form 406, showing mill test results, heat numbers, and manufacturing origin, which must be received before pipe installation and payment.

General Field Inspection

Field Inspectors examine fabrication plant Inspector documentation at the jobsite to ensure correct item delivery and assess product condition prior to shipment. Visually inspect products upon delivery to ensure pipe was not damaged during handling. Contractors should carefully unload, store and handle pipe sections to avoid coating scars, chips, cracks and repairs. Examine pipe sections before placement and verify or note:

- Correct diameter and material specification compliance
- Spalls, dents, or chips around pipe ends
- Interior and exterior cracks
- Precast concrete pipe fabrication date
- Class or “D-load”, plant identification, and elliptical or quadrant reinforcement type for precast pipe
- Pipe identification marks with lot or production numbers matching certification
- Compliance certificates for pipe, gaskets, banding material, and hardware
- Compliance certificate water tightness requirements for water tight joints
- Damage to polymeric or asphalt coating

Corrugated Steel or Aluminum Pipe

Corrugated metal pipe is fabricated from thin corrugated metal sheets, and depend on evenly distributed soil pressure around the pipe. Two flexible metal pipe types are used, corrugated steel pipe (CSP) and corrugated aluminum pipe (CAP). Project culvert summary frames designate pipe material. Various pipe corrugation size and shape combinations are available. Check inspection report pipe heat numbers and wall thicknesses. Compare pipe size, length and wall thickness for each location against contract documents, as well as the manufacturer shipping list. If discrepancies are found, pipe should be rejected and returned to the manufacturer. Manufacturers sometimes convert shell thickness to inches rather than using a gage classification. If pipe is identified via gage rather than thickness, a thickness conversion is necessary for acceptance, which must accompany mill test certifications.

If minor corrugated pipe dents can be pounded into shape without damaging protective coating, pipe sections may be acceptable. If coating has been removed or cracked, or a dent is large, pipes will rust and require replacement. Corrugated 5” x 1” steel pipe is flexible and may be damaged if loaded improperly. Holes can be worn into the pipe if components are in contact during transport. CSP/CMP coating types include polymeric, asphalt, zinc and galvanization. Minor coating damage may be repairable. Coating types require specific repair methods, so Contractors must submit repair procedures for Project Manager review.

Reinforced Concrete Pipe (RCP)

Final acceptance is granted in the field. If products are insufficient for Department usage, paint an orange “X” next to the plant identification stamp, and inform the Contractor material is rejected. Identify needed repairs, and explain needed corrections prior to Departmental usage.

When precast pipe arrives, verify casting dates and supplier certification for each joint. Verify plant certification during production, and forward casting dates to the materials lab to confirm inspection and material testing. Pipe made without plant inspection and testing is unacceptable. Plant inspected pipe may be rejected for poor workmanship or material issues. Poor handling and latent defects often cause damage which only becomes apparent later. In addition to MDT inspection, Contractors should inspect each RCP delivery, and may still be liable for unacceptable damage appearing after installation. Concrete pipe may be rejected if:

- Class, manufacture date, name, or trademark are unindicated
- Manufacturing defects or improper handling damage are present
- Improper size or class is indicated
- Pipe wall cracks excepting single end cracks exceed joint depth
- Continuous cracking 0.0156 inch wide or more, and 12 inches long or longer is present
- Defects indicate concrete proportioning, mixing, or molding has affected pipe structural integrity
- Surficial pipe defects such as honeycombing will adversely affect performance
- Dimensions are outside specified tolerance
- Pipe ends are not normal to pipe axis or have damage
- Pipe sections have failed a specified test

Structural Steel Plate Pipe and Stockpasses

Ensure required paperwork has been provided, and material is in accordance with Standard Specification Section 709. Contractors must furnish Project Managers with Compliance Certificates and Form 406 showing mill test results, heat numbers and manufacturing origin before steel pipe is installed and paid.

Revised Pipe List

Pipe location and length confirmation staking should be completed as early as possible. Project Managers prepare a revised pipe list Contractors use to order pipe and related material. This list incorporates needed field adjustments. Excavation and embankment limit changes often alter pipe length, grade, elevation and alignment. Plan dimensions may be used if approach pipes are ordered before field staking completion. Revised pipe lists should incorporate field adjustments. Pipes to be installed first should be staked first, and an initial pipe list started with these locations. Update Contractors with a revised pipe list as work continues. When Contractors are responsible for pipe staking, they verify pipe length, grade, elevation and alignment. Corrugated metal pipes over 54 inches in diameter are marked to aid with field assembly and manufactured in 2 foot lengths.

Buy America

Unless otherwise approved before work begins, steel products such as rebar and high strength wire incorporated into permanent work must meet domestic steel Standard Specification Subsection 106.09 “Buy America” requirements.

Construction Requirements
Subsection 603.03, Standard Specifications

Planning Before Installation

Drainage systems are located and designed early during project development based on current information. Plan locational information and invert elevations are shown for outlet ditches, sewers, channel changes, culverts and other drainage facilities. Because construction may cause additional drainage issues, particularly with respect to groundwater, continually monitor construction for needed drainage improvements.

Review proposed pipe installation parameters to ensure planned location, skew angle and length meet roadway configuration(s). Check channel grade to determine pipe end elevations. Contractors should check pipe lengths before ordering material. Project Managers should discuss needed pipe length, grade or elevation changes with design Project Managers and Hydraulics before installation to allow hydraulic or structural capacity changes. Before installation review:

- underground utility and structure marking and protection
- OSHA trenching and confined space entry safety requirements, including shoring plan preparation, excavation edge protection, and safety fence
- notification of utility companies affected by trenching, pipe installation, and temporary utility shutdown
- securing local permits
- benchmark and survey monument locations

Preliminary Pipe Staking

Culverts should be staked and installed before grading, but may also be installed during fill operations. If the contract requires Contractor pipe staking, staking notes must be provided to Project Managers before installation. Pipes are staked using pipe notes, and field staked to avoid mistakes during installation. Plan skew angles should correspond with field conditions, with corrections made to suit field conditions. Staked pipe length must account for slope and be compatible with available pipe lengths. Offset hubs at each culvert end should be located outside construction limits to prevent disturbance. Guard stakes placed over each hub must show cut or fill to invert elevation for metal pipe, invert elevation minus shell thickness for concrete pipe, and offset distance from the culvert end. Other installation information regarding pipe length, type and size may be shown on guard stakes. If plan invert elevations are not shown, stake elevations 10% of pipe diameter lower than inlet and outlet channel elevation and use additional bedding to minimize piping.

Locational cross sectional data used to design drainage installation may not match plan stationing, and some station and length adjustment may be needed to fit field conditions. Installations must satisfy ROW Agreements. Check pipe top elevations for adequate cover. If cover thickness changes, consult Hydraulics.

Reinforced concrete pipe over 36 inches is not kept in stock and contract specific. Stake and confirm larger concrete pipe lengths as soon as possible to avoid fabrication delays. Standard reinforced concrete pipe segment length is 8 ft. Two foot reinforced concrete pipe segments are useful when fill slopes cannot be fit using standard lengths. Structural steel plate pipe and stock pass delivery may take place a month after ordering, so staking should be completed early. Large culverts and stock passes may take priority over staking for other culverts.

Staking Inspection

Invert Elevation

Invert elevation is the interior pipe bottom elevation, typically 10% of pipe diameter below channel grade. Invert elevations are easily checked via optical level. Hubs and guard stakes are offset from pipe ends, and marked “cut” or “fill” relative to invert elevation or pipe bed elevation. Stakes should clearly indicate the elevation from which cut or fill values are referenced. (Figure 603-1).

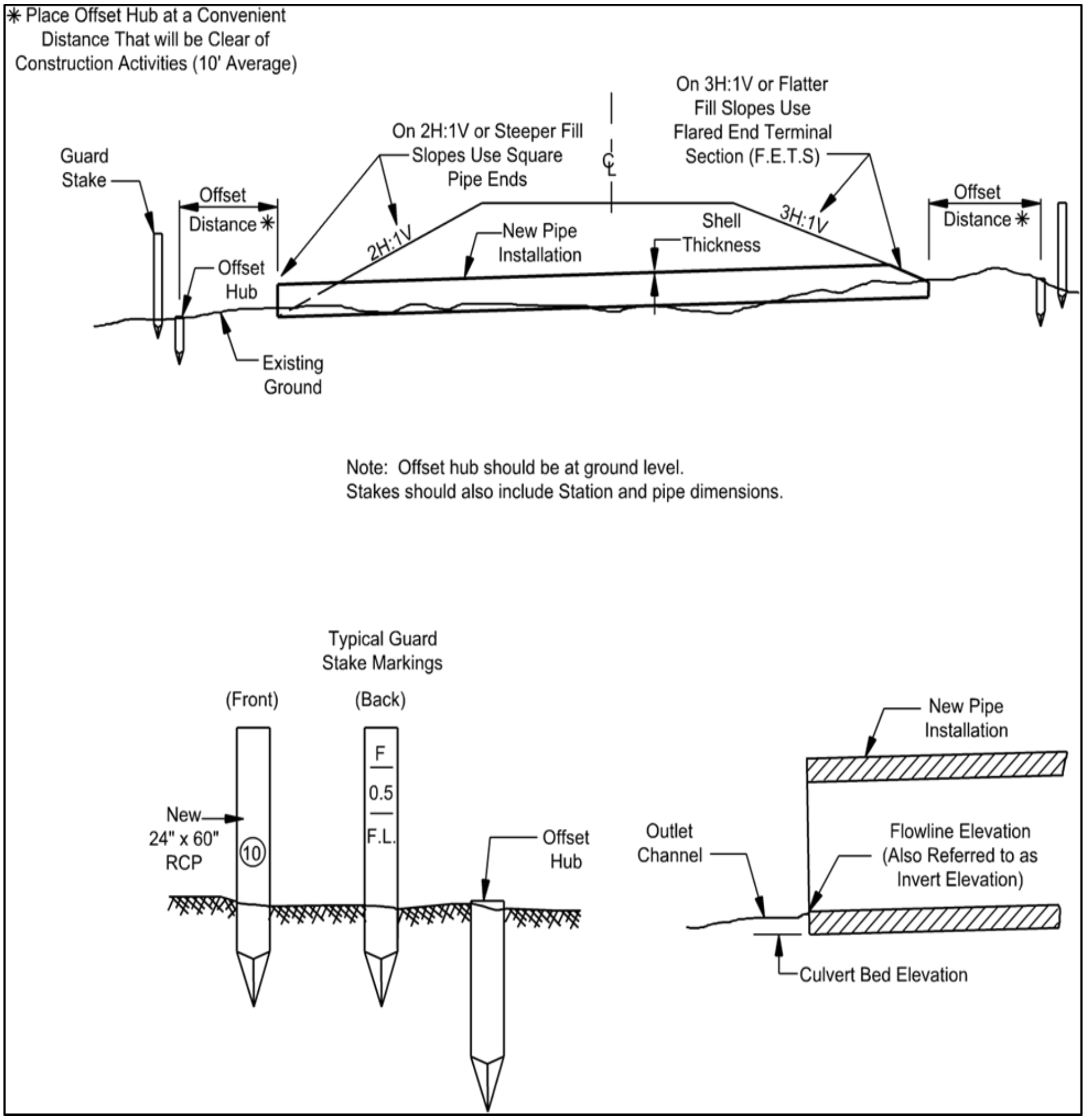


FIGURE 603-1
STAKED ELEVATIONS

Slope or Gradient

Culvert slope is the ratio of vertical drop to horizontal length between invert elevations. A 200 foot culvert with inlet invert elevation 3862.0 ft and lower invert elevation 3860.0 ft has a slope of 2 ft / 200 ft, or 1%. Usually the most desirable slope is the slope of the original pipe. Attaining this slope is often impractical, as construction may cause channel length or invert elevations to change. Consult Hydraulics prior to using minimum slopes.

Lowering Outlet End

Pipes placed within cut sections where an outlet ditch cannot be constructed without difficulty should be avoided. Ditch elevations on both sides of centerline may be equal along tangent sections, and need lowering and widening to provide enough slope to prevent pipe sedimentation. Lowering pipe outlets to increase slope also helps prevent sedimentation within the pipe. Slopes less than 0.3% for reinforced concrete pipe and 0.5% for corrugated metal pipe may be necessary in special cases. Consult Hydraulics before using minimum slopes (See Figure 603-2).

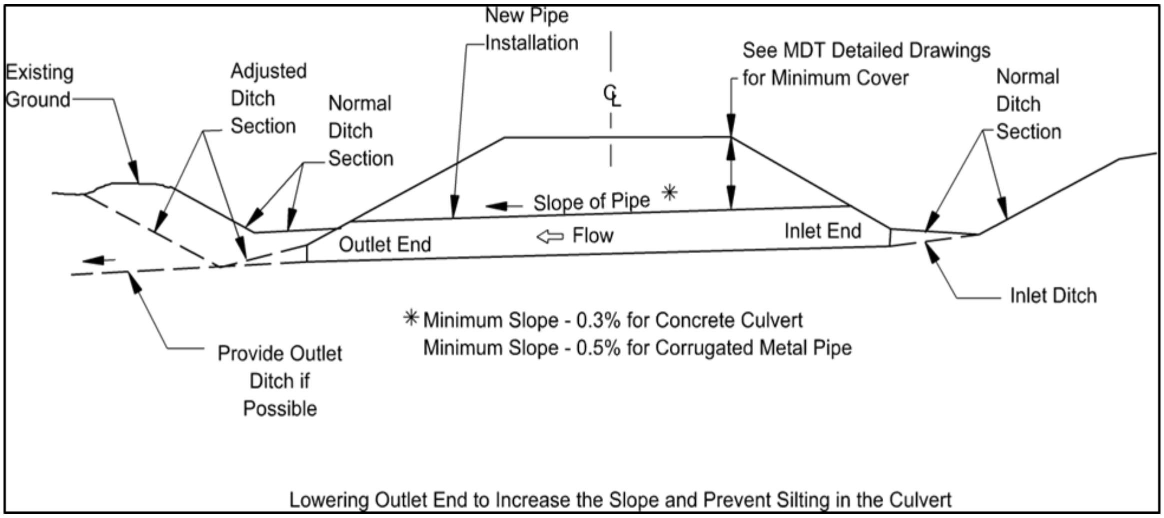


FIGURE 603-2
LOWERING OUTLET ELEVATION

Pipe Slope

Slopes greater than 2% may cause erosive velocities, especially at pipe outlets, although erosive slope values vary with soil type. A 2% slope might be erosive for a silty soil, but a 6% slope might be acceptable for coarse rock. Inform Project Managers of erosive slopes and discuss mitigation.

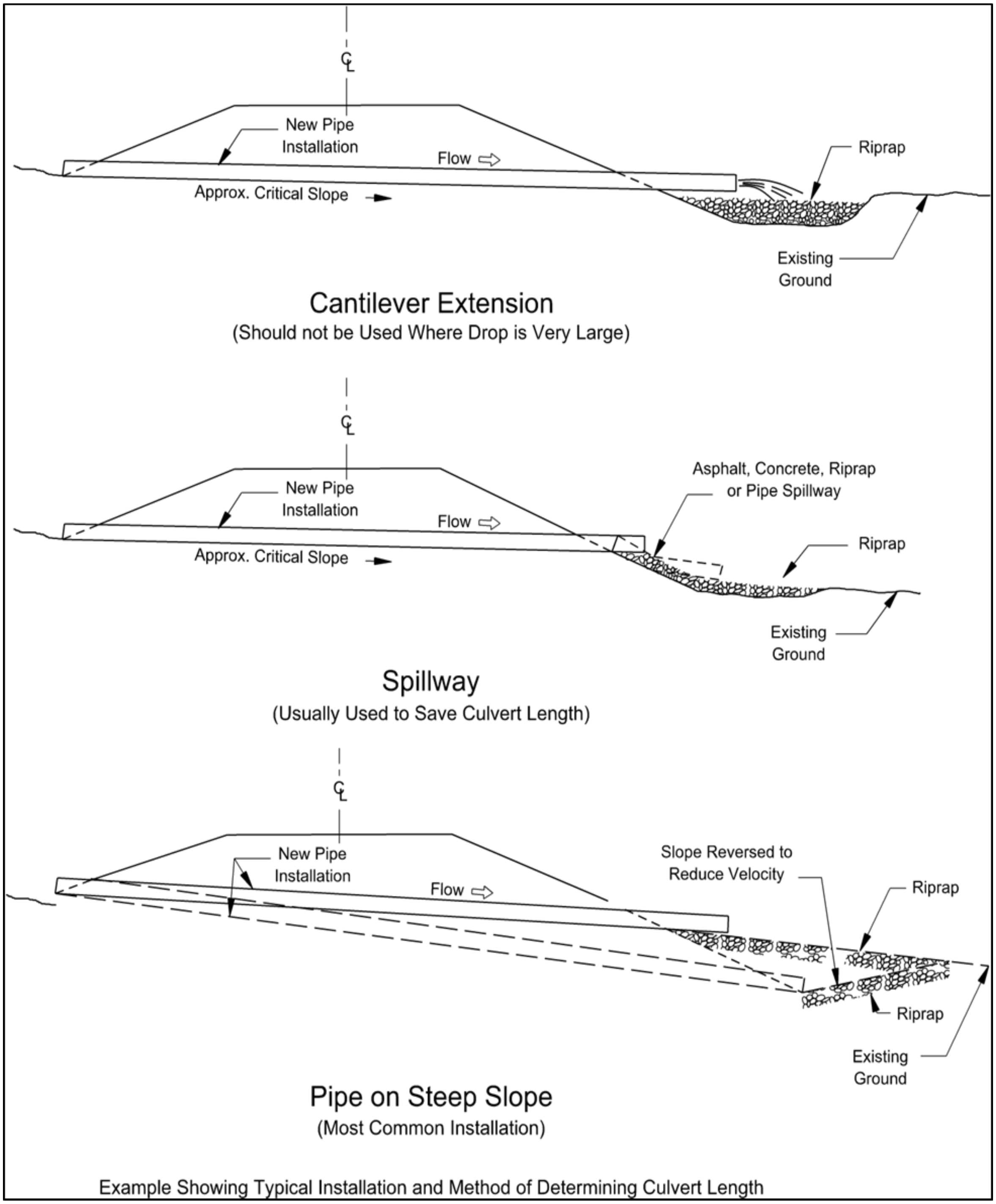


FIGURE 603-3

INLET TO OUTLET ELEVATION CHANGE

Approach Pipe Slope

Approach pipe slopes must match ditch slopes within cut sections, but invert elevations should be at least 2 inches below ditch grade. Roadway sections are ordinarily graded before pipe installation.

Side Slope

Approach side slopes of 6H:1V or flatter provide safe vehicle runoff areas. Approach pipes within the clear zone usually require end treatment.

Pipe Camber

Pipe cambering is a last resort to address settlement issues, and should only be used if specified. After pipe backfilling, further consolidation and settlement may occur to produce a sag after settlement. Bedding can be placed slightly arched, or with "camber" to account for settlement. When camber is computed correctly and adjusted to gradient, culverts settle to nearer desired slope and flow line. Camber varies with foundation soil and fill height, and is usually used under high fills prone to continuing settlement. Camber usage is also a matter of experience and judgment. When camber is used, always provide drop from the inlet to the pipe midpoint to ensure the upstream half does not accumulate sediment. Boxes culverts and pipes with diameters greater than 36 inches usually require geotechnical investigation. If unusually large settlements are predicted, camber may be specified after being computed at intervals along the pipe length:

A 100 ft culvert requires vertical adjustment at 25 feet , 50 ft and 75 ft from the inlet end. The formula for adjustment at each point is:

x @ 1/4 point = 0.06d
x @ 1/2 point = 0.25d
x @ 3/4 point = 0.56d

where:

x = camber adjustment, ft
d = inlet elevation minus outlet elevation, ft

Subtract camber adjustment "x" from the inlet elevation to obtain the cambered gradient elevation at the pipe midpoint, to a maximum of 6 inches measured along a straight line between inlet and outlet invert elevations. A 100 ft pipe with:

Inlet elevation = 1895.00 ft
Outlet elevation = 1894.00 ft
d = 1895.0 – 1894.0 = 1.0 ft

Camber values are:
x0.25 = 0.06 x 1.0 = 0.06 ft (1 in)
x0.50 = 0.25 x 1.0 = 0.25 ft (3 in)
x0.75 = 0.56 x 1.0 = 0.56 ft (7 in)

Pipe Length

Pipe length depends on road width, fill height, side slope, grade, alignment, pipe width and skew, clear zones and end treatment. Pipe length determination examples follow:

Pipe Length Calculation:

Left Shoulder Subgrade Elevation = 4,020.0 ft
Left Invert Elevation = - 4,005.0 ft
Fill Height = 15.0 ft

Slope: = 3H:1V
Horizontal Distance to Slope Stake = (3 ft x 15 ft) = 45.0 ft
Subgrade Width Left = +25.0 ft
Distance from Stake to FETS end = -4.0 ft

Length of Left Side Pipe = (25 ft + 45 ft – 4 ft) = 66.0 ft = 0.5A + B

Right Side Length:

Right Shoulder Subgrade Elevation = 4,020.0 ft
Invert Elevation = - 4,004.0 ft
Fill Height = 16.0 ft

Slope = 2H:1V
Horizontal Distance To Slope Stake = (2 ft x 16 ft) = 32.0 ft
Allowance for Slough = +2.0 ft
Right Subgrade Width = +25.0 ft

Length of Right Side Pipe = (25 ft + 32 ft + 2 ft) = 59.0 ft = 0.5A + C

Total Installation Length Perpendicular to Centerline:

Left Side Pipe Length = 66.0 ft = B + (0.5A)
Right Side Pipe Length = 60.0 ft = C + (0.5A) (round to nearest foot)

Total Length = 126.0 ft = A + B + C

Total Installation Length at 14 degree Skew to Centerline:

Left Side = (0.5A + B)/cos 14 degrees
= 66.0 ft/0.97030 = 68 ft
Right Side = (0.5A + C)/cos 14 degrees
= 59.0 ft/0.97030 = 62 ft (rounded)
Total Length = 130.0 ft = A + B + C

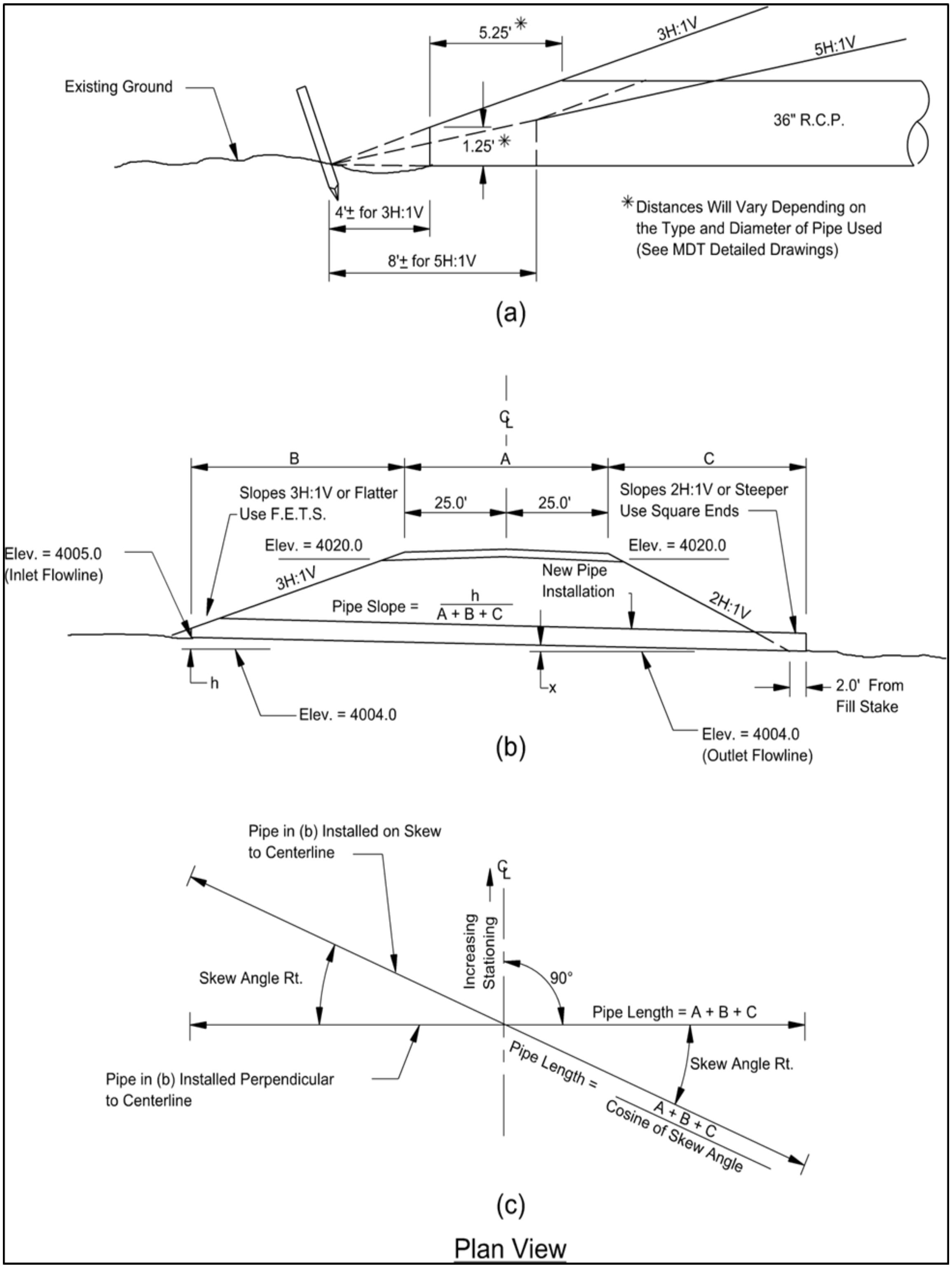


FIGURE 603 - 4
CULVERT LENGTH DETERMINATION

If the above pipe was installed at 5H:1V, 8 feet is subtracted from the FETS to match the slope. Be aware that FETS dimensions influence pipe length.

Longer pipe lengths at steep slopes must account for additional length due to slope. Following is a typical example having lengths (A + B + C = 300 ft), and a 60.0 ft inlet to outlet elevation difference:

$$\text{Total Length} = \sqrt{(A + B + C)^2 + h^2}$$

$$= \sqrt{300^2 + 60^2} = 306 \text{ ft}$$

OR

$$\text{Tan X} = h/(A + B + C)$$

$$x = \tan^{-1}(60/300) = 11°19'$$

$$\text{Total Length} = (A + B + C)/\cos x$$

$$= 300/\cos 11°19' = 306 \text{ ft}$$

Slope has increased pipe length from 300 feet to 306 feet.

Irrigation Pipe

Irrigation pipe invert elevations are critical because grades are typically low. A 0.1 ft error over a 10 ft drainpipe section on a 5% grade would not seriously affect the pipe, but a 0.1 ft error over a 10 ft irrigation pipe section on a 0.5% grade could cause ponding or reverse flow. Do not use hand levels to locate irrigation pipe invert elevations.

Structural Steel Plate Pipe and Stockpasses

Invert elevation grade and alignment for steel plate pipe and stockpasses are staked at approximately 20 ft centers. If used, camber should help ensure a smooth vertical curve, as irregular grade lines complicate erection and plate bolting. Pay particular attention to shaping steel plate arch pipe foundations. Shaping is easier if “blue top” rows are used, with one along centerline and another two along the bottom plate sides. Project Managers approve cambered foundations. Steel plate pipe invert elevations for stockpasses and vehicular underpasses are frequently set low, with floor elevations set slightly higher so water does not pool inside the pipe.

Excavation Considerations

Pipe Excavation

“Pipe excavation” refers to trench excavations not requiring vertical sides, for which Contractors determine excavation width according to operational needs.

Trench Excavation

Trench excavation” is used to place or remove storm drain, sanitary sewer, water line and other installations. Vertical trench walls may be constructed when excavation is 4 ft or deeper. Approved access such as ladders or ramps at required spacing must be provided. Excavations exceeding 5 ft must have trench walls sloped, benched, shored or otherwise supported. Deeper excavations may require a shoring plan approved by a contractor hired professional engineer. Workers should not enter excavations accumulating water. Air quality monitoring equipment may be required, as hazardous atmospheres may exist within excavations. Trench width must comply with Standard Specification Subsection 207.03.3.

Foundation and Bedding Considerations

See MDT culvert installation guidelines for SSPP and RCB culvert bedding, and MDT Road Design Manual Chapter 17. This information addresses bedding and backfill settlement associated with large culvert installations.

Pipe Installation and Assembly Considerations

Unless allowed by Project Managers, pipe is laid along ascending grade to help seat joints and prevent separation during installation. Pipe bells face upstream to reduce joint leakage. Ensure Contractors install gaskets in accordance with manufacturer recommendation, and have written manufacturer recommendations available during inspection. When existing pipe is extended, existing ends must be in adequate condition for joining to a new section. If an existing pipe end is damaged, remove the end to ensure a sound joint. Additional work is typically paid using the "Miscellaneous Work" item.

Corrugated Metal Pipe (CMP)

Placement and Alignment

Circular or arch pipes are relatively easy to keep aligned. Horizontal diameter or span is measured with a tape or rod and plumb bob to locate the top and bottom pipe center. A transit, laser or string line is used to maintain grade and alignment. Coordinate with Contractors to verify proper grade information is input to electronic levels.

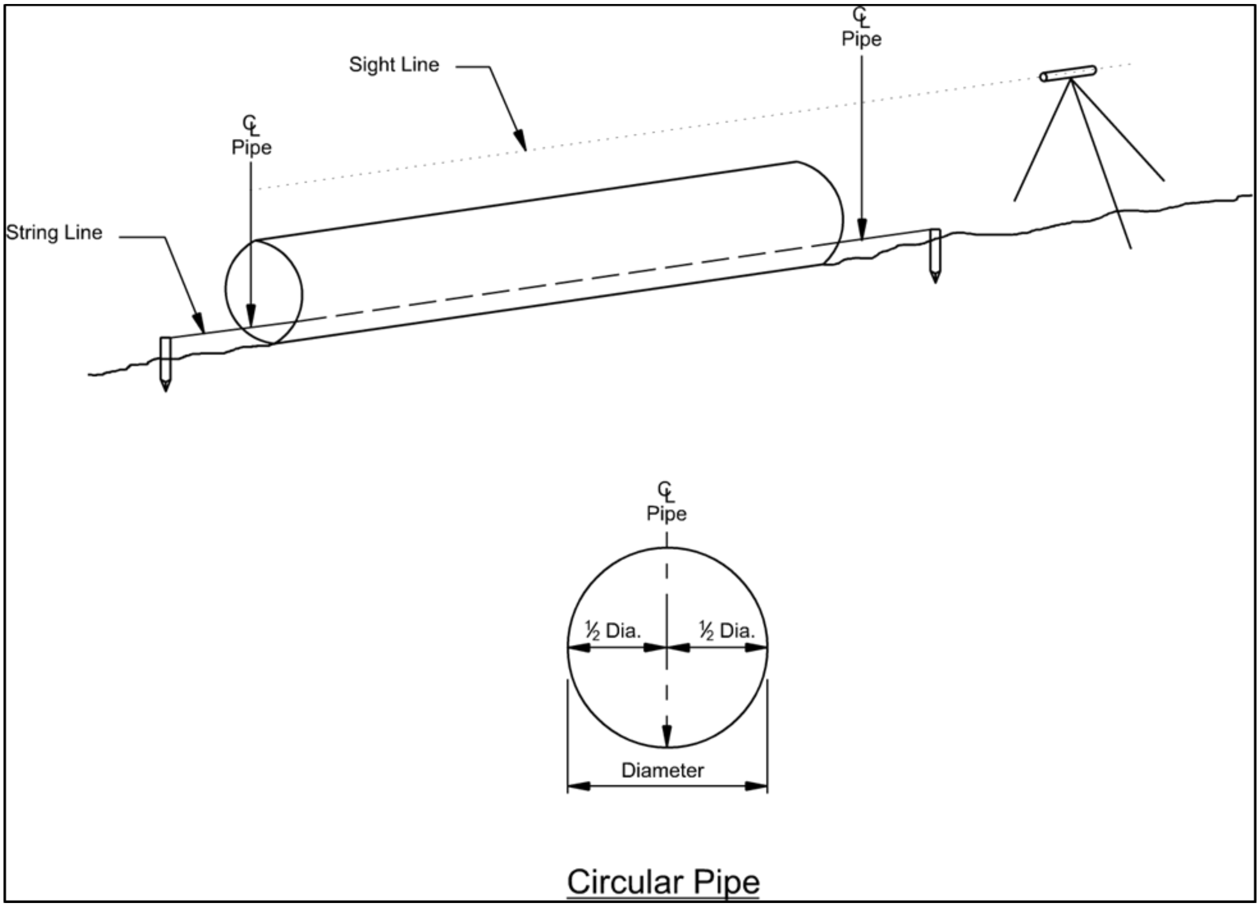


FIGURE 603-5

CORRUGATED METAL PIPE ALIGNMENT

Pipe Section Connections

Bands are used to connect pipe sections as shown by Figure 603-6. Field cast concrete collars may be needed to join dissimilar pipe (Detailed Drawing 603-26). If band quality is in doubt, send a band to the Helena lab for approval. Spaces between the pipe and band should be clear of soil, rock or debris. Tapping bands with a mallet as bolts are tightened helps seat the band for a tight joint. Proper CMP coupling band installation prevents leaky culvert joints.

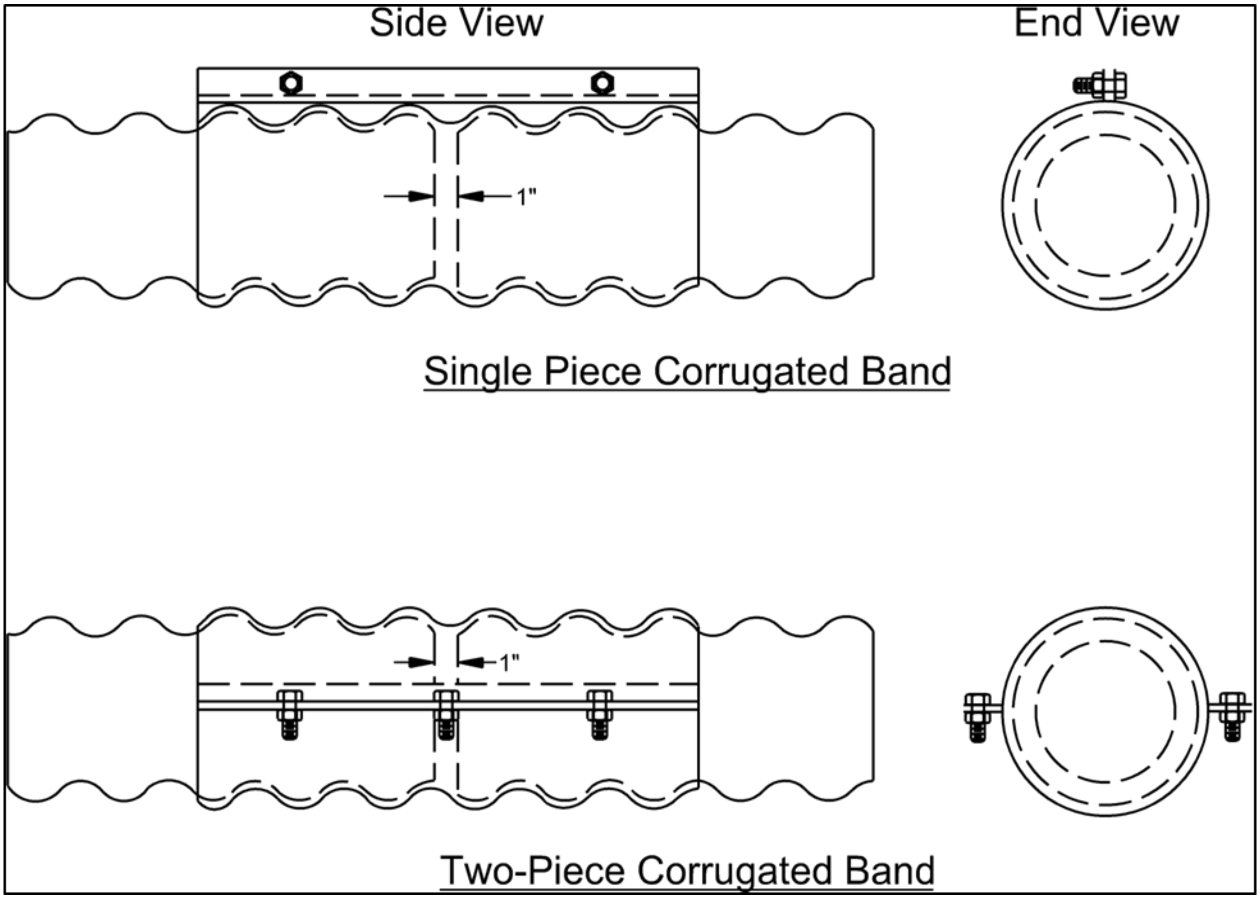


FIGURE 603-6

TYPICAL CORRUGATED METAL PIPE CONNECTION BANDS

CMP Drainpipe Applications

Most corrugated metal pipe is used as drainpipe to covey runoff. Corrugated metal drainpipe seams and joints should be tight, but do not have to be watertight. See Figure 603-7 below. Drainpipe location and type is designated using the following nomenclature:

Station 10+00
New 24″ DR
or
Station 10+00
New 24″ APP DR

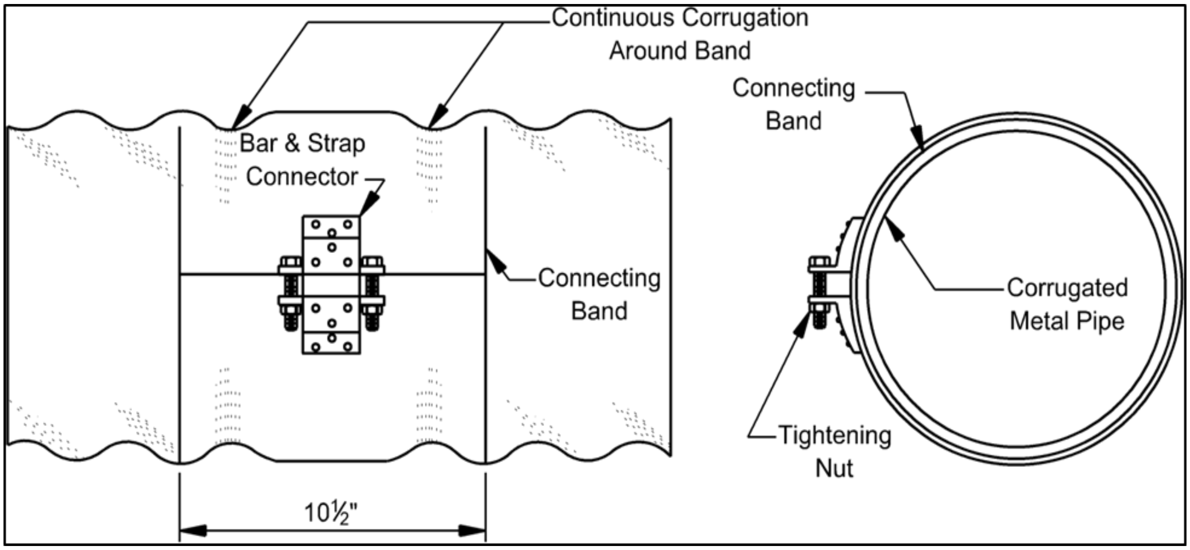


FIGURE 603-7
CMP DRAINPIPE CONNECTION BANDS

Reinforced Concrete Pipe

Reinforced concrete pipe is manufactured in 4 - 8 ft sections. Careful alignment and grade control is necessary. Using a string line, laser or transit for alignment and a level for grade eliminates errors during individual section placement. Contractors often use laser levels to maintain grade and alignment. Each pipe section must be correctly installed before placing the next. Forcing individual sections into alignment during backfilling jeopardizes joints, alignment and the pipe itself. Verify proper grade inputs into electronic levels.

Pipe must be installed with bell end upstream and recessed into the bedding so pipe lies evenly (Figure 603-8). After section placement, ensure bedding is properly shaped and the pipe is snug. Pipe should barely touch bedding on both sides and rest evenly on the trench bottom. Improperly shaped bedding can be further shaped by rolling or lifting pipe from the trench. Never permit contractors to shape bedding by raising and dropping pipe. Pipe should never be used to tamp bedding into shape. Contractor damaged pipe should be rejected. Minor chips can be repaired using grout if flow efficiency is unaffected. Bells may fracture if the adjoining section is not inserted properly, so bells should be inspected after assembly. Notify the Contractor as soon as possible if pipe needs repair or is rejected so replacement pipe can be ordered.

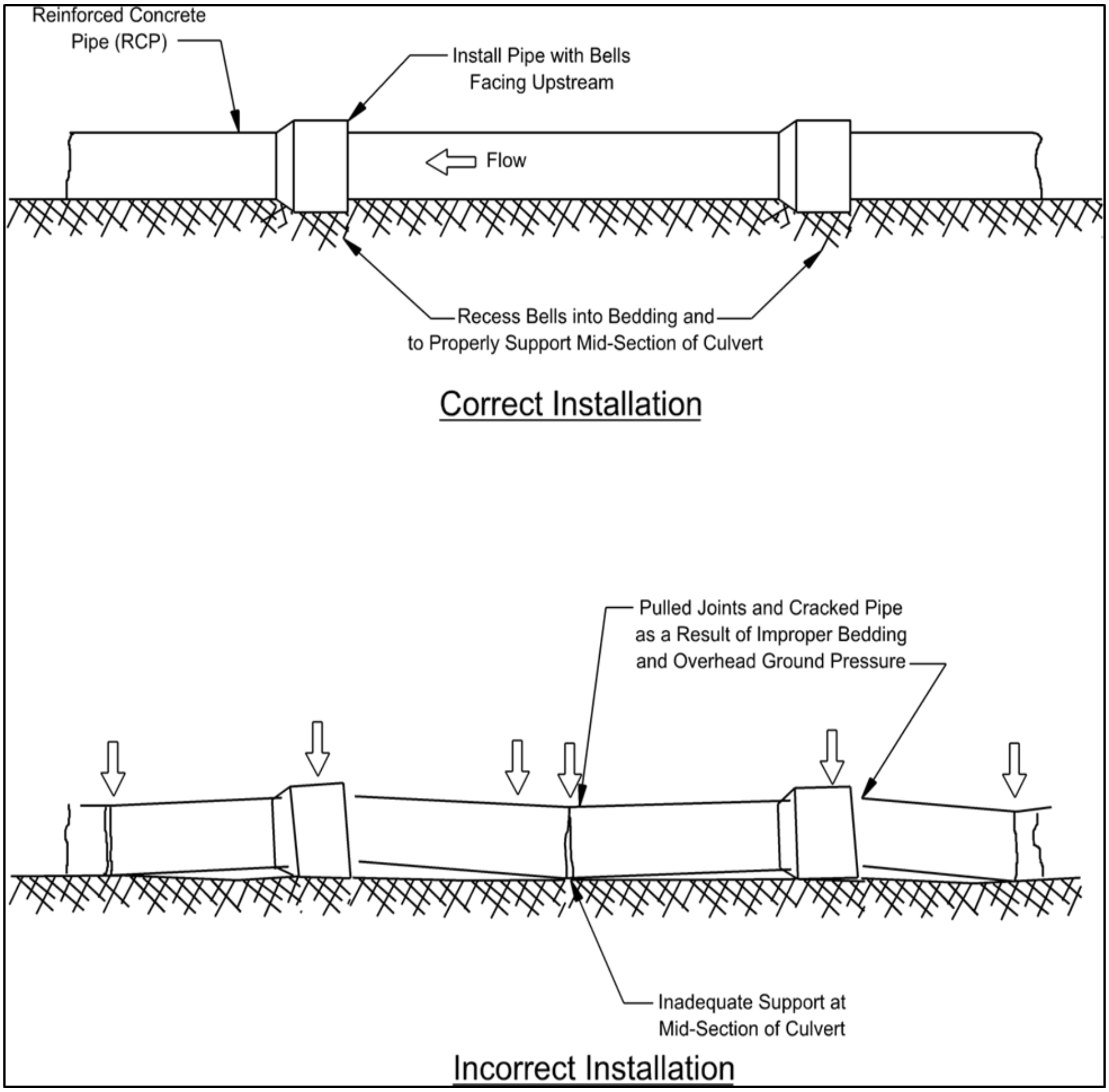


FIGURE 603-8

REINFORCED CONCRETE PIPE INSTALLATION

RCP Drainpipe Applications

Reinforced concrete pipe sections installed as drainpipe are normally dry installations, and use joints sealed by flexible gasket material. Flexible joint sealing compound must meet Standard Specification Subsection 707.02.2 requirements, and is rope sized to fill spaces between pipe sections. Compound should have a removable wrapper permitting one sealant half to be molded around the tongue or inside the bell without disturbing the remaining adhesive sealant surface. Compound should be placed completely around the joint circumference, and trimmed to avoid flow impedance. Rope diameter should be increased with pipe size to fill spaces between sections.

Irrigation and Siphon Pipes

The Hydraulics section designs irrigation and siphon pipes to provide needed flow. Consult Hydraulics if invert elevations, siphon characteristics or installation locations need adjustment. Irrigation appurtenances and siphon pipes usually involve ROW and Irrigation District Agreements, so changes to existing systems require review.

Material Type

Reinforced concrete pipe is used for irrigation and siphon pipes, both of which require watertight joints. Rubber gasket or flexible plastic joint sealing compound is permitted for arch RCP only. Rubber gaskets should not be used with reinforced concrete arch pipe for watertight applications. Rubber gaskets must conform to AASHTO M198 and Standard Specification Subsection 707.02.1, and be compatible with the pipe tongue. Joint sealing is easiest using recommended gasket lubricant although other compounds may be used with Materials Bureau prior approval. Occasionally special joints and seals are required to address unusual installations such as siphons.

Irrigation Pipe Applications

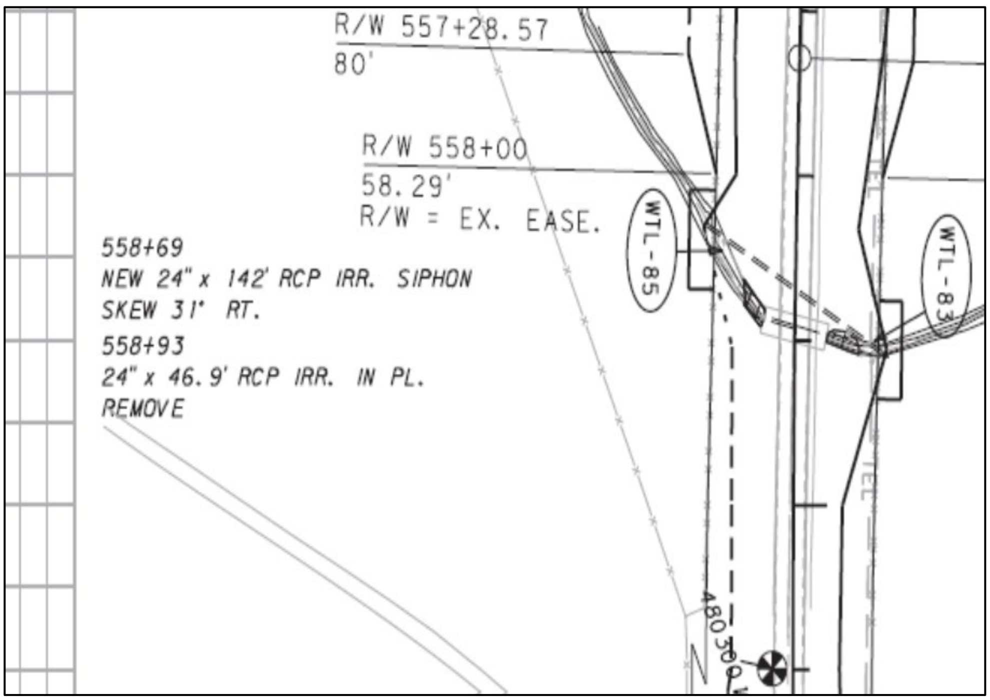
"Irrigation pipe" requires watertight pipe and joints. Conveyances carrying continuous flow over extended periods are referred to as "irrigation pipe", and designated using the following format:

Station 10+00 New 24 RCP IRR. App. Lt.

Siphon Pipes

Siphons are used when outlet elevations at pipe crossings are too high for gravity flow within cuts or shallow fill sections where irrigation ditch invert elevations cannot be changed. Siphon pipes are designated using the following format:

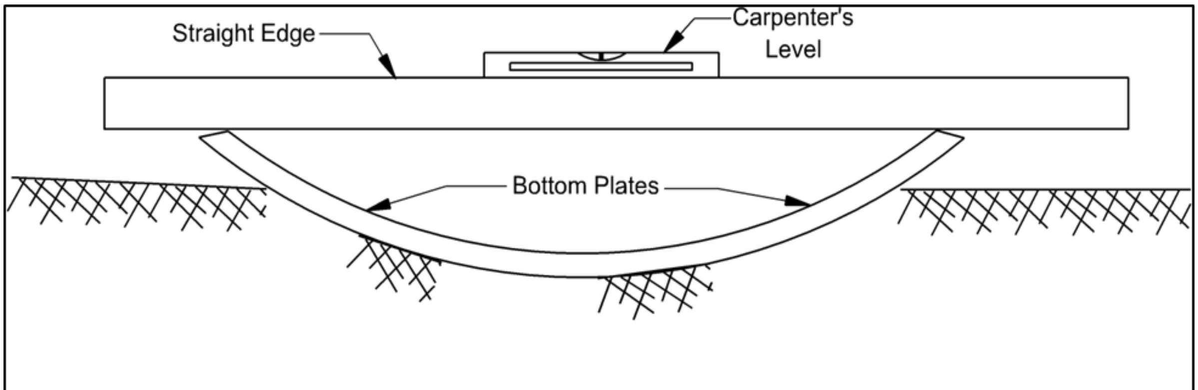
Station 10+00 New 24 RCP SIPH. IRR. App. Rt.



The most critical siphon installation phase is section connection. Siphon pipe and irrigation pipe connection specifications are identical. Siphon pipes have internal water pressure and require carefully sealed joints to prevent leakage. If possible, install pipe and check for leaks before backfilling. Leaks are easiest to address before backfilling. Inlet and outlet elevations should be checked before backfilling after the entire pipe is installed. If bend angles or sloped section lengths are incorrect, inlet and outlet elevations will be incorrect. Verify bend elevations.

Structural Steel Plate Pipe and Stockpasses

Standard Specifications require structural plate assembly in accordance with manufacturer recommendation. Assembly instructions for each structure must be furnished to Project Managers by contractors. Bottom structural plates must be completely placed before side and top assembly to avoid staking errors and verify material lengths. Large diameter and heavy gage pipe rings should be installed promptly to prevent plates from folding and make bolting the top seam easier. Check the vertical axis of steel plate pipe during assembly to avoid spiraling construction, which diminishes pipe height and causes one side of the bottom plate to be sloped side to side. The best way to align the vertical axis is to closely control bottom plate assembly. Place a straight edge across the top edge of the bottom plates, then place a carpenter's level on the straight edge, and adjust plates so they are level (Figure 603-9). Place enough backfill under pipe haunches to keep bottom plates level.



Method of Assuring Proper Alignment of Vertical Axis of Structural Steel Plate Pipe

FIGURE 603-9

STRUCTURAL STEEL PLATE PIPE ALIGNMENT

Steel plates should be bolted loosely into position until 4 rings are assembled (Fig. 603-10). When all plates are positioned, remaining bolts are progressively tightened. Bolts can be placed in corrugation valleys or crests. Nuts are placed on the pipe interior for lower plates and on the pipe exterior for side and top plates. Varying bolt lengths may be used, depending on plate gage and whether seams have double or triple plate thickness. Longer bolts may be used to draw plates together, but should be replaced by standard length bolts.

For heavy gage plates, bolt tightening is done in two or more stages to avoid scarring galvanization around bolt holes. After bolts have been initially placed, tighten snugly by impact wrench. Bolts typically loosen with initial tightening as the pipe takes shape. A second tightening ensures specified torque and tightness.

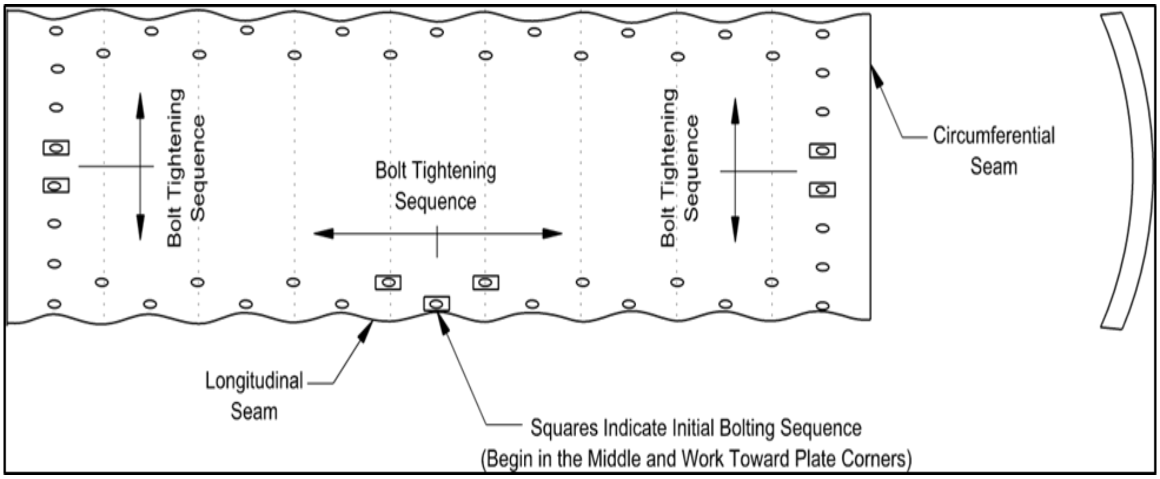


FIGURE 603-10

BOLTING STRUCTURAL STEEL PLATES

After pipe assembly, Project Managers check bolts for proper torque in accordance with manufacturer specification. Torque is measured using a torque wrench to check every tenth bolt in each row. Take additional torque measurements in areas having loose bolts.

Backfill Considerations

Pipe installation can be diminished by difficult to compact backfill. In these cases flowable fill is a good backfill option.

Material Selection

Select quality backfill material without topsoil, stone, frozen soil or deleterious material, such as coal or organic material. Impervious material is best around the pipe to prevent piping and flow along the pipe exterior. Trench backfill is typically native material from the trench. Contractors may use bedding or flowable fill for backfilling if these materials are quicker and more efficient.

Moisture Content

Backfill moisture content during compaction must be uniform prior to placement. Backfill material must be within 2% of optimum moisture content, or within the proper Zero Air Voids range. Backfill soils are much easier to compact at optimum moisture, and pipe movement is minimized during compaction. Compaction is at risk unless material is within 2% of optimum moisture content.

Backfill Placement

Backfill must be compacted uniformly around the pipe in lifts not exceeding 6 inches loose thickness. Unequal backfill pressures can push structures from alignment, and subject pipes to unaccounted for design stresses. Place and compact backfill evenly to original grade.

Compaction Considerations

Ensure Contractors use care when tamping haunch area backfill (lower 10% on both pipe sides) to avoid alignment and flow grade changes. Verify backfill is compacted under pipe haunches (refer to MDT Detailed Drawings) by hand tamping. Poking a stake under the pipe is an effective field check to detect backfill voids. Failure to properly tamp under haunches, introduces excessive stress on the lower 10% of the pipe, and water movement alongside the pipe exterior may cause lateral movement. Tamping under haunches is usually done using hand operated equipment to 95% density. Because arch bottom plates are relatively flat, mechanical tampers cannot be used under pipe arches. In such cases, backfill is compacted by ramming with 2 in x 4 in timbers. Flowable fill may be used around haunches or in difficult to compact areas.

Pavement Restoration

Contractors must maintain the integrity of completed pipe trench areas until final project acceptance. Contracts may require a temporary, plant mix riding surface. Watch for and require Contractors to correct surface defects. Loaded heavy equipment usually exceeds design loading, so pipe failures are likely to occur when only temporary cover is in place to permit hauling. Ensure cover is ramped over pipes using a gradual slope instead of a narrow ridge. Impact from loaded, higher speed equipment may severely damage pipes. Do not allow heavy equipment to pass over pipes until backfill 4 feet or ½ pipe diameter (whichever is greater) thick is compacted over the pipe. Surfaces over structures should be level with a gradual ramp on each side. Ensure hauling units making repeated trips over pipes utilize full roadway width and offset wheel paths to avoid rutting associated with narrow haul paths. Contractors must maintain the work through final acceptance. Inspectors should mention concerns to the Project Manager and Contractor, and document conversations the DWR. Inspect Pipe For:

- Debris or obstructions
- Cracks exceeding specified width or depth
- Properly sealed watertight pipe joints
- Correct invert elevations
- Properly plugged pipe ends
- Properly made connections and hookups
- Properly connected catch basins, inlets, and drains
- Completed patching and crack repair
- Bulges, dents, or other damage
- Complete coating
- Tight concrete pipe joints and within tolerance concrete box joints
- Shape and alignment
- Correctly installed pipe end treatments
- Corner radius bolt hole cracking on structural steel pipe
- Properly draining inlets and outlets
- Properly installed inlet grates
- Settlement over new pipe

Measurement Method
Subsection 603.04, Standard Specifications

Documented pipe information includes heat numbers, wall thickness, length, size, class, pipe type and other information describing the installation. Pipe notes must be signed by the original recorder, and individuals computing quantities and checking computations. In addition to installation date, record foundation material, stabilization fabric and bedding material quantities.

Bedding Material

Bedding material measurement is recorded during trench excavation. Bedding volume is computed from cross sections or by measuring placed material. Excavation to relay pipe culvert is not measured for payment.

Payment Basis
Subsection 603.05, Standard Specifications

SECTION 604
MANHOLES, COMBINATION MANHOLES AND INLETS

Description
Subsection 604.01, Standard Specifications

Detailed Drawings, storm drain details and plan sheet callouts are primary references for Section 604 construction items.

Materials
Subsection 604.02, Standard Specifications

Plant Inspection

Materials Manual MT 110 outlines MDT fabricator plant inspection procedure for manufacturers of precast concrete pipe, manholes, box culverts and other items. Plants meeting certification requirements are listed on the Qualified Products List (QPL). The Materials Bureau evaluates uncertified plant quality control programs, and assigns an MDT inspection “level” to facilitate quality assurance. Uncertified fabrication plant inspectors prepare documentation identifying items shipped to the work site, and note acceptable product defects.

Field Inspection

Final material acceptance is granted in the field. Mark products of insufficient quality with an orange “X” next to the product identification stamp, and inform the Contractor the material is rejected for Departmental project usage. If repairs are feasible, identify repair locations, and inform the Contractor of needed repair. Section 604 items added by change order require additional inspection and early coordination with the fabrication plant inspector. Project Inspectors visually inspect precast items for damage during transit or handling. Contractors should unload, store and handle items without incurring damage. Inspectors should notify Contractors of damaged or rejected items to minimize delay. Inspectors should note:

- correct material specifications
- dimensional requirements
- spalls, dents, or chips
- interior and exterior cracking
- fabrication date on precast concrete items
- item identification marks indicating lot or production numbers shown on compliance certificates
- compliance certificate water tightness requirements

Buy America

Contract documents require steel products such as reinforcing steel bars, bolts, nuts, and washers incorporated into permanent work to meet domestic steel or “Buy America” provisions within Standard Specification Subsection 106.09.

Construction Requirements
Subsection 604.03, Standard Specifications

Inlets

Verify construction inlets are at proper grade, and meet adjacent sidewalk, curb, gutter, and pavement surfaces. Contractor or MDT will set item elevations. Check elevation calculations before setting elevations. Project Managers establish excavation lines and grades.

Inlet station and offset call-outs refer to the inlet structure center, which may not be the inlet grate center. See contract documents for grate placement location(s). Inlet grates must be placed within gutter flowlines and oriented to intercept flow. “Type 1” drop inlet grates are placed perpendicular to gutters for bicycle safety. Inlet grate sizes vary, and plans typically allow several manufacturers. During inlet inspection, ensure:

- ground and bedding are compacted to specification
- inlets are not damaged while being placed
- concrete collars are present between pipe and inlet
- backfill around structures is compacted and notched into firm material
- adjacent pipe connections are water tight
- walls contain specified reinforcement
- inlets are cleaned after form removal
- approved patching compound is used
- inlets are at correct elevation
- inlet interiors match plan or Detailed Drawings for sump drop inlets or continuous flow units
- inlet grates rest securely on inlet frames
- grate cross grade matches curb and gutter cross grade
- grates conform to plan details and specifications
- grates are bicycle safe
- water pumped from inlets does not enter travel ways and adjacent property
- temporary geotextile is provided between inlet frames and grates to prevent debris from entering storm drains. Filtered material is removed after grading and paving

Manholes

Manholes may not have smooth rounded edges at pipe junctions after forms are removed, so finishing is usually necessary. Joints between precast sections must be water tight with a smooth interior. Manhole lids should never be placed within wheel paths. If staking or plans show a lid in the wheel path, inform the Project Design Manager. If a lid must be relocated, inform a Lead Inspector or Project Manager, who will check with the design section or consultant before a field change is made. Manhole station and offset indicate manhole center, but not necessarily manhole lid center. Manhole lid location must coincide with manhole access step location.

MDT field construction staff and Contractors must be hazard aware working in confined spaces. Manhole inspectors must have confined space entry training. When inspecting manholes, verify:

- ground and bedding are compacted to specification
- inlets are not damaged while being placed
- pipe connection voids are filled with concrete or grout
- manhole interiors match plans or Detailed Drawings
- frame and cover bearing faces are in contact
- approved patching materials are used for beveling pipe to wall junctions
- backfill material in 8 inch loose lifts or less are notched into firm material

- frame and cover elevations are adjusted after final paving. Standard Specifications do not prohibit Contractors from setting frames and covers before top lift placement. Inform Project Managers if Contractors intend to adjust frames before top lift placement.
- ring and cover do not significantly contribute to surface roughness
- manhole step access is provided immediately above steps
- excavation sites are barricaded when work is not occurring. Contractors must install safety fencing nightly and during no work periods until backfilling
- water pumped from manholes does not flood travel ways or adjacent property
- manholes and valves are located before paving to be exposed later

Measurement Method
Subsection 604.04, Standard Specifications

Payment Basis
Subsection 604.05, Standard Specifications

SECTION 606
GUARDRAIL AND CONCRETE BARRIER RAIL

Description
Subsection 606.01, Standard Specifications

Guardrail, concrete barrier rail and impact attenuators are referred to as “roadside safety appurtenances.”

Materials
Subsection 606.02, Standard Specifications

Plant Inspection

MDT Fabrication Plant Inspectors randomly spot check guardrail at the plant. A project guardrail inspection report listing manufacturer, heat number, base metal, name brand and thickness is sent to the Project Manager. Manufacturers also provide a list of guardrail components shipped to the project. Contractors must provide Project Managers with compliance certificates and Form 406 listing mill test results, heat numbers and manufacturer origin. Compliance certificates must be received before guardrail installation and progress estimate payment. Materials Manual (MT 110) covers MDT fabricator plant inspection procedure for Concrete Barrier Rail and precast item manufacturers. Plants meeting certified requirements are listed on the QPL. The Materials Bureau evaluates uncertified plant quality control programs, and requires MDT inspection for quality assurance. Documentation is only prepared for inspected items shipped to the construction site, and notes acceptable product defects. Additional barrier rail added via change order requires additional inspection and early coordination with the Fabrication Plant Inspector.

“Buy America”

Contractors complete Form 406 certifying products were manufactured and galvanized domestically, and meet specified requirements. Standard Specification Subsection 106.09, or “Buy America” requirements designate guardrail and impact attenuators as “Category 1” products, for which only smelter and steel mill need to be verified for domestic compliance.

Field Inspection

Inspector material acceptance is granted based on visual inspection, manufacturer certification and mill test reporting. Mill test reports track heat numbers, and ensure material grade compliance, origin and chemical and physical properties.

Inspectors evaluate the following guardrail components:

- **Galvanization.** Check steel rail sections and posts for galvanization damage, especially after materials are stockpiled, field cut or drilled. Require repair or replacement as needed. Contact the Project Manager for galvanization and coating acceptability assessment.
- **Guardrail Sections.** Check for visual defects such as burrs, twists, bends, misaligned holes and uncoated areas. Verify specified type, shape, length and curvature. Require damaged section replacement.
- **Wire Rope.** Check for kinks and frays, and require replacement if needed. Ensure specified type, size and grade.
- **Steel Posts.** Check for bends, twists, uncoated areas, misaligned holes and end damage. Verify post type, weight, length, dimension, and hole diameter.

- **Composite block-outs.** Verify guardrail block-out type, size and material. Confirm hole diameter and template compliance.
- **Wood posts and block-outs.** Verify wood is straight, sound, defect free, and meets specified dimensions. Field cuts must be treated with approved preservative.
- **Fastener hardware.** Verify fastener type, class, diameter and length compliance. Ensure system compliant fasteners. Bolt cutting is prohibited.

Construction Requirements
Subsection 606.03, Standard Specifications

Manufacturer Documentation
Subsection 606.03.1, Standard Specifications

Specifications require Contractors to submit manufacturer installation instructions to Project Managers 15 days prior to installation. Manufacturer documentation includes:

- Shop drawings showing dimensions, steel grade and other information for rail sections, posts, block-outs, wire rope, anchors, bolts, and installation hardware
- Installation instructions, especially for proprietary terminal sections and impact attenuators
- Manufacturer certification guaranteeing the system meets AASHTO Manual on Assessing Safety Hardware (MASH) requirements

Guardrail

Preconstruction Conference

Guardrail standards and manufacturer drawings are constantly updated to improve design and facilitate maintenance. MDT construction staff must be aware of updated guardrail standards and manufacturer drawings. MDT shop drawing reviewers verify drawings meet requirements. Guardrail should be discussed at the preconstruction conference to ensure installation in accordance with manufacturer drawings and Detailed Drawings. Construction conditions may require Project Managers initiate a meeting to address issues.

Terminals

Proprietary item designs, such as with guardrail terminals, change as modifications are introduced. Proprietary item suppliers must submit design changes to MDT for approval. Contractor and Inspector should review installation guidelines to verify installed terminals meet MASH and manufacturer requirements. Contractor proposed terminals are submitted at the preconstruction conference to provide for Project Manager review. If major guardrail locational changes occur, contact the Road Design Section for placement criteria.

Post Staking and Driving

Locate drainage structures before staking to eliminate post installation conflicts, or identify the need for anchoring devices or “nesting” guardrail sections. Nesting is the placement of two W-beam guardrail sections together to maintain strength when standard post spacing isn’t possible. Nesting considerations should be Project Manager reviewed to verify crashworthiness requirements are maintained. Guardrail layout staking marks made on adjacent pavement indicate post offset distance and longitudinal position. Guardrail stakes or markings are located at 50 ft intervals for tangent sections, and 25 ft intervals along horizontal curves. Posts should be inspected before placement and driving. Contractors may drive guardrail posts full depth, or place posts in holes and drive the final 10 inches. Post placement into holes requires the space around the post to be backfilled with moist soils in compacted lifts. Posts must be plumb and undamaged by hydraulic hammers. Excessive driving effort may cause post damage and rejection. Post driving often causes pavement to bulge or adjacent curbing to crack. Contractors must use alternative methods to avoid and repair damage at Contractor expense.

Hard substrate may prevent full depth post driving, in which case Contractors may drill pilot holes before driving.

Paving

Contractors coordinate paving with guardrail installation. Operational details must be included within a project schedule, written narrative and Traffic Control Plan. Paving should occur first to create a stable work base on which guardrail subcontractors can work.

Rail Alignment

W-beam and Thrie-beam guardrail beam slots must be centered at posts so plates can expand and contract without loosening posts. Rail should have a smooth, continuous appearance with the rail top in horizontal and vertical alignment with the roadway, without sags or humps. Rail sections must be overlapped with travel direction.

Field Bolt Holes

MDT prohibits making bolt holes using cutting torches. Heat weakens metal around the hole, and may cause bolt heads to pull through the metal beam under impact forces. Drilling and punching are acceptable for making bolt holes in the field.

Barrier Deflection

Roadside hazards must be outside guardrail deflection distance, which depends upon guardrail type and post spacing. Table 606-1 summarizes barrier deflections in association with guardrail characteristics. Ensure space within deflection distance behind the barrier is hazard free.

Box Beam Guardrail

Monitor box beam guardrail expansion joint locations and gaps for compliance. Incorrect installation may cause beams to deflect in response to weather changes causing expansion and contraction. Gap widths vary depending on temperature and steel rail expansion properties.

Exposed Ends

Blunt end roadside hazards such as exposed concrete barrier rail ends, must be shielded overnight. Often Contractors plan to complete guardrail and terminal section installation during the same work day. Other exposed hazards must be shielded by approved devices. Contractors must provide Project Managers with temporary blunt end protection details as part of the Traffic Control Plan (TCP).

TABLE 606 -1
BARRIER DEFLECTION

Barrier Type	Dynamic Deflection		Barrier Width		Distance from Rail Face to Obstacle	
	US	Metric	US	Metric	US	Metric
W-Beam w/Wood Posts (Detailed Drawing 606-05A)	4′-0″	1.2 m	1′-7″	0.49 m	5′-7″	1.7 m
W-Beam w/Steel Posts (Detailed Drawing 606-05B)	4′-0″	1.2 m	1′-7″	0.49 m	5′-7″	1.7 m
Stiffened W-Beam – Point Obstacle w/3′ - 1-1/2″ (952.50 mm) Post Spacing – Single Rail (Detailed Drawing 606-07)	2′-0″	0.61 m	1′-7″	0.49 m	3′-7″	1.1 m
Stiffened W-Beam – Line Obstacle w/1′ - 6-3/4″ (476.25 mm) Post Spacing – Doubled Rail (Detailed Drawing 606-08)	1′-1″	0.33 m	1′-7″	0.49 m	2′-8″	0.8 m
Nested W-Beam w/ 25′-0″ (7.62 m) Span (Detailed Drawing 606-09)	5′-0″	1.5 m	2′-3″	0.69 m	7′-3″	2.2 m
Metal Guardrail – 7′ (2134 mm) Posts, w/3′ - 1-1/2″ (952.50 mm) Post Spacing, w/2H:1V slopes and w/o widening (Detailed Drawing 606-11)	3′-0″	0.9 m	1′-7″	0.49 m	4′-7″	1.4 m
Cable Guardrail (Detailed Drawing 606-40)	12′-0″	3.7 m	N/A	N/A	12′-0″	3.7 m
Box Beam Guardrail (Detailed Drawing 606-50)	5′-0″	1.5 m	0′-9″	0.23 m	5′-9″	1.8 m
Concrete Barrier Rail (Detailed Drawing 606-60)	4′-6″	1.4 m	2′-0″	0.61 m	6′-6″	2.0 m
Concrete Barrier Rail – Anchored (Detailed Drawing 606-62)	1′-6″	0.5 m	2′-0″	0.61 m	3′-6″	1.1 m

Concrete Barriers

Concrete barrier rail appearance requires a stable and properly prepared foundation. Barrier should be aligned according to specification tolerance. Unsatisfactorily aligned barrier should be removed.

Temporary Concrete Barrier

Sites are classified as high or low risk by evaluating whether barrier displacement exceeding design deflection is likely to cause death or injury, as in the case of a vertical drop within a bridge construction project. In high risk situations, anchor or pin down temporary barrier as shown in Detailed Drawing 606-62. Barrier is also pin anchored in low risk situations if lateral distances needed to accommodate Table 606-2 deflection limits are absent.

Table 606-2

Speed (MPH)	Deflection (ft)
<35	2
35 – 45	3
45+	4

Sites must be evaluated to develop a specific deflection limit. Factors to consider when selecting deflection limits are:

- construction activity duration
- traffic volume
- hazard nature and length
- design speed
- highway functional class
- distance between traffic and workers
- distance between traffic and equipment
- geometrics increasing errant vehicle likelihood
- two way traffic where unidirectional traffic is usually present
- crossover transition areas
- lane closures and transitions

Utility Considerations

Overhead utilities pose electrical hazards during post installation. Monitor post installation to avoid damage to and interference with underground facilities such as lighting, signal cables, and underdrains. Utilities must be located and marked before construction.

Reflectors

Concrete barrier rail is moved via forklift. During section transport and installation, reflectors may be damaged. Ensure reflectors still comply with contract specification, and require Contractors to replace damaged or incorrectly located reflectors.

Measurement Method
Subsection 606.04, Standard Specifications

Payment Basis
Subsection 606.05, Standard Specifications

SECTION 607
FENCES

Description
Subsection 607.01, Standard Specifications

Interstate highway fence is placed one foot inside ROW and maintained by MDT. Other fence is placed on the ROW line and becomes land owner property. Wildlife friendly fence allows movement along migration routes, where signs are often posted indicating wildlife crossing. Some fences encourage wildlife use at suitable crossing locations, but keep cattle off the roadway. Where high wildlife collision rates are identified, wildlife fencing directs animals to crossings like bridges, large culverts and "jump out" structures.

Fence Materials
Subsection 607.02, Standard Specifications

Four fence types are: Type 1 Class C zinc coated (galvanized) steel, Type 2 aluminum coated steel, Type 3 aluminum alloy or Type 4 vinyl coated fabric. Only one type is allowed per fence section. Zinc coated metals should have a dull appearance, but a shiny surface may indicate a thin surface. In such cases, send a sample to the Materials Bureau for coating thickness testing before installation. Check steel fence type, size, shape and dimension. Ensure wire fabric complies with specifications. Under Standard Specification Subsection 106.09 "Buy America" provisions, steel fencing materials are "Category 2" products. Wood posts are inspected at the treatment plant for dimensions, taper and treatment in accordance with Standard Specification.

Construction Requirements
Subsection 607.03, Standard Specifications

Property Owners

Landowner agreements occasionally stipulate that fencing incorporates materials such as steel drill stem fence posts, railroad ties, or metal gates. Project Managers should review ROW agreements for parcels requiring fencing. Fence location, length, and location usually concern adjacent landowners. Schedule a meeting to discuss landowner fencing as early as possible. Ensure Contractors have obtained required landowner agreements, permits and authorizations before fencing. During fencing, verify:

- Fences are installed as early as possible. Fences may restrict Contractor access, but protect the public from construction hazards.
- Inspectors and Project Manager review ROW agreements, detailed drawings, access control lines, gate locations, cattleguards, drainage and angle point locations. Review approach fill height at ROW lines. Fence panels (braces) may need slight relocation to facilitate approach embankment contouring. Embankment and slopes are constructed before braces are installed.
- Contractors are responsible for property damage and loose livestock during fencing.
- Fences are not constructed in washes or along banks where fences may be undercut. Gate and end post assemblies should be relocated if subject to erosion. Wing fences at box culverts should be relocated outside drainage areas as needed.

- Grading does not take place beyond ROW limits, and vegetation disturbance must be minimized outside construction limits. Large, vertical cuts or fills on the ROW line are undesirable. Utility lines are typically located 2 ft inside the ROW line.
- Corner and ROW monumentation is marked before work begins, and remains undisturbed. Monumentation disturbed by the Contractor must be reset by a licensed, Professional Land Surveyor (PLS) at no cost to the Department. Refer to Detailed Drawing 607-20 for ROW break panel (brace) construction.
- Additional inspection is provided to ensure posts are anchored properly where hard ground hinders post driving and hole excavation.
- Class General concrete anchoring fence posts develops adequate strength to resist bending forces before wire is tensioned. If Contractors alter a mix design to obtain early strength, Project Manager approval is required before early wire installation.
- Bottom wire ground clearance is maintained by using extra posts, sag weights or other methods. Bottom clearance is a contract requirement.
- Finished fence post tops are uniform height above the top wire.

Chain Link Fence Inspection

- Use proper wire, tie wire and strain wire gauges
- Install wire as specified
- Allow concrete to cure before wire installation
- Stretch wire taut and securely fasten to posts
- Use correct wire clip number and gauge

Wire Fence and Gate Inspection

- Protect livestock while fencing
- Drive and set posts to proper depth, spacing, plumb and alignment
- Stretch wire taut, and fasten to the pasture side of each post. Wire may be placed on windward post sides except along curves, where high winds and moving debris are present
- Upper post hangers must prevent gate removal
- Install strain and corner posts as required
- Properly affix fencing to structures. Inspectors should review ROW agreements against the plans for consistency
- Drive staples on skew to wood grain, and drive 1/16 - 1/8 inch from contacting wire. Cut or trimmed areas should receive three treating solution coats
- Wire at splices and end posts must be wrapped back on itself using five wraps

Measurement Method
Subsection 607.04, Standard Specifications

Measure fence length along the top wire or rail. Take measurements with the Contractor to ensure agreement regarding length. Verify and notify Contractors of measured fence quantities if Contractor personnel are not present during measurement.

Payment Basis
Subsection 607.05, Standard Specifications

SECTION 608
CONCRETE SIDEWALKS

Description
Subsection 608.01, Standard Specifications

Materials
Subsection 608.02, Standard Specifications

Contractors must submit concrete coloration for Project Manager approval. Concrete color matching requires consistent batching and mixing to produce consistent coloration. Inspectors should notify the Project Manager of coloration changes. Discolored areas may require replacement. Stamped concrete requires clean stamp forms and experienced personnel. Observe the stamping process and note final quality. Identifying concerns early helps ensure corrective action.

Construction Requirements
Subsection 608.02, Standard Specifications

Project Managers should discuss sidewalk construction with landowners to ensure Contractors have obtained agreements and authorizations prior to construction. If new sidewalk is higher than existing property, provisions must be made to address water impounded by construction. Grade adjustments may be necessary if other means of drainage correction are unavailable. Sidewalk elevation is designed to match curb and gutter, which is matched to mainline surfacing grade. Hairline cracks should be inspected with future maintenance in mind. If cracking indicates poor compaction, the panel should be removed, subgrade recompacted, and concrete replaced. Minor cracks should be sealed. Contractors should submit written recommendation to the Project Manager for approval.

Sidewalk to driveway transitions require grade sloping, and may raise or lower existing driveways away from optimal grade for tie in to sidewalk. Project Managers should verify ROW boundary, and see that existing driveways are blended into adjacent sidewalk.

ADA and Pedestrian Accommodation

Project Managers should meet with the MDT ADA coordinator for an onsite review prior to construction, during which ADA requirements regarding width, finished slopes, detectable warning device slopes, landings and accessible ramp locations are discussed.

Pedestrians and Bicyclist Temporary Accommodation
Subsection 618.03.2.A7, Standard Specifications

Permanent Sidewalk ADA Requirements

- Road Design Manual Section 18.1 lists criteria for “accessible” routes. Most sidewalks along Montana highways are accessible routes. Sidewalks must comply with MDT Detailed Drawings. ADA requirements for permanent facilities include:
- 60 in sidewalk width, with minimum 36 in width between obstructions and sidewalk edge
- 1:20 (5%) maximum longitudinal slopes along accessible routes matching adjacent roadway gradient
- 1:20 (5%) maximum allowable cross slope
- Stable, firm, and slip resistant surfaces

- Drainage grates clear of walking surfaces. If clearance is unattainable, grate spaces must be less than one half inch wide. Elongated grate openings must be perpendicular to travel direction

- Curb ramps or other sloped areas are required where new or altered pedestrian walkways cross curbs, and where new or altered streets intersect pedestrian walkways. Curb ramps must conform to MDT Detailed Drawings:

  - ✓ New curb ramp running slopes should not exceed 1:12 (8.33%), but when new construction requirements are technically unfeasible, curb ramps accompanying alterations may have a maximum 1:10 (10%) slope
  - ✓ Level landings should be placed at the top of perpendicular curb ramps, which must connect to travel routes at least 48 in wide with a cross slope less than 1:50 (2%)
  - ✓ Transitions from curb ramps to gutters should be flush. Adjacent counter slopes in the travel direction should not exceed 1:20 (5%), and connect smoothly with pedestrian network elements
  - ✓ The foot of curb ramps should be located within crosswalk markings. Pedestrians using wheelchairs should not be directed outside crosswalks.
  - ✓ Inspectors should be aware of navigable ramp slope requirements. Problematic locations include intersections with signal poles or fire hydrants located immediately behind the sidewalk, where attaining proper ramp slope is difficult. If a ramp cannot be built as designed, contact the Project Manager.
  - ✓ Detectable Warning Devices (DWDs) are warning surfaces for sight impaired pedestrians. They are installed in the sidewalk to remind pedestrians a vehicular area is immediately ahead. DWDs are required for new and altered curb ramps, are typically sidewalk width, and located at curb ramp bottoms. MDT requires DWDs to be grey cast iron, and QPL listed.
  - ✓ Pedestrian Signals are installed at crosswalks accessing curb ramps at pedestrian detecting signaled intersections:
  - ✓ Locate controls close to the curb ramp, and allow operation from a level area.
  - ✓ Provide a firm, stable and slip resistant 36 in by 48 in area allowing a forward and parallel approach to signal controls.
  - ✓ Pedestrian actuated controls height should not exceed 42 inches.

Utility Coordination

Urban sidewalk construction may require relocating meters, valves, cleanouts and other features. If relocated appurtenances are within an area to be newly concreted, contact municipal authorities to minimize contractor inconvenience.

Concrete Sidewalk Inspection

Forms should be firmly staked with a uniform depth equal to sidewalk thickness. Be aware of thinner form depths near sidewalk centers. Place a straight edge over form width to check form depth. Unsuitable material should be removed from subgrade to correct depth and subgrade thoroughly compacted. Forms and subgrade must be moistened before concrete placement. Verify concrete surfaces are screeded, troweled smooth, and given a fine brush finish. Finishing water (Subsection 501.03.8C) dilutes cement paste, weakens concrete, causes spalling and exfoliation, so is prohibited. Concrete workers often want to add water to concrete to make finishing easier. Prohibit and inform the Project Manager of this practice, and note observations within the DWR. Contractors can be required to replace concrete areas sprinkled with water during placement. Joints must be properly formed at required intervals. Check and document ADA slopes using a straightedge or smart level. Verify bond breaker is applied between new sidewalk and existing curb, and sidewalk joints align with curb joints. Approximately every other sidewalk joint should align with curb jointing.

Measurement Method
Subsection 608.04, Standard Specifications

Payment Basis
Subsection 608.05, Standard Specifications

SECTION 609
CURBS AND GUTTER

Description
Subsection 609.01, Standard Specifications

Curbs direct runoff and define urban highways, streets, and approaches.

Materials
Subsection 609.02, Standard Specifications

Construction Requirements
Subsection 609.03, Standard Specifications

Curbed streets often serve as storm water channels. Poor curb and gutter construction may cause ponding at intersection radii, valley gutters and existing gutter line connections.

Consult property owners and ROW agreements before establishing driveway locations. Involve District ROW agents to address landowner conflicts. If safety standards and local ordinances allow, minor driveway size and location adjustments to suit property owners are acceptable.

Inspectors should study existing drainage conditions before grading if new curb will impact drainage, or alter grade, inlet elevations, or culvert locations. Problematic drainage areas include turnouts and curbs along the higher side of superelevated roadways. Review areas behind curb and ROW line to verify flow to drainage structures.

Users appreciate a finished and pleasing appearance. Forms should be clean, straight and in good condition to create a quality product. Flexible forms should be used to form curves. Curb machines are commonly used but require closely monitored slump tests. Wire grade lines should be inspected regularly by sighting along the wire for irregularities. Check curb tops, faces and flow lines using a straightedge during finishing.

Curb and Gutter Inspection

- Verify subgrade and forms are watered before concrete placement.
- Verify expansion joint placement at structures, radius points, and correct intervals.
- Joint depth must be adequate to control cracking.
- Verify contraction joints are at correct intervals when adjacent to asphalt pavement.
- Contraction joints must align with adjacent PCCP joints.
- Confirm expansion joint filler placement between curb back and driveways.
- Lines and finish work appearance must be acceptable.
- Assess curb top surface, front face and flow line with a straight edge, and check plans for “spill” or “catch” curb type locations.
- Inspect concrete for additional specification compliance.

Measurement Method
Subsection 609.04, Standard Specifications

Payment Basis
Subsection 609.05, Standard Specifications

SECTION 610
ROADSIDE REVEGETATION

Description
Subsection 610.01, Standard Specifications

Ground contouring and unsuitable material removal before planting is referred to as "roadside revegetation". This phase minimizes erosion by providing slope stability and an aesthetically pleasing roadside area. Topsoil preparation and distribution as well as seed and fertilizer application should be coordinated with cut and fill slope earthwork. Revegetation must take place during time frames stipulated within the contract. Sod is sometimes placed as an alternative to seeding, and erosion control blankets may be used over steep slopes or ditches. Areas exposed to high water levels and wind erosion require additional protection. Section 404 permits require biodegradable erosion control blanket placement in or adjacent to waterways.

Materials
Subsection 610.02, Standard Specifications

Ensure materials are shipped from sources listed on the "Contractor List of Suppliers," or approved by the Project Manager or Materials Bureau. Commercial seed mix labels must show included ingredients.

Seeding

Seed mixtures are mixed under MDT direction from a district or area laboratory. MDT representatives submit sample seed types to a certified seed testing laboratory before mixing seed to provide purity and germination results used to calculate seed quantities. Seed is specified by genus, species and variety. Substitutes are unacceptable unless an MDT Botanist/Agronomist reviews delivery time, complications, plant characteristics and cost. Testing and reporting may take six weeks, depending upon seed type and laboratory workload. Contractors should notify seed suppliers to allow for testing procedure and avoid delays. Check and retain certification tags attached to each bag of seed, mulch, fertilizer or similar product. Certification tags list seed name, net weight, origin, laboratory, testing date, lot, expiration date, germination percent, purity, and noxious weed seed concentration.

Mulch

Mulch is applied immediately after seeding. Unless otherwise specified, seed should never be blended with mulch.

Wood Cellulose Fibers

"Virgin wood cellulose fiber" excludes shredded newspaper and paper products.

Vegetative Mulch

Straw must be certified free of restricted or noxious weed seed, and from the most recent crop to avoid dry and brittle mulch. Project Managers should open a bale from each straw shipment to verify straw is not brittle. Crimping provides vertical stubble to hold loose straw from blowing. If terrain is too rocky or steep for effective crimping, mulch may be tacked in place.

Compost

Compost is a slow release nutrient source, applied singly or with mulch. Contracts specify application rate and method in dry form using a blower or conveyor truck immediately following broadcast seeding on slopes steeper than 3H:1V. A fiber mulch and tackifier mix is typically sprayed over compost to hold it in place.

Rolled Erosion Control Materials

Contracts may specify rolled erosion control materials as straw, coir, curled wood shavings, or synthetic fibers. In some cases, a combination of different fiber types is necessary near waterways where synthetic material is prohibited. Be aware that “photodegradable” materials are not necessarily “biodegradable.” Site preparation is critical to rolled erosion control product performance. Areas must be relatively smooth to ensure soil contact and prevent material bridging, which allows soil movement and prevents seedling germination through erosion control blankets. Do not allow material stretching during installation. Material should be loosely laid on surfaces and conform to irregularities. Follow manufacturer installation instructions, and bury mat edges to prevent water movement under the material.

Soil Testing

Erosion creates unsightly slopes, maintenance problems, safety hazards and water pollution. Problematic soil conditions may become apparent after rough grading, when soil types are exposed and identified visually by vegetative growth, color and texture. Poor soils may be tested to determine if seeding schedules need alteration. Retain (-10) mesh soil fraction samples for soil testing, and submit to the Materials Bureau. If alternate contractor topsoil sources are used, a soils analysis must be prepared by an accredited soil lab for Project Manager review and approval before topsoil placement. Soil analysis should find soils to be fertile, friable, well drained arable, non-toxic and reasonably free of subsoil, refuse, roots, heavy clay, clods, noxious weed seeds, phytotoxic materials, coarse sand, rocks over 5 centimeters, sticks, brush, litter and other deleterious matter. Soil pH values should be able to be lowered using soil sulfur or gypsum as recommended.

Soil from depths exceeding 4 ft should not be considered topsoil even if complying with other requirements. Soil below 4 ft usually contains significant calcium carbonate, has poor structure, and is without soil bacteria and microbes to support plant growth. Topsoil stripped within staked project limits and stockpiled for later placement does not require testing.

Construction Requirements
Subsection 610.03, Standard Specifications

Planning

Videotape or photograph the revegetation site before construction, and be familiar with contract revegetation requirements. Problems can be prevented during initial construction stages if Contractors protect the roadway during construction. Filling low spots, slope grading and effective drainage all reduce erosion and runoff damage. Contractors must order project seeding and erosion control quantities, and provide a method to verify seed and fertilizer application rates. Measure areas to be seeded and fertilized as soon as possible to give the Contractor an expected revegetation acreage.

Excavation

Ensure excavation work conforms with slope staking. Irregular areas are difficult to stake using conventional methods, so on site adjustment may be necessary. Areas needing additional or less excavation should be corrected before topsoil and mulch placement. Proper topsoil and mulch depth is critical for plant growth. Contractor furnished disposal areas must be accompanied by a permit and documentation signifying the landowner is satisfied with final disposal site condition. Project Managers designate material placement areas and clean up procedures for Department furnished disposal areas. Contractors should minimize erosion and weed growth within prepared areas. If a reasonable revegetation schedule is not maintained, notify the Contractor in writing.

Topsoil Addition

Cut and fill slope protection measures should be in place as soon as possible, and topsoil placed over completed slopes at specified depth. Leave constructed subgrade slopes scarified to enhance vegetation growth. To minimize erosion on slopes 3H:1V or steeper, dozers should travel final passes at angles of 45 - 90 degrees to contour so cleat marks do not parallel flow direction. This practice reduces erosion and sedimentation to ditches and water courses. Contractors must submit documentation to Project Managers regarding herbicide applications. Water must be applied to topsoiled areas.

Seeding and Fertilizing

Measure seeding areas for seed, fertilizer and mulch quantity calculations. Successful roadside revegetation depends upon proper topsoil placement, preparation, adequate fertilization and mulch application. Areas 3H:1V or flatter must be conditioned just before drill seeding. Conditioning should create a friable soil 4 -6 inches thick, and may be done with a disc or harrow. If soils become compacted after grading, soil placement and equipment travel, chisel plows may be used to loosen soil to 6 or 8 inches. Project Managers should consult with MDT botanists regarding soil scarification. Ensure seeding and fertilization materials are placed uniformly. Compare applied seed and fertilizer quantities to specified quantities.

Fertilizer is preferably broadcast immediately before seedbed conditioning. Seeding should occur within 48 hours of conditioning, although Project Managers may extend the durations between conditioning and seeding. Drill seeding is the preferred seeding method specified on ground 3H:1V or flatter to ensure proper seeding depth and application rate. Broadcast seeding should not substitute for drill seeding if areas are accessible to seeding equipment. Periodically monitor seeding to verify equipment seeding rate and specified depth. Broadcast seeding is used to seed slopes steeper than 3H:1V. Broadcast seed must be applied dry from a manual spreader, or by Project Manager approved means. If the site includes hazardous conditions, or seeding rates are difficult to attain using manual methods, Project Managers may allow hydraulic application. A small mulch amount can be added to the seed/water mixture for visual tracking. Broadcast seeding must be practiced where germinated seeds will establish and survive. Rough, uncompacted surfaces offer moist and protected micro habitats, allowing seeds to fall within crevices and be covered by mulch. Seeding smooth and compacted surfaces is ineffective. Mulch should be applied uniformly at specified rates. Areas inaccessible to mulch spreaders may be seeded by hand.

Inspectors and Contractors must agree on seeding methods and application areas. Do not allow broadcast seeding during windy conditions. Tilling, harrowing, discing and scarifying must be carried out as specified.

Mulch

Mulch prevents erosion, traps moisture and regulates soil temperature. If under applied, soil erosion or drying may occur, whereas mulch applied too heavily prevents sunlight from penetrating, and may prevent germination. Contracts specify mulch application method and rate. Monitor mulch application per area, and compare to specified amounts. Mulch is applied using specialty equipment, such as a blower truck and hydro-mulcher. Inspect mulch source and composition for contract compliance. Check that products containing straw or hay are Department of Agriculture certified "weed free". "Tackifiers" sprayed over applied mulch prevent wind and water erosion, but heavy applications may cause soil crusting.

Weed Control

Weed control bid items may be included within contracts if construction activities disturb roadside soils, and Contractor weed control is required. Weed monitoring and control prevents weed growth on disturbed soil. Noxious Weed Control Standard Specifications define acceptable weed control. Mowing is preferred weed control where significant noxious weed concentrations grow within disturbed areas. Mower height should be 6 inches to 8 inches, and occur in mid to late summer. Herbicide is not allowed over seeded ground or ground seeded the previous year, as herbicide often damages perennial grass seedlings.

Measurement Method
Subsection 610.04, Standard Specifications

Seedbed preparation, seeding, fertilization, mulch application and sodding are measured by the unit area treated and accepted. Areas outside construction limits, such as laydown yards, stockpile sites and temporary facilities are not measured for payment. Maintain area descriptions for requested payment areas.

Payment Basis
Subsection 610.05, Standard Specifications

SECTION 611
CATTLE GUARDS

Description
Subsection 611.01, Standard Specifications

Cattle guards prevent livestock passage by extending across pavement width, and are prefabricated metal guards fastened to prefabricated concrete bases (MDT Detailed Drawings, Section 611).

Materials
Subsection 611.01, Standard Specifications

The Materials Bureau inspects and accepts fabricated cattle guards and precast bases. Visually inspect materials for shipping and handling damage. Reject damaged materials unrepairable in the field. Standard Specification Subsection 106.9 "Buy America" provisions apply.

Construction Requirements
Subsection 611.03, Standard Specifications

Schedule and coordinate construction activities with landowners when dealing with private approaches. Cattle guards must drain to prevent ponding, and be installed to grade and cross slope to provide a smooth ride.

Cattle Guard Inspection

- Material certifications are required. Ensure iron and steel products meet Standard Specification Subsection 106.09 "Buy America" requirements.
- Steel components must be primed and field painted.
- Backfill must be compacted to 95% maximum density.
- Grade and cross slope must conform to finished surfaces.

Measurement Method
Subsection 611.04, Standard Specifications

Payment Basis
Subsection 611.05, Standard Specifications

SECTION 612
STRUCTURE FINISHES

Description
Subsection 612.01, Standard Specifications

Structural steel painting prolongs metal longevity by mechanically sealing surfaces against corrosion. Painting also maintains appearance.

Materials
Subsection 612.02, Standard Specifications

Review manufacturer coating description and product information. Ensure finish is applied in accordance with manufacturer recommendation, and primer and paint materials are supplied from a source listed on the Contractor “List of Suppliers”. A single material manufacturer must be used for intermediate and top coats. Verify paint containers note paint type, color, volume, lot number, batch number, manufacturing date, name and address. Paint not having the same lot number as previously tested paint should be sampled and sent to the Materials Bureau. The Materials Bureau inspects and accepts fabricated members and shop coats. Visually inspect structural members for proper marking, and shipping and handling damage. Reject unrepairable materials and those without required documentation. Obtain manufacturer certification, application recommendations and product safety data sheets from the Contractor. Verify paint color before paint is ordered, as special provisions may not specify color. Department and Contractor should agree on color before ordering paint.

Weathering Steel

Weathering steel is designated “W” within the contract, and has specific contract requirements. Weathering steel is not painted, but must be cleaned to ensure a uniform rust coat. Weathering steel is relatively maintenance free with proper detailing and periodic water flushing to remove corrosion.

Construction Requirements
Subsection 612.03, Standard Specifications

Spray Paint Protection

Coordinate with the subcontractor about painting operation safety before painting begins. Protective equipment including goggles and face shields may be needed, and stains containing solvents must be used in well ventilated areas. Also discuss protection from paint spray and splash. Passing vehicles must be protected from paint spray.

Surface Preparation

Cleaning and preparation ensure paint will preserve metal and be attractive. Shop paint coat imperfections cannot be covered with field coats, so Inspectors must insist on proper cleaning and defect correction before initial field coats. Surface preparation is vital to painting, and must meet the stricter of manufacturer recommendation or contract specification. Steel is cleaned of dirt, grease, rust and mill scale using profile blasting at the fabrication plant. Ensure thorough surface preparation, and consult a paint manufacturer representative with questions about surface preparation. After surface preparation, a primer coat is applied to inhibit rust, but primers are easily scarred during handling, transport and install. After steel installation, prime coat damage areas should be cleaned and coated a second time.

Paint Coating

Complete fabrication inspections before painting. Painting should start at higher areas and continue downward so paint drippings can be removed before further paint application. After spot priming and drying, the first field paint coat is applied. Before field painting, surfaces must be dry. Avoid morning dew and humid conditions. Apply paint by brush to avoid exposing passing vehicles to spray. Check areas such as beam edges and bolt heads for compliance with Standard Specification Subsection 612.03.5 minimum paint thickness requirements. Beam edges and bolt head areas are usually where paint films are thinnest.

Powder Coating

Signal, pedestrian and illumination pole powder coating is supplied by approved manufacturers. Compliance certificates must accompany item delivery, and be inspected by Contractor and Inspector. Damaged items may be rejected if onsite repairs cannot be made, or are not Project Manager approved. Repairs must adhere to manufacturer maintenance and repair procedure. Ensure patching material compatible with the coating is onsite to address coating damage due to handling.

Inspection Checklist

- Obtain and abide by product Material Safety Data Sheet (MSDS) safety information. Make sure personal protective equipment and safety devices are available and properly used.
- Collect and send unapproved paint samples to the Materials Bureau for testing.
- Paint must be formulated and mixed in accordance with Standard Specification and manufacturer recommendation.
- Surfaces to be painted must be thoroughly cleaned of rust, mill scale, dirt, oil, grease and foreign substances. Only clean surfaces to be painted the same day.
- Metal must be dry and frost free during painting, and atmospheric conditions favorable.
- Allow painting only during temperature and dew point conditions meeting the more restrictive of manufacturer recommendation or contract specification.
- Ensure Contractors protect vehicular and pedestrian traffic from spotting.
- Ensure uniform paint application to avoid collection at certain points. Make sure runs or thin areas are sanded and recoated.
- Verify paint thickness using a micrometer to track expended paint volumes against area covered. Calculate field application rate and film thickness.

Measurement Method
Subsection 612.04, Standard Specifications

Payment Basis
Subsection 612.05, Standard Specifications

SECTION 613
RIPRAP AND SLOPE AND BANK PROTECTION

Description
Subsection 613.01, Standard Specifications

Section 613 items such as riprap, bank protection and concrete slopes protect erodible areas along the roadside and adjacent to structures such as culverts, foundations, bridge berms, dikes, and animal passes. Riprap is stone placed over bedding to prevent erosion and scour along banks, shorelines, bridge piers and abutments. The “MDT Riprap Acceptance Guide” covers riprap material quality and characteristics, installation, cost, acceptance, and inspection.

Materials
Subsection 613.02, Standard Specifications

Riprap must be supplied from a Materials Bureau approved source. Standard Specification Subsection 701.06 requires “hard and durable” stone, which is subject to interpretation. Materials Bureau or District Lab personnel should evaluate Contractor proposed rock sources as soon as possible.

Construction Requirements
Subsection 613.03, Standard Specifications

Project Managers should not disregard riprap aesthetics. Cross sections should be uniform, with lines and grades conforming to the contract. If outcrop is discovered during slope or bank protection, notify the Project Manager and Hydraulics.

Measurement Method
Subsection 613.04, Standard Specifications

Payment Basis
Subsection 613.05, Standard Specifications

Riprap Re-vegetation
Subsection 613.06, Standard Specifications

Riprap revegetation is addressed by adding a special provision to the contract.

Description

Riprap revegetation minimizes water quality and endangered species impacts, satisfies US Army Corps of Engineer stream mitigation requirements, creates a more natural area for wildlife and encourages wildlife usage. Riprap revegetation is not a permit requirement but demonstrates MDT commitment to minimize impact. Riprap revegetation earns the MDT mitigation credits with the Army Corp of Engineers, and is cheaper than offsite mitigation. Bridge sites are reviewed individually to determine riprap revegetation needs.

Installation

Riprap revegetation requires proper installation and construction procedure. Riprap contours should blend into fill slopes, and slopes should allow even and adequate topsoil distribution over rock. Riprap should not show at the surface, to facilitate seeding and erosion control blanket installation.

Use seed and fertilizer generously. Ensure seeds are placed with ¼ inch to ½ inch topsoil coverage.

Place straw mat over seeded areas to minimize erosion and allow germination. Place erosion control such as wattles at slope bases near the waterline to anchor straw matting and keep soil and seed under the mat during high flow. Fill rock voids with No. 2 filter aggregate to reduce voids between individual rocks. Void elimination encourages vegetative development.

SECTION 614
RETAINING WALLS

Description
Subsection 614.01, Standard Specifications

Retaining walls stabilize vertical or near vertical soil gradients that would otherwise cave, slump or slide. MDT uses earth retaining walls to stabilize slopes, grade separations, structures supporting live loads, environmentally sensitive areas, and bridge abutments.

Retaining walls are classified as “fill” or “cut” walls depending on how they are constructed. Fill walls are constructed from the bottom up, whereas cut walls are constructed from the top down. Table 614-1 lists common cut and fill type retaining walls.

Engineered Retaining Structures

Contracts may include an MDT engineered retaining structure, but Contractors may also submit engineered retaining structure designs.

TABLE 614-1
CUT AND FILL RETAINING WALLS

Fill Wall	Cut Wall
MSE Walls	Non-Gravity Cantilever (Sheet Pile) Walls
CIP Concrete Cantilever Walls	Soldier Pile Walls
Gabion Walls	Anchored Walls
Rockery Walls	Soil Nail Walls
Prefabricated Modular Walls	

Materials
Subsection 614.02, Standard Specifications
Material Considerations

“Metal Bin” retaining walls are closed face walls of connected bins supplied from an approved supplier list. Obtain manufacturer certifications and assembly instructions. A manufacturer representative may be present to begin assembly. The Materials Bureau may provide inspection at the fabrication plant, but may not if the wall system is manufacturer furnished, in which case design and fabrication is manufacturer responsibility.

Visually check structural members for proper match marking, galvanized hardware and general condition. Check base metal and spelter coating for damage. Members should be one nominal size. Do not allow Contractors to drill, punch or torch cut holes to correct manufacturing defects.

Mechanically Stabilized Earth (MSE) wall materials must be supplied from the project “List of Suppliers”. Obtain manufacturer certification and assembly instructions. If required by special provision, manufacturer representatives may be present during assembly. For manufacturer engineered wall systems, design and fabrication is manufacturer responsibility.

Upon delivery, check for material compliance covering structural reinforcement, precast segmental concrete facing units, concrete leveling pads, perforated underdrain pipe, drainage aggregate and backfill material. Typical concrete masonry unit (CMU)

MSE walls require specific geogrid sizes supplied in rolls identified by manufacturer product tags. Ensure that plan depicted geogrid is used.

Geotextile or geogrid may be specified for retaining wall usage. Geogrid usage in retaining walls serves a different purpose than geotextile. Geotextile separates different materials, or can be used as a filter in high moisture environments or flow conditions associated with drainage features. Geogrid provides interlock between each backfill layer and each CMU, and may also strengthen backfill for vertical loading. Check for proper size, correct location within the wall, installation length, and pin placement. Fiberglass pins are commonly used with CMU walls for placement and alignment.

Geotextile and geogrid must be supplied from approved Materials Bureau sources. Collect field samples before installation. Positive test results and manufacturer certification constitute approval (Standard Specification Section 622).

Construction Requirements
Subsection 614.03, Standard Specifications

Before retaining wall foundations are excavated, review geotechnical reports and design specifications for required and anticipated subsurface conditions. Report subsurface changes to the Geotechnical Bureau with accompanying photos and samples to help explain encountered soil conditions.

Geotechnical Section Support

The Geotechnical Section reviews retaining wall submittals, provides field inspection, checks wall foundations and reviews anchored and soil nail wall testing. Anchored wall tieback anchors and 5 -10% of soil nails are tested. Tieback or soil nail contractors must provide testing. The Geotechnical Section reviews testing results to confirm design criteria, and may propose alternative wall construction.

Construction Testing

Geotech project specialists provide inspection for:

- MSE wall subgrades before initial lift placement. Soft areas are replaced with compacted granular fill. During lift placement, review Contractor placement methods to confirm that lift material, thickness, and compaction meet specification.
- Standard Cast-in-Place (CIP) Concrete Wall subgrades, and needed soil replacement with compacted granular fill.
- Anchored and Soil Nail Wall testing during to determine grouted anchor and soil nail capacity. Tests evaluate an imposed loading response to assess anchoring capacity. Anchors are accepted when the rate of movement is within acceptable limits during test loading applied incrementally to 1.5 to 2 times design load.
- Project geotechnical specialists should review Contractor testing plans, particularly load application and monitoring methods. During testing, specialists observe initial testing phases to ensure Inspectors understand testing requirements. Inspectors must discuss proposed testing requirements or soil nail design changes with the Geotechnical Section.

Temporary Shoring During Wall Construction

Temporary shoring design and safety for retaining wall construction is Contractor responsibility, and should be submitted with wall designs. In most cases, licensed engineers design temporary shoring, and submit computations for MDT review. Temporary designs must meet OSHA and Montana State Department of Labor and

Industry 29 CFR 1926, Subpart P “Excavations” requirements. Contracts usually require contractors to submit shoring designs for Geotechnical section review. Temporary shoring is discussed within Standard Specification subsections 105.02, 207.01.2, 207.03.5, and 209.01.

Geotechnical Support During Retaining Wall Construction

Project Managers or the CES Bureau may contact the Geotechnical Section to help resolve construction conditions affecting long term wall function, such as foundation conditions or backfill material evaluation. In most cases, project geotechnical specialists review wall location and condition, and may revise bearing capacities, drainage methods or temporary shoring.

Contractor and Supplier Designed Proprietary Walls

Wall suppliers normally design proprietary wall systems using gabion, MSE, or crib wall concepts. Contractor designed walls often refer to unique specifications, which should be reviewed by Project Manager and Inspectors. Contractor retaining wall specifications more stringent than MDT specifications may become part of the contract upon submittal acceptance. Geotech usually evaluates backfill slope stability, then identifies engineering parameters and design criteria, including safety factors, seismic criteria, earth pressure coefficients, surcharge loads, allowable bearing values, sliding resistance coefficients and internal friction angles used by wall suppliers.

Wall suppliers size walls to meet internal and external stability requirements. External checks should include those against sliding, bearing and overturning. Geotech reviews Contractor submitted wall design and analyses for conformance with engineering design criteria. MSE wall suppliers may field demonstrate wall construction and be onsite during construction. Geotechnical specialists should be present during the initial stages of large MSE wall construction.

MSE Wall Inspection Checklist

Inspect the following items by referencing manufacturer plans and specifications, project plans, and special provisions:

- Excavation grade and elevation limits
- Wall excavation base is supported by adequate bearing material
- Backfill lift thickness and compaction
- Observe manufacturer representative onsite during initial construction
- Installed drainage is at correct location and spacing. Outfalls conform to specifications, and drainage elements exiting through wall faces
- Erosion control and drainage minimize washout during leveling pad installation
- The first facing course is aligned and plumb
- Connections are compliant
- Block wall cores are backfilled with free draining aggregate
- Reinforcement type, length and spacing conform to shop drawings. Backfill layers are level prior to reinforcement placement. Reinforcement is pulled tight and held in place before backfilling
- Only hand operated compaction equipment is used close to the wall
- Soil is retained with the top course properly capped
- Damaged wall elements are replaced
- Geotech is notified of issues during construction

Measurement Method
Subsection 614.04, Standard Specifications

Payment Basis
Subsection 614.05, Standard Specifications

SECTION 615
IRRIGATION FACILITIES AND HEADWALLS

Description
Subsection 615.01, Standard Specifications

Materials
Subsection 615.02, Standard Specifications

Construction Requirements
Subsection 615.03, Standard Specifications

Irrigation structures, pipes and facilities must be installed at plan invert elevations. Project Managers should contact Hydraulics if discrepancies between plan and field elevations exist. Project Manager, Inspector and Contractor must coordinate with irrigation facility operators during construction.

Irrigation facility design requirements may be part of ROW agreements. Irrigation system work outside the ROW cannot be carried out without written consent from the facility owner. Existing irrigation system work should occur when systems are not in use, unless an agreement allows construction during the irrigation season. Coordination with water users helps avoid service interruptions. Contractors must have irrigation owner written approval to use irrigation sources for dust control. A permit may be required.

Irrigation system owners should attend the final walk through to verify work agreements have been honored and work is acceptable. Document additional work requests and obtain a written request for the work before work continues. At completion, Project Managers should request a letter from the owner accepting work.

Measurement Method
Subsection 615.04, Standard Specifications

Payment Basis
Subsection 615.05, Standard Specifications

SECTION 616
CONDUITS AND PULL BOXES

Description
Subsection 616.01, Standard Specifications

Contracts specify type, length and location for conduit material, junction boxes and pull boxes. Location may be changed to avoid utility conflicts and underground obstructions. Changes must be documented within as-built plans.

Materials
Subsection 616.02, Standard Specifications

Galvanized steel conduit is used for underground installation and when conduit is exposed to weather. Polyvinylchloride (PVC) conduit may be used in fine soils with little rock.

Construction Requirements
Subsection 616.03, Standard Specifications

Contractors may use larger conduit at their own expense, unless otherwise restricted between conduit runs, pull boxes and standard bases. Conduit size should not change within single conduit runs. Conduit may be rerouted to avoid obstruction(s).

Trenching and Backfilling

Conduit is preferably installed under roadbeds using directional drilling, which requires a level bottomed area or “pit” to locate jacking and drilling equipment next to the roadway. Project Managers may approve additional holes or pits to locate, identify and remove obstructions encountered during drilling, or approve an open trench for conduit installation. Before trenching, verify paved surfaces are sawcut at trench margins to minimize existing surfacing damage. Trenches should be no wider than needed for installation, backfilled and paved as soon as possible, closed during weekends, and excavation delayed if inclement weather is expected. Water infiltration may cause trench failure. Utility trench patches should be smooth, and trenches may be backfilled with “excavatable” flowable fill.

Inspection

Excavation area utility locates must be requested and staked.

Conduit Installation Checklist

- Send conduit samples to the Materials Bureau for testing before installation.
- Verify PVC conduit is stamped with UL approval stamp, manufacturer name, trade size, and schedule, with imprinted 80 and 150 degree temperature rating.
- Verify conduit embedded in concrete is securely tied to reinforcing steel.
- Ensure expansion fittings are installed across expansion joints.
- Open trench conduit installation is straight, on grade and at proper depth.
- Verify warning tape is placed at proper depth above the utility.
- Make sure trenches open overnight are barricaded.
- Conduit designated “future use,” must be pull string equipped and be properly capped and plugged.
- New conduit must be cleared with compressed air.
- Conduit should enter pull boxes near the side of and at proper height above pull box bottoms, and slope to depth.

- When steel conduit is used for conduit termination, do not allow Contractors to pull conductors until conduit end bells are installed. Inspect PVC conduit ends for damage to conductors or cables pulled through the conduit.
- Ensure jacking and drilling pits are barricaded from the PTW.

Electrical Conductor Splicing and Tagging Checklist

- Wire and cable for traffic signals, highway lighting, and other electrical systems are UL listed copper, and rated for specific usage.
- Bell ends are installed on conduit ends before wire is pulled.
- Conduit has been cleaned with compressed air.
- UL label is affixed to each reel, coil or wire container delivered to the job site.
- Check to see if wire has distinctive permanent markings indicating manufacturer name or trade mark, insulation type, size and voltage rating.
- Conductor number and size for each conduit run is in accordance with the conductor schedule.
- Pulling lubricant is used if required.
- Wire is not dragged to avoid insulation damage.
- At least 2 ft of slack wire is present in each pull box and signal pole.
- Detector cables have no splices between from the detector loop pull box and control cabinet.
- Conductors are tagged to identify circuit number and function.
- Signal wires are tagged in pull boxes, mounting assembly terminal compartments and control cabinet.
- Roadway lighting conductor pull boxes and service cabinets are tagged with circuit number tagging.
- Inline nonlocking fuse connectors are installed in luminaire pull boxes.
- Lighting conductor splicing is only used in pull boxes with watertight connectors. Only signal cable connections are made in terminal compartments and cabinets.
- Loop wire soldering splices are as identified in the plans.
- Verify waterproof loop cable splices are used.

Precast Reinforced Concrete Pull Box Installation

- Check pull box size
- Reject chipped or cracked pull boxes, extensions, and covers
- Verify boxes are at grade and level with curb or sidewalk
- Pull boxes installed in concreted areas are bordered by expansion joint material
- Ensure pull boxes in soil are encased in the concrete pad as required

Measurement Method
Subsection 616.04, Standard Specifications

Lineal feet markings are stamped on wire to determine installed wire length. These markings are more accurate than ground measurement.

Payment Basis
Subsection 616.05, Standard Specifications

SECTION 617
TRAFFIC SIGNALS AND LIGHTING

Description
Subsection 617.01, Standard Specifications

Traffic signals, highway lighting and other electrical systems are integral parts of roadway design and construction. Electrical system installation and testing is specialized work. Diligent electrical inspection and quality control minimize repair and maintenance costs.

MDT Procedures

During preconstruction, Design Project Managers and District Offices address electrical work procedures impacting contract administration. Contact the Traffic Electrical Unit for assistance.

Electrical Service Connections

The Electrical Section initiates contact with utility providers during project design except during consultant projects, for which consultants initiate and maintain utility company communication. Electrical (or Consultant) sends two proposed plan sets to the utility identifying:

- planned project service type
- needed service agreement(s)
- approximate service installation duration, including permit procurement time
- cost estimates including associated costs and final connection fee(s)

Plans typically show service details, wiring details and approximate service location. The District Utility Agent is copied on the letter and receives a plan copy. Utility companies respond regarding needed service changes, installation, permit procurement durations, and service charges. District Utility Agents and the Electrical Section provide assistance to utility companies if field questions arise.

After receiving written utility company responses, the Electrical Section or Consultant incorporates plan changes. Electrical or Consultant Design sends estimated utility charges to the Engineering Construction Contracting Bureau (ECCB) so a non-bid item “Service Connect” contract item can be included to cover connection fees.

Upon contract letting, District Utility agents provide Project Managers the original service connection cost and time to complete the connection. Project Managers and Contractors determine when electrical service installation needs to be in place based on lead time, utility company work, and project progress. Utility companies provide construction costs and a new service application to the Project Manager, who forwards the application and estimate to the Traffic Electrical Section for signing. Copies are sent to Maintenance and the CAS. The CAS supervisor issues payment for the service connection, and maintenance covers utility bills following construction. After the Contractor finishes the new service assembly, the electrical contractor contacts the utility to arrange for final connection. Utility Agents provide onsite utility location assistance as requested by the Project Manager.

Traffic Signal Maintenance

The Department designs and installs traffic signals on state highways. Local jurisdictions cover signal maintenance and operating costs with state reimbursement if a local agreement is in effect. Without an agreement, MDT covers signal maintenance and operating costs.

Highway Lighting Maintenance

District offices determine at Plans Specifications Estimate (PSE) Review if the District or a utility will maintain lighting facilities.

Private Electrical Installations

Private entities may request signal installation on state highways. The District Office and the Electrical Section jointly decide if work is warranted, after which Electrical reviews the plans and provides comment to the District.

Materials
Subsection 617.02, Standard Specifications
Electrical Equipment and Materials

Standard Specification, Subsection 617.03.2 requires Contractors to submit an equipment and materials list after award. The Traffic Engineering Section approves the list before Contractors order materials. Contractors should be notified of review time durations and the possibility that some items may need resubmission.

Traffic Controllers or Cabinets

MDT supplies traffic controllers and cabinets for MDT project traffic signals. Traffic control assemblies include controller units, auxiliary equipment, controller cabinet, foundation, conduit, anchor bolts and clearance pads. Traffic control cabinets house intersection and auxiliary control signal controller assemblies.

Inspection

Inspect materials, equipment, poles and standards for damage having occurred during shipping, handling and installation. Sampling and inspection may be performed at the fabrication shop or warehouse before delivery.

Buy America

Steel products such as structural and reinforcement steel, bolts, nuts, and washers incorporated into permanent work must meet Standard Specification Subsection 106.09 domestic steel or “Buy America” provisions. “Buy America” conformance for State furnished materials is MDT verified at purchase. Inspectors verify and document “Buy America” information in the field, and place documentation in the project file.

Construction Requirements
Subsection 617.03, Standard Specifications

Traffic signal and lighting equipment installation requires correct equipment wiring, wire labeling and diagrams, signal phase layout and incidental work. The electrical section advises Project Managers during traffic signal and highway lighting construction. Inspectors ensure contract, code and regulatory compliance for electrical system installation and operation. Review documentation to inform Project Managers of discrepancies or omissions and help avoid change orders.

During Installation Verify:

- Signal hardware packages conform with the approved materials list, MDT Detailed Drawings, and specifications
- Mounting assembly pole layout is according to the pole schedule and MDT Detailed Drawings
- Mounting bolts on Contractor furnished poles are sized, galvanized and configured per approved pole drawings
- Pipe nipple lengths on mounting assemblies are correct
- Elevator plumbizers and pole plates are bronze as required
- Through bolt double nutting for elevator plumbizers is correct
- Traffic signal mounting assemblies are plumbed and securely assembled with appropriate standard or plumbizer mounting to allow roadway design clearance
- Tunnel visors are specified length
- Back plate dimensions are correct
- Wattage and signal lamp types are correct
- Back plate between elevator plumbizer and signal face section is without a gap
- Fiber optic turn arrow lens holders are mounted perpendicular to signal faces
- Signal heads not in service are covered
- Non-breakaway signal head foundation portions protrude <4 inches above ground

Controller Cabinet Inspection Points

The interface between cabinet bottom and foundation is caulked
Controller cabinet mounting orientation and height complies with plans
Check service load center cabinets and entrance equipment to verify:

- Contractor installed the proper amperage interruption capacity breaker, if different than specified
- Service assembly is acceptable for utility connection
- Contractor and Inspector met with utility company to verify service run location(s)
- Live electrical components are protected by a front panel
- After electrical service energizing, voltage and amperage readings were taken for individual circuits
- Padlocks are furnished and installed, and plans made for a key transfer

Video Detection System Evaluation Checklist

Video cameras are installed on traffic signal mast arms. Cameras identify vehicles entering designated areas, and message signal controllers to sense a vehicle.

- Ensure necessary mounting hardware is installed
- Vehicle detection video processor is mounted to detect vehicles
- One video monitor per traffic signal cabinet is provided
- Video detection cable is specified by the video detection equipment manufacturer
- Camera is shielded against sun and inclement weather to operate at -20°F to +120°F
- Contractor provided lightning protection between the video camera and the video processor is as recommended by video manufacturer

- Terminal blocks are installed for connection
- Video detection system factory representative is present at traffic signal start up
- Contractor installed video detection cable is a continuous cable from the traffic signal cabinet to each video camera
- Video detection cable is not spliced
- Wire entrance holes drilled in the signal standard are sealed and approved by Project Manager
- Video processor is onsite during signal activation and cabinet installation

Radar Detection Systems

Radar sensor detection units mounted over travel lanes detect changes in reflected energy to signal traffic controllers. Verify that:

- Contractor provided a cabinet side mount, preassembled back plate with power supply meeting manufacturer specification, and a contact closure input card.
- Back plate provides communication, power conversion, power supply and surge protection to support 4 detection units.
- The radar detection system can detect vehicle presence over 90° at 6 - 100ft.
- Radar detection systems provide at least 8 RF channels, allowing multiple units to be mounted nearby without interference.
- The detection system has automatic and manual lane configuration, stop bars and zones.
- The detection system saves detector configurations and firmware upgrading.
- A radar detection system manufacturer representative is present for signal activation.

Loop Detectors

Inductive loops are rectangular wire loops sawed into the pavement surface to accommodate wire in conduit. Vehicles arriving over the loop disrupt the electric field in the wire, signaling the controller. Project Managers may need to layout detector locations if project plans conflict with existing detectors. Contact designers regarding apparent conflicts.

After loop detector installation and testing and the system is functional, work may be accepted. Project Managers submit Contractor preliminary test results to the MDT Traffic Electrical Unit, and include the detector in the State highway system log. Ensure loop detectors are installed in subbase or base during new construction and:

- Detectors are centered in traffic lanes, and located the proper distance into the stop bar area
- Trenching is minimized
- Sand surrounds loop wires
- Ground resistance is at least 50 megohms before and after saw cut sealant application, and tested with Inspector present. Inductance, resistance and quality properties must meet plan specifications
- Contractor documented continuity test results
- Wire marking tags identify loop detector wire phase number, direction and lane

When saw cutting to install loop detectors within asphaltic concrete verify:

- Detectors are installed before final lift placement
- Corner holes are drilled first
- Saw cuts are straight
- Saw cut depth is checked every 3 ft
- Wire has been approved
- Number of wire turns
- Hold down tabs are installed as specified
- Applied sealant is approved
- Ground insulation resistance is at least 50 megohms before and after saw cut sealant application, and was tested with Inspector present
- Contractor documented continuity testing
- Loop detector wire marking tags indicate phase number, direction and lane or plan loop number.

Traffic Signal Activation and Final Cleanup Checklist

- Signal circuits were tested by the Contractor with 120V power applied to each signal wire at the pull box with Inspector present
- Activation date was coordinated with Electrical to finalize controller activation
- Roadway striping and signing is complete before activation
- Contractor has arranged traffic control for activation day
- Stop signs were removed after signal activation
- Signal heads are aligned
- Grouting and touch up painting are complete
- Pavement patching is complete
- Pre-existing landscaping and grade is restored
- Final measurements and quantities are submitted to Project Manager
- As-built plans are complete and have been submitted
- Salvaged material is dismantled and stockpiled or delivered
- Salvaged material damaged by the Contractor has been replaced
- Contractor delivered manufacturer warranty and guarantee to project office

Highway Lighting

- Delivered luminaires are on the approved materials list
- Lamp socket positions deliver specified light distribution
- Vertically mounted luminaires are installed at specified tilt angle
- Lamp wattage is as specified
- Horizontal luminaires are leveled with tightened mounting bolts
- Vertical luminaires are plumb with correct tilt angle

Other Construction Inspection Issues

Safety Considerations

Contractors must obtain daily safety circuit clearance from utilities before starting electrical circuit work. Make sure the Contractor pulls cut out plugs and places “worker” signs at cut out boxes before starting electrical work. “Worker” signs indicate work in progress, and prevent circuit reconnection during work.

Surveying

MDT marks known MDT utility locations, resolves utility conflicts and coordinates relocations. Proposed locations must provide required vertical clearance above roadway. Coordinate with MDT Maintenance personnel as necessary. Contractors should establish survey referencing to locate benchmarks. Multiple survey reference points are preferable.

Preemption and Railroad Interconnects

Verify preemption equipment location and installation for emergency incidents or railroad coordination. Do not allow contractors to work within railroad ROW without written Project Manager approval. Railroads provide railroad ROW work inspection.

Foundation Design

MDT Detailed Drawings depict foundation designs for luminaires and signals. Soil conditions used for foundation design are medium dense to dense granular soil. If subsurface conditions are less favorable, or nonstandard loadings applied, special foundation design may be required.

Project designers typically select luminaire and traffic signal foundations according to Traffic Engineering Manual requirements. If unsuitable soil conditions or unusual situations require custom design, contractors must hire a PE for design. Geotech reviews design submittals and checks consultant foundation design.

Measurement Method
Subsection 617.04, Standard Specifications

Payment Basis
Subsection 617.05, Standard Specifications

SECTION 618
TRAFFIC CONTROL

Description
Subsection 618.01, Standard Specifications

Traffic safety and mobility must be maintained in construction zones to minimize delay. Contractor convenience must never supersede safety when planning or approving traffic control measures. Public safety, minimal economic loss and positive public relations are earned through diligent, efficient traffic accommodation, which depends significantly upon Contractor construction strategy. Standard Specification Section 618 governs MDT temporary traffic control. Contractors must follow approved traffic control plans, or develop a revised plan to provide safe and efficient traffic passage through and around work zones.

Traffic Control Plan

Traffic control plans accommodate traffic movement while maintaining safe work areas. Plans are based on expected field construction sequences, for which a contract special provision is included. Traffic control plans range from a comprehensive strategy tailored to specific projects, to simply a reference to special provisions and Detailed Drawings. Project Managers administer traffic control plans, and may consult with the CES Bureau Traffic Control Engineer. Contractor developed traffic control plans must be evaluated and approved by Project Managers, based on work conditions. Traffic control inspectors or Project Managers may request the plan be reviewed by the Construction Traffic Control Engineer.

Traffic Control Definitions

Construction Zone is the entire area on a public highway or adjacent ROW where construction, repair, maintenance or survey work is performed by MDT, local authority, utility company or private contractor under contract with MDT or local authority. “Construction Zone” in Montana is analogous to “Work Zone”, although Construction Zone is a broader term. Work zones are defined by Montana statute as “an activity area within a construction zone.”

Project Advisory Committees are project specific groups reviewing and managing project impacts on behalf of stakeholders. Committee members usually include Project Design Manager, DES Engineer, Project Manager, FHWA representative(s), DCE, an MDT or consultant public information representative, and possibly Chamber of Commerce or other local representatives.

Public Information (PI) components of the TMP include communication strategies informing road users, the public, area residents, businesses, and public entities about construction impacts and changing project conditions
.

Significant projects are those creating intolerable construction zone impacts based on MDT guidelines and engineering judgment.

Construction Zone Impact Criteria are listed in the “Work Zone Safety and Mobility Guidelines” (Appendix A).

Stakeholders are those affected by construction, including business owners, road users, government officials, regulators, or tribal officials.

Traffic Control Plans (TCP) describe contract measures such as plans or specifications, to move traffic through construction zones, work zones or incident areas. TCPs address traffic safety and control during construction.

Transportation Management Plan (TMP) is a group of strategies to manage construction impacts, and always includes a TCP, Public Information (PI) Plan and Transportation Operations Plan (below) for significant projects. For other projects, the TMP must include a TCP Plan, and may include TO and PI strategies.

TCPs outline strategies for moving traffic through work zones, and address construction zone safety and control. The TO (below) component addresses construction zone impact area management. The PI component addresses public and concerned stakeholder communication.

Transportation Operations (TO) Plans mitigate construction zone impacts to transportation system operation. Construction zone impact areas may extend beyond immediate project areas, so TO plans address detour signal timing, signing, and road and intersection capacity issues due to detour traffic.

Traveling Public refers to public transportation infrastructure users.

Work Zone is a construction, repair, maintenance or survey work area for which boundaries are clearly signed.

Work Zone Mobility is the extent to which travelers move efficiently through a work zone measured against a no construction condition.

Work Zone Safety refers to work zone hazard minimization.

Traffic Control (TC) Standard Specification Sections

The following Standard Specification sections apply to MDT temporary traffic control:

104.05.3	traffic and detour maintenance
104.05.4	traffic maintenance during work suspensions
107.07	railway and highway provisions
107.16	opening project sections to traffic
301.03.7	traffic gravel
606	guardrail and concrete barrier rail
617	traffic signals and lighting
703	lighting and signal materials
704	signing materials
705	guardrail and guideposts
714	pavement marking materials
715	TC devices

Applicable Publications:

“Manual on Uniform TC Devices for Streets and Highways” (MUTCD) establishes TC device design and uniformity. Part 6 “Temporary TC” applies to work zone TC. The Department may require minimum requirements be exceeded. MUTCD provisions containing “shall” and “should” are mandatory for contractors, as are specific MDT project requirements (MUTCD, Section 2A.03 “Standardization of Application”).

“Manual for Assessing Safety Hardware” (**MASH).** FHWA policy requires National Highway System roadside safety device usage in accordance with the AASHTO MASH, applying to temporary TC devices. Contact the MDT TC Engineer for information regarding MASH testing, device category, application and acceptance criteria.

The “**MDT Flagger Handbook”** is consistent with ATSSA guidelines and MUTCD requirements, and provides flagging instruction for MDT usage (Standard Specification Table 618-1, Subsections 618.03.9, 618.03.13 and 618.03.14).

MDT Work Zone Safety and Mobility: Goals and Objectives, Procedures and Guidelines. In September 2004, the FHWA published updates to work zone regulations in 23 CFR 630, Subpart J. This updated rule is referred to as the “Work Zone Safety and Mobility Rule”, and applies to state and local governments receiving federal highway funds. These guidelines document MDT processes and goals for measuring safety and mobility throughout work zones to improve construction zone safety.

MDT Road Design Manual Chapter 15 entitled “Maintenance and Protection of Traffic through Construction Zones,” discusses temporary TC. This chapter should be used alongside the MUTCD and MDT Detailed Drawings to assess acceptability for crossovers, lane shifts, transitions, taper rates and geometric elements within Contractor TC plans.

The “MDT Traffic Engineering Manual” provides guidance for temporary TC and TC devices, and should be used with the MUTCD, Detailed Drawings and contract documents to assess Contractor TC methods.

Contractor Traffic Control (TC) Plan

Although Detailed Drawings are sufficient for small, routine projects, TC plans including project specific plan sheets are necessary for larger, multi-phased projects. Prior to work, ensure a TCP is submitted by the Contractor in accordance with Standard Specification Subsection 618.03.2. The TCP may include drawings and documentation addressing TC devices and traffic accommodation methods used during each project phase. MUTCD provisions containing “shall” and “should” are mandatory for contractors, as are specific MDT project requirements (MUTCD, Section 2A.03 “Standardization of Application”).

Contractor Coordination with MDT Units

Effective TC plans depend on input from other Departmental personnel. Road designers:

- propose a project TC plan
- develop or review at least one acceptable Contractor furnished construction method
- develop detour and crossover design
- ensure a proposed traffic TC review is held during PSE review
- provide temporary pavement marking quantities

District traffic and construction personnel:

- develop TC plans
- coordinate wide load detours and staging location(s)
- ensure proper TC device selection and placement
- address roadside elements within construction zones, such as clear zones, median barriers, construction equipment and material placement
- inform the public via various media
- provide TC device quantities

The Engineering Construction Contracting Bureau (ECCB)

- compiles bid package documents
- inserts standard and special provisions into contract documents before bidding.

Motor Carrier Services (MCS) issues oversize vehicle permits. Coordinate with MCS when:

- Placing width restrictions on highway segments. Contact MCS at least 10 days in advance, and as quickly as possible if the restriction is due to an emergency.
- Notify MCS of detours, including four lane to two lane interstate oversize vehicle detours.

Materials
Subsection 618.02, Standard Specifications

Roadside safety appurtenances must meet MASH requirements for the intended application. Obtain certification from the Contractor for Category II and Category III devices. Category I device certification is not necessary. Certification letters verify traffic control devices are MASH compliant, and include device name, model number, description, manufacturer and certification for reflective sheeting.

Construction Requirements
Subsection 618.03, Standard Specifications

Traffic Control (TC) Reviews

Considerations Before Award

Prior to letting, the Engineering Construction Contracting Bureau (ECCB) includes special provisions addressing routine contract TC. DCE, District Traffic

Engineer and Project Manager review planned traffic control strategies. Project Managers then forward revisions to the ECCB for plan inclusion.

Preconstruction Conference

At the preconstruction conference, MDT personnel discuss project phasing, TC plan requirements, approved TC devices, special provisions, detailed drawings, inspection responsibilities and contractor coordination with utility and railroad companies. Meeting minutes should note MDT approved contractor TC recommendations.

Traffic Control Plan (TCP) Review

Review the TCP to understand proposed device type and location for each traffic accommodation method during each construction phase. TC plans should include flagger location and purpose, pilot cars and variable message boards. Project Managers should explain how each traffic accommodation method transitions between construction phases. Smaller projects may be straight forward, but multi-phased projects are often complicated. Project Managers should note TC detailed drawing revisions. Consult with the Construction TC Engineer and Traffic and Safety Bureau as needed.

Traffic Control (TC) Conference

Obtain written concurrence from the contractor TC Supervisor regarding TC plan changes, and document TC conference minutes within the DWR. Contact the Materials Bureau, Construction TC Engineer and Traffic and Safety Bureau for assistance.

Contractor Responsibilities

Contractors must comply with Departmental Work Zone Safety and Mobility Policy by:

- designating a trained and experienced person to implement the TMP and other safety and mobility policies
- ensuring personnel are TC trained and certified
- ensuring construction zones are maintained, orderly and safe
- minimizing delays and disruption during construction
- reviewing construction zones to encourage compliance with contract documents, policies and guidelines
- recommending TC improvements to Project Managers

Contractor Traffic Control (TC) Supervisor Coordination Responsibilities

Project Managers must have TC supervisor contact information and communicate with Contractor superintendents and subcontractors to ensure traffic control devices and methods comply with the TC plan. Weekly meetings address potential TC conflicts between subcontractors and utility companies.

Contractor TC supervisors must inform Project Managers, local police, emergency medical services, fire agencies and the US Air Force of planned lane closures, detours, clearance restrictions and anticipated traffic delays. Contractor TC supervisors request additional highway patrol enforcement if needed. Requests must be processed through the Project Manager and district office before highway patrol assistance is hired. The DCE typically arranges contracts with the highway patrol to monitor construction zones. Contractor TC supervisors should establish an inspection partnership and direct communication with the Highway Patrol to enhance project TC. Highway Patrols typically notify Contractor TC supervisors and Project Managers of TC deficiencies.

Inspection Items

Contractor TC supervisors must:

- inspect temporary TC for compliance each day devices are used, and at least weekly during nighttime hours
- verify TC configurations comply with TC plans
- ensure a safe route
- ensure TC devices function as intended
- continually check devices for damage, visibility and location
- ensure warning lights, flashing beacons, portable arrow boards and changeable message signs are functioning and clearly visible with sufficient battery life
- supervise TC device cleaning to ensure legibility and reflectivity. Clean devices every two weeks and as needed

Inspection Documentation

Daily Work Report

Inspect TC daily and document observations within the DWR. Work zone setups and TC quantities are recorded using a DWR template using stationing references, so TC inspection notes and documentation should correspond to stationing.

Contracts Bid by Traffic Control (TC) Unit

Device quantities shown within the TC rate schedule must be recorded within SiteManager or AASHTOware:

- Enter begin and end station within the work zone series. If data does not represent a defined work zone, as with damaged devices, enter “misc” within the stationing field. Descriptive locations referencing intersections or other features may be more useful than stationing.
- Enter a brief defined work zone description, such as “closed right lane and shoulder”. If devices are not within a defined work zone, indicate device location.
- “Install Type” is also designated within MDT specifications as “category number”. “Install” designates a new installation, whereas “Reuse” indicates a reset item, per Standard Specification Subsection 618.05.1.
- “Group No.” refers to the group shown within the TC Rate Schedule. Group descriptions are shown in the drop down selection list.
- Start and stop times are for hourly tracked devices, with durations entered in military time. Times are required for items having red asterisks.
- “Number of Items” is the number of devices used.
- Multiple work zones or miscellaneous devices can be recorded using daily templates.

Contracts Bid by Traffic Control Lump Sum or Unit Length

Although device quantities are not tracked, work zones must be documented using station and description. The following information is required for each template row:

- For defined work zones, enter beginning and ending station for work zone series. Use descriptive locations referencing intersections or other features if useful.
- If the work zone is undefined, enter a work zone description. If no defined work zone is utilized, indicate the zone purpose.
- Beginning and ending work zone times.

Traffic Control Report

Run TC reports in Oracle regularly, and give to Contractors. The report can be run weekly for limited work zones, or if a project involves different activities run the report more frequently, even daily. The report provides Contractors the opportunity to review information and discuss issues with Project Managers.

Flagger Oversight

Contractor TC Supervisors verify flagging operations, flaggers, uniforms and equipment are in compliance. Relief flagging should not interfere with TC Supervisor duties.

Emergency Preparedness and Response

Contractor TC supervisors should:

- exchange 24 hr contact information, and coordinate with Project Managers and local emergency responders such as highway patrol, police and fire departments
- ensure appropriate traffic TC availability and replacement during emergencies
- implement project emergency TC plans during emergencies and traffic incidents, and contact emergency response services
- respond to project incidents to assess temporary TC needs

MDT Personnel Responsibilities

Project Managers perform duties presented within this subsection during most construction projects, but delegate to TC Inspectors during complex projects needing continuous review. Ensure the Contractor TC Supervisor is present during MDT project meetings affecting temporary TC.

Work Zone Safety and Mobility Policy

MDT staff must implement the MDT Work Zone Safety and Mobility Policy by:

- measuring preconstruction travel duration through projects
- conducting daytime and nighttime construction zone reviews to ensure orderly and effective construction zones
- collecting project construction zone data for statewide analysis
- monitoring traffic control to improve safety and minimize delay
- enacting project law enforcement agreements to enhance construction safety
- obtaining law enforcement documentation relating to construction zone incidents
- evaluating Contractor proposed TC plans

Inspection Duties

MDT employees should notify Project Manager or Inspector of TC ambiguities or unclear direction. Observe traffic to verify TC devices provide for public safety and mobility, and address conditions affecting TC. Inspection requires TC inspection, reassessment and adjustment.

Perform detailed reviews according to Standard Specification Subsection 618.03.4 at least weekly, and after adopting new TC methods or configurations.

Make a nighttime inspections at least twice monthly, and when major alignment changes occur. Daytime TC devices and pavement markings may be ineffective at night, especially during rain or snow conditions. Sign reflectivity and striping problems are apparent during night inspection. Project work often ceases during holiday weekends, and affects TC device efficiency and placement. Signs and barricades moved or destroyed by traffic must be addressed. Project Managers should schedule holiday inspections.

Monitor TC during adverse weather, and spot check flaggers for current certification.

Inspectors must indicate to Project Managers locations where safety and mobility may be improved, and provide recommended action.

Inspection Documentation

Document compliance inspections using the MDT Inspection Report. Note uncompliant devices or features, corrective action directives given to the Contractor TC Supervisor, and date and time of Contractor notification. Reference the Inspection Report within the SiteManager Daily Work Report. Contractors must begin correcting temporary TC deficiencies. Project Managers may stop work to have deficiencies corrected at Contractor expense.

Emergency Preparedness and Incident Response

Emergency project conditions such as washouts, floods, and landslides authorize Project Managers to close a project to traffic to protect life and property. Project Managers should inform the DCE of urgent and emergency conditions. If a project emergency or traffic incident has occurred, or TC devices have been damaged, contact in the following order:

- emergency response services, such as Highway Patrol, local fire department, or MDT hazmat personnel
- Contractor TC supervisor
- MDT district and headquarter support personnel
- other entities such as FHWA, DEQ, OSHA, railroads, utility companies and school systems

Have an emergency contact sheet available. MDT personnel should respond based on need and severity. Document occurrences using photos, video and notes to protect MDT if a claim is filed or legal action taken.

Incidents Involving MDT Personnel and Equipment

Immediately notify the Highway Patrol when a state vehicle is in an accident, and report information to the Project Manager to notify the District Equipment Superintendent, who will initiate insurance claim processing. Project Managers review the incident with an MDT employee driver, and report to the DCE. The DA and District Human Resources Specialist determine if legal or disciplinary action is required.

Incident Report Form

An Incident Report Form must be completed for incidents involving MDT personnel or property. MDT personnel should only record first hand information. Note incidents within the DWR, and include conditions, signing and pertinent information. MDT vehicles must have an accident form in the vehicle. Information recorded on accident forms in the field can later be transferred to the Incident Report Form.

Incidents Involving the Public

Project Managers must document incidents involving private individuals, vehicles or property if MDT may be liable. Incidents include fatalities, injuries, commercial vehicle losses and alleged property damage, such as vehicular damage. Incidents occurring during work hours require Project Manager or inspector to immediately collect incident information. Use notes, drawings, photographs and silent video as needed. Information for incidents occurring outside working hours are conveyed to the Contractor TC supervisor and highway patrol. Incidents may initiate lawsuits, and take years to settle. Incident data should be recorded describing:

- weather conditions
- project signing and corresponding stationing
- signing leading into the project
- speed limits
- signing installation date(s)
- road conditions
- in place TTC devices
- current TCP document copy

MDT personnel must photograph approaches, approach signs and conditions, and oncoming vehicle perspectives. Label digital photographic files, and file with project records. Create a schematic crash site drawing showing traffic control devices and project features. Forward completed forms, drawings, photographs and video to the DCE for coordination with the Montana Risk Management and Tort Defense Division.

Construction Zone Crash Documentation Form

Injuries requiring transport to a medical facility and fatal crashes must be documented via the “Construction Zone Crash Documentation” form.

Video showing the construction and crash site is required. Contact the Construction TC Engineer for more information.

Traffic Control Process Review

Periodic evaluation of construction zone policies, processes, procedures and construction zone impacts helps address and manage construction zone safety and mobility impacts. Reviews help assess TC program effectiveness, and enable MDT and FHWA to make procedural or product related improvements. Document performance measures used to conduct the review. Construction TC Engineers organize a multidisciplinary review team to review specific procedures such as traffic control device payment methods or construction zone safety and mobility objectives.

Roadside Safety Considerations

Roadside obstacle hazards must be shielded. Construction project hazards are localized situations, such as partially completed drainage structures, idle equipment, material stockpiles, rubble or debris. Use roadside safety criteria within MDT Road Design Manual Chapter 15 to assess Contractor TC plans and implementation during construction. TC plans should address parameters such as construction clear zones, barrier lengths, and barrier flare rate. Roadside obstacles must be outside construction clear zones, as defined by the Montana Road Design Manual, Figure 15.4B.

Public Information

Public information and outreach campaigns communicate with public road users, residents, businesses, and public entities about road construction and associated safety and mobility. Public information and outreach campaigns should be initiated well before construction, and require updates during construction. Work with the MDT Public Information Officer (PIO) to develop public information and outreach plans. (FHWA manual "Work Zone Public Information and Outreach Strategies").

Construction Road Report

Project Managers should submit a Construction Road Report weekly to District Office and Construction Headquarters for posting to the MDT Intranet. Notify MCS of height, width and weight restrictions.

Speed Limit Changes

Speed Limit Reductions

Speed limit reductions within the construction zone should comply with Standard Specification Table 618-5 and the Detailed Drawings. In accordance with MUTCD Section 6C.01 entitled "Temporary Traffic Control Plans", reduced speed should be used only within the temporary TC zone portion where conditions or restrictive features are present. As construction zone length and location vary during the project, speed zones require some adjustment, but avoid frequent speed limit changes. TC plans should ensure safe vehicular travel through construction zones with speed reductions less than 10 mph. 10 mph speed reductions should only be used only as required by restrictive construction zone features. Speed reductions exceeding 10 mph should be accompanied by additional notification, and posted gradually to the lowest speed, with additional temporary TC warning devices used as needed.

Speed Limit Increases

Below are MDT methods to increase speed limits as drivers resume normal roadway speed. Post an end of work zone speed limit appropriate for all vehicles through the remainder of construction, before resuming to normal posted speed limits. Post the end of construction project speed limit.

Construction Zone Speed Limit Signing

Speed Limit Step Down Signing

Detailed Drawing 618-08, depicts W3-5 usage 3000 feet before the construction zone. W3-5 accompanied by W16-2 signs are placed 2000 feet before the construction zone. A W3-5 is required only when speed steps down 30 mph or greater, where incoming speed limits are high, at project beginnings or between project work zones when resuming to normal speed limits. Sign placement is important where permanent speed limits are already at or below the construction zone speed limit, as with many urban projects. Advanced warning speed limit signs draw driver attention to a major speed limit change. Consider existing project situations before placing step down signs. W3-5 and the W3-5/W16-5 signs are not required if:

- posted permanent speed limit is at or within 30 mph of the speed limit entering the construction zone
- posted permanent speed limit is equal to the construction zone speed limit
- end work zone speed limit signs are always required

End of Work Zone Speed Limit Signing

Detailed Drawing 618-08 requires R2-1 (End of Work Zone Speed Limit) placement 500 feet beyond the work zone to clearly denote speed limits between work zones, and remind drivers that pre-work zone speed limits are once again effective.

Speed Limit Signing Between Work Zones

Posted speed limits signs between work zones help reduce driver confusion while driving through changing speed zones. Standard Specification Table 618-5, entitled “TC Speed Limits in Construction Zones”, is useful for setting speed limits. Distances separating construction zone speed limit signs depends on the distance between work zones and other construction zone specifics. Project Managers determine sign spacing as needed.

Temporary TC Devices

An effective temporary TC device must be needed, convey clear and simple meaning, command road user attention, and allow response time. Prudent and reasonable road users must be able to navigate a project in a safe and mobile manner. Temporary TC device maintenance is necessary to retain legibility, visibility, and proper function. Work zone device quality is assessed using these categories:

- “Acceptable” devices are new or in “like new” condition.
- “Marginal” devices are those on the lower end of “like new” condition.
- “Unacceptable” devices failing to meet “like new” conditions must be removed within 12 hours of removal notification.

The American Traffic Safety Services Association (ATSSA) “Quality Guidelines for Work Zone TC Devices” publication offers more information to assess work zone signing condition. Classifications, photos and written descriptions for example TC devices are included.

TC Inspection Plan

TC device maintenance ensures performance, retro-reflectivity, cleanliness, placement, and condition. Temporary TC devices must comply with approved TC plans, MDT Standard Specifications, Detailed Drawings and the MUTCD.

Project Managers and TC Inspectors develop a project inspection plan to include:

- TC plan review to become familiar with specified device application, operation, maintenance and work during device setup.
- Device inspection during an onsite yard inspection before placement, to devices are TC plan appropriate, in acceptable condition and sufficient number.
- Driving the TC device field set up. Inspect lanes in both directions and entry or exit points within the construction zone. Day and night inspections are required to ensure properly functioning, clean, legible, and retro-reflective devices.
- Stationary observations allowing Inspectors to observe driver behavior within a particular work zone portion.
- Walk-Up inspection for major devices such as crash cushions and portable message boards. Ensure work zone device assembly and installation in accordance with contract documents and manufacturer recommendation.
- Nighttime inspections to ensure work zones appear at night as intended. Conduct nighttime inspections for all projects.
- TC plan review to become familiar with specified device application, operation, maintenance, and work required for device setup.
- Device inspection during an onsite yard Inspection before placement to ensure devices are traffic control plan appropriate, in acceptable condition and of sufficient number.
- A TC set up drive-through. Inspect lanes in both directions and entry or exit points within the construction zone. Daytime and nighttime inspections are required to ensure properly functioning, clean, legible, and reflective devices.
- Stationary observations allowing Inspectors to observe driver behavior within a particular work zone portion.
- Walk-Up Inspection for devices such as crash cushions and portable message boards. Work zone device assembly and installation must be in accordance with the contract and manufacturer recommendation.

Nighttime inspection for all projects:

- Conduct nighttime inspections at least twice monthly for projects having only daytime work, and when alignment changes occur. Verify sign reflectivity, legibility, and warning light function. Verify the work zone is easily navigated.
- Conduct inspections each night for projects having nighttime work. Ensure the work zone is easily navigated. Workers and flaggers must wear approved reflective clothing. Flagging stations and work zones must be lighted, and pilot cars easily identified.
- TC documentation helps evaluate TC plan effectiveness, and identify needed changes. Keep a daily project diary detailing TC activities and information needed for SiteManager. Document when and by whom TC corrections are made. MDT field, District and Headquarter personnel may perform TC device inspection, but field personnel should inspect daily. District and headquarter personnel may inspect devices as requested by field personnel or as necessary. Inspection should comply with “Work Zone Safety and Mobility Policy” guidance.

Work and Construction Zone Signing

Construction zones include the entire highway construction project area, and are initially signed with one of two warning signs:

- G20-1 “Road Work Next xx Miles”, which are rectangular and black on orange.
- W20-1 “Road Work Ahead”, which are diamond shaped and black on orange.

Project endings are signed with a G20-2 “End Road Work”, which are rectangular and black on orange. Work Zones are defined by Montana Code as a construction zone area where work is occurring and these regulatory signs are posted:

- R97-1 “Begin Work Zone”, which are rectangular and black on white.
- R97-2 “End Work Zone”, which are rectangular and black on white.

These signs are unique to Montana and shown within MDT Detailed Drawings. Montana state law requires:

- Work zone boundaries to be no further than 500 feet from construction activities.
- The MDT, local authority, utility company, or contractor to remove or cover work zone signs if work is not in progress and no hazards exist.

Ensure Contractors keep “Work Zone” signs no more than 500 feet from working personnel and equipment, remove or cover them when work is not in progress, and use correct signage. The last project sign must read “End Road Work”, and be black on white.

Temporary TC Signals

Temporary TC signal requirements are listed within the MUTCD.

General Temporary Traffic Control Guidance

Temporary TC signals are preferable to flaggers for long term work activities and work requiring night flagging. Ensure advance signal warning signs are present and meet current Departmental and MUTCD criteria. Provide a clearly defined traveled way between signals to prevent equipment from encroaching upon signals. Review Detailed Drawings for signing, pavement markings and signal placement. Temporary TC signals must be included within the TC plan.

Temporary TC Signal Application

For rural Applications:

- Use temporary TC signals where each end of the controlled roadway section is visible in both travel directions. Exceptions can be made where vehicles traveling a short distance past the signal (~200 ft) can see the signal controlling opposing traffic.
- Place a stop bar at least 40 feet before temporary signals, and remove stop bars when signals are not operating or removed.
- Verify “STOP HERE ON RED” sign placement does not obscure the signal face. “STOP HERE ON RED” signs should precede signals by at least 40 feet.

- Set signals on a fixed time interval, and monitor traffic queues before
- adjusting wait times to address observed queues.
- In steady traffic, drivers approaching the back of recently departed queues may be uncertain about stopping. Consider adding a flagger to address this confusion. Often flaggers are more appropriate to control traffic.
- Temporary signals may be used on non-Interstate chip seal projects.
- Use “walk back flaggers” if queues are more than 10 vehicles half the time.
- Ensure the green signal phase is displayed when pilot cars depart the queue.

For urban Applications:

- Temporary signals at urban intersections should be placed closely to intersections to provide a clear view of approaches.
- Place stop bar markings in accordance with the MUTCD.
- Use flaggers or stop signs if signal locations do not provide intersection visibility.
- Typically, temporary signals do not provide pedestrian instruction. Flaggers may be more effective controlling vehicular and pedestrian interaction when pedestrians are consistently present. Signing a pedestrian route to an alternative intersection may be safer.

Type 2 Object Markers and Portable Vertical Panels

Required object marker and portable vertical panel characteristics are listed within the MUTCD. Type 2 Object markers identify an object or roadside condition, but are not intended for use as channelizing devices. Use engineering judgment to select portable vertical panel channelizing devices such as flexible guide posts, drums or portable vertical panels.

Flaggers

Flaggers must provide certification upon request, and are used where changing or intermittent conditions affect usual traffic flow, such as equipment crossings. Flaggers observe conditions, signal traffic and warn workers if needed. Flagger placement and number vary with traffic speed, volume, lane number and highway alignment. If vehicle density precludes adequate reaction and stopping sight distance, or obscures the flagger, extend advanced warning sign spacing, or provide additional flaggers to ensure approaching traffic is not surprised by vehicles within or approaching the queue. Flagging operations are used only if no other TC is effective. Use only alert and trained flaggers. Review the “MDT Flagger’s Handbook” and Standard Specification Section 618.03.4 for guidance.

Detours and Temporary Roadways

Allow continuous travel through the project via one or a combination of:

- existing unmodified highway
- newly constructed highway portions
- interim construction
- temporary or alternate route detour
- delineated passage through construction

General Detour or Temporary Route Considerations

Designers should create facilities encouraging drivers to follow an intended path. The intended traffic lane is the most important roadway element, and includes lane geometry, surface condition, texture and delineation. Elements affecting driver response include edge of travel lane and guide marker delineation. Directional, lane, alignment, and speed changes increase crash potential. Visibility and lighting changes associated with glare, rain, and low angle sunlight alter roadway appearance. Consider special treatments such as additional striping or markings as needed.

Review project areas for driver difficulty. Broken barricades, skid marks, and damaged curbing or guardrail indicate needed improvement.

Pedestrian and Bicyclist Accommodation

Consider pedestrian and bicyclist needs especially when:

- sidewalks traverse work zones
- school routes traverse work zones
- pedestrian and bicycle activity is considerable
- high activity areas such as parks, schools, shops or churches are present

Ensure pedestrian and bicyclist movement by:

- Physically separating pedestrians from bicyclists and vehicles if possible.
- Ensuring pedestrian walkways and bicycle paths are without obstruction or hazards such as holes, debris, mud, construction equipment or material.
- Providing temporary walkway lighting after dark if adjacent walkways are lighted.
- Clearly marking ditches, trenches, and excavations near walkways.
- Covering walkways under or adjacent to elevated work activities.
- Emphasizing positive guidance to pedestrians by placing guide signs where pedestrians or bicyclists may detour to a safer alternative route.
- Minimizing and scheduling sidewalk removal time around pedestrian usage, and leaving at least one walkway open.
- Providing motion sensing audible information devices to provide closure notification to pedestrians with visual disabilities. If disabled pedestrians use a particular route, maintain the route with detectable channelization. Additional distances and street crossings are less safe for the visually disabled.
- Providing detectable edging required for facilities accessible to visually disabled pedestrians using long canes. Edging should protrude 6 inches above the sidewalk surface with edging bottom at least 2.5 inches above the surface, and be provided to direct visually impaired pedestrians where sidewalks are closed or near excavation.
- Providing detectable edging when equipment and supply staging areas encroach upon sidewalks. Edging is not required if supplies and equipment are separated from the sidewalk by grassy areas.
- Providing temporary sidewalks or sidewalk detours.

- Providing temporary sidewalks if existing sidewalk is removed where schools, neighborhood shopping centers, nursing homes or churches are near, if principal pedestrian routes to businesses are via existing paved surfaces, or new sidewalk will be unfinished for an extended time period.
- Verifying temporary sidewalks meet ADA criteria, are at least 4 ft wide, in place over four weeks, and have 2 inch concrete or plant mix surfacing. Surfacing for sidewalks in place less than four weeks may be 2 inches concrete or plant mix, or 3 inch compacted aggregate. Avoid aggregate sidewalks if wheelchairs are expected. Pedestrian detours to an opposite sidewalk should maximize continuous access throughout construction.
- Ensuring sidewalks and crosswalks are maintained free of mud and debris.

Measurement Method
Subsection 618.04, Standard Specifications

The Department uses lump sum traffic control payment for projects having well defined work scopes, low risk of change, a special provision defining traffic control requirements, and a well defined detour. Lump sum contracts incorporate TC Rate Schedules to cover TC work outside the contract scope. Projects typically administered using lump sum TC include:

- bridge projects
- urban projects with sequenced, in place detours and well defined TC quantities
- multiple small defined work areas such as guardrail or signal installation work
- mobile operations such as rumble strip and pavement marking work
- well defined project portions such as crossovers, intersections, and detours
- interstate projects using two lane, two-way detours

Daily TC unit adjustments are made in accordance with Subsection 618.04 for items not meeting Section 618 requirements. TC units may be reduced by 10% after contractors are notified of noncompliance, and:

- Devices do not meet the ATSSA guide, and the Contractor has been notified to remove specific devices without payment. If device remains, or condition is uncorrected, apply a 10% daily deduction. Devices in poor condition should not remain on the project.
- Temporary traffic signals and arrow boards do not operate correctly. Notify the Contractor immediately if traffic signals and arrow boards do not work properly or need bulb replacement. Devices should not earn daily TC units unless working properly. If a Contractor corrects a maintenance issue promptly, Project Managers may waive the 10% deduction.
- Devices are at incorrect height, tilted, unreadable, or improperly covered.
- Do not pay for incorrect TC setups. TC supervisors must work with contractors to ensure correctly placed TC. The Department is not committed to pay for TC when contractors unexpectedly change work plans. TC contractors typically meet with other project Contractors at the end of each shift to discuss how operations will resume the following day. TC contractors typically have devices and detours set up before beginning the work shift. If another contractor changes operational plans, the Department is not obligated to pay for in place devices, and only pays for devices in place for work performed that day.

- On certain occasions and at Project Manager discretion, a contractor operation is directed or changed. The Department pays for such TC changes.

618.5 Payment Basis
Subsection 618.05, Standard Specifications

SECTION 619
SIGNS AND DELINEATORS

Description
Subsection 619.01, Standard Specifications

Highway signs are permanent traffic control. Delineators and guideposts delineate roadway alignment during darkness and when roads are wet or snow covered. Guideposts include chevron signs, milepost signs, object markers and barricades. In addition to Standard Specification requirements, signs and delineators must meet requirements set forth by MDT Detailed Drawings, MDT Sign and Sign Materials guidance, the FHWA Standard Highway Signs Book, and the MUTCD. Project Managers should review MDT Traffic Engineering Manual Chapter 18 entitled “Highway Signing”, or consult the MDT Traffic Engineering Section.

Materials
Subsection 619.02, Standard Specifications

Standard Specification Section 704 covers MDT sign material and fabrication requirements applying to sheet aluminum, plywood, aluminum, steel and timber posts and reflective sheeting. Standard Specification Subsection 705.04 addresses guidepost and delineator material requirements as depicted within the Detailed Drawings. Inspectors should obtain manufacturer certified mill test reports and compliance certificates upon signing material delivery. Inspectors should verify sign material condition conforms to contract requirements.

Construction Requirements
Subsection 619.03, Standard Specifications

Sign Inspection

Verify specified sign installation shown by plan sheets and Detailed Drawings by:

- inspecting staked location
- reviewing sign visibility
- verifying sign type, color, size, message, location, offset, height, orientation, and reflectivity
- ensuring posts are plumb and bases meet breakaway requirements
- inspect sign placement angle
- ensuring signs are installed to proper height
- verifying sign overlays are plumb and level, and Contractor has furnished reflective sheeting matching color, shade, and existing sheeting material for partial overlays
- ensuring sign overlay matches existing sign size
- ensuring sign placement does not compromise pedestrian ADA safety requirements
- ensuring sign backs show installation date

Cantilevered and Overhead Signs

Contractor Designed

Contracts may require Contractors to design cantilevered or overhead sign structures, including the foundation. In such cases:

- MDT designers request soil borings from the Geotechnical Section.
- Geotech provides designers with soil boring logs and retains soil samples.
- The designer includes boring logs within the contract documents and provides vertical and lateral clearances, sign dimensions, wind loading and static loading.
- Contractors may perform additional soil analyses. Foundation details, structure member sizes or attachment details are not shown within contract documents.
- Contractors submit structural and foundation design to the Project Manager with design calculations and shop drawings approved by a Professional Engineer. Project Managers forward this information to the Bridge Bureau for review.

Inspection

Overhead sign foundations must have properly oriented anchor bolts projecting from the foundation top for connection with the superstructure. Bolts connect superstructures to foundations, and fasten sign uprights. Connections must be made while connections are unloaded, so cranes are used to relieve loads during connection tightening. Ensure bolts are not over tightened to close gaps, and steel components do not become distorted. Anchor and leveling nuts may require adjustment during sign leveling. Verify leveling nuts are in contact with the base plate before tightening anchor nuts.

Drilled shaft foundations should not be excavated. Casing or sono-tube stabilizing drilled shaft excavation should be removed to ensure concrete with soil contact.

Replace, Reuse, and Reset Signs
Subsection 619.03.6, Standard Specifications

Before work begins Project Managers should inventory existing signs designated for replacement, reuse, or resetting, and note sign condition before removal and reuse.

Measurement Method
Subsection 619.04, Standard Specifications

Payment Basis
Subsection 619.05, Standard Specifications

SECTION 620
PAVEMENT MARKING APPLICATION

Description
Subsection 620.01, Standard Specifications

Pavement markings guide motorists and are available in a variety of materials for temporary, interim and permanent applications. Project Managers should review Traffic Engineering Manual Chapter 19 entitled “Pavement Markings”, or consult with the Traffic Engineering Section.

Materials
Subsection 620.02, Standard Specifications

Standard Specification Section 714 covers MDT pavement marking material requirements. The QPL lists preapproved pavement marking materials including, glass beads, water borne paint for temporary or interim striping, and epoxy for permanent application. Verify compliance certification and manufacturer certification for pavement marking material delivered to construction sites. Also verify manufacturer certification for lot and batch numbers match supplied material.

Thermoplastic marking material may cause allergic reactions. Ensure contractors have MSDS information for these products available. Spilled material must be removed quickly and correctly.

Construction Requirements
Subsection 620.03, Standard Specifications

Ensure pavement marking installation is correct, and proper materials, equipment, application rates, location and dimensions are used.

Quantity Measurement
Standard Specification Subsection 620.04

Epoxy marking is field measured in accordance with Standard Specification Subsection 620.03.6 using paint “tank stabs” to measure tank levels before and after work shifts, and after paint is added to the tanks. Paint quantity usage is recorded from Contractor equipment meters. The lesser quantity is used for payment. In accordance with Standard Specification Subsection 620.03.6, a nonporous metal plate is placed before the application to measure epoxy and thermoplastic application rate and thickness. The MDT intranet displays a marking paint application rate chart.

Temporary and Interim Pavement Markings

Interim markings delineate travel lanes during construction until permanent marking application. Contractors may also use paint or pavement marking tape as interim markings before permanent marking application. Permanent and interim markings are measured differently for payment. Temporary removable pavement marking tape may be applied where Contractors plan to modify traffic patterns. Tape adheres after being pressed to the pavement surface. Verify marking tape is removed before subsequent HMA paving. Table 620-1 provides troubleshooting guidance to address problems during paint application.

Preformed Plastic Pavement Marking Material

Preformed pavement markings have a reflective coating and adhesive backing. Preformed markings are factory or field cut to specified shapes, and adhesively applied. Marking location can be adjusted before final installation pressure is applied. Pavement must be clean, warm and dry, and without bleeding. Note pavement temperature, condition and cleaning observations within the DWR.

Epoxy Pavement Markings

Pavement grinding provides a roughened surface to enhance adherence. Pay particular attention to specified grinding depth. Ensure Contractors apply glass beads at 25 lbs/gallon to the epoxy (Standard Specification Subsection 620.03.6.D.2). Table 620-2 addresses problems encountered during epoxy application.

Thermoplastic Pavement Markings

Surface preparation is critical to thermoplastic marking durability. Concrete pavement must be cleaned using water or sand blasting, and free of curing compound. Oil or fuel must be removed. During thermoplastic striping application, verify:

- material temperature is within specified range
- road surface temperature is above minimum
- pavement is clean and dry
- thermoplastic bonds to pavement
- stripe thickness and width
- beads application at specified rate and adherence to thermoplastic
- markings are protected from traffic until thermoplastic sets

TABLE 620-1
PAINT APPLICATION TROUBLESHOOTING

Problem	Cause	Effect	Remedy
Uneven or Spotty Paint Line	• Atomizing air pressure too low • Paint tank pressure too low • Old paint (viscosity too high) • Loose paint gun tip and/or shroud • Insufficient heat • No shroud	• Poor appearance • Line has fuzzy edges • Slow drying time • Paint won't flow smoothly	• Increase atomizing air pressure • Increase material tank pressure • Rotate material stock • Secure paint gun tip and/or shroud • Increase heat to attain even paint flow • Install shroud
Excessive Thickness at middle of line	• Paint tank pressure is too high • Paint gun volume control needs adjustment • Pump pressure is too high • Atomizing air pressure is off or too low • Buildup in paint gun tip or shroud	• Buried beads – poor retro-reflectivity • Slow drying time, and paint tracked by motorists • Paint won't cure properly and has short life	• Reduce tank pressure • Adjust paint gun • Reduce pump pressure • Increase atomizing air pressure • Clean tip and/or shroud

Excessive Thickness at line edge	• Material buildup in paint gun tip and/or shroud • Clogged hole(s) in paint gun atomizing tip	• Buried beads have poor initial retro-reflectivity • Slow drying time and paint tracked by motorists	• Clean paint tip and/or shroud • Clear clogged hole(s) in paint atomizing tip
Insufficient Thickness	• Paint tank pressure is too low • Paint gun volume control is restricted • Paint pressure is too low • Applicator speed is too low • Atomizing pressure is too high • Material buildup in paint gun tip or shroud • Materials buildup in paint filter(s) and/or plumbing	• Poor line quality or shortened life • Beads don't adhere or retro-reflectivity is poor	• Increase tank pressure • Adjust paint gun volume control • Increase pump pressure • Decrease application speed • Decrease atomizing air pressure • Clean paint gun tip and/or shroud • Clean paint filter or pump
Wide Paint Line	• Paint gun set too high • Tip and/or shroud	• Line does not meet standards • Fuzzy lines	• Lower gun • Repair or replace tip and/or shroud
Narrow Paint Line	• Paint gun too low • Paint gun tip not at 90° angle to paint line • Clogged paint gun tip and/or shroud • Low air pressure in paint machine tire	• Line does not meet standards • Less visible than a full width line	• Raise paint gun • Reposition paint gun tip • Clean paint gun tip and/or shroud • Inflate tire

TABLE 620-2

EPOXY APPLICATION TROUBLESHOOTING

Problem	Cause	Effect	Remedy
Heavy centers	• Inadequate fluid delivery	• Tracking • Erratic wear patterns • “Railroad Tracks” initially	• Increase tip size • Replace tip
Light centers	• Inadequate fluid delivery	• Tracking from the edges • Erratic wear patterns • “Railroad tracking” with time	• Increase tip size • Replace tip
Surging pattern	• Pulsating fluid delivery	• Does not conform to standards • Erratic wear pattern	• Reduce demand • Remove supply system restrictions • Check supply hose for leaks
Surging pattern	• Pulsating fluid delivery	• Does not conform to standards • Erratic wear pattern	• Reduce demand • Remove supply system restrictions • Check supply hose for leaks
“Lop-sided” mills	• Worn tip sides • Clogged tips	• Erratic wear pattern	• Replace tips • Clean tips
Line is too wide	• Gun too high • Fan angle on tip is too wide	• Does not meet standards	• Lower gun • Adjust tip size if necessary
Applied line is too thin	• Inadequate tip hole • Traveling too fast for tip size • Delivery pressure change	• Poor durability • Does not meet standards	• Change tip size • Slow application speed • Verify pressure settings
Applied line is too thick	• Tip size is too large • Traveling too slowly for tip size • Change in delivery pressure	• Cure time is too long • May cause shape problems • Poor retro-reflectivity	• Change tip size • Increase application speed • Verify pressure setting

Too much hardener	• Displacement pumps improperly synchronized	• Dark or black lines • Excessive curing time	• Adjust pumps
Too little hardener	• Displacement pumps improperly synchronized	• Poor durability	• Adjust pumps

TABLE 620-3

THERMOPLASTIC APPLICATION TROUBLESHOOTING

Problem	Cause	Effect	Remedy
Line edges are rough	• Material is uncured	• Loss of durability • Not to various specifications	• Raise material temperature • Increase material quantity • Decrease atomizing air pressure
Line is wavy with irregular edges	• Material is too hot • Application pressure is too high • Extrusion gate is too wide or material is flowing past gate • Road surface is uneven	• Poor reflectivity • Poor appearance • Poor durability	• Verify correct material for application method • Adjust material temperature • Lower application pressure • Adjust application equipment or lower application rate
Line appears discolored, beige or dull white	• Material is overheated or has been reheated too often	• Does does not meet color standard • Material is brittle with low durability	• Discard material
Line appears pitted	• Trapped moisture • Material not cured • Trapped air	• Poor surface bond -low durability	• Stop operation until road dries and/or primer cures • Slow application
Line appears lumpy	• Charred material • Unblended material	• Low durability	• If lumps appear burnt or dark in color, screen material to remove lumps

Problem	Cause	Effect	Remedy
			• If lumps appear grainy or unmixed, hold material at 420°F until they dissolve
Line appears stretched or pulled	• Material applied too cold • Material applied too fast	• Poor surface bond -low durability	• Raise temperature • Lower speed of application
Line appears scarred or gapped	• Charred material • Dirt or debris on surface	• Poor surface bond -low durability	• If lumps appear burnt or dark in color, screen material to remove lumps • Clean pavement surface
Line appears uneven at beginning or end	• Applicator not adjusted properly	• Poor appearance	• Adjust applicator

Measurement Method
Subsection 620.04, Standard Specifications

Payment Basis
Subsection 620.05, Standard Specifications

SECTION 621
FACILITY REMOVAL, RESET AND ADJUSTMENT

Description
Subsection 621.01, Standard Specifications

Manholes, catch basins, curb inlets, water valve boxes, and gas and water valves commonly require vertical adjustment. Section 621 items are included for facility grade adjustment during resurfacing.

Materials
Subsection 621.02, Standard Specifications

Construction Requirements
Subsection 621.03, Standard Specifications

During facility adjustment ensure debris is kept from entering drains. Document preexisting conditions prior to construction. Ensure water valve lines are plumb, clean and functional. Document deficiencies within the DWR. Project Managers and Contractors should meet with utility companies before mitigating utility conflicts.

Measurement Method
Subsection 621.04, Standard Specifications

Payment Basis
Subsection 621.05, Standard Specifications

SECTION 622
GEOTEXTILES

Description
Subsection 622.01, Standard Specifications
Terminology

Geotextiles provide drainage, filtration, stabilization, sediment and erosion control, reinforcement, and adjacent material separation. Geotextiles Types Used by MDT are:

- Permeable material fibers combined into planar textile structures. Woven geotextile is monofilament, multifilament or fibrillated yarns. Nonwoven geotextile is continuously extruded and spun. Fibers or filaments are then connected using needle punching or heat bonding. Geotextiles are used for strength, separation, drainage and filtration purposes.
- Geogrids are polymer mats of coated yarns or punched and stretched polymer sheets used for soil reinforcement. Geogrids are formed using integrally connected elements with apertures exceeding ¼ in to allow interlock with surrounding material. Geogrid types are:
- Junction Geogrid, categorized by the method used to form junctions between grid ribbing. Junction geogrids include extruded, bonded and woven geogrid
- Directional Geogrid, which supports loading along uniaxial or biaxial strength directions
- Geonets are integrally connected netlike polymeric materials with parallel ribs used for planar drainage.
- Geo-composites are polyethylene drainage cores wrapped in geotextile, used as edge, wall, vertical and sheet drains.
- Geomembranes are impervious polymer sheets used to line ponds, landfills or encapsulate moisture sensitive clays. Various materials are used for geomembranes, including polyvinyl chloride, high density polyethylene, polypropylene, and polyester.
- Geotextile Clay Liners (GCL) are manufactured hydraulic barriers with bentonite clay between geotextile layers or adhering to a geomembrane. GCLs control moisture infiltration into soil subgrades, and moisture content within frost sensitive soils. GCLs also seal wetland mitigation berms and waterproof walls and bridge abutments.

Geotextile Applications

Geotextiles are used to separate:

- subgrade and aggregate roadway bases
- foundation and embankment fills or surcharge loads
- foundation soils from retaining walls
- existing soils from stockpiles
- existing and new asphalt
- Separation geotextiles separate subgrade from overlying base course, and prevent fine material migration into the base course, which diminishes base course structure.

- Separation geotextile is also used where subgrade is compactible and workable with typical earthwork equipment. Separation geotextiles do not increase bearing capacity.
- The Geotechnical Section often includes geotextile strength requirements for survivability, permittivity, opening size, ultraviolet stability requirements and installation requirements.

Soil Stabilization

Stabilization geotextiles cover unstable soil conditions caused by wet subgrade often identified by pumping or rutting. Stabilization geotextiles separate, filter and reinforce soft material, and typically include a geotextile or both geogrid and geotextile.

Drainage and Filtration

Geotextiles can be installed below grade to drain water into subsurface drains and/or retain soil. Geotextiles, geo-composites and geonets can also be used to drain low permeability soils, or in place of granular filters. Geotextiles retain soil particles, prevent piping and collect and transport water. Geotextile drainage and filtration installation applications include:

- beneath aggregate roadway bases
- around clean crushed stone or perforated pipe
- separation between backfill and gabions and retaining walls
- capillary breaks within frost sensitive areas
- chimney drains behind retaining walls
- drainage blankets beneath surcharge fills
- edge drains

Temporary Silt Fence

Temporary silt fence is used near water resources or along ROW lines, and controls sediment by retaining eroded soil particles and impeding runoff.

Permanent Erosion Control (PEC)

Geotextile usage as permanent erosion prevents soil erosion and piping. Geotextile erosion control mats retain soil, moisture and seed to promote plant growth. Permanent erosion control geotextile applications include:

- roadside ditches
- bridge ends
- cut and fill transitions
- cut and fill slopes

Soil Reinforcement

Geotextile reinforces soil and embankment, and stabilizes steep slopes and MSE wall construction. Embankments over soft foundation soils tend to spread laterally. Properly designed horizontal layers of high strength geotextiles or geogrids increase stability and reduce differential settlement failures. However, geotextile reinforcement usage usually does not eliminate embankment settlement. MDT installs various geotextile types depending on the need for:

- separation, stabilization, or erosion control
- geotextile survivability
- permanent erosion control and subsurface drainage

Materials
Subsection 622.02, Standard Specifications

Standard Specification Section 716 covers MDT geotextile requirements. The QPL lists preapproved geotextile materials and sources. When geotextile materials are delivered, verify manufacturer certification, QPL listing or Compliance Certification. Materials must pass testing and be certified before installation. Verify geotextile material as specified by the contract. Most geotextile failures are due to incorrect application, such as erosion control fabric used as stabilization fabric. Ensure correct material usage and submit required samples. Geotextile must not be installed without passing test results.

Construction Requirements
Subsection 622.03, Standard Specifications

Standard Specification Subsection 622.03 covers geotextile installation. Manufacturers and suppliers provide Installation instruction, which Project Managers should review before construction. Geotextile anchoring is required to prevent fabric from shifting during backfill, and wind from moving unweighted geotextile. Contractors should use dump trucks to place fill on fabric, before spreading fill to form a bridging lift. A geotextile backfilling Special Provision is often included in the contract. Damaged geotextile may be patched by removing damaged areas and covering with fabric 3 feet beyond the patch perimeter. Polymer geotextiles become brittle with sunlight radiation (ultraviolet) exposure, so must be protected during storage until covered.

Surface Preparation

In most cases geotextile is placed over cleared and grubbed subgrade, but may be placed over undisturbed vegetation in soft areas to provide additional support. Geotechnical section approval and special provision are needed in cases leaving vegetation place. Verify remaining stumps or roots are covered with fill to avoid puncturing geotextile. In other cases, geotextile may be placed on native subgrade soil. If geotextile is used for slop reinforcement, loose material must be removed from slope bases. Proposed fill areas at slope bases must be compacted and graded before geotextile placement.

Erosion control mat installation areas should be compacted to grade before installation. Erosion control blankets and geotextiles used in or adjacent to “waters of the US” must be biodegradable. Verify large rocks, soil clods, vegetation and sharp objects that may damage geotextile are removed to ensure contact with prepared surfaces.

Separation and Stabilization Applications

Shingle transverse laps in the direction of aggregate placement to prevent displacement during fill placement.

Temporary Silt Fence

Fabric at geotextile fence bottoms must be buried to specified contract depth to prevent flow under the fence. Verify that:

- posts are spaced at proper intervals
- fabric is anchored as specified
- wire fence supports are placed properly
- silt fence will handle sediment loading

Measurement Method
Subsection 622.04, Standard Specifications

Geotextiles are measured per square yard and staked by Project Managers. Silt fence is measured per linear yard. Laps, seams and joints are not measured for payment.

Payment Basis
Subsection 622.05, Standard Specifications

SECTION 623
MAILBOXES

Description
Subsection 623.01, Standard Specifications

Materials
Subsection 623.02, Standard Specifications

Construction Requirements
Subsection 623.03, Standard Specifications

Permanent Mailbox Installations
Mailbox locations are identified in the contract. Supplemental Specifications outline MDT mailbox support crashworthiness requirements. MDT Detailed Drawings provide mailbox dimensions and construction details. Contractors and Project Managers should coordinate with the postal service and property owners during mailbox installation.

Mail Delivery to Temporary Installations
Ensure continuous mail delivery by coordinating with owners and the postal service when mailboxes are removed during construction. Temporary mailboxes may be supported on traffic control barrels if barrels are not construction orange, in good shape and properly supported.

Measurement Method
Subsection 623.04, Standard Specifications

Payment Basis
Subsection 623.05, Standard Specifications

SECTION 624
WELDING

Description
Subsection 624.01, Standard Specifications

Materials
Subsection 624.01, Standard Specifications

Construction Requirements
Subsection 624.03, Standard Specifications

Contact the MDT Certified Welding Instructor regarding welding inspection.

Measurement Method
Subsection 624.04, Standard Specifications

Payment Basis
Subsection 624.05, Standard Specifications

APPENDICES:

Appendix A	Construction Inspection Checklists
Appendix B	Construction Forms and Memos
Appendix C	Sample Change Orders
Appendix D	Field Nomenclature, Technical Information, Formulas and Measurement Techniques
Appendix E	Hot Plant Inspection Manual
Appendix F	Construction Field Crew Activities
Appendix G	Quality Assurance (QA) Guide
Appendix H	Materials Control