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Section 100

Administration - General Provisions

100.1. General

100.1.1. Description

- A. The Town's DESIGN STANDARDS, Technical Specifications (SPECIFICATIONS) and the approved Construction Improvement Drawings (CD's) are intended to supplement each other. When conflicts and/or questions arise between the accepted plans, specifications, development standards, referenced standards or other contract documents, the appropriate Town staff shall make the final decision concerning such matters.
- B. Whenever the provisions of these SPECIFICATIONS are found to be inconsistent with any other regulations or codes, the appropriate Town staff shall determine the standard to apply. The provisions of these regulations are minimum requirements that do not preclude imposition of more restrictive standards by agreement or by law.
- C. All standard specifications (e.g. ASA, AWWA, ASTM, ACI, CHS, ISSA etc.) are made a portion of these SPECIFICATIONS by reference and shall be the latest edition and revision thereof.
- D. All pavement and street construction within the Town of Johnstown on Town right-of-way's or Town owned property shall be constructed in accordance with the requirements of these SPECIFICATIONS, the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction as referenced herein, the Mile High Flood District Standard Specifications for drainage facilities, and as related to Town Ordinances, Code and DESIGN STANDARDS.
- E. These Specifications contain many command sentences which are directed at the Contractor/Owner unless otherwise stated.

100.1.2. Interpretation and Authority

- A. The Public Works Director, Utility Director or their designated representative shall have the authority on behalf of the Town to ascertain that all design and construction is equal to or exceeds the minimum requirements set forth in these SPECIFICATIONS.
- B. The Town's Inspector shall have authority on behalf of the Public Works Director and Utility Director to make detailed inspections for compliance with Construction Improvement Drawings and SPECIFICATIONS.
- C. The Contractor/Owner shall request clarification of all apparent conflicts by contacting the appropriate Town staff. The Town will not be responsible for any explanations, interpretations, or supplementary data provided by others.
- D. The contractor shall be licensed and bonded with the Town of Johnstown prior to construction of facilities for acceptance by the Town.

100.1.3. Errors and Omissions

- A. All risks of error and omission are assumed by the Contactor, the Town of Johnstown will have no responsibility thereof.

100.1.4. Notification of Work

- A. The Contactor shall notify the Town Public Works and Utility Department office a minimum of 48 hours before beginning construction.

100.1.5. Submittals

- A. This Section includes provisions for Contractor submittals. Additional provisions may be included in specific Specifications Sections.

- B. Submittals shall be mailed or emailed as follows:

1. Town of Johnstown –to the following email: dgosset@JohnstownCO.gov

- C. Unless otherwise specified, make all submittals in groups containing all associated items to ensure that information is available for checking each item when it is reviewed. Partial submittals may be rejected as not complying with these specifications.

- D. All submittals must be approved by the project's Engineer of Record prior to submittal to the Town.

- E. Submittal Format Shop Drawings

1. Submittals shall be clear and legible and of sufficient size for sufficient presentation of data.
2. Minimum sheet size: 8½ x 10" to assure clarity.
3. Identify each submission with the following:
4. Date of submission. Project title and number.
5. Names of Contractor, Supplier, and Manufacturer.
6. Specification section number.
7. Intended use of item in the work and equipment designation.
8. Identify details by reference to sheet, detail, schedule or room numbers shown in the specifications.
9. Deviations from specifications.
10. Revision or resubmittal number.
11. Contractor's verification, initialed or signed, certifying review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Town.
12. Approval stamp and signature from the Engineer of Record.
13. Provide a clear space approximately 3½" x 2½" for the Town's stamp.

- F. All submittals shall be clearly identified by reference to Specification Section, Paragraph and Town of Johnstown Standard Detail(s), Approved Materials List, as applicable.

- G. The cover sheet shall fully describe the packaged data and include a listing of all items within the package.
- H. Provide to the Town a copy of each submittal transmittal sheet for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples. The transmittal sheet shall include the following:
 - 1. The Contractor shall utilize a submittal identification numbering system in the following manner:
 - 2. The first two characters shall represent Shop/Working Drawing and other Product Data (SD), Sample (SL), Operating/Maintenance Manual (OM), Certificate of Compliance (CC), Statement of Qualification (SQ), or Test Results/Report (TR).
 - 3. The next two digits shall be the numbers 01-99 to sequentially number each initial separate item or drawing submitted.
 - 4. The next character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawing, i.e., A=1st submission, B=2nd submission, C=3rd submission, etc.
 - 5. The next digits shall be the applicable Specifications Section Number.
 - 6. The next digit should indicate if the product is on the Town's Approved Materials List Y=Yes the material is included, N=No, the material is not included.
 - 7. A typical submittal number would be as follows: SD-08-B-301.1-Y (*SD = Shop Drawing 08 = The eighth initial submittal, B = The second submission (first resubmission) of that particular shop drawing, 301.1 = Specifications Section, Y=indication that the material is included on the Approved Materials List*)
- I. Minimum Number Required: Shop Drawings:
 - 1. Number Contractor requires plus three (3) copies which will be retained by the Town, five (5) copies minimum.
 - 2. Submit four (4) additional copies for inclusion in Operation and Maintenance manuals where Operation and Maintenance manuals are called for.
 - 3. Where field modifications are made after acceptance, indicate "as constructed" conditions, mark copies "AS CONSTRUCTED", and submit prior to Substantial Completion.
- J. Samples: Two (2) unless required otherwise by individual specification sections.
- K. Operations and Maintenance Manuals:
 - 1. Submit in a format suitable for binding in a three ring binder or a post binder.
 - 2. Minimum sheet size: 8" x 10½"
 - 3. Fold drawings larger than 11" x 17" and insert into individual pockets bound into the manuals.
 - 4. Enclose sheets pages subject to frequent usage by operators in clear plastic.

5. Individually annotate standard drawings which are furnished, describe exactly which parts of the drawing apply to the equipment being furnished.
6. Identify each submission with the following:
 - a. Date of submission
 - b. Project title and number.
 - c. Names of Contractor, Supplier and Manufacturers, include telephone numbers and addresses.
 - d. Names of subcontractors with telephone numbers and addresses, contracted by Contractor for servicing and maintenance of portions of the project.
 - e. Specification section number, intended use of item in the Work, and equipment designation.
 - f. Identify details by reference to sheet detail, schedule or room numbers shown in the Contract Documents.
- L. The "Submittal Transmittal Form" and the "Certification Statement" to be used with each submittal is included in Chapter XXX and must include the signature of the Engineer of Record.
- M. If the submittal is returned to the Contractor marked "Rejected," the Contractor shall revise said submittal and shall resubmit the revised submittal to the Engineer of Record and resubmit back to the Town after receiving approval from the Engineer of Record.
- N. The Contractor shall not deviate from the approved submittal without the prior written consent from the Town.
- O. Commencement of production work performed in advance of the receipt of the Town's approval of submittals shall be entirely at the Contractor's risk.
- P. The Contractor shall prepare, maintain, and submit submittal logs as specified herein.
- Q. The Contractor and Engineer of Record shall notify the Town in writing, at the time of submittal, of any deviations in the submittals from the requirements of the approved Construction Drawings.
- R. The review and approval of shop drawings, samples or product data by the shall not relieve the Contractor from their responsibility with regard to the fulfillment of the completion of the construction of the Project. Shop Drawings.
- S. Shop drawings include, but are not necessarily limited to:
 1. Custom-prepared data such as fabrication and erection/installation (working) drawings, design calculations, lists, graphs, operating instructions, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the work.

- T. All details on shop drawings submitted for approval shall show clearly the relation of the various parts of the work and control lines, and where correct fabrication of the work depends upon field measurements such measurements shall be made and noted on the drawings before being submitted for approval.
- U. Product data as specified in individual sections include, but are not necessarily limited to standard prepared data for manufactured products (sometimes referred to as catalog data), such as:
 - 1. The manufacturer's product specification and installation instructions,
 - 2. Availability of colors and patterns,
 - 3. Manufacturer's printed statements of compliance and applicability,
 - 4. Roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams,
 - 5. Printed performance curves and operational- range diagrams,
 - 6. Production or quality control inspection and test reports
 - 7. Certifications, mill reports, product operating and maintenance instructions
 - 8. Recommended spare-parts listing and printed product warranties, as applicable to the work.

100.2.2. Samples:

- A. Samples specified in individual sections may include, but are not necessarily limited to:
 - 1. Physical examples of the work, such as sections of manufactured or fabricated work,
 - 2. Small cuts or containers of materials,
 - 3. Complete units of repetitively used products,
 - 4. Color/texture/pattern swatches and range sets,
 - 5. Specimens for coordination of visual effect,
 - 6. Graphic symbols and units of work to be used by the Town for independent inspection and testing, as applicable to the work.
- B. Submit operation and maintenance manuals by the time the Work is 50% complete for all equipment so designated in the individual Specification Sections and for which the Shop Drawings have been reviewed and marked "No Exceptions Taken" or "Make Corrections Noted." In addition, submit instruction books and other pertinent information for equipment not so designated which requires special instruction or knowledge for proper operation and maintenance.
- C. Submit operation and maintenance manual for equipment by the time Work is 90% complete.
- D. Do not start or operate equipment until the respective operation and maintenance data has been reviewed, approved and copies made available at the site.

- E. The operation and maintenance manuals shall be in addition to instructions or parts lists packed with or attached to equipment when delivered.
 - 1. Include as a minimum the following information:
 - a. Equipment function, normal operating characteristics, and limiting conditions complete motor data, test data and performance curves where applicable.
 - b. Operating instructions for start-up, routine and normal operations, regulations and control, shutdown, and emergency conditions.
 - c. Lubrication and routine maintenance instructions.
 - d. Guide to "troubleshooting."
 - e. Parts list(s), including predicted life of parts subject to wear and recommended list of spare parts to be on hand.
 - f. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.
 - g. Copy of accepted or as constructed Shop Drawings.
 - h. Temperature control diagrams.
 - i. System balancing report including a description of system operation as prepared by the balancing contractor which includes a schedule of inspection and maintenance.
- F. System Schematic Flow Diagrams.
- G. The Contractor shall prepare, approve, sign and submit to both the Engineer of Record and to the Town (following Engineer of Record approval) any and all Shop Drawings, Manufacturers' Project Data, Certificates, Wiring Diagrams, Operation and Maintenance Manuals and Samples.
- H. The submitted information must be reviewed and approved by the Engineer of Record prior to submittal to the Town. The Submittal process is outlined in **Section X**.
- I. The Contractor, by preparing, reviewing, approving and submitting the Shop Drawings, Manufacturers' Product Data, Certifications, Wiring Diagrams, Operation and Maintenance Manuals and Samples, represents that the Contractor has determined and verified all materials, field measurements and filed construction criteria related thereto, and has checked and coordinated the information contained within such submittals.
- J. The Contractor shall provide reproducible Shop Drawings.
- K. All Shop Drawings, Manufacturers' Product Data, Wiring Diagrams, Certifications, Operation and Maintenance Manuals and Samples submitted, shall be accompanied by a preprinted standard transmittal form with submittal number, and shall be addressed to the Town to be reviewed and approved.

- L. The Contractor is not relieved of the responsibility for any deviation from the requirements of the DESIGN STANDARDS, by virtue of approval of the Shop Drawings, Manufacturers' Product Data, Wiring Diagrams, Operation and Maintenance Manuals and Samples by the Town.
 - M. The Contractor shall be responsible for a fully functional system as intended by the approved Construction Improvement Drawings (CD's).
 - N. The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:
 - 1. Catalog numbers and similar data.
 - 2. Conformance with the Specifications.
 - 3. Conformance to the Town's Approved Materials List.
 - 4. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor:
 - a. "Certification Statement: By this submittal, I hereby represent that I have determined and verified all materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all requirements of the approved Construction Improvement Drawings as signed and sealed by [Insert name of Engineer of Record] on [insert date] and as approved by the Town of Johnstown on [insert approval date]."
- 100.2.3. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk.
- 100.2.4. The Town will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- 100.2.5. Project Work, materials, fabrication, and installation shall conform to approved shop drawings, applicable samples, and product data.
- 100.2.6. It shall be the responsibility of the Contractor to verify the existence and location of all underground utilities, including service connections, along the route of the work at least 48 hours prior to interruption of service or operation and to coordinate the construction schedules with these utility owners.
- 100.2.7. Erosion control measures required for compliance with State and Federal law shall be designed, installed, and maintained in conformance with the DESIGN STANDARDS and the MHFD USDCM (Volume 3), as amended.
- 100.2.8. The Contractor shall field verify all utilities and coordinate construction with utility owners prior to starting construction. The Contractor shall be responsible for protecting utilities during construction and scheduling utility adjustments to eliminate conflict with progress of the work. Any damage to existing utilities shall be repaired.

- 100.2.9. Throughout all phases of construction, including suspension of work, and until final acceptance of the project, the Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site as soon as they are no longer necessary. Upon completion of the work, the Contractor shall clear the work site of equipment, unused materials, and rubbish.

100.2. Quality Control Submittals

- 100.2.10. For standard testing requirements, refer to **Chapter XXX** of the DESIGN STANDARDS.

100.3. Manufacturer's Certificate of Compliance:

- 100.3.11. When specified in individual Specification Sections or where products are specified to a recognized standard or code, submit prior to shipment of product or material to the project site.
- 100.3.12. The Town may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
- A. Must be signed by product manufacturer certifying that materials, manufacture, and product specified conform to or exceed specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.
 - B. May reflect recent or previous test results on material or product, but must be acceptable to the to the Town.

100.4. Certificates of Successful Testing or Inspection

- 100.4.1. Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual Specification Sections.

100.5. Operation and Maintenance Manual:

- 100.5.1. Submit Operation and Maintenance Manual in accordance with Town requirements.

100.6. Statements of Qualification:

- 100.6.1. Evidence of qualification, certification, or registration may be required by federal, state, or the Town's Municipal Code to verify qualifications of Engineers, materials testing laboratories, specialty subcontractors, trades, specialists, consultants, installers, and other professionals.

100.7. Safety Requirements

- 100.7.2. The Contractor shall comply with Federal, State, and local safety requirements.
- 100.7.3. Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work.
- 100.7.4. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:
- A. Employees on the work and other persons who may be affected.

B. The work and materials or equipment to be incorporated therein, whether in storage on or off the site.

100.7.5. Other property at the site or adjacent thereto, including, but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

100.8. Written Test Reports

100.8.1. Written Test Reports shall be provided based on **Chapter (or Appendix) XXX** of the DESIGN STANDARDS

100.9. Project Record Documents Quality Assurance:

100.9.1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.

100.10. Accuracy of Records:

100.10.1. Purpose of Project Record Documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.

100.10.2. Field verify all as-built dimensions and materials.

100.10.3. Make entries within 48 hours after receipt of information that a change in the Work has occurred.

100.10.4. When a field change is requested or made, the Engineer of Record may require and the Town will require review and approval of the proposed field change. The Town reserves the right to review Redline Drawings maintained by the contractor reflecting field changes.

100.10.5. Engineer of Record shall incorporate changes from the contractor's approved Redline Drawings to produce final As-Constructed Record Drawings.

100.10.6. As-Constructed Record Drawings shall be submitted to the Town for review and approval within 2 months of the Engineer of Record receiving the approved Redline Drawings.

100.10.7. The Town shall review the submitted As-Constructed Drawing information and any corrections, additions, or omissions identified from the comparison to the approved Redline Drawings shall be incorporated into the As-Constructed Record Drawings by the Engineer of Record prior to approval.

100.10.8. Engineer of Record shall submit approved As-Constructed Record Drawings to the Town as noted below within 1 month of Town approval of As-Constructed Record Drawings:

100.10.9. Refer to DESIGN STANDARDS for required As-Built submittal format.

100.11. Review of Submittals

- 100.11.1. A minimum of fourteen (14) days will be required for the Town to review each submittal or resubmittal following the receipt of all information required for review of the submittal.
- 100.11.2. The Town will notify Contractor when the review time must be extended in order to correlate the submittal with other forthcoming submittals or for any other reason that prevents the Town's timely review.
- 100.11.3. The Town will review submittals, affix a stamp, and initials or signature will indicate subsequent action to be taken and will return the submittals to Contractor for distribution. The review actions listed on the Town's stamp are defined as follows:
- 100.11.4. No exception taken - Signifies material or equipment represented by the Submittal conforms to the design concept and complies with the information given in the Town's criteria. Contractor is to proceed with fabrication or procurement of the items and with related work.
- 100.11.5. Make corrections noted - Signifies material or equipment represented by the submittal conforms to the design concept, and complies with the requirements of the Town. Contractor may proceed with the work in accordance with the Town's notations.
- 100.11.6. Revise and resubmit - Signifies material or equipment represented by the submittal conforms with the basic design concept, however, it does not comply with the requirements of the Town. Contractor is to submit a revised submittal responsive to the notations marked on the returned submittal and to the requirements of the Town.
- 100.11.7. Rejected - Signifies material or equipment represented by the submittal does not conform to the design concept or comply with the requirements of the Town and is not acceptable. Contractor is to submit material or equipment responsive to the requirements of the Town.
- 100.11.8. Submit specified item - Signifies material or equipment represented by the submittal is not the item specified by the Town and is not to be incorporated into the work. Contractor is to submit only the material or equipment specified by the Town.

END OF SECTION

Section 101

Material, Equipment and Workmanship

101.1. General

101.1.1. Description

- A. This Section includes the requirements for materials and equipment on the construction site, and for the workmanship and qualifications of workforce.

101.2. Materials

101.2.1. Contractor shall furnish all materials, equipment, labor, and all other facilities and incidentals necessary for the execution, disinfection, testing, and completion of the work, as follows:

- A. All materials and equipment shall be of good quality and new, except as otherwise provided on the approved Construction Improvement Drawings.
- B. When requested by the Town, the Contractor shall furnish satisfactory evidence (including manufacturer's certification) as to the kind and quality of materials and equipment, and their compliance with these SPECIFICATIONS.
- C. It is the Contractor's responsibility to ensure that the manufacturer's materials supplied, meet these SPECIFICATIONS.
- D. The Town shall test any manufacturer's material it deems necessary, in addition to the testing required by the DESIGN STANDARDS, **Chapter XX**.
 - 1. All materials and equipment shall be installed and used in accordance with the instructions of the applicable manufacturer, fabricator, supplier or distributor, except as otherwise provided in these SPECIFICATIONS.
- E. Prior to using existing materials, written approval must be obtained from the appropriate Town department.
- F. The specification of materials and equipment shall be understood to be representative of a quality of performance, operation and construction acceptable to the Utility.
 - 1. The appropriate Town department shall evaluate all written requests for product substitution.
 - 2. Such requests shall include detailed product literature and a description of benefits which might be achieved by this substitution.
- G. In approving materials or equipment for installation, the Town assumes no responsibility for injury or claims resulting from failure of the materials or equipment to comply with the applicable National, State, and local safety codes or requirements, or the safety requirements of a recognized agency, or failure due to faulty design concepts, or defective workmanship.
- H. Contractor shall provide competent, disciplined, suitably qualified personnel to supervise the work and perform the construction.

1. Any workmen deemed not qualified, in the opinion of the Town, shall not be allowed to perform any construction, and shall be restricted from participating in the Work.
- I. The construction standards, tests and methods outlined in these SPECIFICATIONS are considered adequate to produce the product desired by the Town.
- J. The Town will evaluate alternative methods of construction upon request.
 1. Requests for alternative methods of construction shall include detailed descriptions of the equipment, methods and controls needed for the alternative, and a description of the benefits which might be achieved by this substitution.

101.3. Execution

- 101.3.1. All materials and equipment shall be safely stored and secured by the contractor.
- 101.3.2. The Town assumes no liability for stored materials or stored equipment.

END OF SECTION

Section 102

Site Cleanup

102.1 General

- 102.1.1 This Section includes requirements for cleanup of the construction site.
- 102.1.2 When the work is being done as a part of a contract between a Developer and a Contractor, this Section shall be used as a guideline to establish minimum standards. Additional requirements may be contained in the contract between the Developer and Contractor.

102.2 Materials (not used)

102.3 Execution

- 102.3.1 Site cleanup shall be executed during the progress of the work, and at completion of the work.
- 102.3.2 Site cleanup shall be maintained in a safe condition at all times.
- 102.3.3 Construction materials shall be neatly stored.
- 102.3.4 Containers shall be provided for the collection of waste material and debris.
- 102.3.5 Containers shall not be stored in any existing public right-of-way without the written permission of the Town.
- 102.3.6 Construction materials, equipment, waste containers, construction buildings, parking, etc., shall not be allowed within any existing public right-of-way without written permission from the Town. Refer to **Chapter XXX** of the DESIGN STANDARDS for the Right-of-Way Permit process.
- 102.3.7 Any off-site storage of construction material, equipment, waste containers, construction buildings, parking, etc., shall be allowed only after the Contractor has obtained the written permission of the property owner.
- 102.3.8 A copy of the agreement shall be available at the job site at all times.
- 102.3.9 Contractor shall conform to the requirements set forth in the DESIGN STANDARDS and the MHFD USDCM (Volume 3), as amended. During construction the job site shall be adequately protected from soil erosion in accordance with the DESIGN STANDARDS.
- 102.3.10 Sanitary facilities shall be provided for all workers who are working outdoors.
- 102.3.11 Upon completion of the construction, the job site shall be restored in accordance with these SPECIFICATIONS.

- 102.3.12 All exterior paved surfaces shall be broomed and/or washed clean and left in good repair (exterior = outside the project limits).
- 102.3.13 Engineer of Record and Contractor shall inspect all exterior paved surfaces before and after construction to ensure their condition is returned to the pre-project condition.
- A. A photo log or other documentation to record conditions for archiving must be produced and the Town may require that this log is submitted with the record drawings to memorialize pre-project conditions.
 - B. Damage to exterior paved surfaces must be repaired by the contractor.
- 102.3.14 In order to maintain an orderly site, waste material and debris shall be removed weekly.
- 102.3.15 Volatile wastes shall be stored in clearly marked, covered, metal containers and removed daily in accordance with federal, state and local requirements.

END OF SECTION

Section 103

Field Engineering and Surveying

103.1 General

- 103.1.1 This Section includes requirements for Field Engineering and Surveying
- 103.1.2 It shall be the responsibility of the Developer to provide construction staking for horizontal and vertical alignment of the centerline, grading, and all appurtenant features of the work including all offset lines necessary for construction.

103.2 Materials (not used)

103.3 Execution

- 103.3.1 All construction surveying provided by the Developer shall be completed under the supervision of a Colorado Registered Land Surveyor.
- 103.3.2 The Design Engineer shall provide the elevations and descriptions of the original and temporary project benchmarks.
- 103.3.3 Adequate staking shall be provided to establish acceptable horizontal and vertical control.
- 103.3.4 Offsets shall be staked so that vertical and horizontal alignment may be checked.
- 103.3.5 All survey data, which is developed by the Contractor or the Design Engineer in performing surveys which are required by the work, shall be available to the Town for examination throughout the construction period.
- 103.3.6 The Contractor shall have supervision, knowledge of the project requirements and proper installation, and construction procedures, available in the field at all times that work is progressing.

END OF SECTION

Section 104

Site Preparation

104.1. General

104.1.1 Description

- A. This Section includes requirements for preparation of the construction site.
- B. Site Preparation includes removal of materials, stockpiling, replacement and disposal of material existing on the site.

104.1.2 Stripping

- A. Any material containing roots, grasses and other deleterious or organic matter generally found in the top twelve inches of undisturbed natural terrain shall be stripped from all areas requiring excavation, grading, trenching, subgrade preparation for foundations and embankment work.
- B. The Town may require stripped topsoil deemed suitable for spading over the finished grades to be stockpiled and preserved until the finished grading operation, at which time it shall be spread uniformly over areas to be seeded or sodded.
- C. Whenever it is necessary to disturb existing grass or soil in the yards of existing residences, care shall be taken so as to strip existing grass, landscaping and topsoil in a manner that will permit the replacement thereof as close as possible to the original condition and to the satisfaction of the property owner.

104.2. Material (not used)

104.3. Execution

104.3.1. Removal of Existing Improvements.

- A. The Contractor shall be responsible for removal and disposal of all materials including but not limited to woody debris, bituminous pavement and concrete.

END OF SECTION

Section 105

Dewatering Systems

105.1 General

105.1.1 Description

A. This Section includes requirements for controlling groundwater, site drainage, and storm flows during construction. The Contractor shall be cautious when work involves construction in and around drainage channels, local streams or rivers, and areas of local drainage. These areas are subject to frequent periodic inundation.

105.1.2 The Contractor shall the dewatering operation in such a manner that storm or other waters may proceed uninterrupted along their existing drainage courses.

105.1.3 It shall be the responsibility of the Contractor to secure all required permits from the Colorado Department of Health and Environment.

B. Contractor or their designated representative is required to complete and process Discharge Monitoring Reports (DMR) that are typically a part of the dewatering permit.

C. Discharge of water from dewatering operations may need additional approvals and/or permissions based on water quality and location of discharge.

105.1.4 Pumps and generators used for dewatering and water control shall be quiet equipment enclosed in sound deadening devices.

105.1.5 If the Contractor purchases, rents, installs, or mobilizes to the site any elements of the dewatering system before approval of the dewatering submittal, the Contractor does so at its own risk.

105.1.6 Approval of the dewatering system proposed by the Town will only be with respect to the basic principles of the methods the Contractor intends to employ. Approval does not relieve the Contractor of full responsibility for adequacy of the dewatering system.

A. The Contractor is solely responsible for determining the methods and adequacy of water control measures. The Contractor shall provide all material, equipment, and labor to install and maintain all pumps, piping, drains, well points, and other facilities required to effectively control, collect, and dispose of groundwater or surface water to permit safe and proper completion of the Work.

- B. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with Contractor.
- 105.1.7 The Contractor shall install adequate measures to maintain the level of groundwater below the foundation subgrade elevation and maintain sufficient bearing capacity for all structures, pipelines, earthwork, and rock work.
- A. Such measures may include, but are not limited to, installation of perimeter subdrains, pumping from drilled holes or by pumping from sumps excavated below the subgrade elevation.
- 105.1.8 The foundation bearing surfaces are to be kept dewatered and stable until the structures or other types of work are complete and backfilled.
- A. Disturbance of foundation subgrade by Developer's operations shall not be considered as originally unsuitable foundation subgrade and shall be repaired.
 - B. Use appropriate equipment and methods for dewatering based on existing site conditions.

105.2 Materials (not used)

105.3 Execution

- 105.3.1 Design, furnish, install, maintain, and operate a dewatering system that prevents loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottom of excavations so that every phase of the work can be performed in a dry, safe, and stable environment.
- 105.3.2 Operate dewatering systems such that excavation bottoms are firm, suitably dry, and free from standing water at all times. Locate elements of the dewatering system such that interference with excavation and construction activity is minimized. Locations are subject to approval by the Engineer or Record and the Town.
- 105.3.3 At all times during construction, provide ample means and devices to remove promptly, and dispose of properly, all water entering excavations and keep the bottoms of excavations firm and free of standing water until structures to be built thereon are completed and/or backfill to be placed therein is placed. Conduct pumping and dewatering operations such that no disturbance to foundation subgrade materials or to fill materials supporting any other work will result.
- 105.3.4 Discharged water shall be piped to an approved area.
- 105.3.5 Install silt barriers or other discharge control measures at dewatering discharge locations, to control and prevent siltation. Provide suitable discharge controls in accordance with applicable federal, state, and local permit regulations. Do not

allow dewatering discharge to cause siltation or other negative environmental impact on natural waterways or other property.

105.3.6 Operation and Removal

- A. Operate the dewatering system to lower water levels as required and then operate continuously 24 hours per day, 7 days per week until all facilities and structures affected by the dewatering have been satisfactorily constructed, including placement of fill materials.
- B. Maintain groundwater levels low enough to fulfill the requirements of this Section and do not allow the water level to rise until constructed facilities are complete, so that the water can be allowed to rise without damaging facilities, their foundations, or surrounding areas and structures.
- C. Provide superintendence in accordance with the approved permit and/or Dewater Plan during all periods of dewatering. Superintendence means providing qualified Contractor personnel knowledgeable in operation and maintenance of dewatering system(s).
- D. The Contractor is responsible for any damage resulting from failure to maintain the dewatering system.
- E. Provide complete standby equipment and power sources available for immediate operation as may be required, to adequately maintain the dewatering on a continuous basis in the event that all or any part of the dewatering system becomes inadequate or fails. Provide an automatic switchover system to the standby power source to ensure uninterrupted power supply to pumps in an emergency. Spare pumps shall be automatically engaged if primary pumps fail for any reason.
- F. When the dewatering system does not meet the specified requirements, and as a consequence, loosening or disturbance of the foundations strata, instability of the slopes, or damage to the foundations or structures occurs, the Contractor is responsible for supplying all materials and labor and performing all work for restoring foundation soils, slopes, foundations, and structures.
- G. When failure to provide adequate dewatering and drainage causes disturbance of the soils below design foundation or excavation grade, provide adequate dewatering and excavate and re-fill the disturbed areas with approved, properly compacted fill material. Such work shall be at the Contractor's expense.
- H. Properly dispose of discharge water in accordance with Federal, State, and local requirements and permits. For discharge of water into holding tanks or infiltration ponds, include a means of overflow protection that is acceptable to the Engineer of Record and the Town.

- I. Control release of groundwater to its static level to prevent disturbance of natural foundation soils, or compacted backfills and fills and to prevent flotation or movement of structures, pipelines, or other facilities.
- J. Obtain written approval from the Engineer of Record before discontinuing operation of any portion of the dewatering system(s) and complete a Colorado Department of Public Health and Environment Discharge Termination Notice..
- K. Remove all elements of the dewatering system(s) from the site at the completion of dewatering work.

END OF SECTION

Section 106

Pipe Boring and Jacking

106.1. General

106.1.1 Description

- A. This section is a minimum guideline and concerns the furnishing and the installation of casing pipe, either by boring or jacking.
- B. Each casing pipe installation shall be specifically designed by Design Engineer.
- C. Each specific crossing shall be detailed on the Construction Drawings as to type of installation required.

106.1.2 Quality Assurances

- A. Design Criteria.
 - 1. Specified thickness for pipe and casings are based upon the superimposed loads and not upon the loads which may be placed on the pipe as a result of jacking operations.
 - a. Increased pipe strength shall be provided as necessary to withstand jacking loads and other loads not accounted for in the design.
- B. Construction Criteria.
 - 1. Developer shall obtain the necessary permits from the entity which owns or has governmental control of the roadway, railroad, utility, irrigation ditch, etc. which is being crossed, prior to commencing construction.
 - 2. Developer shall obtain the bonds or the indemnity which are required by the permits, for protection against any damage and interference with traffic and service, which are caused by the construction activities.
- C. All excavations shall meet the trenching, backfilling and compaction requirements set forth in **Section XXX - Trenching, Bedding and Backfill**.

106.2. Materials

106.2.1 Casing Pipe – Smooth Steel

- A. The minimum yield point of smooth steel casing pipe shall be 35,000 psi and conform to ASTM 139, Grade B (No hydro).
- B. The minimum wall thickness of smooth steel casing pipe shall be determined by the agency granting the crossing permit.

1. In instances where the Town is granting the crossing permit, the minimum thickness of the casing pipe shall be 1/4-inch.
- C. The ends of smooth steel casing pipe shall be beveled for field welding.
 1. All field welds shall be painted with a coal-tar enamel exterior coating, which conforms to AWWA C203, Section 2.
- D. Smooth steel casing pipe shall have an epoxy polyamide coating of sixteen (16) mils.
 1. If the CONTRACTOR elects to omit the epoxy polyamide exterior coatings, 1/16-inch shall be added to the required thickness of the casing pipe.

106.2.2 Accessories

- A. Casing Seals
 1. Casing seals shall be constructed of either high density rubber casing seals with stainless steel straps.
 2. The acceptable type and manufacturer of high-density rubber casing seals are:
 - a. Reference the Design Standards Volume II, Appendix A - Approved Materials List.
 - b. Or an approved equal.
- B. Casing Spacers or Chocks
 1. Casing spacers/chocks shall be constructed of stainless steel with polymer runners.
 - a. Stainless steel casing spacers with polymer runners shall be manufactured by an Approved Product Listing in the Design Standards Volume II, Appendix A - Approved Materials List.
 2. Casing spacers/chocks shall be twelve inches (12") long.
 3. Three (3) casing spacers/chocks shall be installed on each joint of pipe.
- C. Anodes and Accessories
 1. Reference the Design Standards Volume II, Appendix A - Approved Materials List, for approved accessories for connection of anodes.
 2. Twenty pound (20 lb) high-potential magnesium anodes shall meet the following requirements.
 - a. Anode backfill material shall consist of 75 percent gypsum, 20 percent bentonite, and 5 percent sodium sulfate, and shall be of

the quick wetting type. The backfill shall have a grain size such that 100% is capable of passing through a 20 mesh screen and 50% will be retained by a 100 mesh screen.

b. Anodes shall be:

- i. Reference [the Design Standards Volume II, Appendix A - Approved Materials List](#).

106.3. Execution

106.3.1 Casing Installation

A. General

1. Wherever it is indicated in the Drawings, the casing pipe shall be installed by open-cut methods in accordance with [Section xxx - Trenching, Bedding and Backfill](#).

B. Smooth Steel Pipe

1. Contractor shall provide a smooth, continuous, and uniform casing pipe with no exterior voids.
2. Each section of casing pipe shall be welded with a full penetration butt weld around the entire circumference of the joint to form a watertight continuous conduit capable of resisting all stresses, including jacking stresses.
3. A high-potential magnesium anode shall be installed at each end of the casing.
 - a. Anode wire connection to buried pipe shall be accomplished by exothermic welding. The surface of the pipe shall be cleaned with a grinder or metal file to a bright, shiny condition. The exothermic weld shall be completed using by appropriate weld charge and welder per the manufacturer's recommendations. For #12 AWG or smaller wire, a properly sized copper wire sleeve shall be installed around the bare wire end prior to welding to improve weld strength and thermal capacity. Completed welds shall be capable of withstanding moderate hammer blows.

For steel pipe the weld and surrounding cleaned metal surface shall be lightly coated with a cold applied mastic compound or pipeline coating primer and covered with an exothermic weld cap.

C. Grouting

1. All spaces between the casing pipe and the earth shall be filled with cellular concrete.

106.3.2 Carrier Pipe Installation

- A. Carrier pipe shall be installed at the grade shown on the Construction Drawings.
- B. Each section of pipe shall have a minimum of 3 casing spacers or chocks centered every 120 degrees around the pipe.
- C. All joints of the carrier pipe shall be restrained inside of the casing.
- D. The annular space between the casing and the carrier pipes shall be left vacant.
- E. The ends of the casing pipe shall be sealed with casing seals.
- F. Reference [Section xxx - Trenching, Bedding and Backfill](#).

END OF SECTION

Section 107

Trenching, Bedding and Backfill

107.1 General

107.1.1 Description

- A. This section includes the requirements for Trenching, Bedding and Backfill including:
 - 1. Labor, equipment, and materials necessary for excavation and trenching for water, sewer and stormwater conduits and appurtenances.
 - 2. Provision of bedding and compacted fill over water, sewer and stormwater conduits and appurtenances.

107.1.2 Quality Assurance

- A. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D698 or AASHTO T99 - Tests for Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 5.5 lb (2.49 kg) Rammer and 12-inch (305mm) Drop (Standard Proctor).
- C. ASTM D2049 - Test for Relative Density for cohesionless soils.
- D. Testing Agency: All soils testing during construction will be performed by a testing laboratory selected and paid by the Developer.
- E. For preferred laboratories, refer to the Town's Approved Materials List.
- F. Excavations - U. S. Department of Labor Occupational Safety and Health Administration latest revision thereto.

107.1.3 Testing

- A. In-place moisture density tests will be performed to ensure trench backfill complies with specified requirements. The following minimum tests should be expected to be performed:
 - 1. Trench bedding - 1 per 200 feet
 - 2. Backfill - 1 per 200 feet
 - 3. The Contractor shall cooperate with the geotechnical engineer in obtaining samples of all bedding materials.

107.1.4 Protection and Safety

- A. Sheeting and Shoring

1. The Contractor must provide protection for individuals who require access to the trench.
 - a. The safety of the workers shall be provided for as required by the most recent standards adopted by the Colorado Occupational Safety and Health (COSH) Standards Board as enforced by the Colorado Department of Labor.
 - b. The latest requirements of OSHA shall be complied with at all times including trenching and confined space entry requirements.
2. The Contractor shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures.
3. The Contractor shall be responsible for underpinning adjacent structures which may be damaged by excavation work.

107.1.5 Weather and Frost

- A. The Contractor shall protect bottom of excavations and soil adjacent to and beneath foundations from frost.
 1. Do not place backfill, fill or embankment on frozen surfaces.
 2. Do not place frozen materials, such as snow or ice, in backfill, fill or embankment(s).
- B. Do not deposit, tamp, roll or otherwise mechanically compact backfill in water.

107.1.6 Drainage and Groundwater

- A. The excavation shall be graded to prevent surface water run-off into trench or excavation.
 1. Maintain excavations and trench free from water during construction.
- B. Remove water encountered in the trench to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.
 1. Divert surface runoff and use sumps, gravel blankets, well points, drain lines or other means necessary to accomplish the above.
 2. Maintain the excavation or trench free from water until the structure, or pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
- C. Water shall be prevented from entering into previously constructed pipe.

1. The pipe under construction shall not be used for dewatering, refer to **Section xxx - Dewatering.**

107.1.7 Underground Facilities

- A. Contractor shall expose and verify size, location and elevation of all utilities and obstructions sufficiently in advance in order to permit changes in the event of conflict. The Contractor shall be fully responsible for any and all damages which might be occasioned by their work and failure to locate and preserve any and all utilities and obstructions.
- B. If Contractor elects to remove underground obstructions, such as sprinklers, drainage culverts, catch basins or other structures, the following shall apply:
 1. Drainage culverts may be salvaged, stored and reused if approval is obtained from the Engineer of Record/Utility or property owner having jurisdiction thereof, and if all criteria established in the Town's DESIGN STANDARDS are met.
 2. Replace all other underground obstructions with new materials.
 3. Restore to original conditions or better.
 4. Maintain the flow in field drains at the quantity, quality, and velocity present prior to the temporary removal of the drain pipe.

107.2 Materials

107.2.1 Subbedding

- A. Subbedding shall be used to provide a firm foundation in soils which are judged by the geotechnical engineer to be soft or unstable, and as required in specific locations by the DESIGN STANDARDS, and as required by the Engineer of Record.
- B. Sub-bedding materials shall consist of:
 1. Uniformly graded rock ranging from 3/4-inch to 1-1/2-inch.
- C. All situations where Sub-bedding material is required, geotextile fabric shall be placed between stabilization material, and pipe bedding.
 1. Geotextile fabric shall meet the requirements of CDOT 712.08 (AASHTO M-288) Class A Fabric.

- D. Water Distribution System Pipe Zone Bedding shall be granular material, uniformly graded, crushed material conforming to the following gradation, ("Squeegee"):

Water Distribution System Bedding (Squeegee)	
Size	Percent Passing
1/2"	100
3/8"	85-100
#4	10-30
#8	0-10
#16	0-5

- E. Wastewater Collection System Pipe Zone Bedding shall be granular material uniformly graded, crushed material, conforming to the following gradation, CDOT #67:

Wastewater Collection System Bedding (CDOT #67)	
Size	Percent Passing
1"	100
3/4"	90-100
3/8"	20-55
#4	0-10
#8	0-5

- F. Stormwater Collection System Pipe Zone Bedding shall be granular material uniformly graded, crushed material, conforming to the following gradation, CDOT #67:

Stormwater System Bedding (CDOT #67)	
Size	Percent Passing
1"	100
3/4"	90-100
3/8"	20-55
#4	0-10
#8	0-5

- G. It will be the responsibility of the Contractor to locate material meeting these Specifications, to test its ability to consolidate to at least 65% relative density, and to secure approval of the Engineer of Record before such material is delivered to the project. Relative density shall be determined as stipulated in ASTM-Designation: D-2049.
- H. If the contractor is unable to locate material meeting the above Specifications than they may submit an approved equal to be determined by the Engineer of Record and by the Town prior to the start of trenching and bedding activities.

107.2.2 Backfill

A. Backfill shall meet the following requirements:

1. Use only backfill for trenches that is free from boulders, large roots, other vegetation or organic matter, and frozen material.
2. No material containing rock greater than three (3) inches in diameter shall be allowed.

Commented [SEC1]: Does the TOJ want a smaller allowance here?

107.2.3 Cut-Off Walls

A. Clay or controlled low strength material backfill cut-off walls are acceptable.

1. Clay cut-off walls
 - c. More than 50% shall pass a No. 200 Sieve. The plasticity index shall be greater than 12.
2. Controlled low strength material backfill cut-off walls.
 - d. See Section xxx for requirements.

107.2.4 Pipeline Marker or Detection Tape

A. Marker tape shall be 6" wide, minimum 0.04" thick polyethylene, refer to the Town's Approved Materials List for additional information.

107.3 Execution

107.3.1 General

A. The following procedures shall be followed by the Contractor in sequencing the work.

1. No more than 150 feet of trench shall be left open at any time. The entire trench shall be backfilled upon conclusion of each day's work. The trench shall not be backfilled until the pipe installation is reviewed by the Engineer.
2. Trench shall be backfilled within 50 feet of the pipe installation at all times.
3. Clean-up shall be maintained within 400 feet of the trench excavation.

107.3.2 Prior to placement in the trench, all pipe, fittings, and appurtenances shall be cleaned and examined for defects by the Contractor. If found defective, the Contractor shall reject the defective pipe, fitting, or appurtenance. The Contractor shall advise the Engineer of Record and the Town of all defective materials discovered.

107.3.3 All sub-bedding, bedding, and pipe zone material shall be imported.

107.3.4 Topsoil shall be removed and stockpiled separately. See [Section 104 - Site Preparation](#).

107.3.5 Upon completion of the work, all plants, rubbish, unused materials, concrete forms and other like material shall be removed from the jobsite. The site shall be left in a state of order and cleanliness. See [Section 102 Site Cleanup Technical Specification](#).

107.3.6 Maintenance and Correction

- A. Scarify surface, reshape and compact to required density completed or partially completed areas of work disturbed by subsequent construction operations or by adverse weather.
- B. Contractor shall maintain and correct backfill, fill and embankment settlement and make necessary repairs to pavement, structures, seeding and sodding which may be damaged as a result of settlement, were installed incorrectly, or otherwise prove to be defective.
- C. Contractor shall provide a two-year (2) maintenance guarantee and a five-year (5) guarantee covering all errors and omissions in the design and/or construction of the improvements and which guarantees shall run concurrently and shall commence upon the date of completion of the improvements and acceptance thereof by the Town.

107.3.7 Obstructions and Removal of Waste Material

- A. The Contractor shall remove obstructions that do not require replacement from within the trench or adjacent areas such as tree roots, stumps, abandoned piling, buildings and concrete structures, frozen material, logs, and debris of all types without additional compensation.
- B. The Contractor may, if requested and approved by the Town and the Engineer of Record, make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the work limits without adversely affecting the intended function of the facility.
- C. Excavated materials unsuitable for backfill or not required for backfill shall be disposed of in accordance with [Section 102 Site Cleanup Technical Specifications](#).

107.3.8 Trench Excavation

- A. All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line, and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill.
- B. The trench shall be excavated so that a minimum clearance of twelve (12) inches is maintained on each side of the pipe for proper placement and densification of the bedding or backfill material. The maximum clearance measured at the spring line of the pipe shall be eighteen (18) inches

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regardless of the type of pipe, type of soil, depth of excavation or the method of densifying the bedding and backfill.

- C. All excavations shall be made to the lines and grades as established by the Construction Improvement Drawings. Pipe trenches shall be excavated to a minimum depth of four inches (4") or $\frac{1}{4}$ of the O.D. (Whichever is greater) below the bottom of the pipe. Deviation from grades or minimum depths will be allowed only when approved by the Town. Over excavation shall be rectified to the satisfaction of the Engineer of Record and the Town.
- D. Except as otherwise dictated by construction conditions, the excavation shall be of such dimensions as to allow for the proper pipe installation and to permit the construction of the necessary pipe connections. Care shall be taken to ensure that the excavation does not extend below established grades. If the excavation is made below such grades, the excess excavation shall be filled in with graded gravel stabilization Sub-bedding material deposited in horizontal layers not more than six inches (6") in thickness after being compacted and shall be moistened as required to within two percent (2%) of the optimum moisture content required for compaction of that soil. After being conditioned to have the required moisture content, the layers shall be compacted to the required density.
- E. The Contractor shall stockpile excavated materials in a safe manner. Stockpiles shall be graded for proper drainage.
- F. The Contractor shall place and grade the trench base to the proper grade ahead of pipe laying. The invert of the trench shall be compacted to provide a firm unyielding support along entire pipe length.

107.3.9 Foundations on Unstable Soils

- A. If the bottom of the excavation is soft or unstable, and in the opinion of the Geotechnical Engineer or Engineer of Record, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to six inches (6") below grade with rock uniformly graded between $\frac{3}{4}$ inch and 1 $\frac{1}{2}$ inch (Sub-Bedding) to provide a firm foundation for the pipe or structure. From six inches (6") below grade to grade, the appropriate bedding material shall be placed to provide support for the pipe or structure.

107.3.10 Pipe Bedding

- A. After completion of the trench excavation and proper preparation of the foundation, a minimum of four inches (4") or $\frac{1}{4}$ O.D. (whichever is greater) of bedding material shall be placed on the trench bottom for support under the pipe. All pipe shall be installed in such a manner as to insure full support of the pipe barrel over its entire length. After the pipe is adjusted for line and grade and the joint is made, the bedding material shall be carefully placed and tamped under the haunches of the pipe. For all types of pipe, the limits of bedding shall be as shown on the trench section details in the

Town's Standard Details and on the approved Construction Improvement Drawings.

- B. Non-cohesive bedding shall be compacted to 65% relative density in accordance with ASTM D2049. Care shall be exercised to assure sufficient tamping under the pipe to achieve uniform support. (Refer to the approved Construction Improvement Drawings and the Town's Standard Details for a typical trench cross-section).

107.3.11 Backfill and Compaction

A. Pipes:

1. The pipe trench shall be backfilled to the limits as shown on the Construction Improvement Drawings. The backfill in all roadway rights-of-way and paved areas shall be compacted by vibrating, tamping or a combination thereof to sixty-five percent (65%) relative density for sand material as determined by the relative density of cohesionless soils test, ASTM Standard Designation D2049 or to 95% of maximum density for cohesive soils as determined by ASTM Standard Designation D698. Required compaction in all other areas will be ninety percent (90%) ASTM D698 for cohesive soils or 65% relative density for cohesionless soils, unless otherwise specified.
2. All backfill shall be brought up to equal height along each side of the pipe in such a manner as to avoid displacement. Wet, soft or frozen material, asphalt chunks or other deleterious substances shall not be used for backfill. If the excavated material is not suitable for backfill, suitable material shall be hauled in and utilized and the rejected material hauled away and disposed of.
3. Backfilling shall be conducted at all times in a manner to prevent damage to the pipe or its coating and shall be kept as close to the pipe laying operation as practical.
4. Backfilling procedures shall conform to the additional requirements, if any, of appropriate agencies or private right-of-way agreements.

B. Structures

1. Backfill, and fill within three feet (3') adjacent to all structures and for full height of the walls, shall be selected non-swelling material. It shall be relatively impervious, well graded, and free from stones larger than three inches (3"). Material may be job excavated, but selectivity will be required as determined by Engineer of Record and Geotechnical Engineer.
2. Stockpiled material, other than topsoil from the excavation shall be used for backfilling unless an impervious structural backfill is specified.

3. The backfill material shall be free from rubbish, stone larger than five inches (5") in diameter, clods and frozen lumps of soil. All backfill around the structures shall be consolidated by mechanical tamping.
4. The material shall be placed in six inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of maximum density for cohesive soils as determined by ASTM Standard Designation D698 or to seventy percent (70%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM Standard Designation D2049.
5. Impervious structural backfill, where shown or specified, shall consist of material having 100% finer than three inches (3") in diameter and a minimum of twenty percent (20%) passing a #200 U.S. Standard sieve. The material shall be placed in six inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety five percent (95%) of maximum density for cohesive soil as determined by ASTM Standard Designation D698.

107.3.12 Surface Restoration

A. Unsurfaced areas

1. All surface cuts shall be, as a minimum, restored to a condition equal to, or better than, that prior to construction.

B. Surfaced areas

1. All surface cuts shall be, as a minimum, restored to a condition equal to, or better than, that prior to construction. All gravel or paved streets shall be restored in accordance with the regulation and requirements of the agency having control or jurisdiction over the street, roadway or right-of-way.

C. Grassed, Agriculture, or Landscaped Areas

1. In landscaped or agricultural areas, topsoil, to a depth of 12 inches, shall be removed from the area of general disturbance and stockpiled.
2. After installation of all pipelines, appurtenances and structures and completion of all backfill and compaction, the stockpiled topsoil shall be redistributed evenly over all disturbed areas. Care should be taken to conform to the original ground contour or final grading plans.

107.3.13 Blasting

- A. Blasting is not permitted unless approved by the Town.

END OF SECTION

Section 108

Excavation and Embankment for Detention Basins

108.1 General

108.1.1 Description

- A. This section covers the work that consists of excavation, embankment fill, disposal of excess material, shaping, and compaction of all material encountered within the limits of work, including excavation and backfill for structures. The excavation shall include, but is not limited to, the native soils which must be excavated for the project work. All work shall be completed in accordance with these Specifications and the lines and grades on the approved Construction Improvement Drawings.
- B. This work shall consist of excavation, disposal, placement, and compaction of all material encountered within the limits of the work, and not being completed under some other item, necessary for the construction of the project in accordance with the Specifications and the lines, grades, and typical cross-sections shown on the Construction Improvement Drawings.
- C. All excavation will be classified, "unclassified excavation", or "muck excavation" or "rock excavation", as hereafter described.
- D. All embankment will be classified "embankment material" as hereafter described.

108.1.2 Definitions

- A. Unclassified Excavation shall consist of the excavation of all materials on site to final grades.
- B. Muck Excavation shall consist of the removal and disposal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.
- C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of 1/2 cubic yard or more, as determined by physical or visual measurement. It shall also include replacement with approved material as required.
- D. Embankment (Complete in Place): shall consist of placing all excavated material, except material being hauled and disposed, as embankment and compacted to final grades as specified in the Construction Improvement Drawings.

108.1.3 Quality Assurance

- A. Final topography and/or cross-sections will be surveyed of areas that are to finished grade and compared to the design section for accuracy. Final grade shall match design grades within the tolerances discussed in 108.xxx Execution.

108.2 Materials

108.2.1 Embankment material may consist of approved material acquired from excavations or material hauled from outside the project limits. Soil material for backfill shall be soils free from debris, roots, organic material, and non-mineral matter containing no particles larger than three inches (3") in size.

108.2.2 Muck excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, on-site or imported soils, or other material whichever is most suitable for the specific situation encountered. The Design Engineer and Engineer/Utility will determine which type of aggregate

108.3 Execution

108.3.1 General Excavation/Embankment

- A. The excavation and embankment for the project work shall be finished to reasonably smooth and uniform surfaces.
- B. Variation from the subgrade plane shall not be more than .08 feet in soil or more than .08 feet above or .50 below in rock.
- C. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than 0.04 feet.
- D. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed.
- E. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with these Specifications.

108.3.2 Excavation

- A. Unclassified: All excess suitable material excavated from the project site and not used for embankment shall remain the property of the Developer.
 - 1. Where material encountered within the limit of the work is considered unsuitable for embankment (fills) on any portion of this project work, such material shall be excavated and replaced with suitable fill material.
 - 2. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than 3 inches in diameter and boulders shall be hauled from the project site and disposed of. Debris is defined as "anything that is not earth which exists at the job site".

- B. Muck: Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, the Contractor shall remove the unsuitable materials and backfill to the finished graded section with approved material.
 - 1. Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.
- C. Rock: Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 feet below subgrade within the limits of the pipe installation, and the excavation shall be backfilled with the material as shown on the approved Construction Improvement Drawings.

108.3.3 Embankment Construction: Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, and the placing and compacting of embankment material in holes, pits and other depressions within the project area. Only approved materials shall be used in the construction of embankments and backfills.

- A. Approved materials shall consist of clean on-site cohesive soils or approved imported soils. On-site cohesive soils are suitable for use as compacted fill provided the following recommendations are met:

Gradation	Percent Finer by Weight (ASTM C136)
1/2 Inch	100
3/8 Inch	70-100
No. 4 Sieve	50-100
No. 200 Sieve	60 (min)

- 1. Liquid Limit: 35 (max)
 - 2. Plasticity Index: 20 (max)
 - 3. In Situ Coefficient of Permeability: 1×10^{-6} cm/sec
- B. On-site cohesive soils or imported soils should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift and embankment height. On-site or imported cohesive soils should be compacted within a moisture content range of 2% below, to 2% above optimum moisture content and compacted to 95% of the Maximum Standard Proctor Density (ASTM D698).
 - C. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built 1/2 width at a time, the slopes that are steeper than 4:1 when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the work is brought up in layers. Benching shall be well keyed and where practical a minimum of 8 feet. Each horizontal cut shall begin at the

intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material.

- D. The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of 8 inches and recompacting to 95% of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - 2% prior to fill placement.
- E. Embankment material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to 95% of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - 2%. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density.
- F. For embankments which serve as berms, the downstream portion shall be "keyed" into the subsurface soils a minimum of 3 feet to enhance the stability of the slope.
- G. Materials which are removed from excavations beneath the water table may be over the optimum moisture content and will require that they be dried out prior to reusing them.
- H. Cross hauling or other action as appropriate will be ordered when necessary to ensure that the best available material is placed in critical areas of embankments, including the top 2 feet of all embankments.
- I. Frozen materials shall not be used in construction of embankments.
- J. During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.
- K. Excavation or Embankment (Fill), and Structural Backfill work either completed or in a stage of completion that is either eroded or washed away or becomes unstable due to either rains, snow, snow melt, channel flows or lack of proper water control shall be either removed and replaced, recompacted or reshaped as directed by the Engineer/Utility and in accordance with the Construction Drawings and Specifications.

108.3.4 Proof Rolling

- A. Proof rolling with a heavy rubber tired roller will be required, if designated on the Construction Improvement Drawings or when ordered by the Town.
- B. Proof rolling shall be done after specified compaction has been obtained.

- C. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompactd to the requirements for density and moisture.
- D. Proof rolling shall be done with equipment and in a manner acceptable to the Design Engineer and City.

108.3.5 Excavation and Backfill for Structures

- A. Poor foundation material for any of the work shall be removed.
- B. Foundation materials which are:
 - 1. Saturated by either surface or subsurface flows due to the lack of adequate water control or dewatering work, frozen for any reason or those that are disturbed by the work or caused to become unacceptable for foundation material purposes by means of the equipment, manpower, or methods of work shall be removed and replaced.
- C. Dewatering should not be conducted by pumping from inside footing, structural floor slab, or other structure foundation limits. This may decrease the supporting capacity of the soils.
- D. Care should be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete work.

108.3.6 Excavation for Detention Ponds

- A. Subgrade for lined channel embankments shall be backfilled and compacted to 95% of maximum density as determined by ASTM D698.

108.3.7 Settlement

- A. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the ground surface, re-shape, and compact to required density prior to further construction.
- B. Any settlement in backfill, fill, or in structures built over the backfill or fill, which may occur within the two (2) years guarantee period will be considered to be caused by improper compaction methods and shall be corrected. Any structure damaged by settlement shall be restored to their original condition by the Contractor.

END OF SECTION

Section 109

Controlled Low Strength Material Backfill (Flo-Fill)

109.1 General

109.1.1 Description

- A. This section outlines the requirements where the Contractor is required to furnish and place control low strength material (CLSM) backfill where indicated on the approved Construction Improvement Drawings or as required by the Engineer of Record, or the Town.

109.1.2 Quality Assurance

- A. ASTM C 33 - Concrete Aggregates
- B. ASTM C 94 - Specification for Ready-Mixed Concrete
- C. ASTM C 143 - Test Method for Slump of Hydraulic Cement Concrete
- D. ASTM C 150 - Portland Cement
- E. ASTM C 168 – Fly Ash
- F. ASTM C 494 - Chemical Admixtures for Concrete
- G. ASTM C 618 - Fly Ash in Portland Cement Concrete
- H. ASTM D 4832 - Standard Test Method for Preparation and Testing of Soil-Cement Slurry Test Cylinders
- I. ASTM PS 28 - Provisional Standard Test Method for Flow Consistency of Controlled Low Strength Material
- J. ASTM PS 29 - Provisional Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Controlled Low Strength Material
- K. ASTM PS 30 - Provisional Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material
- L. ASTM PS 31 - Provisional Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application
- M. CDOT Section 206 – Structure Backfill (Flow-Fill), Standard Specifications for Road and Bridge Construction.

109.2 Materials

109.2.1 General:

- A. The CLSM shall consist of a mixture of sand, coarse aggregate, cement and water. Fly ash and approved admixtures may be used to obtain the required properties of the mix. The mix shall have good workability and flowability with self-compacting and self-leveling characteristics. Proportions of the mix shall be as given in the following table:

CLSM Mix Proportions	
Component	Amount
Cement	30 lbs
Fly Ash	30 lbs
Fine Aggregate	1,845 lbs
Coarse Aggregate	1,700 lbs
Water	325 lbs

- B. Flowable Fly Ash Fill (May Be Used If Approved By Engineer of Record)

Materials	Pounds/Cubic Yard
Class C Fly Ash	200 to 400
Class F Fly Ash	1600 to 1800
Water	800 (96 gallons or as needed)

- C. Cement: All cement used shall be Type II Portland cement, which shall conform to the requirements of ASTM C 150.
- D. Fly Ash: Fly ash may be either Class C or Class F. The fly ash shall conform to ASTM C 618.
- E. Aggregates:
1. Fine Aggregate: All fine aggregate shall conform to the grading and quality requirements of ASTM C 33.
 2. Coarse Aggregate: Coarse aggregate shall conform to the grading and quality requirements of ASTM C 33 for size No. 57 or No. 67.
- F. Water: The batch mixing water and mixer washout water shall conform to the requirements of ASTM C 94.
- G. Admixtures: Chemical admixtures that do not contain calcium chloride and conform to ASTM C 494 for concrete may be used in the CLSM mix. All chemical admixtures shall be compatible with the cement and all other admixtures in the batch.
- H. CLSM Properties:
1. Strength:
 - i. CLSM shall have a minimum 28 day compressive strength of 50 psi when tested in accordance with ASTM D4832.

2. CLSM shall have a minimum 24-hour strength of 10 psi.
 3. Air-Entrainment: All CLSM shall be air entrained to a total air content of 4 – 8 %.
 4. Slump: The minimum slump shall be seven inches (7") and the maximum slump shall be nine ten (10") as when tested in accordance with ASTM PS 28.
 5. Aggregate: Fine aggregate shall be between 50% and 60% by volume of the total aggregates in the CLSM mix.
 6. Consistency: The consistency of the CLSM slurry shall be such that the material flows easily into all openings and the area to be filled. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CSLM from flowing down the trench. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.
- I. Flo-fill placed in areas that require future excavation, such as utility backfill shall have a Removability Modulus (RM) of 1.5 or less. (Refer to CDOT Section 206 – Structure Backfill (Flo-Fill)).
 - J. Flo-fill is prohibited as a temporary or permanent street surface.
 - K. No changes shall be made in the specified mix ingredients without the approval of the Engineer/Utility.

109.3 Execution

109.3.1 Placement

- A. CLSM shall be used as an alternative to backfill, as directed by the Engineer/Utility, but may not be used as a substitute for bedding material.
- B. Rodding, mechanical vibration and compaction of CLSM shall be performed to assist in consolidating the CLSM.
- C. CLSM shall be placed as closely behind pipe laying operations as possible.
- D. When required to prevent uplift, the CLSM shall be placed in two stages as required, allowing sufficient time for the initial set of the first stage before the remainder is placed. CLSM shall be deposited as nearly as practical in its final position and in no way disturb the pipe trench or cause foreign material to become mixed with the CLSM.
- E. Soil backfill shall not be placed until the CLSM has reached the initial set. If backfill is not to be placed over the CLSM within 8 hours, a 6-inch cover of moist earth shall be placed over the CLSM surface.

- F. If the air temperature is 50° F or less, the moist earth cover should be at least 18-inches thick. CLSM shall not be placed when the air temperature is below 40° F unless the air temperature is 35° F or more and the temperature is rising.
- G. CLSM shall not be placed, if, in the judgment of the Engineer/Utility, weather conditions are unsuitable.
- H. CLSM shall not be placed when the trench bottom or walls are frozen or contain frozen materials.

END OF SECTION

Section 110

Identification and Signage for Utilities

110.1. General

110.1.1 Description

A. Section Includes:

1. Detectable Marking Tape
2. Non-Detectable Marking Tape.
3. Tracer Wire.

B. Related Work specified elsewhere:

1. Section 4 – Sanitary Sewer Design and Construction
2. Section 9 – Potable Water Pipe

110.1.2 Quality Assurance

- A. Perform Work in accordance with Town standards, specifications, and details.
- B. Materials used for the construction of water and sewer components and appurtenances shall be new and free of defects. Materials and appurtenances shall be clearly, legibly, and appropriately marked for identification purposes.
- C. The Town/Engineer must inspect, review, and approve materials to be used for water and sewer components and appurtenances prior to installation.

110.1.3 Delivery, Storage, and Handling

- A. Comply Manufacturer's Product Requirements, for transporting, handling, storing, and protecting products.
- B. Inspect products thoroughly upon arrival for damage. Remove damaged or rejected materials from the site immediately.

110.2. Products

110.2.1 Tracer Wire

- A. All trace wire shall have HDPE insulation intended for direct bury, color coated per APWA standard for the specific utility being marked.

1. Open-cut Excavation Installations: #12-gauge AWG Copper Clad Steel, High Strength with minimum four hundred fifty-pound (450 lb.) break load, with minimum thirty (30) mil HDPE insulation thickness.
2. Directional Drilling/Boring: #12-gauge AWG Copper Clad Steel, Extra High Strength with minimum one thousand one hundred fifty-pound (1150 lb.) break load, with minimum thirty (30) mil HDPE insulation thickness.
3. Pipe Bursting/Slip Lining: 7x7 Stranded Copper Clad Steel, Extreme High Strength with minimum four thousand seven hundred-pound (4700 lb.) break load, with minimum fifty (50) mil HDPE insulation thickness.

110.2.2 Connectors

- A. Copperhead (Direct Bury Wire Connectors) or Equal, specifically manufactured for use in underground trace wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion. Non-locking friction fit, twist on or taped connectors are prohibited.

110.2.3 Test Stations

- A. Termination points must utilize an approved trace wire access box, specifically manufactured for this purpose.
- B. Copperhead Cobra (Above Grade Access Point) or SnakePit (At Grade Access Point) or Equal (Water or Sewer) cast in the cap.
- C. A minimum of two (2) feet of excess/slack wire is required in all trace wire boxes after meeting final elevation.
- D. Locations:
 1. Water Mains: Fire Hydrants and near curb stop on water services (new or reconnection to new mainline). In addition to splice into the main line tracer wire, ground rod should be installed near each service tap.
 2. Sewer Mains: Sewer Services at limits of right-of-way (new or reconnection to a new mainline), and manholes installed or incorporated into the improvements.
 3. If storm sewer includes service laterals for connection of private drains, underdrains, etc. it shall have same requirements as a sanitary sewer application.

110.3. Execution

110.3.1 Installation

- A. Detectable Marking Tape:

1. Place nine (9) to twelve (12) inches below finished grade (for 3-inch wide tape) directly above installed utility pipe with printed side up during backfill procedure. Tape shall not be pulled, distorted, or otherwise misplaced during completion of the trench backfill.

B. Non-Detectable Marking Tape:

1. Place six (6) to twelve (12) inches below finished grade directly above installed utility pipe with printed side up during backfill procedure. Tape shall not be pulled, distorted, or otherwise misplaced during completion of the trench backfill.

C. Tracer Wire:

1. Trace wire installation shall be performed in such a manner that allows proper access for connection of line tracing equipment, proper locating of wire without loss or deterioration of low frequency signal for distances in excess of one thousand (1000) lineal feet, and without distortion of signal caused by multiple wires being installed in close proximity to one another.
2. Trace wire systems must be installed as a single continuous wire, except where using approved connectors.
3. Install continuously along the top of installed utility pipe (conductive & non-conductive) and attach securely every five (5) feet with electrical tape or zip ties. A mainline trace wire must be installed, with all no service lateral trace wires connected to the mainline trace wire. Alternatively, new construction, scrape, or full replacement require a grounding rod be installed near the service lateral connection to the mainline and tracer wire installed to the house, for water, or to the cleanout, for sanitary sewer.
4. Make splices in the wire only by use of an underground-rated, watertight, and approved splice connector. Do not twist wire ends. Do not wrap tracer wire around the pipe, flanges, bells, valves, or other appurtenances. All mainline trace wires must be interconnected in intersections, at mainline tees and mainline crosses. At tees, three wires shall be joined using a single 3-way lockable connector. At crosses the four wires shall be joined using a 4-way connector. When an existing trace wire is encountered when connecting to an existing utility, the new trace wire and existing trace wire shall be connected using approved splice connectors and shall be properly grounded as required.
5. Tracer wire shall be accessible above ground at least every five hundred (500) feet. Valve boxes shall not be used for accessibility due to maintenance activities.

6. Electrical conductivity along the pipe shall be continuous and uninterrupted between valve boxes.
7. At each access point, provide sufficient excess length of wire such that the wire can be extended at least two (2) feet above finished grade for connection to locating equipment.
8. Grounding: Trace wire must be properly grounded at all dead ends/stubs. Grounding of trace wire shall be achieved by use of a drive-in grounding rod with a minimum of twenty (20) feet of #12 red HDPE insulated copper clad steel wire connected to anode (minimum 1.5 lb.) specifically manufactured for this purpose and buried at the same elevation as the utility.
 - a. When grounding the trace wire at dead ends/stubs, the grounding anode shall be installed in a direction 180 degrees opposite of the trace wire, at the maximum possible distance.
 - b. When grounding the trace wire in areas where the trace wire is continuous and neither the mainline trace wire or the grounding anode wire will be terminated at/above grade, install grounding anode directly beneath and in-line with the trace wire. Do not coil excess wire from grounding anode. In this installation method, the grounding anode wire shall be trimmed to an appropriate length before connecting to trace wire with a mainline to lateral lug connector.
 - c. Where the anode wire will be connected to a trace wire access box, a minimum of two (2) feet of excess/slack wire is required after meeting final elevation.
9. Any damage occurring during installation of the trace wire must be immediately repaired by removing the damaged wire and installing a new section of wire with approved connectors. Taping and/or spray coating shall not be allowed.

110.3.2 Field Quality Control

A. Tracer Wire Testing

1. Contractor shall perform locate on new trace wire installations using typical low frequency line tracing equipment in the presence of the Town/Engineer prior to acceptance.

END OF SECTION

Section 111

Structural Concrete

111.1. General

111.1.1 Description

- A. The Contractor shall supply all labor, tools, equipment and materials to set forms for the proper placement of concrete for structures. It is the Contractor's responsibility to de-sign and build adequate forms and to leave them in-place until the forms can be safely removed. The Contractor is responsible for damage and injury caused by removing forms carelessly or before the concrete has gained sufficient strength. Means and methods of repair shall be reviewed by the Engineer prior to performing the work.

111.1.2 Related Sections

- A. Section XX – Construction Joints.
- B. Section XX – Concrete Finishing.
- C. Section XXX – Grout.

111.1.3 Quality Standards

- A. American Concrete Institute
 - 1. ACI 318 - Building Code Requirements for Structural Concrete
 - 2. ACI SP-4 - Formwork for Concrete
- B. American Plywood Association
 - 1. PS 1 - US Product Standard for Construction and Industrial Plywood
 - 2. J20 - Grades and Specifications
 - 3. V345 - Concrete Forming

111.1.4 Quality Assurance

- A. Formwork, and if required shoring and reshoring, shall be designed by a Professional Engineer licensed to practice in the state where the project is located and having a minimum of five years' experience in the design of concrete formwork or form systems.

111.2. Products

111.2.1 General

- A. For the purposes of this specification exposure shall be defined as a surface, interior or exterior, of a structure that will be exposed to view during its use. For example, the interior wall of a structure is a surface exposed to view.

111.2.2 Forms for Surfaces Exposed to View

A. Walls

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.
2. Symons hand set steel-ply forms, or equal.

B. Beams

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.
2. Symons hand set steel-ply forms, or equal.

C. Sides of Column Footings

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.
2. Symons hand set steel-ply forms, or equal.
3. Steel of sufficient thickness that the form will remain true to shape after numerous repetitive uses.

D. Sides of Curved or Straight Continuous Wall Footings

1. APA High Density Overlay Plyform Class I Exterior.
2. APA B-B Plyform Class I, Exterior, PS-1-83.

For curved surfaces, plywood of sufficient thickness, free from knots and other imperfections, which can be cut and bent and held in place accurately to the required curvature without splintering or splitting shall be used.

E. Floor and Roof Slabs

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.

F. Columns

Regardless of materials of construction the forms shall be such to permit bracing in two directions at half-height and full height at a minimum. Two braces at 90° are required at half and full height.

1. Steel of sufficient thickness that the form will remain true to shape after numerous repetitive uses.
2. Fiberglass of sufficient thickness that the form will remain true to shape.

G. Column Capitals

1. Steel, 16 gage or thicker, so that the form will remain true to shape after numerous repetitive uses.

111.2.3 Forms for Surfaces Not Exposed to View

Wood or steel sufficiently tight to prevent mortar leakage.

111.2.4 Anchorage in Slabs for Braces for Wall and Column Forms

Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column alignment under all load conditions including wind.

Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of wall or column braces in water retaining structures. Wedge anchors or nails may be used in other structures when in the opinion of the Engineer/Utility the resulting concrete finish patch will be acceptable. The Contractor shall make a submittal including information about the type of wedge anchor or nail and the means of patching the surface for review and acceptance by the Engineer.

111.2.5 Anchorage in Slabs for Uprturned Column Footing Forms

Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column configuration and diameter. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of column footing forms.

111.2.6 Form Ties

A. Water Retaining Structures and Below Grade Structures:

Symons, S-Panel Ties, or equal, with water seal and one-inch break back cones on both tie ends, shall be used on all wall forms.

B. Structures without formliners:

Symons, S-Panel Ties, or equal, with one-inch break back cones on both tie ends unless otherwise called out or shown in the Drawings or approved by the ENGINEER, shall be used on all wall forms.

C. Structures with formliners:

Ellis Construction supplied heavy duty loop panel ties with 1" extension, 2" break back minimum unless otherwise called out or shown in the Drawings or approved by the ENGINEER, shall be used on all wall forms where formliner will be used.

D. Twisted Wire Ties:

Twisted wire ties with loops to hold forms in position are not permitted.

111.2.7 Chamfer Strip

Chamfer strips (3/4 inch) shall be placed in the corners of forms and at the tops of walls or up-turned footings, to produce beveled edges on permanently exposed concrete surfaces. Interior angles of intersecting concrete surfaces and edges of construction joints shall not be beveled unless otherwise indicated in the Construction Drawings. The chamfer strip may be made of wood or polyvinyl chloride (PVC).

111.2.8 Stiffbacks

Stiffbacks for wall forms shall be constructed of lumber or Glulams, uniform in width and thickness, free from knots and other surface defects. Only one joint is permitted in the board of a stiffback and joints shall be offset so as to not occur at the same point. Stiff-backs shall extend to a point not less than six inches above the top of forms.

111.2.9 Gang Whaler Plates for the Top of Curved Walls

Gang whaler plates shall be constructed of plywood as described below cut to the radius of the wall curve. The gang whaler plate shall be of sufficient depth to permit notching for stiffbacks.

- A. APA High Density Overlay Plyform Class I Exterior.
- B. APA B-B Plyform Class I, Exterior, PS-1-83.

111.2.10 Wedge Inserts

When permitted by the Design Engineer at the tops of walls or columns, wedge inserts may be used to support future formwork or catwalks. The inserts shall be Richmond Screw Anchor, or equal.

111.2.11 Form Release Agent

- A. Magic Kote by Symons Corp. or equal.

111.3. Execution

111.3.1 General

Forms shall be used, wherever necessary, to confine the concrete and shape it to the specified lines and grades as shown on the Construction

Drawings. The Contractor shall set and maintain concrete forms so as to ensure completed work is within all applicable tolerance limits. If a type of form does not, in the opinion of the Design Engineer and Engineer/Utility, consistently perform in an acceptable manner, the type of form shall be changed and the method of erection shall be modified by the Contractor, subject to the review of the Design Engineer and Engineer/Utility.

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete, and shall be maintained rigidly in position. The design of formwork and placing rate of concrete with medium and high-range water reducing agents shall be adjusted to compensate for the greater hydraulic pressures exerted on the forms by concrete of high fluidity.

Forms shall be clean and free from mortar and other foreign material from previous use prior to being placed.

The Contractor shall demonstrate that forms are vertical, proper alignment, grade or radius when requested by the Engineer/Utility

111.3.2 From Surface Treatment

A. General.

1. Prior to placing reinforcing steel coat the forms with a non-staining release agent that will effectively prevent the absorption of moisture and prevent bond of the concrete to the form. Contact with hardened concrete against which fresh concrete is to be placed is prohibited. All bond breaking materials or processes shall be used only after acceptance by the Design Engineer. Care shall be taken in applying form oil to avoid contact with reinforcement steel. Embedded material which becomes coated with form oil shall be thoroughly cleaned or replaced.

B. For Potable Water Facilities.

1. Form release agents for potable water facilities, such as treated water storage reservoirs or water treatment plants, shall be non-toxic 30 days after application.

C. Tolerances.

Tolerances are defined as allowable variations from specified alignments, grades and dimensions. Allowable variations from specified alignments, grades and dimensions are prescribed in the following sub-section. Descriptions of these criteria can be found in Part 2 of the ACI Manual of Concrete Practice 1995, Commentary of

Standard Specifications for Tolerances for Concrete Construction and Materials (ACI 117-90).

1. Footings and Foundations

a. Drilled Piers

Vertical alignment $\leq 2\%$ of the shaft length

Lateral alignment $\leq 1/24$ of shaft diameter, 3 inch maximum

Level alignment to cut-off elevation: +1 inch, -3 inch

b. Continuous Wall Footings (Circular and Non-circular)

Lateral alignment: $\leq 2\%$ of the footing width, 2 inches maximum

Relative alignment: Variation ≤ 1 inch in 10 feet (variation between specified plane and as built surface)

Cross-sectional dimension:

Horizontal dimension: Variation +2 inch, -1/2 inch

Vertical dimension (thickness): Variation $\pm 1/2$ inch

Circular Wall Footing Only

Variation in Radius in any 20 feet of wall length: $\leq 1/2$ inch

Variation in Radius in entire wall length: ≤ 1 inch

c. Column footings

Lateral alignment: Variation ≤ 2 inch

Level alignment: Variation from specified elevation +1/2 inch, -2 inch

Relative alignment: Variation ≤ 1 inch in 10 feet (variation between specified plane and as built surface)

Cross-sectional dimension:

Horizontal dimension: Variation +2 inch, -1/2 inch

Vertical dimension (thickness): Variation $\pm 1/2$ inch

D. Cast-in-Place Concrete for Buildings and other Structures

1. Member (such as a beam, column, wall, slab, or pier)

Vertical alignment:

Variation from specified plumb $\leq 3/8$ inch (full height) 1/4 inch (one form section)

Lateral alignment:

Maximum in any bay: Variation $\leq 1/2$ inch

Maximum in any 20 feet of length: Variation $\leq 1/2$ inch

Maximum for entire wall length: Variation ≤ 1 inch

Floor and wall opening locations: Variation $\leq 1/2$ inch

Sawcuts and joints: Variation $\leq 3/4$ inch

Level alignment:

Top elevation of slabs: Variation $\leq 3/4$ inch

Lintels, other lines exposed to view: Variation $\leq 3/4$ inch

Cross sectional dimensions:

Walls and slabs (thickness): Variation $\pm 1/4$ inch

Columns and Beams: Variation $+1/2$ inch, $-1/4$ inch

Size of wall and floor openings: Variation $\pm 1/4$ inch

Relative alignment:

Offset between adjacent formwork: Variation $\pm 1/4$ inch

Variation in Specified Grade:

For any distance less than 10 feet: Variation $\leq 1/4$ inch

For entire structure: Variation $\pm 1/2$ inch

For manholes and outlet structures: Variation ≤ 1 inch

2. Stairways

Relative alignment:

Difference in height between adjacent risers: $1/8$ inch

Difference in width between adjacent treads: $1/4$ inch

111.3.3 Plumb and String Lines

Plumb and string lines shall be installed on wall and column forms before, and maintained, during concrete placement. There shall be sufficient number of plumb or string lines in walls, for example at every other stiffback, properly installed to permit continuous monitoring. During concrete placement, the Contractor shall continually monitor plumb and string line positions and immediately correct deficiencies. The plumb and

string lines shall extend to a point at least six inches above the top of wall or column.

111.3.4 Formwork Camber

In order to maintain specified tolerances of joists, beams or slabs subject to dead load deflection, the Contractor shall camber formwork to compensate for dead load deflection prior to hardening of the concrete.

111.3.5 Gang Whaler Plates for Circular Walls

The Contractor shall place a gang whaler plate cut to the curvature of the wall, such as a circular reservoir wall, at the top of the wall forms. The gang whaler plate shall be attached to the forms with a gang whaler rod at appropriately designed intervals. The gang whaler plate may be notched to permit the stiffback to extend above the top of the wall forms. The gang whaler plate shall be sufficiently stiff to maintain the required curvature.

111.3.6 Hand Set Modular Forms

Hand set modular forms, such as Symons hand set steel-ply forms, shall be placed with no more than two intersecting joints occur at one level in the formwork above the bottom modular form level. The following figure illustrates the required form pattern.

The above form configuration is one way recommended by Symons Corp. to eliminate vertical, in plane, bending of the forming system. The Contractor may develop alternate means of maintaining vertical alignment. Alternate form system configurations require preparation by a licensed Professional Engineer in Colorado.

111.3.7 Formwork Closure

Forms which will prohibit visual review of items such as reinforcing steel, waterstops and bearing pads by the Engineer/Utility, shall not be placed until the Engineer/Utility has performed a final review of the reinforcing steel.

The Contractor shall use compressed air from an air-compressor to blow-out construction debris and dirt at the bottom of sections or members to be placed such as walls, slabs, beams and columns, prior to placing forms or concrete. The Contractor shall demonstrate to the Engineer/Utility that all debris, such as loose concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

111.3.8 Hot or Cold Weather Placement and Steel Forms

Prior to placing concrete when steel forms are used, the forms shall be heated when the surface temperature of the form is below 40° F or cooled

when the surface temperature of the form is above 90° F. If water is used to cool forms where ponding of water may occur, i.e., at the bottom of a column, the water shall be permitted to drain prior to placing concrete.

111.3.9 Removal of Forms

The forms for any portion of a structure shall not be removed until the concrete has reach sufficient strength with a factor of safety of 2.0, to withstand applied loads such as self-weight and wind loads or withstand damage when the forms are removed. For post-tensioned concrete slabs and beams, formwork shall not be removed until the entire slab or member has been stressed and stressing records accepted.

END OF SECTION

Section 112

Reinforcing Steel

112.1. General

112.1.1 Work Included

- A. This work shall consist of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the Construction Drawings, and install all tapping sleeves as either shown or implied on the Construction Drawings.

112.1.2 Related Sections

- A. **Section XXX – Structural Concrete**

112.1.3 Quality Standards

- A. American Concrete Institute
 - 1. ACI 318 - Building Code Requirements for Reinforced Concrete
 - 2. ACI Detailing Manual - (SP-66)
 - 3. ACI 117 - Standard Tolerance for Concrete Construction and Materials
- B. American Society for Testing and Materials
 - 1. ASTM A 615, A 616 including supplementary requirement S1, A 617, A 706
 - 2. ASTM A 767, Zinc-coated (galvanized) reinforcing bars
 - 3. ASTM A 775 Epoxy-coated reinforcing bars
- C. Concrete Reinforcing Steel Institute (CRSI)
 - 1. Manual of Standard Practice
 - 2. Placing Reinforcing Bars
- D. American Welding Society (AWS)
 - 1. AWS D1.4 - Structural Welding Code - Reinforcing Steel

112.2. Products

112.2.1 Reinforcing Steel

- A. Deformed Bars:

All bar steel reinforcement shall be of the deformed type, ASTM A 615, (AASHTO M31) and grade (40 or 60) as specified in the Drawings.

B. Spirals:

Spirals, hot-rolled plain or deformed bars per ASTM A 615, Grade 60 or cold drawn wire per ASTM A 82 as specified in the Construction Drawings.

Spirals for columns shall have two "spacers" with a section modulus > 0.008in³ in order to maintain the proper pitch and spacing.

C. Epoxy-Coated Reinforcing Bars:

Epoxy-coated reinforcing bars shall conform to ASTM A 775. When required, damaged epoxy coating shall be repaired with patching material conforming to ASTM A 775 in accordance with the material manufacturer's recommendations.

D. Zinc-coated (Galvanized Reinforcing Bars):

Zinc-coated reinforcing bars shall conform to ASTM A 767. When required, damaged zinc coating shall be repaired with a zinc-rich formulation conforming to ASTM A 767.

112.2.2 Tie Wire

16-gauge wire ties, manufactured by American Wire Tie, Inc., or equal. When epoxy coated reinforcing steel is shown in the Drawings, PVC coated wire ties shall be used. The minimum PVC coating is 0.7 mils.

112.2.3 Identification

Bundles of reinforcing bars and wire spirals shall be tagged, with a metal tag, showing specification, grade, size, quantity and suitable identification to permit checking, sorting and placing. When bar marks are used to identify reinforcing bars in the Drawings, the bar mark shall be shown on the tag. Tags shall be removed prior to concrete placement.

Bundles of flat sheets and rolls of welded wire fabric shall be tagged similar to reinforcing bars.

112.2.4 Storage and Protection

Reinforcing steel shall be stored off of the ground and protected from oil or other materials detrimental to the steel or bonding capability of the reinforcing bar. Epoxy-coated reinforcing bars shall be stored on protective cribbing.

Rust, seams, surface irregularities, or mill scale, shall not be cause for rejection provide that the weight and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM Specification.

When placed in the work, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust or other foreign substance.

112.2.5 Bar Supports

A. General:

Bar supports and spacing shall be in accordance with the CRSI Manual of Standard Practice, Chapter 3, a maximum of four feet or as required by the Drawings.

B. Floor Slabs:

Uncoated steel or non-metallic composite chairs shall be used unless otherwise shown in the Drawings. If required by the ENGINEER, the chair shall be stapled on a bearing pad to prevent chair displacement. The bearing pad shall be made of exterior grade plywood and be approximately five inches square.

C. Soffits:

Steel wire bar supports in concrete areas where soffits are exposed to view or are painted shall be Class 1 or Class 2, Types A or B: Class 3 is acceptable in other areas.

D. Water and Wastewater Vaults, Tank and Basin Walls, and Roof Slabs:

Only plastic clip, non-metallic composite or 100% epoxy coated steel chair bar and bolster supports are acceptable for use in walls and roof slabs. Supports shall be securely stapled to formwork.

E. Columns:

Plastic "space wheels" manufactured by Aztec (Model DO 12/40), or equal, are required.

F. Epoxy-Coated and Zinc-Coated Bar Supports:

Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports made of dielectric or other acceptable materials. Wire supports shall be fully coated with dielectric material, compatible with concrete. Reinforcing bars used as support bars shall be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars shall be epoxy coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing shall be made of corrosion-resistant material or coated with dielectric material.

112.3. Execution

112.3.1 General

The Contractor shall be responsible for furnishing and placing all reinforcing steel in accordance with fabrication details and/or as shown on the Construction Drawings.

112.3.2 Fabrication

Fabrication tolerances for straight and bent bars shall be in accordance with the requirements of Subsection 4.3, Tolerance, of the American Concrete Institute Standard 315 and the CRSI Manual of Standard Practice.

112.3.3 Bending

All reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on the Construction Drawings or as permitted by the Engineer/Utility.

Bars shall not be bent or straightened in a manner that will injure the material.

112.3.4 Spirals

One and one-half finishing bends are required at the top and bottom of the spiral. Spacers shall be provided in accordance with Chapter 5, Section 9 of the CRSI Manual of Standard Practice. Welding as an aid to fabrication and/or installation is not permitted.

112.3.5 Placing and Fastening

The placing, fastening, splicing and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the Construction Drawings and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars". In case of discrepancy between the Construction Drawings and the CRSI publication stated above, the Construction Drawings shall govern. Reinforcement shall be placed within the tolerances provided in ACI 117.

Steel reinforcement shall be accurately placed in the positions shown on the Construction Drawings and firmly held during the placing and setting of concrete by means of spacer strips, stays, metal chairs or other approved devices or supports. Chair and bolster supports for slabs and walls shall be spaced at a maximum of four foot centers unless otherwise shown in the Construction Drawings. Staples used to attach bar supports to wall and roof forms shall have the staple "tails" clipped after form removal. For Columns, three wheels, spaced 120 degree apart, shall be placed every four feet of column height. The Contractor may increase the column spiral pitch if a conflict occurs with the wheel. Pre-tied column reinforcing steel lowered into column forms shall be lowered vertically to prevent damage to the space wheels.

Bars shall be securely tied at 50% of all intersections except where spacing is less than one foot in each direction, when alternate intersections shall be tied unless otherwise called out in the Construction Drawings or in applicable specifications. Tying of steel by spot welding will not be permitted unless specifically authorized by the Design Engineer and Engineer/Utility. The placing and securing of the reinforcement in any unit or section shall be accepted by the Engineer/Utility before any concrete is placed in any such unit or section.

Bundle bars shall be tied together at not more than 6-foot centers.

Unless specified on the Construction Drawings, the minimum protective cover for reinforcement shall be as listed, below.

Concrete Protection for Reinforcement

	<i>Minimum Cover, inches</i>
A. Cast-In-Place Concrete	
1. Concrete cast against and permanently exposed to earth	3
2. Concrete exposed to earth or weather:	
#6 and larger	2
#5 bar, W31 or D31 wire, and smaller	1/2
3. Concrete not exposed to weather or in contact with ground:	
Slabs, walls, joists:	
#14 and larger	1-1/2
#11 bar and smaller	3/4
Beams, columns:	
Primary reinforcement, ties, stirrups, spirals	1-1/2
B. Precast Concrete (manufactured under plant control conditions)	
1. Concrete exposed to earth and weather:	
Wall panels:	
#14 and larger	1-1/2
#11 bar and smaller	3/4
Other members:	
#14 and larger	2
#6 through #11 bars	1-1/2
#5 bar, W31 or D31 wire, and smaller	1-1/4
Concrete not exposed to weather or in contact with ground:	
Slabs, walls, joists:	
#14 and larger	1-1/4
#11 bar and smaller	5/8
Beams, columns:	
Primary reinforcement	<i>d_b but not less than 5/8 and need not exceed 1-1/2</i>
a. Ties, stirrups, spirals	3/8

Bar steel reinforcement shall be furnished in the full lengths indicated on the Construction Drawings. Splicing of bars, except where shown on the Construction Drawings, will not be permitted without the written acceptance of the Design Engineer. Splices shall be staggered. In cases where permission is granted to splice bars, other than those shown on the Construction Drawings, the additional material required for the lap shall be furnished by the Contractor. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar. All splices shall be full contact splices.

Splices will not be permitted at points where the section is not sufficient to provide a minimum distance of two inches between the splice and the nearest adjacent bar or the surface of the concrete.

Welding of reinforcement shall be done only if detailed on the Construction Drawings or if authorized by the Design Engineer and Engineer/Utility. Welding shall be done by a certified welder. The welding shall conform to AWS D 12.1, Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, with the modifications and additions specified hereinafter. Where AWS D 2.0 Specifications for Welded Highway and Railway Bridges is referenced, the reference shall be construed to be for AWS D 1.1. Where the term AWS D1.1 is used it shall mean the American Welding Society Structural Welding Code, D 1.1 as modified and amended by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. After completion of welding, coating damage to coated reinforcing steel bars shall be repaired.

When required or permitted, a mechanical connection may be used to splice reinforcing steel bars or as substitution for dowel bars. The mechanical connection shall be capable of developing a minimum of 125% of the yield strength of the reinforcing bar in both tension and compression. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

112.3.7 Cutting

When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage. All rebar cut in the field shall be cut with a cut-off saw, any other method must be approved by the Design Engineer.

END OF SECTION

Section 113

Welded Wire Fabric

113.1. General

113.1.1 Work Included

- A. This work shall consist of furnishing and placing welded wire fabric in accordance with these specifications and in conformity with the Construction Drawing.

113.1.2 Related Sections

- A. **Section XXX – Reinforcing Steel**
- B. **Section XXX – Structural Concrete**

113.2. Materials

113.2.1 Materials used in the work shall meet the requirements for the class of material named.

- A. Size: 6 x 6 / W10 X W10 wire or as shown on the Drawings.
- B. Manhole bases may use 4 x 4 / W4 x W4 as a minimum.

113.2.2 Welded wire fabric shall conform to the requirements of the following specifications:

- A. Welded Steel Wire Fabric for Concrete Reinforcement – AASHTO M55 (ASTM A185).
- B. Welded Deformed Steel Wire Fabric for Concrete Reinforcement – AASHTO M221 (ASTM A497)

113.3. Execution

113.3.1 Storing and Surface Condition of Reinforcement

- A. Welded wire fabric shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, the wire fabric shall be free from dirt, detrimental rust, loose scale, paint, grease, oil, or other foreign materials. The welded wire fabric shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross section area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

113.3.2 Placing and Fastening

The placing, fastening, splicing and supporting of the wire mesh shall be in accordance with the plans and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars". In case of discrepancy between the plans and the CRSI publication stated above, the plans shall govern.

The wire mesh shall be accurately placed in the positions shown on the Construction Drawings and firmly held during the placing and setting of concrete by means of spacer strips, stays, metal chairs or other approved devices or supports. When metal chairs are used, the part of the chair in contact with the form and at least 1 inch from the form shall be hot dip galvanized or plastic coated. Other coatings or treatments will be acceptable when specifically accepted by the Design Engineer and Engineer/Utility. Precast concrete bricks or other accepted bricks or blocking may be used in structures to support reinforcement in slabs placed on grade; however, the bricks or blocking shall not contact the reinforcement over a distance greater than the depth of a standard concrete brick. The placing and securing of the wire mesh in any unit or section shall be accepted by the Design Engineer and Engineer/Utility a minimum of 24 hours before any concrete is placed in any such unit or section.

At the time the concrete is placed, the wire fabric required shall be free from flaky rust, mud, oil or other coatings that will destroy or reduce the bond.

113.3.3 Splicing

Sheets of welded wire fabric reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than 1 mesh in width or six inches (6") minimum.

113.3.4 Ties, Chairs, Spacers

The wire mesh shall be accurately placed and adequately supported by concrete, metal or other approved spacers or ties and secured against displacement within the tolerance permitted.

113.3.5 Placement

Unless otherwise specified by the Design Engineer, the wire fabric shall be placed in specified positions within the following tolerances:

- A. In slabs, all wire mesh shall be placed within, plus or minus, one-quarter inch of specified location.

END OF SECTION

Section 114

Construction Joints

114.1. General

114.1.1 Work Included

- A. The Contractor shall supply all labor, tools, equipment and material for the preparation of construction joints in concrete in accordance with these specifications and as shown in the Construction Drawings. This includes joints such as column-footing joints, wall construction joints, column capital-slab joints, grout closures around pipe-slab penetrations and footing-slab joints.

114.1.2 Related Sections

- A. Section XXX – Reinforcing Steel
- B. Section XXX – Structural Concrete
- C. Section XXX – Grout
- D. Section XXX – Structural Cast-In-Place Concrete Forms
- E. Section XXX - Waterstops

114.1.3 Quality Standards

- A. American Concrete Institute (ACI)
 - 1. ACI 117 - Standard Tolerance for Concrete Construction and Materials
 - 2. ACI 301 - Specifications for Structural Concrete for Buildings
 - 3. ACI 302 - Guide for Concrete Floor and Slab Construction
 - 4. ACI 318 - Building Code Requirements for Structural Concrete

114.1.4 Construction Review

- A. The Engineer/Utility shall review the preparation of all construction joints prior to concrete and grout closure placements. It is the responsibility of the Contractor to notify and provide a minimum of 24 hour's notice to the Engineer/Utility of these activities. If joint placement is performed without the Engineer/Utility's presence, the work will be deemed unacceptable and non-conforming to these specifications. If the Engineer/Utility determines that construction review of a particular activity is unnecessary, he will provide notify the Contractor to proceed with that particular activity without his/her construction review.

114.2. Materials (not used)

114.3. Execution

114.3.1 Surface Preparation

- A. The surface of concrete construction joints shall be clean and all materials that inhibit bond, such as curing compounds, laitance, saw dust, wood, dirt, polyethylene, pipe tape coating and paper shall be removed. Concrete shall be roughened to produce a rough, plus or minus 1/16-inch, surface texture. Concrete surfaces shall be wetted with clean potable water and standing water removed immediately before new concrete or closure grout is placed. Unless otherwise called out in the Construction Drawings, a bonding agent shall be used prior to placing the concrete or grout.

114.3.2 Pipe Grout Closure Sections

A. Pipe Surface Preparation

Unless otherwise detailed in Construction Drawings, all pipes penetrating concrete sections such as wall and floor slabs shall have all coatings and other materials that can inhibit bond completely removed from the portion of the pipe to be in contact with the concrete or slab closure grout.

B. Ground Surface Preparation

The ground surface at joints such as pipe / slab closures shall be smooth and properly graded and compacted. All debris such as Styrofoam™, paper, polyethylene and wood shall be removed. The ground surface shall be dampened and prepared to prevent the inclusion of dirt, pieces of aggregate or balls of soil in the concrete or grout.

114.3.3 Concrete and Closure Grout Placement

Mixing, surface preparation in addition to that prescribed above, placement, and curing of grout at pipe closure joints shall be performed in strict accordance with Specification Section 03615 and when a proprietary grout is specified, with the grout manufacturer's directions. Special care shall be taken to ensure that the grout is thoroughly and properly consolidated at waterstops, pipe weep rings, and existing concrete surfaces. An appropriate capacity vibrator shall be used when necessary or required by the manufacturer to properly consolidate the grout.

END OF SECTION

Section 115

Concrete Finishing

115.1. General

115.1.1 Work Included

The Contractor shall supply all labor, tools, equipment and materials to finish properly placed concrete for structures such as box culverts, vaults, foundations, hydraulic and water retaining structures.

The means and methods of repair of improperly placed or finished concrete shall be reviewed by the Design Engineer and Engineer/Utility prior to performing the work. Regardless of prior approval of the means and methods of concrete finish repair, no concrete finish shall be repaired until the Engineer/Utility has reviewed the existing finish. This includes defects caused by ineffective and improper vibration such as honeycomb, excessive air voids on formed surfaces, placement "pour" lines (cold joints) and sand streaking. It also includes defects caused by excessive form deflections, form damage or form failure.

Unless otherwise called out in the Construction Drawings tie holes shall be finished as specified herein.

115.1.2 Related Sections

- A. Section XXX – Structural Concrete
- B. Section XXX – Grout
- C. Section XXX – Structural Cast-In-Place Concrete Forms

115.1.3 Quality Standards

- A. American Concrete Institute (ACI)
 - 1. ACI 116 - Cement and Concrete Terminology
 - 2. ACI 121 - Quality Assurance Systems for Concrete Construction
 - 3. ACI 301 - Specifications for Structural Concrete for Buildings
 - 4. ACI SP-15 - ACI 301 Field Reference Manual
 - 5. ACI 304 - Placing Concrete by Pumping Methods
 - 6. ACI 309 - Identification and Control of Consolidation-Related Surface Defects in Formed Concrete Delivery, Storage, and Handling
 - 7. ACI 311 - Guide for Inspection of Concrete

- B. American Society for Testing and Materials
 - 1. ASTM STP 169C - Significance of Tests and Properties of Concrete and Concrete-Making Materials
 - 2. ASTM C 150 - Standard Specification for Portland Cement
 - 3. ASTM C 33 - Concrete Aggregates
- C. US Department of Interior - Bureau of Reclamation
 - 1. M-47 Standard Specifications for Repair of Concrete

115.1.4 Delivery, Storage, and Handling

- A. Deliver the materials to the project site in the manufacturer's containers with all labels intact and legible at the time of use. Materials shall be stored in a secure, indoor, dry area. Maintain grouts and aggregates in a dry condition during delivery, storage, and handling.

115.2. Products

115.1.5 Premixed Pre-Packaged Grouts

- A. Master Builders EMACO R320
- B. Master Builders EMACO S66-CR

115.1.6 Epoxy Bonding Agents

115.1.7 Cement

- A. ASTM C 150, Type 1

115.1.8 Aggregate

- A. ASTM C 33, 100% passing the No. 30 mesh sieve.

115.1.9 Bond Coat Mortar

- A. Mortar used to bond patching mortar shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of 1 part cement to not more than 1 part sand by damp loose volume

115.1.10 Patching Mortar

- A. Patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of 1 part cement to not more than 2-1/2 parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the gray Portland Cement on exposed concrete in order to produce a color matching the

color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

115.1.11 Water

- A. Only clean potable water shall be used. A calibrated measuring device is required for measuring the proper amount of water to be added to pre-packaged grouts and mortars.

115.3. Execution

115.3.1 Repair of Surface Defects

- A. Surface defects, unless otherwise specified by the specifications, shall be repaired immediately after form removal but not before review by the Engineer/Utility. The surface temperature of the concrete shall be 50° F and rising. The Contractor shall measure surface temperatures when requested by the Engineer/Utility. If necessary the Contractor shall enclose and heat the area to be repaired to bring the surface temperature of the concrete and air temperature to acceptable levels and to permit proper curing.

All honeycombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. Feathered edges will not be permitted. The area to be patched and an area at least six inches wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared, mixed to the consistency of thick cream, and after surface water has evaporated from the area to be patched, well brushed into the surface.

When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Metal tools shall not be used in finishing a patch in a formed wall that will be exposed.

115.3.2 Tie Holes

- A. Below Grade Vaults with Breakback Cone Ties
Fill tie holes solid as specified in [Section XXX - Grout](#).
- B. Other Structures

After being cleaned and thoroughly dampened, fill tie holes solid as specified in [Section XXX – Grout](#).

115.3.3 Proprietary Materials

Certain types of defects may require the use proprietary compounds for adhesion or as patching ingredients. The Engineer/Utility will review these defects and request means and methods for these repairs from the Contractor.

In lieu of, or in addition to, the foregoing patching procedures using bond coat and patching mortars, epoxy bonding agents and premixed pre-packaged grouts may be used for repair of defective areas. Such compounds shall be used in accordance with the manufacturer's written recommendations and directions.

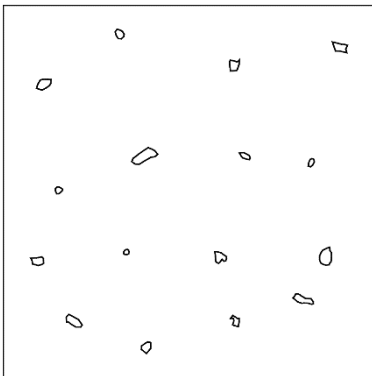
115.3.4 Finishing of Formed and Unformed Surfaces

Finishes shall be performed as called out in the Construction Drawings and in referenced specifications.

A. Formed Surfaces

1. Smooth Form Finish

The form facing material shall produce a smooth, hard, uniform texture on the concrete. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. Surface textures that result from forms with raised grain, torn surfaces, worn edges, patches, dents, or other defects shall be ground smooth or otherwise repaired.



a. Air Voids on Formed Surfaces

Air voids on formed surfaces deeper than 1/4 inch shall be filled with patching mortar. The frequency and size of air voids shall be equal to or better than shown in the figure to the left. The total void area is 1% of the surface area, or 0.36 sq. in. This 6-inch x 6-inch figure is the visual standard for acceptance of the finish that does not require filling of air voids.

b. Tie Holes

Tie holes shall be filled as specified in [Section XXX – Grout](#).

c. Form Fins

Chip or rub-off form fins exceeding 1/16 inch in height.

d. Rock Pockets

Poorly consolidated concrete shall be removed to sound concrete and the defect repaired. The Engineer/Utility shall outline the area to be repaired.

2. As-Cast Finish

For as-cast concrete finish form materials shall produce a sound surface.

a. Air Voids

Fill air voids deeper than 1/4 inch. and larger than 0.50 sq. in. The total area of acceptable air voids is 0.72 sq. in. in a 6 inch by 6-inch square.

b. Tie Holes

Tie holes shall be filled as specified in [Section XXX - Grout](#).

c. Form Fins

Chip or rub-off form fins exceeding 1/8 inch in height.

3. Rubbed Finish

Immediately after removing the forms, form ties shall be broken back a minimum of 3/4 inch from the surface, honeycomb, voids and other surface defects grouted. The surfaces shall then be thoroughly dampened and rubbed with a No. 16 carborundum stone or equal abrasive to create a uniform surface paste. The rubbing shall be continued to remove all form marks and surface irregularities producing a smooth, dense surface. After setting, the surface shall then be rubbed with a No. 30 carborundum stone until the surface is smooth in texture and uniform in color. Unless otherwise shown in the Construction Drawings only exposed surfaces shall have a rubbed finish.

4. Grout Finish

Prepare surface as described in Rubbed Finishes above. Mix one part Portland cement and one-half parts fine sand with sufficient water to produce a grout with the consistency of thick paint. Wet surface of concrete to prevent absorption of water from grout and apply grout uniformly with brushes. Immediately after applying grout mix, scrub the surface with a cork float or stone to coat surface and fill remaining air voids and other remaining surface defects. Remove excess grout by working the surface with rubber float. After the surface whitens from drying, rub with clean burlap. Cure surface for a period of 72 hours

B. Unformed Surface

Unless otherwise shown in the Construction Drawings unformed surfaces shall be finished as follows.

1. Slabs

Screed with straightedge to remove low and high spots bringing the surface to the required finish elevation of slope and float with a steel float at least 3 feet in width. When the concrete has reached its initial set, finish with a steel (power) trowel. Leave finish essentially free of trowel marks, uniform in texture and appearance and plane to the correct tolerance. Dusting the surface with dry cement, sand or sprinkling with water is prohibited.

Finishes that are exposed and subject to foot traffic shall receive a broom finish with a texture of $\pm 1/16$ inch.

2. Tops of Walls with Bearings

Strike smooth tops of walls and similar unformed surfaces that will have bearings or bearing pads, and finish with a steel trowel.

3. Stairways and Sidewalks

Strike smooth tops of stairs and sidewalks and finish with a light broom providing a texture of $\pm 1/16$ inch.

4. Slabs with Waterproofing Membranes

Strike smooth and float finish.

5. Construction Joint Surfaces

Surface shall be broom or raked finished. Surface shall be water or grit blasted prior to placing additional concrete, such as columns on column footings and column footings on reservoir slabs.

C. Finishing Concrete Drainage Structures

1. Drainage structures which are either below ground or are not visible from a travel way, shall be finished with a Class I finish. Drainage structures which are above ground and also visible from a travel way shall receive either a Class 2 or Class 5 finish at the Contractor's option. Concrete surfaces other than those listed shall receive the finish shown on the Construction Drawings. The various classes of finish are described as follows:

- a. Class I, Ordinary Surface Finish

- All fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties,

honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned, moistened with water and carefully pointed and trued with a mortar consisting of cement and fine aggregate and the surface left sound, smooth, even and uniform in color. Mortar used in pointing shall not be more than 30 minutes old. The mortar patches shall be cured. All construction and expansion points in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length and clean and true edges.

Where cutting compound is used, the Class 1 finish shall be applied immediately after the forms are removed and forms may be removed for only that portion of the work that can be finished in the remainder of the workday. The exposed concrete shall be kept damp during the finishing period and covered with the curing compound immediately following the completion of the finishing.

b. Class 2, Rubbed Finish

After completion of Class 1 - Ordinary Surface Finish, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be kept moistened with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surface to be finished shall be rubbed with a medium course carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the same proportions as the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

c. Class 5, Masonry Coating Finish

The specified surface shall be coated with a cement bas concrete coating as specified herein:

- i. Materials: Masonry coatings shall be a hydraulic cement base coating designed for use on porous surfaces of concrete as a decorative, protective and water repellent coating. The powder shall consist of a heavy cement base coating packaged in a dry form and shall conform to Federal Specifications TT-P-21, Type I, Class B. The liquid acrylic shall be an approved combination of polymers, and modifiers designed for use with Portland cement, shall be fully compatible with water and shall be a product of the manufacturer of the cement base powder. Masonry coating shall be pearl gray in color unless otherwise specified.
- ii. Preparation of Surface: Surfaces shall be thoroughly cleaned by approved methods, free of dirt, projections, loose mortar particles and laitance.
- iii. Mixing: One part by volume of liquid acrylic to three parts by volume of water shall be mixed in a clean container. The dry powder shall be added to the liquid mixture and stirred until the resulting mixture attains the consistency of a mortar mix. If the components are hand mixed, the mixture shall set for 15 minutes, additional liquid shall be added, and the mixture shall be re-stirred to the batter consistency. The Contractor shall not use mixed quantities that cannot be applied within time limits specified by the manufacturer.
- iv. Application: The masonry coating shall be applied in two coats using a tempico fiber brush, roller, trowel, or spray. The first coat shall be applied at the rate of approximately 2 pounds per square yard of surface area and the second shall be applied at the rate of approximately one pound per square yard. The second coat shall be applied the day following the first application or before material has become too hard or glazed for good bond.

Surfaces to be coated shall be dampened immediately ahead of the application. The masonry coating shall not be applied as a thin coat but shall be laid on the surface and leveled out. If the wall becomes dry or the coating starts to pull during application, the wall shall be dampened again. The mixture shall not be applied on frost, covered surfaces, frozen walls, when temperature is below 40 degrees F, or when temperatures are predicted to fall below 40 degrees F within 24 hours. If the surfaces have been exposed to hot sun conditions, they shall be cooled by hosing with clean water.

When the work is progressing under hot sun, drying wind, or when evidence of extremely rapid drying appears, the finished surface shall be cured by fog spraying with water until final set occurs.

END OF SECTION

Section 116

Concrete Curing

116.1. General

116.1.1 Work Included

The Contractor shall furnish all labor, tools and equipment for curing plain, reinforced and post-tensioned cast-in-place concrete.

116.1.2 Related Sections

A. Section XXX – Structural Concrete

B. Section XXX – Construction Joints

C. Section XXX – Concrete Finishing

116.1.3 Quality Standards

A. American Concrete Institute (ACI)

1. ACI 305 - Hot Weather Concreting
2. ACI 306 - Cold Weather Concreting
3. ACI 308 - Standard Practice for Curing Concrete

B. American Society for Testing Materials (ASTM)

1. ASTM C 171 – Sheet Materials for Curing Concrete
2. ASTM C 309 – Liquid Membrane-Forming Compounds for Curing Concrete
3. ASTM D 2103 – Polyethylene Film and Sheeting

116.1.4 Quality Control

Perform the work in accordance with this specification and in accordance with applicable ACI standards. When a conflict occurs between this specification and ACI occurs, the ACI standard shall control.

116.1.5 Delivery, Storage, and Handling

A. Deliver curing materials in manufacturer's original packaging including applicable instructions and manufacturer's safety data sheets (MSDS).

116.2. Products

116.1.6 Sheet Materials for Curing Concrete

White burlap-polyethylene sheeting weighing not less than 10 oz/linear yard, 40 inches wide, impregnated on one side with white opaque polyethylene 0.004 inches thick as specified in ASTM C 171 shall be used when called out in the Drawings or in other applicable specifications. The polyethylene shall be securely bonded to the burlap so that there will be no separation.

116.1.7 Liquid Membrane-Forming Compounds for Curing Concrete

Liquid membrane-forming compounds for curing concrete shall and conform to ASTM C 309, Type 1-D with a red or white fugitive dye. Use a white dye unless otherwise directed by the Engineer/Utility.

116.1.8 Polyethylene Film

Polyethylene film shall conform to ASTM D 2103. The film shall have a thickness of 6 mils and be a white opaque color.

116.1.9 Liquid Membrane Forming Compound and Evaporative Retardant Applicators/Sprayers

Membrane curing and evaporative retardant compounds shall be applied with a sprayer manufactured by Allen Engineering, Inc., or equal, capable of maintaining a constant pressure. (Allen Engineering, Inc., P.O. Box 819, Paragould, Arizona 74450, telephone (800) 643-0095.) Unless otherwise accepted in writing by the Engineer/Utility, spraying membrane curing compounds or evaporative retardants by other methods, such as hand pressurized sprayers, is unacceptable.

116.1.10 Evaporative Retardant

Confilm manufactured by Master Builders, Inc. or approved equal.

116.1.11 Water

Water shall only be used when prior approval is granted by the Engineer/Utility. Only water that has been determined to be non-detrimental to concrete shall be used.

116.3. Execution

116.3.1 General

Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete in accordance with

ACI 308, "Standard Practice for Curing Concrete". The materials and method of curing shall be subject to review and acceptance by the

Engineer/Utility. Specific curing requirements may be called out on the Construction Drawings or other specifications.

Curing shall be continued for at least seven days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70% of the specified concrete strength.

When a spray applied membrane-curing compound is used, it shall be applied in two coats with the second coat applied at right angles to the first coat.

116.3.2 Evaporative Retardant

An evaporative retardant shall be used during concrete placement for water retaining structure floor and roof slabs and other slabs larger than 2,500 square feet in size. The retardant shall be sprayed using a power sprayer at a rate of 10 gallons per 2,000 square feet after screeding and repeated after the first floating operation. The evaporative retardant shall not be applied during the final steel troweling operations or after the water sheen has disappeared from the concrete surface.

116.3.3 Slabs

For concrete surfaces not in contact with forms, a procedure determined by the Design Engineer shall be applied immediately after completion of placement and finishing.

116.3.4 Walls and Columns

Moisture loss from surfaces placed against wooden or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the curing time by one of the previously described curing methods. Concrete shall not be placed against forms that have been exposed to air below freezing temperatures until the forms have been heated so that the surface temperature of the form is $\geq 40^{\circ}$ F.

The top of walls and columns not covered by forms shall be cured using a membrane-curing compound conforming to ASTM C 309 immediately after placement.

116.3.5 Other Surfaces

Unless otherwise shown in the Construction Drawings all other surfaces shall be cured using two applications of a membrane-curing compound conforming to ASTM C 309. The second application shall be applied at 90° to the first application.

116.3.6 Cold Weather

Curing during cold weather conditions shall include the above methods except for water cure unless measures are taken to prevent freezing of the water.

116.3.7 Hot Weather

If the rate of evaporation approaches 0.2 lb/ft²/hr, as estimated by ACI 305, precautions against plastic shrinkage cracking are required. The Contractor shall have a recording thermometer, hygrometer and wind gage on site seven days prior to first concrete placement. When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow. Precautions against plastic shrinkage cracks may be required in conditions other than what is normally considered hot weather conditions.

116.3.8 Rate of Temperature Change

Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5° F in any one hour or 50° F in any 24-hour period.

116.3.9 Protection From Mechanical Injury

During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

END OF SECTION

Section 117

Grout

117.1. General

117.1.1 Work Included

The Contractor shall furnish all labor, tools and equipment for the placement of grout in tie holes and other locations as shown on the Construction Drawings and specified here-in.

This section includes basic mixing, application, and curing methods for grout.

117.1.2 Related Sections

- A. Section XXX – Structural Concrete
- B. Section XXX – Construction Joints
- C. Section XXX – Concrete Finishing
- D. Section XXX – Structural Cast-In-Place Concrete Forms

117.1.3 Quality Standards

- A. ASTM C 78 - Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
- B. ASTM C 109 - Test Method for Compressive Strength of Hydraulic Cement Mortars- Modified
- C. ASTM C 469 - Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
- D. ASTM C 666 - Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- E. ASTM C 882 - Test Method for Bond Strength of Epoxy Resin Systems used with Concrete - Modified
- F. ASTM C 1012 - Test Method for Length Change of Hydraulic Cement Mortars Exposed to Sulfate Solution - Modified
- G. ASTM C 1202 - Electrical Indication of Resistance to Chloride Ion Penetration

117.1.4 Quality Assurance

- A. Field Tests

1. Contractor shall assist the concrete testing consultant as requested during the performance of quality control testing.
2. All mortar, already placed, that fails to meet the requirements of this specification, is subject to removal and replacement.

B. Construction Tolerances

Construction tolerances shall be as specified in the Section 03110 except as modified herein and elsewhere in the specifications.

117.1.5 Acceptable Manufacturers/Products

Master Builders Technologies

EMACO R320 - Polymer-Modified Vertical/Overhead Patching Mortar

MB 429, Masterkure CR, Masterkure 200W or Masterkure 100W - curing compounds.

117.1.6 Delivery, Storage and Handling

Cement based mortar shall be delivered and stored in manufacturer's packaging until it is ready to be mixed and placed. Mortar bags shall be stored off the ground and protected from water and all other substances that will penetrate packaging.

117.2. Products

117.1.7 Mortar for Tie Holes

EMACO R320 or approved equal.

117.1.8 Bonding Adhesives

Concresive Liquid LPL, Concresive Standard Liquid or approved equal.

117.1.9 Water

Only clean potable water shall be used. A calibrated measuring device is required for measuring the proper amount of water to be added to grouts and mortars.

117.1.10 Curing Compound

MB 429, Masterkure 100W, Masterkure 200W or approved equal.

117.1.11 (Exposed) Reinforcing Steel Coating

EMACO P22 or approved equal.

117.3. Execution

117.3.1 General

These grouts contain admixtures that increase grout strength and workability. The strength and performance of the grout is dependent on proper surface preparation, grout mixing and curing. The Contractor shall be required to use a calibrated measuring device to add clean potable water to the grout mix. Water added to a grout mix without a calibrated device is cause for grout rejection, removal and re-placement.

Curing is critical to prevent shrinkage cracks that can develop with grouts containing some admixtures. Curing shall begin immediately after placement.

All mixing, surface preparation, handling, placing, consolidation, and other means of execution for pre-packaged mortars shall be done according to the instructions and recommendations of the manufacturer and this specification. In the event that a conflict occurs between this specification and manufacturer's instructions, the manufacturer's instructions shall prevail in all cases.

117.3.2 Grout for Tie Holes

A. Preparation:

Thoroughly clean the roughened surface and any exposed reinforcement of rust, dirt, loose chips, and dust. Maintain substrate in a saturated, surface-dry condition.

Where applicable, exposed reinforcing steel shall be coated with EMACO P22 reinforcing steel bar protection coating prior to patching.

B. Mixing:

Comply with mortar manufacturer's recommendations for water quantity. Mechanically mix with a slow speed drill (400 to 600 RPM) and Jiffler-type paddle. Pour approximately 90% of the mix water into the mixing container; then add the bagged material while continuing to mix. Add remaining water as needed. Mix time shall not exceed 5 minutes.

C. Walls Application:

Apply bonding adhesive such as Concessive Liquid LPL or Concessive Standard Liquid.

Place and finish with trowel or screed. In hot, windy, or dry conditions, where rapid surface evaporation may occur, use Confilm Evaporation Reducer.

D. Curing:

Apply Masterkure 200 W curing compound in accordance with label instructions.

END OF SECTION

Section 118

Structural Cast-In-Place Concrete Forms

118.1. General

118.1.1 Work Included

The Contractor shall supply all labor, tools, equipment and materials to set forms for the proper placement of concrete for structures. It is the Contractor's responsibility to design and build adequate forms and to leave them in-place until the forms can be safely removed. The Contractor is responsible for damage and injury caused by removing forms carelessly or before the concrete has gained sufficient strength. Means and methods of repair shall be reviewed by the Engineer prior to performing the work.

118.1.2 Related Sections

- A. Section XXX – Structural Concrete
- B. Section XXX – Construction Joints
- C. Section XXX - Concrete Finishing
- D. Section XXX - Grout

118.1.3 Quality Standards

- A. American Concrete Institute
 - 1. ACI 318 - Building Code Requirements for Structural Concrete
 - 2. ACI SP-4 - Formwork for Concrete
- B. American Plywood Association
 - 1. PS 1 - US Product Standard for Construction and Industrial Plywood
 - 2. J20 - Grades and Specifications
 - 3. V345 - Concrete Forming

118.1.4 Quality Assurance

Formwork, and if required shoring and reshoring, shall be designed by a Professional Engineer licensed to practice in the state where the project is located and having a minimum of five years' experience in the design of concrete formwork or form systems.

118.2. Products

118.1.5 General

For the purposes of this specification exposure shall be defined as a surface, interior or exterior, of a structure that will be exposed to view during its use. For example, the interior wall of a structure is a surface exposed to view.

118.1.6 Forms for Surfaces Exposed to View

A. Walls

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.
2. Symons hand set steel-ply forms, or equal.

B. Beams

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.
2. Symons hand set steel-ply forms, or equal.

C. Sides of Column Footings

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.
2. Symons hand set steel-ply forms, or equal.
3. Steel of sufficient thickness that the form will remain true to shape after numerous repetitive uses.

D. Sides of Curved or Straight Continuous Wall Footings

1. APA High Density Overlay Plyform Class I Exterior.
2. APA B-B Plyform Class I, Exterior, PS-1-83.

For curved surfaces, plywood of sufficient thickness, free from knots and other imperfections, which can be cut and bent and held in place accurately to the required curvature without splintering or splitting shall be used.

E. Floor and Roof Slabs

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.

F. Columns

Regardless of materials of construction the forms shall be such to permit bracing in two directions at half-height and full height at a minimum. Two braces at 90° are required at half and full height.

1. Steel of sufficient thickness that the form will remain true to shape after numerous repetitive uses.
2. Fiberglass of sufficient thickness that the form will remain true to shape.

G. Column Capitals

1. Steel, 16 gage or thicker, so that the form will remain true to shape after numerous repetitive uses.

118.1.7 Forms for Surfaces Not Exposed to View

Wood or steel sufficiently tight to prevent mortar leakage.

118.1.8 Anchorage In Slabs for Braces for Wall and Column Forms

Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column alignment under all load conditions including wind.

- A. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of wall or column braces in water retaining structures. Wedge anchors or nails may be used in other structures when in the opinion of the Engineer/Utility the resulting concrete finish patch will be acceptable. The Contractor shall make a submittal including information about the type of wedge anchor or nail and the means of patching the surface for review and acceptance by the Engineer.

118.1.9 Anchorage in Slabs for Uprturned Column Footing Forms

Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column configuration and diameter. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of column footing forms.

118.1.10 Form Ties

- A. Water Retaining Structures and Below Grade Structures:

Symons, S-Panel Ties, or equal, with water seal and one-inch break back cones on both tie ends, shall be used on all wall forms.

- B. Structures without formliners:

Symons, S-Panel Ties, or equal, with one-inch break back cones on both tie ends unless otherwise called out or shown in the Drawings or approved by the ENGINEER, shall be used on all wall forms.

C. Structures with formliners:

Ellis Construction supplied heavy duty loop panel ties with 1" extension, 2" break back minimum unless otherwise called out or shown in the Drawings or approved by the ENGINEER, shall be used on all wall forms where formliner will be used.

D. Twisted Wire Ties:

E. Twisted wire ties with loops to hold forms in position are not permitted.

118.1.11 Chamfer Strip

A. Chamfer strips (3/4 inch) shall be placed in the corners of forms and at the tops of walls or up-turned footings, to produce beveled edges on permanently exposed concrete surfaces. Interior angles of intersecting concrete surfaces and edges of construction joints shall not be beveled unless otherwise indicated in the Construction Drawings. The chamfer strip may be made of wood or polyvinyl chloride (PVC).

118.1.12 Stiffbacks

A. Stiffbacks for wall forms shall be constructed of lumber or Glulams, uniform in width and thickness, free from knots and other surface defects. Only one joint is permitted in the board of a stiffback and joints shall be offset so as to not occur at the same point. Stiffbacks shall extend to a point not less than six inches above the top of forms.

118.1.13 Gang Whaler Plates for the Top of Curved Walls

Gang whaler plates shall be constructed of plywood as described below cut to the radius of the wall curve. The gang whaler plate shall be of sufficient depth to permit notching for stiffbacks.

A. APA High Density Overlay Plyform Class I Exterior.

B. APA B-B Plyform Class I, Exterior, PS-1-83.

118.1.14 Wedge Inserts

When permitted by the Design Engineer at the tops of walls or columns, wedge inserts may be used to support future formwork or catwalks. The inserts shall be Richmond Screw Anchor, or equal.

118.1.15 Form Release Agent

Magic Kote by Symons Corp. or equal.

118.3. Execution

118.3.1 General

Forms shall be used, wherever necessary, to confine the concrete and shape it to the specified lines and grades as shown on the Construction Drawings. The Contractor shall set and maintain concrete forms so as to ensure completed work is within all applicable tolerance limits. If a type of form does not, in the opinion of the Design Engineer and Engineer/Utility, consistently perform in an acceptable manner, the type of form shall be changed and the method of erection shall be modified by the Contractor, subject to the review of the Design Engineer and Engineer/Utility.

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete, and shall be maintained rigidly in position. The design of formwork and placing rate of concrete with medium and high-range water reducing agents shall be adjusted to compensate for the greater hydraulic pressures exerted on the forms by concrete of high fluidity.

Forms shall be clean and free from mortar and other foreign material from previous use prior to being placed.

The Contractor shall demonstrate that forms are vertical, proper alignment, grade or radius when requested by the Engineer/Utility

118.3.2 Form Surface Treatment

A. General

Prior to placing reinforcing steel coat the forms with a non-staining release agent that will effectively prevent the absorption of moisture and prevent bond of the concrete to the form. Contact with hardened concrete against which fresh concrete is to be placed is prohibited. All bond breaking materials or processes shall be used only after acceptance by the Design Engineer. Care shall be taken in applying form oil to avoid contact with reinforcement steel. Embedded material which becomes coated with form oil shall be thoroughly cleaned or replaced.

B. For Potable Water Facilities

Form release agents for potable water facilities, such as treated water storage reservoirs or water treatment plants, shall be non-toxic 30 days after application.

118.3.3 Tolerances

Tolerances are defined as allowable variations from specified alignments, grades and dimensions. Allowable variations from specified alignments, grades and dimensions are prescribed in the following sub-section. Descriptions of these criteria can be found in Part 2 of the ACI Manual of

Concrete Practice 1995, Commentary of Standard Specifications for Tolerances for Concrete Construction and Materials (ACI 117-90).

A. Footings and Foundations

1. Drilled Piers

Vertical alignment $\leq 2\%$ of the shaft length

Lateral alignment $\leq 1/24$ of shaft diameter, 3 inch maximum

Level alignment to cut-off elevation: +1 inch, -3 inch

2. Continuous Wall Footings (Circular and Non-circular)

Lateral alignment: $\leq 2\%$ of the footing width, 2 inches maximum

Relative alignment: Variation ≤ 1 inch in 10 feet (variation between specified plane and as built surface)

Cross-sectional dimension:

Horizontal dimension: Variation +2 inch, -1/2 inch

Vertical dimension (thickness): Variation $\pm 1/2$ inch

Circular Wall Footing Only

Variation in Radius in any 20 feet of wall length: $\leq 1/2$ inch

Variation in Radius in entire wall length: ≤ 1 inch

3. Column footings

Lateral alignment: Variation ≤ 2 inch

Level alignment: Variation from specified elevation +1/2 inch, -2 inch

Relative alignment: Variation ≤ 1 inch in 10 feet (variation between specified plane and as built surface)

Cross-sectional dimension:

Horizontal dimension: Variation +2 inch, -1/2 inch

Vertical dimension (thickness): Variation $\pm 1/2$ inch

B. Cast-in-Place Concrete for Buildings and other Structures

1. Member (such as a beam, column, wall, slab, or pier)

Vertical alignment:

Variation from specified plumb $\leq 3/8$ inch (full height) 1/4 inch (one form section)

Lateral alignment:

Maximum in any bay: Variation $\leq 1/2$ inch

Maximum in any 20 feet of length: Variation $\leq 1/2$ inch

Maximum for entire wall length: Variation ≤ 1 inch

Floor and wall opening locations: Variation $\leq 1/2$ inch

Sawcuts and joints: Variation $\leq 3/4$ inch

Level alignment:

Top elevation of slabs: Variation $\leq 3/4$ inch

Lintels, other lines exposed to view: Variation $\leq 3/4$ inch

Cross sectional dimensions:

Walls and slabs (thickness): Variation $\pm 1/4$ inch

Columns and Beams: Variation $+1/2$ inch, $-1/4$ inch

Size of wall and floor openings: Variation $\pm 1/4$ inch

Relative alignment:

Offset between adjacent formwork: Variation $\pm 1/4$ inch

Variation in Specified Grade:

For any distance less than 10 feet: Variation $\leq 1/4$ inch

For entire structure: Variation $\pm 1/2$ inch

For manholes and outlet structures: Variation ≤ 1 inch

2. Stairways

a. Relative alignment:

b. Difference in height between adjacent risers: $1/8$ inch

c. Difference in width between adjacent treads: $1/4$ inch

118.3.4 Plumb and String Lines

- A. Plumb and string lines shall be installed on wall and column forms before, and maintained, during concrete placement. There shall be sufficient number of plumb or string lines in walls, for example at every other stiffback, properly installed to permit continuous monitoring. During concrete placement, the Contractor shall continually monitor plumb and string line positions and immediately correct deficiencies. The plumb and

string lines shall extend to a point at least six inches above the top of wall or column.

118.3.5 Formwork Camber

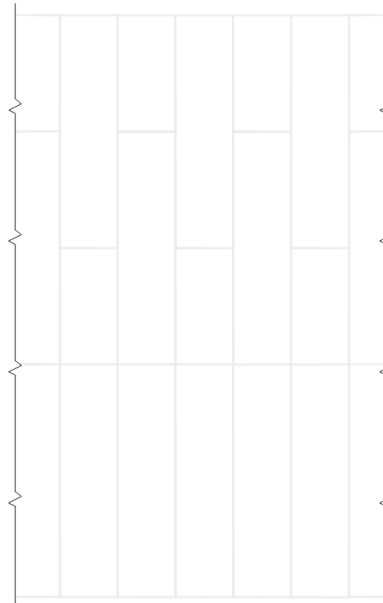
- A. In order to maintain specified tolerances of joists, beams or slabs subject to dead load deflection, the Contractor shall camber formwork to compensate for dead load deflection prior to hardening of the concrete.

118.3.6 Gang Whaler Plates for Circular Walls

- A. The Contractor shall place a gang whaler plate cut to the curvature of the wall, such as a circular reservoir wall, at the top of the wall forms. The gang whaler plate shall be attached to the forms with a gang whaler rod at appropriately designed intervals. The gang whaler plate may be notched to permit the stiffback to extend above the top of the wall forms. The gang whaler plate shall be sufficiently stiff to maintain the required curvature.

118.3.7 Hand Set Modular Forms

Hand set modular forms, such as Symons hand set steel-ply forms, shall be placed with no more than two intersecting joints occur at one level in the formwork above the bottom modular form level. The following figure illustrates the required form pattern.



The above form configuration is one way recommended by Symons Corp. to eliminate vertical, in plane, bending of the forming system. The Contractor may develop alternate means of maintaining vertical alignment. Alternate form system configurations require preparation by a licensed Professional Engineer in Colorado.

118.3.8 Formwork Closure

Forms which will prohibit visual review of items such as reinforcing steel, waterstops and bearing pads by the Engineer/Utility, shall not be placed until the Engineer/Utility has performed a final review of the reinforcing steel.

The Contractor shall use compressed air from an air-compressor to blow-out construction debris and dirt at the bottom of sections or members to be placed such as walls, slabs, beams and columns, prior to placing forms or concrete. The Contractor shall demonstrate to the Engineer/Utility that all debris, such as loose concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

118.3.9 Hot or Cold Weather Placement and Steel Forms

Prior to placing concrete when steel forms are used, the forms shall be heated when the surface temperature of the form is below 40° F or cooled when the surface temperature of the form is above 90° F. If water is used to cool forms where ponding of water may occur, i.e., at the bottom of a column, the water shall be permitted to drain prior to placing concrete.

118.3.10 Removal of Forms

The forms for any portion of a structure shall not be removed until the concrete has reached sufficient strength with a factor of safety of 2.0, to withstand applied loads such as self-weight and wind loads or withstand damage when the forms are removed.

For post-tensioned concrete slabs and beams, formwork shall not be removed until the entire slab or member has been stressed and stressing records accepted.

END OF SECTION

Section 119

Waterstops

119.1. General

119.1.1 Work Included

The Contractor shall furnish and securely install expanding rubber waterstops where shown or specified in the DRAWINGS. The WORK includes cleaning of concrete surfaces and installation of expanding rubber waterstop.

119.1.2 Related Sections

A. Section XXX – Structural Concrete

B. Section XXX – Construction Joints

119.1.3 Quality Standards

A. ASTM International (ASTM):

1. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
2. D2240, Standard Test Method for Rubber Property—Durometer Hardness.

119.1.4 Submittals

A. Provide product data for the following:

1. Waterstop Product.
2. Adhesive.

119.1.5 Delivery, Storage, and Handling

A. Deliver the waterstop materials to the PROJECT site in the manufacturer's unpacked containers with all labels intact and legible at time of use. Materials shall be stored in a secure, indoor, dry area. Maintain the waterstops in a dry condition during delivery, storage, handling, installation, and concealment.

119.2. Products

119.1.6 Materials

A. Hydrophilic Rubber Waterstop.

1. The waterstop shall have the minimum performance standard of:

Property	ASTM Standard	Results
Tensile Strength (MPa)	D412	0.98
Elongation	D412	550
Hardness (Hs)	D2240	30 Durometer Type A
The time period to maximum expansion is 35 days.		

2. Materials approved for use are:
 - a. Adeka Corporation; MC-2010M.
 - b. Adeka Corporation; KM-3030M.
 - c. Adeka Corporation; P201 (except in contact with potable water).
 - d. Adeka Corporation; KC Series.

B. Adhesive:

1. The adhesive shall be 3M-2141 as manufactured by the 3M Company, or Adeka Corporation H-1000 Ultra Bond.

119.3. Execution

119.3.1 General

- A. Coordinate as required with other trades and SPECIFICATIONS to ensure proper execution of the waterstop installation.
- B. The components and installation procedures shall be in accordance with the manufacturer's printed specifications and recommendations. Installation shall be performed by skilled workers who are trained in procedures and methods required for proper performance of the waterstop.

119.3.2 Examination

- A. Examine the concrete surface and correct any surface imperfections which may prevent proper installation and performance of the waterstop. The finished concrete surface, prior to surface preparation, shall be equal to a steel trowel finish.

119.3.3 Surface Preparation

- A. Concrete surfaces shall be clean and free of dirt, saw dust, laitance, grease, form oils, form release agent, or other contamination to ensure proper adhesion of the waterstop to the concrete surface. Use a wire brush to lightly roughen the surface. Remove all concrete dust with a soft brush.

119.3.4 Waterstop Placement

- A. Measure and cut an exact length of waterstop. Splices are not permitted in the waterstop in vertical wall joints of structures. Splices in horizontal joints are acceptable, however, only one (1) splice is permitted in twenty-five (25) feet. Splice of waterstops in horizontal joints shall be made by butting and gluing the ends of the waterstop with an approved adhesive.
- B. Refer to the manufacturer's recommendations for minimum clearance to a concrete face. Unless a greater clearance is recommended by the manufacturer, the minimum clearance shall be two (2) inches. Use the greater clearance if the recommended clearance is more than two (2) inches.
- C. Using a brush, apply a uniform coat of adhesive to the concrete surface along the line of placement. Apply a uniform coat of adhesive to the waterstop. Gaps in the glue application shall not be permitted.
- D. After the adhesive has dried to a tacky condition (about fifteen [15] minutes in the summer and thirty [30] minutes in the winter), firmly press the waterstop to the concrete surface. When installing the waterstop on curved surfaces such as pipes, temporary bands (for example, wire or rope) may be used to assist in securing the waterstop to the surface. Any temporary means of securing the waterstop shall be removed prior to placing concrete or grout.
- E. Concrete placement within twelve (12) hours is required. The waterstop shall be protected from water and from displacement prior to concrete placement. During concrete placement, CONTRACTOR shall visually observe the waterstop to ensure proper placement and alignment.

END OF SECTION

Section 120

Horizontal Directional Drilling

120.1. General

120.1.1 Work Included

The section covers the furnishing and installation of pipelines installed by trenchless directional boring method. (HDD) Steerable trenchless method of installing underground pipes, conduits and cables in a shallow arch along a prescribed bore path by using a surface launched drilling rig.

120.1.2 Quality Assurances

A. Requirements of Regulatory Agencies

1. Owner will obtain the necessary permits from the appropriate entities.
2. Obtain bonds or indemnity required by the permits for protection against damage and interference with traffic and service by construction activities.
3. Drilling in CDOT Rights of Way.
 - a. CONTRACTOR shall coordinate with the TOWN to obtain appropriate utility and special use permit from CDOT. Including submission of appropriate documentation such as insurance certificates, traffic control plans, and boring quality control plans as required.

120.1.3 Submittals

A. Experience Summary

1. If requested CONTRACTOR or SubCONTRACTOR shall submit experience statement of similar projects.

B. Submit Quality Control Plan to TOWN and/or CDOT (if applicable) for approval. Quality Control Plan shall include the following:

1. Submit a complete written description and drawing identifying details of the proposed method of construction, equipment, procedures, and sequence of operations to perform during construction.
2. Submit the type and capacity of the drilling rig to be used on the project, including pullback and push torque. CONTRACTOR to verify that the allowable pipe stresses of the pipe will not be exceeded by the drilling rig. Submit information on the type of locating and tracking

system. Submit type and capacity of mud mixing system, and composition of drilling fluid, viscosity, and density.

3. Submit a drawing showing proposed crossing configuration, including entry and exit angles, radius of curvature, entry and exit points. Drawing shall include location and applicable dimensions of any excavations. Include information on the diameter of the pilot hole and size and number of pre-reamers used for development of the borehole.
4. Submit information on the method to address and mitigate obstruction problems during drilling, reaming, and potential problems of product becoming stuck during pipe pull back, emergency procedures when drilling through existing underground utilities, or other events that lead to work stoppage. Procedures must comply with all regulations.
5. Submit information on the method of slurry containment, method of recycling drilling fluids and spoils, or method of containing drilling fluids or spills and transporting drilling fluids and spoils. All material must be disposed of in accordance with local, state, and federal regulations.
6. Submit information on the method to address and mitigate collapse or subsidence of surface roadways, adjacent utilities during drilling, reaming, and installation of the pipe.
7. CONTRACTOR shall maintain a logbook that includes driller notes and records for bores using steering and tracking system. Data will include pipe number, depth, pitch, and other notes. Log must also contain rig performance parameters, ground conditions, obstruction encountered, etc. Logbook must be submitted to TOWN at the completion of the project.

120.1.4 Quality Assurance

A. Qualifications

1. CONTRACTOR or SubCONTRACTOR shall submit a Qualification Statement to the TOWN upon request providing information on the company's experience:
 - a. Provide years of experience and an installation list including the following information: TOWN or District, project name and location, contact person – phone, project environment, pipe diameter, material, and maximum length of each bore.

B. Regulatory Requirements

1. Horizontal Directional Drilling
 - a. Conform to Federal and State regulatory requirements.

- b. Coordinate with/verify all applicable permits are obtained prior to starting construction.
- c. Perform work in accordance with requirements of permit.

C. Geotechnical Data

- 1. Geotechnical Data may or may not be provided for this project, it is the responsibility of the CONTRACTOR to make him/herself aware of the site conditions.
- 2. If Geotechnical Data is made available to the CONTRACTOR by the TOWN the CONTRACTOR shall assume all risks resulting from actual conditions differing from conditions set forth in such Data.

120.1.5 Project/Site Conditions

A. Unanticipated Conditions

- 1. Notify the TOWN of unexpected subsurface conditions and discontinue work in affected area until notified by TOWN to resume work.
- 2. Take emergency measures as required to protect persons and improvements.

- B. CONTRACTOR shall restore site to original condition or better following construction activities.

120.1.6 Warranty

- A. CONTRACTOR shall provide warranty as required by TOWN and/or as necessary for CDOT as applicable.

120.2. Products

120.1.7 Materials

A. Pipe/Tubing

- 1. HDPE Tubing Meeting requirements of ASTM D 2737 and AWWA C901 with Copper Tube Size (CTS) outside diameters). Listed for potability to ANSI/NSF Standard 161
- 2. SDR 9 – Pressure Rating two hundred (200) psi – or as required for installation stresses.
- 3. Eagle Pure-Core Pipe and Tubing or Approved Equal.

B. Directional Boring System

1. CONTRACTOR shall provide a pneumatically or hydraulically operated fluid assisted remote guided boring system capable of installing the pipe by trenchless methods without damage.
2. Equipment shall be designed to provide accurate control of both line and grade of the boring head.
3. Provide pumps, compressors, tools and all equipment certified as suitable by the system manufacturer to install the new pipe without excessive stress or damage to the pipe/tubing.
4. Provide a circulatory and recovery system that will recover the bentonite or other drilling fluids.

120.4. Execution

120.2.1 Preparation

A. Coordinate Protection

1. Provide necessary safety measures for construction activities including but not limited to traffic control, barricades, warning signs, lights etc.
2. Locate and pothole utility conflicts, identify required lines, contours, location and depth of all utilities, including service connections, to be paralleled or crossed prior to the start of drilling operations.
3. Modify alignment, depth or grade as necessary to avoid utility conflicts and minimize the number of peaks and valleys along the alignment. Coordinate changes in alignment with the TOWN.
4. Expose all utilities that will be crossed with HDD.
5. All major utilities (gas, fiber optic, high voltage, major pipelines, etc.) should be exposed every one hundred feet (100') at minimum for parallel utilities within five feet (5') of the proposed installation to verify depth and location of the utility. The TOWN and Utility owner should be notified immediately if location is not accurate.

120.2.2 Installation

A. General

1. Install pipe by the directional drilling methods unless conditions require open trench installation. Obtain TOWN and/or CDOT approval prior to open trench construction.
2. Install pipe by continuously pulling the pipe into place from the insertion point to exit point without causing damage to the pipe being inserted. Provide lubricants as required by the pipe manufacturer to avoid stressing the pipe beyond its elastic limit.

3. CONTRACTOR to provide rollers or alternative apparatus to prevent damage to the pipe during pulling operations.
4. Provide installation and receiving pits as necessary for complete installation of the pipe. The excavation of the installation and receiving pits shall be incidental to the work.
5. The CONTRACTOR shall not start the pullback unless it can be completed without interruptions. CONTRACTOR shall coordinate schedule with the TOWN.
6. CONTRACTOR shall provide sediment and erosion control measures to prevent drilling fluid or borehole cuttings from entering adjacent properties, water courses or otherwise.
7. The pilot hole shall establish the horizontal plane of the pipeline. A plot of length versus elevation versus left/right variance will dictate the actual as-built plan and profile of the pipeline. Data feedback and electronic guidance systems shall be used to provide confirmation of position.
8. Reaming shall consist of using an appropriate tool to open the pilot hole to a slightly larger diameter than the carrier pipeline. The percentage oversize shall depend on soil types, soil stability, depth, drilling fluid hydrostatic pressures, etc. Normal oversizing shall be from one hundred twenty to one hundred fifty percent (120% to 150%) of the product pipe diameter. Drilling fluid shall be forced down the hole to stabilize the hole and remove soil cuttings. The CONTRACTOR shall carefully monitor the reaming operations to prevent damage to adjacent utilities.
9. The CONTRACTOR shall maintain accurate alignment and grade control and shall determine the pipe elevation at intervals not exceeding twenty five (25').
10. The pipe shall be installed by continuously pulling and/or pushing the pipe into place through the drilling fluid along the reamed hole pathway from insertion point to exist point without causing damage to the pipe and the pipe joints being inserted. The pullback speed shall be within the pipe manufacturer's recommendations. Drilling fluid/lubricants shall be provided as required by the pipe manufacturer's recommendations and specifications to avoid stressing the pipe and joints past the materials elastic limits. Proper pipe handling, cradling, bending minimization and consistent insertion velocity shall be recorded.
11. Any bits, drills, reamers or other tools lost or stuck in the hole shall be removed at the CONTRACTOR's expense. If tools cannot readily be

removed, CONTRACTOR may at his/her option abandon the hole. The CONTRACTOR will seal the borehole and redrill the area. No payment shall be made for any lost equipment, material or work on abandon holes.

12. Drilling fluid to be used to facilitate the installation of the pipe shall be adjusted within acceptable limits such that ground heaving and subsurface cavity formation through erosion are prevented.
13. A variation greater than eighteen inches (18") from the horizontal and one foot (1') from desired grade may be sufficient reason for the rejection of the pipe unless such deviations are coordinated in advance. The alignment reflected on the drawings is for general quantities only. The final alignment shall be coordinated with the TOWN in advance and adhered to unless physical obstructions prevent otherwise. The CONTRACTOR shall be responsible for determining the number of set ups, pits, etc. To install the pipe to the general alignment shown on the drawings. The number of setups shall be incidental to the work, which will be paid for based on the lineal footage installed.
14. The CONTRACTOR shall supply portable mud tanks or construct temporary mud pits (if allowed by TOWN) to contain excess drill fluids during construction. Spent drilling fluids and cuttings shall be confined to the entrance and exit pits. The CONTRACTOR shall take all necessary precautions to minimize the damage to the adjacent properties. Any drilling fluid that enters the pipe shall be removed by flushing or other suitable methods. Upon completion of the bore, CONTRACTOR will dispose of any drill cuttings and excess drill fluids in a manner consistent with the local and state regulations. Such disposal is incidental to the work.
15. The CONTRACTOR shall be responsible for pressure testing and bacteriological testing of the installed pipeline.
16. The CONTRACTOR shall be responsible for cleanup and restoration, due to hydrofractures from excessive pressure in the drilling fluid.
17. Pits excavated to permit connection of bored pipe shall be backfilled, and disturbed areas shall be restored to original state or better. Sections of sidewalks, curbs, and gutters or other improvements damaged during horizontal directional drilling operations shall be repaired or replaced at the CONTRACTOR's expense. Backfilling of the boring and receiving pits shall be incidental to the work.

END OF SECTION

Section 121

Sculpted Concrete

121.1. General

121.1.1 Work Included

- A. The CONTRACTOR shall furnish all labor, tools, and equipment for the construction of reinforced cast-in-place sculpted concrete (concrete and Shotcrete). Where "sculpted concrete" is called out on the DRAWINGS, it shall be up to the CONTRACTOR whether to use concrete and Shotcrete or just Shotcrete as necessary to conform to the lines, grades, thicknesses, and typical cross sections shown on the DRAWINGS. Sculpted concrete is to be finished to look like natural rock where exposed above ground.
- B. Work includes preparation of substrate surface, placing reinforcing steel, and placement and shaping of the top concrete or Shotcrete surface to look like natural sedimentary rock, and related items as shown or specified.

This section includes basic finishing and curing methods, accessory control, and expansion and contraction joint devices.

121.1.2 Related Sections

- A. Section XXX - Structural Concrete.
- B. Section XXX – Structural Cast-In-Place Concrete Forming.
- C. Section XXX - Construction Joints.
- D. Section XXX - Waterstops.
- E. Section XXX - Reinforcing Steel.
- F. Section XXX - Concrete Finishing.
- G. Section XXX - Concrete Curing.
- H. Section XXX – Sealants.

121.1.3 References

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. C33, Standard Specification for Concrete Aggregates.

- b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - c. C150, Standard Specification for Portland Cement.
 - d. C260, Standard Specification for Air-entraining Admixtures for Concrete.
 - e. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
 - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. C979, Standard Specification for Pigments for Integrally Colored Concrete.
 - h. C1059, Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.
 - i. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
2. American Concrete Institute (ACI):
- a. 211, Standard Practice for Selecting Proportions for Concrete.
 - b. 301, Specifications for Structural Concrete.
 - c. 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. 305.1, Specification for Hot Weather Concreting.
 - e. 306.1, Specification for Cold Weather Concreting.
 - f. 309, Standard Practice for Consolidating Concrete.
 - g. 318, Building Code Requirements for Structural Concrete.
 - h. 504, Guide to Joint Sealants.
 - i. 506, Recommended Practice for Shotcreteing

121.1.4 Submittals

- A. Provide product data on the following:
- 1. Ready-mixed concrete or Shotcrete mix designs.
 - 2. Fly ash.
 - 3. Admixtures (such as air-entraining and water-reducing admixtures).
 - 4. Form release agents.

5. Bonding agents.
6. Grout.
7. Concrete coloring pigment.
8. Data for proprietary materials and items including patching compounds, curing compounds, and other requested by the ENGINEER.
9. Contractor statement detailing previous sculpted concrete experience.
10. A sculpted concrete construction plan is to be submitted in writing to the ENGINEER for review 7 days prior to construction. The plan shall describe methods and equipment proposed for hauling, placing, curing, and protecting sculpted concrete as well as placement schedules indicating anticipated daily progress.
11. Shop drawings for sculpted concrete feature indicating sizes, spacing, locations, and quantities of reinforcing steel, bending and cutting schedules, splicing, supporting and spacing devices, and other accessories.
12. The CONTRACTOR shall construct a sample sculpted concrete panel measuring not less than 50 square feet. The sample panel shall represent the finished surface texturing, coloring, and etching of the sculpted concrete feature. The ENGINEER or other representatives of the OWNER shall observe and approve the sample panel prior to the construction of any sculpted concrete features.
13. The CONTRACTOR shall submit to the ENGINEER for review and approval, all proposed texture mats to be utilized by the CONTRACTOR to achieve the most natural rock appearance and texture possible. If other methods of texturing will be performed, the contractor shall submit detailed descriptions of such methods for review.

121.1.5 Quality Assurance

- A. Structural Concrete as specified in **Section XXX - Structural Concrete**, shall be used in the construction of the sculpted concrete feature unless Shotcrete is previously approved.
- B. Prior to placement of structural concrete for the sculpted concrete feature, the ENGINEER or other representatives of the OWNER must observe all reinforcing bar, forms, and surfaces receiving concrete. Prior to placing concrete CONTRACTOR must repair all discrepancies identified by ENGINEER or other representatives of the OWNER.

C. OWNER's Direction:

1. It is intended that the finished sculpted concrete feature simulate natural rock as shown on the DRAWINGS. OWNER's direction and aesthetic intentions are specified herein.
2. To achieve the natural rock simulation, the CONTRACTOR shall coordinate fully with ENGINEER or other representatives of the OWNER. The ENGINEER or OWNER explicitly reserves the right to continuously monitor the WORK for aesthetic quality until the desired effects are achieved.
3. All WORK in this section shall be observed by the ENGINEER or other representatives of the OWNER. The CONTRACTOR shall ensure a representative of the OWNER is onsite prior to placement of concrete.
4. For sculpted concrete work, visits to other project sites (to view examples) may be required. Adequate notification of the intent to begin WORK on this item (minimum 24 hours) is required to ensure inspection and oversight by the ENGINEER and/or OWNER.

D. The fabrication of artificial rockwork and placement, installation, and/or adjustment of finish details and sculptures shall be accomplished in such a manner as to appear as realistic as possible and "read right" to the trained eye. This element is artistic in nature and may require field adjustments to completed work to obtain the desired effect. The ENGINEER will decide questions of aesthetic effect. Minor changes or adjustments to in-place work shall be made at the CONTRACTOR's expense.

121.1.6 Delivery, Storage, and Handling

- A. Structural concrete delivery, storage, and handling shall be performed in accordance with **Section XXX - Structural Concrete**.
- B. Ready-mixed Shotcrete shall comply with ASTM C94 except that it may be delivered to the Shotcrete equipment in the dry state if that equipment is capable of adding the water and mixing satisfactorily with the dry ingredients, or with ASTM C685, in which case the ingredients are delivered dry and proportioned and mixed at the site.
- C. Structural reinforcing steel delivery, storage, and handling shall be performed in accordance with **Section XXX - Reinforcing Steel**.

121.2. Products

121.1.7 Materials

A. Definition: Where “sculpted concrete” is called out on the plans, concrete or Shotcrete shall be used as necessary to meet the thickness, lines, and grades indicated on the plans.

B. Concrete class:

1. Concrete

- a. Concrete shall have the following characteristics:
 - i. Required field compression strength of 4,500 psi at 28 days.
 - ii. Air Content Range of 5% - 8%
 - iii. Maximum water | cementitious ratio of 0.45
 - iv. For all concrete mix designs with ASTM C150 cements, up to a maximum of 20% Class C fly ash, 30% Class F fly ash, or 30% high-reactivity Pozzolan by weight of total cementitious material may be substituted for cement.
- b. The concrete mix shall be made with AASHTO M 43 size No. 8 coarse aggregate (see table below).

Sieve Size (U.S. Standard Square Mesh Sieves)	AASHTO M 43 Size No. 8 Coarse Aggregate (% by Weight Passing)
3/4"	-
1/2"	100
3/8"	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

2. Shotcrete

- a. Shotcrete shall be placed as a wet mixture of aggregate and Portland cement.
- b. The minimum 28-day compressive strength shall be 4500 psi.
- c. Coarse aggregates.
 - i. AASHTO M 43 Size No. 8 (see table above).
- d. Fine aggregates.
 - i. AASHTO M6

ii. ASTM C33 (see table below)

Sieve Size (U.S. Standard Square Mesh Sieves)	AASHTO C33 Fine Aggregate (% by Weight Passing)
3/4"	-
1/2"	-
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

- C. Use cement conforming to one of the following:
1. Portland Cement conforming to ASTM C-150. Use only one brand of cement throughout the project.
 2. Blended hydraulic cement conforming to ASTM C-595 type IS, IS-A, IP, or IP-.
- D. Water shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. For finished Shotcrete, use curing water that is free from elements that could cause staining.
- E. Submit for acceptance proportioning and test data from prior experience. If data from prior experience are not available or accepted, make and have tested specimens from three or more different mix proportions. Submit mix design containing recommended mix proportions and test results for acceptance of ready-mixed Shotcrete. Air entrainment shall be 5-8% prior to pumping.
- F. General: Structural concrete shall conform to **Section XXX - Structural Concrete**. Structural reinforcing steel shall conform to **Section XXX - Reinforcing Steel**.
- G. Concrete Pigment: Concrete coloring shall conform to ASTM C979.
- H. Reinforcing Steel: reinforcing steel shall meet the requirements of **Section XXX - Reinforcing Steel**.

121.1.8 Compressive Strength

- A. Concrete compressive strength shall conform to **Section XXX - Structural Concrete**.

121.1.9 Source Quality Control

- A. Batching, Mixing, Transporting Mixed Concrete; Mixed Concrete or Truck Mixers: Shall comply with **Section XXX - Structural Concrete**.

121.1.10 Admixtures

- A. Use of admixtures shall be permitted upon approval by the ENGINEER.

121.1.11 Staining

- A. See **Section XXX – Structural Concrete Coating** of these specifications for information related to staining sculpted concrete.

121.3. Execution

121.2.1 Equipment

- A. All Shotcrete shall be applied to the substrate surface via pneumatic-feed or positive displacement guns. All guns, air compressors, delivery hoses, and nozzles shall work together to provide the appropriate Shotcrete product as determined acceptable by the ENGINEER. Failure to meet the desired product and strengths may result in rejection of equipment and/or methods employed by the CONTRACTOR at the discretion of the ENGINEER.

121.2.2 General

- A. "Sculpted concrete" shall be constructed with a single layer of concrete or Shotcrete. The CONTRACTOR is responsible for reviewing the DRAWINGS and deciding which application method will maintain the intended shape and grades. Any other application approach must be reviewed and approved by the ENGINEER.
- B. The "Test Section" shall be constructed first. This section will be inspected by the ENGINEER and OWNER. Once deemed acceptable and any necessary modifications to future work are discussed and agreed upon, the CONTRACTOR shall commence construction on other sculpted concrete. There is no specified sequence for the other areas.

121.2.3 Preparation

- A. Excavation to subgrade shall be carefully considered by the CONTRACTOR. Subgrade may be sloped uniformly or stepped in accordance with the grading shown on the DRAWINGS as a means of reducing the concrete/Shotcrete quantity required. No adjustment in quantity shall be made for concrete/Shotcrete placed at thicknesses greater than the uniform layer shown on the DRAWINGS. The building of earthen steps on top of a sloping subgrade plane that has been compacted and approved is strictly prohibited. All concrete/Shotcrete necessary to achieve the layout shown on the DRAWINGS shall be included in the unit cost of the sculpted concrete.

- B. Prior to placing concrete, the CONTRACTOR shall remove all debris and thoroughly dampen the surfaces that may be in contact with the concrete to be placed.
- C. The CONTRACTOR shall examine the subgrade, and the conditions under which concrete reinforcement is to be placed, and correct conditions that would prevent the proper and timely completion of the work. The subgrade shall be free of water, unfrozen, mud, debris, or loose materials and have met compaction requirements as specific in **Section XXX – Excavation and Fill**. The CONTRACTOR shall not proceed with the work until unsatisfactory conditions have been corrected.

A Shotcrete flash coat may be applied over the top of the completed subgrade. The flash coat shall consist of a 1-inch layer of Shotcrete that will cap and protect the subgrade material during placement of reinforcing steel and prior to placement of sculpted concrete. The flash coat thickness can be counted towards the total required thickness of sculpted concrete if the following conditions are met: This requirement may be waived by OWNER or ENGINEER if CONTRACTOR can demonstrate it is not required and will not compromise the quality of the structure.

1. The thickness of the flash coat does not exceed 1.5 inches.
 2. The flash coat is power washed clean after steel placement is complete.
 3. The flash coat Shotcrete does not excessively crack, break apart, and/or separate from the subgrade prior to placement of sculpted concrete. Determination of acceptance shall be performed by the ENGINEER.
- D. CONTRACTOR shall use compressed air from an air compressor to blow out construction debris and dirt at the bottom of members to be placed such as walls, beams, and columns, prior to final placement of forms that may obscure any joint. CONTRACTOR shall demonstrate to ENGINEER that all debris, such as concrete particles, saw dust, loose tie wire, bar tags, tape, trash, and dirt, have been thoroughly removed.
 - E. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.
 - F. No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms, and preparation of surfaces involved in the placing have been reviewed by ENGINEER.
 - G. Concrete shall be placed when form surfaces that may be in contact with the concrete, reinforcement, embedded items or sub-base are greater

than thirty-two degrees Fahrenheit (32°F). When the mean daily outdoor temperature is less than forty degrees Fahrenheit (40°F), the temperature of the concrete shall be maintained between fifty degrees Fahrenheit (50°F) and seventy degrees Fahrenheit (70°F) for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury as a result of concentration of heat. Combustion heaters shall not be used during the first twenty four (24) hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

- H. Concrete shall not be placed against forms exposed to heating unless the temperature of the forms is first cooled to less than or equal to ninety degrees Fahrenheit ($\leq 90^{\circ}\text{F}$).

121.2.4 Concrete Placement

- A. Concrete shall be placed directly on approved subgrade in accordance with the requirements set for in **Section XXX – Structural Concrete**.
- B. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.
- C. Concrete shall not be dropped more than five (5) feet unless confined by closed chutes or pipes. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the ends of projecting reinforcement.
- D. D. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement.
- E. E. Concrete shall not be pumped through aluminum alloy pipe.
- F. F. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete.

121.2.5 Shotcrete Placement

- A. Place Shotcrete using suitable delivery equipment and procedures that will meet the requirements of this specification. Refer to ACI Standard 506-66, Recommended Practice for Shotcreteing.
- B. Do not place Shotcrete if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle. Do not use rebound or previously expended material in the Shotcrete mix.

C. Remove over-spray or rebound prior to final set and before placement of Shotcrete material on such adjacent surfaces.

D. Placement Techniques:

1. Control thickness, method of support, air pressure, and/or water content of Shotcrete to preclude sagging or sloughing off. Discontinue Shotcreting or provide suitable means to screen the nozzle stream if wind or air currents cause separation of the nozzle stream during placement.
2. Dampen absorptive substrate surfaces prior to placement of Shotcrete to facilitate bond and to reduce the possibility of shrinkage cracking developing from premature loss of the mixing water.
3. Broom or scarify the surface of freshly placed Shotcrete to which, after hardening, additional layers of Shotcrete are to be bonded. Dampen surface just prior to application of succeeding layers.
4. Provide a supply of clean dry air adequate for maintaining sufficient nozzle velocity for all parts of the Work, and if required, for simultaneous operation of a suitable blow pipe for clearing away rebound.

E. Placement Around Reinforcement:

1. Hold the nozzle at such a distance and angle to place material behind reinforcement before any material is allowed to accumulate on its face. In the dry-mix process additional waste may be added to the mix when encasing reinforcement to facilitate a smooth flow of material behind the bars.
2. Do not place Shotcrete through more than one layer of reinforcing steel rods or mesh in one application unless demonstrated by pre-construction tests that steel is properly encased. Test to ascertain if any voids or sand pockets have developed around or behind reinforcement by probing with an awl or other pointed tool; by removal of randomly selected bars; or by coring or other suitable means.

121.2.6 Cover of Reinforcement

- A. Place concrete and/or Shotcrete to provide the 1 ½" (minimum) cover over all reinforcement.

121.2.7 Line and Thickness Control

- A. Use adequate ground wires or other accepted means to establish the thickness, surface planes, and finish lines of the concrete/Shotcrete.
- B. No additional payment will be made for concrete volume or steel reinforcement placed in excess of amounts shown on the DRAWINGS,

unless the ENGINEER agrees that conditions warrant such a change that go beyond the requirements set forth in [Section 120.1.9.A](#) of this SPECIFICATION. If the CONTRACTOR prepares the subgrade in such a manner requiring additional concrete to meet design lines and grades without ENGINEER approval, the ENGINEER may require additional reinforcement steel at no additional charge to the OWNER.

121.2.8 Consolidation

- A. Concrete vibrators for consolidating concrete shall be two and one-half inch (2-1/2") diameter "high cycle" vibrators with a frequency under load of eight thousand (8,000) to ten thousand four hundred (10,400) vibrations per minute (vpm). Concrete vibrators of lesser capacity are unacceptable for use in any part of the construction. CONTRACTOR shall have at least one standby concrete vibrator ready for use for every two (2) concrete vibrators in use during a concrete placement.
- B. All concrete shall be thoroughly consolidated with internal vibrators as recommended in ACI 309 immediately after deposition. The concrete shall be thoroughly worked around the reinforcing steel, around embedded items, and into corners of forms. Vibration shall be supplemented by spading, rodding, or forking to eliminate all honeycomb and voids around embedded items.
- C. The vibrator shall be inserted vertically, allowing it to penetrate rapidly to the bottom of the lift and at least six (6) inches into the previous lift. The vibrator shall be held at the bottom of lift for five to fifteen (5 - 15) seconds. The vibrator shall be pulled up at a rate of about three (3) inches per second.
- D. The vibrator shall be inserted so that the fields of action overlap. The field of action is approximately eight (8) times the vibrator's head diameter. Thus for a two and one half (2-1/2) inch diameter vibrator, the spacing of each insertion shall be approximately twenty (20) inches.
- E. Vibration shall be stopped when the concrete surface takes a sheen and large air bubbles no longer escape.
- F. Do not use a vibrator to move concrete horizontally.

121.2.9 Openings and Inserts

- A. Pipe sleeves, inserts for pipe connections, anchors, and forms for pipe holes shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. In the event that openings are inadvertently omitted or improperly placed, ENGINEER may require the concrete to be cored at the proper location. Filling of improperly placed openings shall be done

with expansive grout or dry pack or mortar applied with an accepted epoxy adhesive. The surfaces of the opening shall be roughened prior to filling.

121.2.10 Embedded Items

- A. At the time of concrete placement, embedded items shall be clean and free from mud, oil, and other coatings that may adversely affect bonding capacity. Aluminum embedments shall be coated with a bituminous material to prevent electrolytic action between the embedded item and reinforcing steel that results in concrete deterioration. Embedment items shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. Contact between embedded items and reinforcing steel or tendon ducts is unacceptable and is not permitted.

121.2.11 Construction Joints

- A. The location of all construction joints shall be subject to the acceptance of ENGINEER. The surface of all construction joints shall be thoroughly cleaned and all laitance and standing water removed. Clean aggregate shall be exposed by abrasive blast cleaning. Wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning. Construction joints shall be keyed at right angle to the direction of shear. Except where otherwise shown on the DRAWINGS, keyways shall be at least one and one-half (1-1/2) inch in depth over at least twenty five percent (25%) of the area of the section.
- B. Construction joints shall not be allowed within a location where water is expected to flow over in the final constructed condition.
- C. Taper construction joints to a shallow edge form, about 1 inch thick, except where the joint will be subjected to compressive stress. In this case, use non-tapered joints and take special care to avoid or remove trapped rebound at the joint.
- D. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional concrete/Shotcrete.
- E. Make joints perpendicular to the main reinforcement. Continue reinforcement across joints.
- F. Position construction and control joints to conform to the locations of natural occurring cracks and joints in the simulated rock and earth forms.

121.2.12 Finishes

- A. CONTRACTOR will provide an expert(s) to perform texturing and shaping of the concrete/Shotcrete that is left exposed above ground.

- B. Finished product shall simulate natural rock as described in the SPECIFICATIONS and DRAWINGS. The CONTRACTOR shall achieve the desired appearance by 1) troweling the concrete/Shotcrete smooth, 2) cutting rock formation scars into the surface, and 3) texturing the entire surface using both texture mats and power washing to achieve a natural rock finish. Alternative methods must be approved by ENGINEER.
- C. Extend texture layer a minimum of 3 feet below finished grade.
- D. If a trail section is included in the sculpted concrete a broom finish shall be applied to the trail surfaces shown on the DRAWINGS. Broom marks shall be perpendicular to the traveled direction. The broomed surface shall be smooth and void of sculpted concrete carvings.

121.2.13 Curing and Protection

A. Concrete:

- 1. Curing requirements specified in **Section XXX - Concrete Curing**, shall be followed at all times.
- 2. The use of an evaporative retardant is required to assist in proper placement of concrete in accordance with **Section XXX - Concrete Curing**. Apply two (2) times; after screeding and after the first floating operation. The retardant should be applied at a rate of one (1) gallon of sprayable solution per two hundred to four hundred (200 - 400) square feet by spraying with an industrial type sprayer. If the nozzle of the sprayer becomes plugged, CONTRACTOR shall clean or replace the nozzle. Under no circumstances shall the retardant be used except by spraying a mist with a nozzle. The retardant shall be applied in strict conformance with the manufacturer's recommendations and precautions. In no case shall the retardant be used as a finishing agent. The use of an evaporative retardant requires review and approval by ENGINEER.

B. Shotcrete:

1. Initial Curing

- a. Following curing procedures of ACI Standard 308. Immediately after finishing, keep Shotcrete continuously moist for at least 24 hours. The methods and materials used for curing shall be approved by ENGINEER prior to placing Shotcrete.

2. Final Curing

- a. Provide additional curing immediately following the initial curing and before the Shotcrete has dried. Use one of the following materials or methods:

- i. Continue the method used in initial curing.
 - ii. Materials conforming to "Specifications for Sheet Materials for Curing Concrete," (ASTM C171).
 - iii. Other moisture retaining coverings accepted upon approval by ENGINEER.
- b. Duration and Temperature of Curing
 - c. Continue curing for the first 7 days after installation or for the first 3 days if high early strength is obtained. During the curing period, maintain Shotcrete or concrete above 40° F and in a moist condition as specified above. Prevent rapid drying at the end of the curing period.

121.2.14 Repair of Surface Defects

- A. Remove and replace concrete or Shotcrete, which lacks uniformity, exhibits segregation, honeycombing, or lamination, or which, contains any dry patches, slugs, voids or sand pockets. Remove and replace damaged in-place concrete or Shotcrete.
- B. Replace any concrete or Shotcrete which subsides after placement.

121.2.15 Field Quality Control

- A. CONTRACTOR shall assist OWNER or the concrete testing consultant as requested during the performance of quality control testing. Testing will be taken from the concrete truck.
- B. Test panels shall be shot for the Shotcrete. The panels should be 18" by 18" by 3" and shot at the same orientation as the majority of the structure. Panels shall be shot for every day of placement and every 25 CY of Shotcrete placed. All panels should be cured at the project site. Cores should be taken from the panel in accordance with ASTM C 42. Cores will be used to verify compressive strength. CONTRACTOR is to provide the panels for use in Shotcrete testing and have them available in the field prior to the start of Shotcrete. CONTRACTOR is to notify the ENGINEER 48 hours in advance of the start of Shotcrete operations.

END OF SECTION

Section 122

Structural Concrete Coating

122.1. General

122.1.1 Description

- A. This WORK shall consist of furnishing and applying two (2) coats of a semi-opaque pure acrylic water repellent and colored coating to all designated concrete surfaces in accordance with the DRAWINGS and SPECIFICATIONS.

122.1.2 Related Sections

- A. **Section XXX - Concrete Finishing.**

122.1.3 Submittals

- A. Submit color mixture to be used in a color block for approval by OWNER.

122.1.4 Quality Assurance

- A. Mock-ups:
 - 1. Three (3) two-foot by two-foot (2' x 2') samples showing the designated colors and texture shall be prepared for initial approval. The coating shall be applied by the same method to be used in the final field application to a surface similar in pattern and texture to the surfaces to be coated on the PROJECT.
 - 2. A final sample for the chosen color and texture measuring at least four feet by four feet (4' x 4') shall be prepared as specified above and shall be set at the PROJECT site for a period of three (3) days for review by ENGINEER. The final samples shall receive ENGINEER's written approval before the coating can be incorporated into the WORK.

122.2. Products

122.1.5 Materials

- A. The coating shall be self-priming, semi-opaque colored toner containing only methyl methacrylate ethyl acrylate copolymer resins. The toning pigments shall be suspended in solution at all times by a chemical suspension agent and solvent. The toning pigments shall be laminar silicates, titanium dioxide, and inorganic oxides. There shall be no settling or color variation. Use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of the coating formulation shall not be permitted.

Physical Properties	
Weight by Gallon	8.3 lbs, min.
Solids by Weight	30% min.
Sand (Silicone)	3.2 to 3.8 lbs/gallon (exclude at retaining walls with form liner finish)

122.3. Execution

122.2.1 Preparation

- A. All concrete finishing shall be completed in accordance with the SPECIFICATIONS. The concrete shall be at least fourteen (14) days old before the bonding agent and coating may be applied.
- B. Prior to application of the coating material, all voids and irregularities shall be pointed and trued with a mortar consisting of cement and fine sand aggregate. Only minor voids, which can be completely filled with the coating material, may remain.
- C. Within twenty-four (24) hours before the coating is applied, the concrete surfaces to be coated shall be hot water blasted at a minimum of three thousand (3,000) psi followed by a cold-water rinse to remove dirt, curing agents, form release agents, or other foreign substances that would be detrimental to the coating penetration or color.
- D. All surfaces to be coated shall be clean, dry, and free of frost or other foreign substances at the time of application.

122.2.2 Application

- A. The coatings shall be applied to all exposed concrete elements above the ground line and shall extend a minimum of one (1) foot below the ground line or as shown on the DRAWINGS.
- B. The coating shall be applied only when the ambient temperature is between forty degrees Fahrenheit (40°F) and ninety degrees Fahrenheit (90°F).
- C. The coating shall be mixed by a mechanical mixer and shall be applied by spraying. A roller shall be used immediately after the spray application to obtain texture and fill minor voids as approved by ENGINEER. A brush may be used to apply coating to form liner finishes as approved by ENGINEER.
- D. The process shall be applied uniformly in the following sequences:
 1. Application of the first coat applied at a rate of forty-five (45) square feet per gallon, and eighty (80) square feet per gallon for the second coat.

2. The second coat shall not be applied until at least twelve (12) hours after application of the first coat, but not to exceed ninety-six (96) hours, or as recommended by the manufacturer.
3. Workmanship shall be such that the final coated surface is colored uniformly and presents a pleasing appearance.

END OF SECTION

Section 123

Seeding

123.1. General

123.1.1 Description

- A. The WORK under this section consists of the revegetation with seeded grasses. CONTRACTOR shall furnish all labor, materials, equipment, tools, and transportation required to complete the WORK, and shall perform all operations in connection with and reasonably incidental to establishing, maintaining, and warranting the reseeded areas.
- B. All WORK shall be completed in accordance with these SPECIFICATIONS, the DRAWINGS and CONTRACT DOCUMENTS, and in a manner consistent with accepted horticultural practices. All permits, licenses, and fees associated with any WORK under this CONTRACT are the responsibility of CONTRACTOR, unless otherwise noted.

123.1.2 Related Sections

- A. Section XXX – Topsoil?
- B. Section XXX – Excavation and Embankment

123.1.3 References

- A. Association of Official Seed Analysts (AOSA).

123.1.4 Submittals

- A. CONTRACTOR shall be required to submit statements of guarantee and/or certifications from vendors who supply seed, mulches, tackifiers, and fertilizers.
- B. CONTRACTOR shall furnish to ENGINEER a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory for seed testing within six (6) months prior to the date of delivery.
- C. Seed container labels shall be submitted to ENGINEER at the completion of PROJECT.
- D. CONTRACTOR shall submit to ENGINEER the manufacturers guaranteed chemical analysis, name, trade name, trademark, and conformance to state law of all fertilizers and herbicides.
- E. Submit compost sample for approval.

123.1.5 Delivery, Storage, and Handling

- A. All materials shall be furnished in original manufacturers shipping bags or containers and remain in these bags or containers until they are used. All materials shall be stored in a manner that will prevent them from coming into contact with precipitation, surface water, or any other contaminating substance.
- B. Fertilizer: It shall be delivered in original, unopened containers, unless provisions are made and approved by ENGINEER for bulk deliveries to the site of the WORK.
- C. Herbicide: It shall be delivered in original, unopened containers, unless provisions are made and approved by ENGINEER for bulk deliveries to the site of the WORK. All herbicides will be stored in a manner that satisfies local, State and Federal Guidelines for Herbicide Storage.

123.2. Products

123.1.6 General

- A. All materials used shall be new and without flaws or defects of any type, and shall be the best of their class and kind. Seeds shall be prepared for sale during the year of installation.
- B. All materials and equipment furnished shall be free of noxious weeds including, but not limited to Russian knapweed, diffuse knapweed, Canada thistle, field bindweed, Johnsongrass, leafy spurge, kochia, or any state-listed noxious weed species.
- C. Any materials that have become wet, moldy, or otherwise damaged in transit or in storage shall not be used.

123.1.7 Seed

- A. Seed shall be only that which is specified by ENGINEER or PLANT ECOLOGIST (refer to DRAWINGS). All seed shall be mixed by a wholesale seed supplier in order to obtain the specified mixture and application rate required by ENGINEER or PLANT ECOLOGIST. No species substitutions shall be permitted without prior approval of the ENGINEER or PLANT ECOLOGIST.
- B. All seed shall conform to all current State and Federal regulations and shall be subject to the testing provisions of the Association of Official Seed Analysts.
- C. All seed and seed mixes shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the common, scientific, and variety name(s) of the seed(s), the lot number, point of

origin, net weight, percent of weed content, and the guaranteed percentage of purity and germination.

- D. All seed shall be guaranteed for purity and germination, free of noxious weed seed and supplied on a Pure Live Seed (PLS) basis.

123.1.8 Fertilizer

- A. Fertilizer shall be as shown on the DRAWINGS. All fertilizer shall be a standard commercial product of uniform composition, free flowing and conforming to applicable State and Federal laws.
- B. No cyanamide compounds shall be permitted in fertilizers.

123.1.9 Mulch

- A. The type of mulching material to be used shall be crimped weed-free straw. At least seventy percent (70%) of the mulch by weight shall be ten (10) inches or more in length. Mulch shall not contain any noxious weed, must, mold, cake, or decay. No hay may be used on the PROJECT unless approved in advance by the PLANT ECOLOGIST.

123.1.10 Organic Tackifier/Binder

- A. Organic tackifier/binder shall be applied as shown on the DRAWINGS.

123.1.11 Erosion Control Netting, Blankets, Mats, Fabrics

- A. Erosion control blankets, mats, or other commercial products for stabilizing land disturbed areas may be required in certain areas. If so, the type, manufacturer, and installation method for these products shall be specified by ENGINEER or PLANT ECOLOGIST.

123.1.12 Water

- A. All water used on the PROJECT shall be free of any substances harmful to plant germination and growth or to the environment in general. CONTRACTOR shall be responsible for furnishing and applying water that meets these requirements. ENGINEER or PLANT ECOLOGIST may, at CONTRACTOR's expense, submit samples of water used on the PROJECT for laboratory analysis (of a reasonable number and kind) to ensure the quality of the water. Onsite water shall not be used unless approved by OWNER or OWNERS REPRESENTATIVE.

123.1.13 Topsoil and Wetland Topsoil

- A. Topsoil and Wetland Topsoil shall meet the requirements of **Section XXX – Topsoil.**

123.1.14 Organic Compost (Soil Amendment)

- A. For use as a component for seed establishment use a well decomposed, stable, weed free organic matter source, derived from agricultural food, or industrial residuals' biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (less than one percent [$<1\%$] by dry weight) of man-made foreign matter. Compost shall be processed at sustained high heat so that any weed seeds contained within it shall no longer be viable and it shall possess no objectionable odors and shall not resemble the raw material from which it was derived.
- B. Compost shall have the following characteristics:
 - 1. pH Range: 5.5 - 8.0.
 - 2. Moisture Content: 35% - 55%.
 - 3. Particle Size: Pass through 1-inch screen or smaller.
 - 4. Stability: Stable to highly stable, providing nutrients for plant growth.
 - 5. Maturity/Growth Screening: Demonstrate ability to enhance plant growth.
 - 6. Soluble Salt Concentrations: 2.5 dS (mmhos/cm) or less preferred.
 - 7. Organic Matter Content: 30% - 70%.
 - 8. Suggested Source: A-1 Organic, Eaton, Colorado (970) 454-3492 or an approved equal.

123.3. Execution

123.2.1 General

- A. Contractor's Site Responsibilities: It shall be the responsibility of CONTRACTOR to locate and protect all utilities, structures, roadways, parking areas, fences, survey markers, and existing vegetation (such as, trees and shrubs) on all WORK sites. Any damage caused by CONTRACTOR or SUBCONTRACTORS shall be immediately repaired or corrected by CONTRACTOR at no expense to OWNER.
- B. Timing of the Work: Seeding shall be completed as soon as practical after the completion of final grading. CONTRACTOR shall coordinate the actual start of the seeding operation with ENGINEER or PLANT ECOLOGIST. Seeding shall occur between September 15 and April 15, unless otherwise permitted by the ENGINEER or PLANT ECOLOGIST
- C. Notice to Proceed: CONTRACTOR shall inform ENGINEER when they are ready to commence permanent revegetation. Upon agreement with CONTRACTOR's preparation for this WORK ENGINEER shall provide

CONTRACTOR with a Notice to Proceed. CONTRACTOR shall begin and complete the WORK as specified in this section.

- D. Performance of the WORK: All WORK is to be performed by personnel thoroughly familiar with proper and accepted methods for soil preparation, herbicide applications, fertilizing, seeding, and mulching. All WORK is to be performed under the direct supervision of CONTRACTOR's superintendent, who shall be thoroughly familiar with the provisions of this CONTRACT.
- E. Project Monitoring: CONTRACTOR shall notify ENGINEER prior to the commencement of any WORK under this section. ENGINEER shall monitor the progress of the WORK throughout the CONTRACT period, and shall assist in determining where soils samples, as required in Article Submittals, are to be collected. ENGINEER or PLANT ECOLOGIST shall also collect samples of the seed used on the PROJECT, and may collect samples of fertilizers, soil additives, water, or other materials as they deem necessary to ensure the PROJECT SPECIFICATIONS are met.

123.2.2 Soil/Seedbed Preparation, Soil Amendments

- A. All ripping and tilling operations shall be done in a direction which follows the natural contour of the land on slopes of three to one (3:1) or less. Soils on slopes greater than three to one (3:1) shall be prepared for planting in a manner specified by ENGINEER. Any irregularities in the ground surface resulting from soil preparation operations shall be corrected and sloped to drain.
- B. Limit subgrade preparation to areas that shall be planted in the immediate future.
- C. Prior to spreading salvaged topsoil and seeding, thoroughly till or rip to a depth of twelve (12) inches all areas compacted by access, staging, or construction traffic. Till all remaining areas to a depth of six (6) inches. Channel bottom areas are to be ripped to a depth of at least twelve (12) inches on approximately two- (2-) to four- (4-) foot centers. The soils shall be worked until no clods greater than two (2) inches in diameter remain, unless directed otherwise by ENGINEER. Remove rocks and other objects three (3) inches or greater in any dimension.
- D. Spread topsoil to depth required to meet grades and elevations shown on DRAWINGS after light rolling and natural settlement.
- E. Either mix soils with soil amendments and fertilizers before spreading or apply soil amendments or fertilizers on surface of spread topsoil and till thoroughly into top four (4) inches before planting. Mix soil amendments at the rate that is indicated on the DRAWINGS. Delay mixing fertilizer if planting does not follow placing of planting soil within a few days.

- F. Organic Compost:
 - 1. Organic Compost Soil Amendment shall be applied at a rate of three (3) cubic yards per one thousand (1,000) square feet or as shown on the DRAWINGS.
 - 2. Organic Compost shall only be applied if required and designated on the DRAWINGS.
- G. Prior to seeding, grade the areas to be seeded to a smooth, even surface with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Soils shall meet grades and elevations shown on DRAWINGS after light rolling and natural settlement. Limit fine grading to areas that can be planted in the immediate future.
- H. Moisten prepared areas to be seeded prior to planting when soils are dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy conditions. Restore prepared areas if eroded or disturbed after fine grading and before planting.

123.2.3 Seeding

- A. General: ENGINEER or PLANT ECOLOGIST shall be on site during seeding operations and will collect representative samples of the seed used on any PROJECT for testing/compliance purposes. CONTRACTOR shall notify ENGINEER or PLANT ECOLOGIST when seeding is to take place so these samples can be obtained (seed tags from all mixtures shall also be supplied to the ENGINEER or PLANT ECOLOGIST).
- B. Drill Seeding:
 - 1. All seed is to be drilled one-quarter (1/4) inch to one-half (1/2) inch into the soil at the specified pure live seed (PLS) per acre rate with a mechanical grass drill with depth bands and an agitator in the seed box. Rows shall be spaced not more than seven (7) inches apart. CONTRACTOR shall drill one-half (1/2) of the required PLS per acre in one compass direction, and then drill the remaining half of the required PLS per acre in a direction ninety degrees (90°) to the first half.
 - 2. Following drill seeding of all areas, the forb patch seed mix and the grass/shrub patch seed mix should be broadcast in the areas specified on the DRAWINGS. All forb and grass/shrub patch areas shall be both drill seeded with the appropriate upland or riparian mix as specified on the DRAWINGS and then immediately broadcast with the appropriate forb or grass/shrub patch seed mix prior to mulch application
- C. Broadcast Seeding:
 - 1. Some portions of PROJECT areas may be inaccessible to a drill. In these areas, which shall be agreed upon by CONTRACTOR and

ENGINEER or PLANT ECOLOGIST, seed shall be uniformly broadcast at twice the specified PLS per acre and covered with soil to a depth of one-quarter (1/4) inch to one-half (1/2) inch by hand raking or harrowing by some other means acceptable to ENGINEER or PLANT ECOLOGIST.

2. Broadcast seeding shall be accomplished using hand-operated "cyclone-type" seeders or rotary broadcast equipment attached to construction or revegetation machinery. All machinery shall be equipped with metering devices. Broadcasting by hand shall be acceptable on small, isolated sites. Prior to hand broadcast seeding, divide the seed required into two portions. Apply the first half of the seed and then follow up by applying the second portion to ensure complete coverage by seed. When broadcast seeding, passes shall be made over each site to be seeded in a manner to ensure an even distribution of seed. When using hopper type equipment, seed shall be frequently mixed within the hopper to discourage seed settling and uneven planting distribution of species.
3. Broadcast seeding shall take place immediately following the completion of final seedbed preparation techniques and upon inspection and approval of ENGINEER. Broadcast seeding should not be conducted when wind velocities would prohibit even seed distribution.

123.2.4 Fertilization

- A. Any fertilizers specified by ENGINEER or PLANT ECOLOGIST shall be applied and mixed with the soil as specified in Article Soil/Seedbed Preparation, Soil Amendments. In some instances, as directed by ENGINEER or PLANT ECOLOGIST, fertilizers shall be spread evenly on the surface of the soil rather than tilled into the top four (4) inches. All fertilizers shall be applied using standard application equipment at rates indicated by required soils tests (Article Submittals), or in some cases as specified by ENGINEER or PLANT ECOLOGIST.

123.2.5 Mulching

- A. Straw mulch shall be applied immediately after seeding has been completed with a mechanical spreader at a rate not less than one and one-half (1-1/2) tons per acre, and not more than two (2) tons per acre. Straw mulch shall then be anchored to the soil with a standard commercial crimper which shall crimp the fiber four (4) inches or more into the soil. Failure to apply designated mulch at the specified rate may result in the ENGINEER or PLANT ECOLOGIST requiring the CONTRACTOR to remobilize and complete the specified WORK at no additional cost to the OWNER.

123.2.6 Herbicide/Chemical Applications

- A. All noxious weed growth on the site shall be controlled by the CONTRACTOR during the construction period and until the final inspection by spot application of herbicides which have been pre-approved by the ENGINEER or PLANT ECOLOGIST. Spot application of herbicides means detailed application of only the targeted weed species by wand or wick with a backpack applicator. No herbicides shall be permitted for general application (broadcast) during a time when it would cause detrimental impact to germination or establishment of the seeded grasses.
- B. Herbicides or other chemicals, if required, shall be applied using well-maintained spraying equipment by individuals working for CONTRACTOR who are appropriately licensed by any State and/or Federal agency having jurisdiction over such applications. It shall be the responsibility of CONTRACTOR to be knowledgeable of any and all current laws and regulations pertaining to herbicide and other chemical applications, and to advise ENGINEER or PLANT ECOLOGIST immediately if any requests for these applications made by ENGINEER or PLANT ECOLOGIST are inappropriate as they pertain to these laws and regulations. Herbicide application shall be conducted by trained weed control personnel who also can recognize the targeted weed species.
- C. Herbicides and other chemicals shall not be applied during periods when wind or other physical conditions cause the herbicides or chemicals to be transported a distance of more than five (5) feet from the immediate area where they are being placed. It shall be the responsibility of CONTRACTOR to stop WORK immediately and to notify ENGINEER or PLANT ECOLOGIST if any weather or other physical condition exists which would make the application of herbicides or other chemicals inappropriate.
- D. All herbicides or other chemicals used (except solid fertilizers, Article Fertilizers) shall be applied at a rate and strength, and by the method recommended by the manufacturer of the product being used. Failure to properly apply herbicides (spot treatment) may result in the ENGINEER or PLANT ECOLOGIST requiring the CONTRACTOR to reseed the damaged area at no cost to the OWNER.

123.2.7 Erosion Control Netting, Blankets, Mats, Fabrics

- A. Slopes over three to 1 (3:1), concave areas on slopes, drainage swales, areas along the edges of hard surfaces (trails and roads), and any other areas which may rill, shall be mulched with jute netting or other erosion control fabric as specified in DRAWINGS. These fabrics shall be installed only after the installation area is graded smooth. All clods or rocks shall

be removed from the area, so that the fabric will lie flat on the surface of the soil and not bridge over it. The edges of the fabric shall be secured by two- (2-) foot wooden stakes installed two (2) feet on center along all edges and seams. Seams shall overlap one (1) foot and the body of the fabric shall be further secured to the soil surface on three- (3-) foot centers. The fabric shall not be stretched tight.

123.2.8 Field Quality Control

A. Final Acceptance:

1. When WORK has been completed for the PROJECT, CONTRACTOR and ENGINEER shall inspect the site together and determine the total area of the WORK, and whether or not the WORK is complete and has been done in accordance with CONTRACT DOCUMENTS and SPECIFICATIONS. If mutual agreement cannot be reached on these issues, the determinations made by ENGINEER shall be final. Deficiencies in the WORK, if any, shall be noted and a checklist of these deficiencies given to CONTRACTOR by ENGINEER. CONTRACTOR shall immediately correct any deficiencies listed on the checklist at no cost to OWNER.
2. When all checklist items are completed to the satisfaction of ENGINEER, ENGINEER shall issue a Certificate of Final Acceptance. CONTRACTOR shall then submit these items for payment to OWNER based on the original project BID prices and any CHANGE ORDERS which have been agreed to and signed by both parties.

123.2.9 Cleaning

- A. All WORK sites shall be kept clean and free from all debris. At the conclusion of WORK at any site, CONTRACTOR shall remove and haul from the site all excess materials, debris, and equipment. Any damage (for example, damaged fencing, damaged road surfaces, excessive tire furrows, mud tracked onto pavement) resulting from CONTRACTOR's activities shall be repaired by CONTRACTOR to ENGINEER's satisfaction at no expense to OWNER.

END OF SECTION

Section 124

Sealants

124.1. General

124.1.1 Description

- A. The CONTRACTOR shall furnish all labor, materials, tools, equipment, and perform all WORK and services for all sealant WORK, both exterior and interior where the words caulk, caulking, or sealant is shown on DRAWINGS or specified, in accordance with provisions of the CONTRACT DOCUMENTS, and completely coordinated with WORK of all other trades.
- B. Although such WORK is not specifically indicated, CONTRACTOR shall furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to, or necessary for, a sound, secure, and complete installation.

124.1.2 Related Sections

- A. Section XXX – Structural Concrete

124.1.3 References

- A. ASTM International (ASTM):
 - 1. ASTM C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
 - 2. ASTM C920, Standard Specification for Elastomeric Joint Sealants.
 - 3. ASTM D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- B. Sealant, Waterproofing and Restoration Institute (SWRI):
 - 1. SWRI 2, Sealants the Professionals' Guide.
 - 2. SWRI 7, Sealant Specifications.
- C. Federal Specification (FED):
 - 1. H-08-1 SEC 07920, Sealants and Caulking.

124.1.4 Submittals

- A. CONTRACTOR shall submit product SPECIFICATIONS for all items pertaining to the WORK covered in this section.

124.2. Products

124.1.5 Manufacturers

- A. Materials, equipment, and accessories specified in this section shall be products of:
 - 1. Potable Water Containment Structures (Polyurethane Sealant): Sika; Sikaflex 1-a or Sikaflex 1-c.
 - 2. Fire Resistant Sealant for Buildings: General Electric; 3-6548 silicone RTV foam.
 - 3. Portland cement Concrete Pavements:
 - a. Dow Corning; 888 or 890.
 - b. Sika; Sikaflex, 15 LM.
 - 4. Portland Cement Concrete Curb, Gutter, and Sidewalk: Sika; Sikaflex 1-a or Sikaflex 1cSL.

124.1.6 Materials

- A. Sealant:
 - 1. Type: Provide non-sagging sealant for vertical joints. Sealants for horizontal joints may be self-leveling.
 - 2. Filler Compatibility: Before use of any sealant, investigate its compatibility with joint surfaces, fillers, and other materials in joint system. Provide only materials compatible with installation conditions.
 - 3. Color: Provide colors matching materials being sealed. Where compound is not exposed to view in finished WORK, provide manufacturer's color which has best performance.
- B. Joint Cleaner: Provide as recommended by sealant manufacturer.
- C. Joint Primer-Sealer: Provide as recommended by sealant manufacturer.
- D. Bond Breaker: Bond breaker material shall be furnished as recommended by sealant manufacturer.
- E. Sealant Backer Rod: Rod stock of polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer. The backer rod shall:
 - 1. Control joint depth.
 - 2. Break bond of sealant at bottom of joint.
 - 3. Provide proper shape of sealant bead to minimize possibility of sealant extrusion.

- F. Compressible Sealant:
 - 1. Size compressible sealant so that width of material is twice joint width.
 - 2. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing.
 - 3. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on front face with non-reactive release agent that will act as bond breaker for applied sealant.
 - 4. Apply adhesive as recommended by sealant manufacturer.

124.3. Execution

124.2.1 General

- A. Perform WORK in accordance with SWRI requirements for materials and installation or in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Maintain one (1) copy of each SWRI document on site.
- C. Areas to be Sealed: Seal any joints or areas which may permit penetration of moisture, unless sealing WORK is specifically required under other sections and/or as shown on the DRAWINGS. Make all joints watertight.
- D. Priming: Where required, prime joint surfaces. Limit application to surfaces to receive caulking. Mask off adjacent surfaces.

124.2.2 Preparation

- A. Surface Preparation: Clean all joint surfaces. Joint walls shall be sound, clean, dry, and free from oil, grease, and frost. Curing compound residues and any other foreign matter shall be thoroughly removed. Where required to completely clean the joint, the joint shall be mechanically cleaned by water or sand blasting.

124.2.3 Application

- A. Bond Breaker or Backer Rod Installation: Install bond breaker or backer rod as specified to regulate depth of sealant.
- B. Compressible Joint Sealant: Install compressible sealant in joint to depth recommended by manufacturer. Take care to avoid contamination of sides of joint. Protect sidewalls of joint (to depth of sealant) as recommended by manufacturer. Install with adhesive on two (2) faces in contact with sides of joints.
- C. Sealant:
 - 1. Location:

- a. One or two component polyurethane (exterior and interior use).
 - b. One or two component silicone (exterior use and interior wet area use).
 - c. Compressible Sealant (where indicated).
 - d. Epoxy Sealants (where indicated).
2. The joint shall be cleaned as recommended by sealant manufacturer.
 3. The joint shall be primer-sealed as recommended by sealant manufacturer.
 4. Use sufficient pressure to fill all voids and joints solid. Apply sealant when joint slot is at the mid-point of its designed expansion and construction. Install sealant with hand or power-operated caulking gun horizontally in one (1) direction and vertically from top to bottom. Avoid overlapping of sealant to eliminate entrapment of air.
 5. To facilitate tooling, wet concave pointing tool with a diluted soap solution. Apply sealants when the surface and ambient temperature is forty degrees Fahrenheit (40°F) or higher and in accordance with the temperature limitations of the manufacturer.

124.2.4 Manufacturer's Field Services

- A. Field Services: Obtain sealing compounds only from manufacturers who shall, when required, provide services of manufacturer's field service representatives at PROJECT site for purposes of advising and instructing installers in proper procedures and precautions for use of materials. Provide such services, when required, without expense to OWNER.

124.2.5 Cleaning

- A. Dispose of all spillage and refuse sealant material in accordance with applicable regulations.

END OF SECTION

Section 125

Topsoil

125.1. General

125.1.1 Description

- A. This work consists of placing of topsoil or wetland topsoil upon constructed cut and fill slopes or in designated areas after grading operations are complete.

125.1.2 Related Sections

- A. **Sections 100-110** for general specifications.

125.1.3 Quality Control

- A. ASTM International (ASTM):
 1. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
 2. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

125.1.4 Submittals

- A. Informational Submittals:
 1. Certified Topsoil Analysis Reports:
 - a. Indicate quantities of materials required to bring onsite.
 - b. Provide certification of topsoil compliance with gradation requirements.
 - c. Provide certification of topsoil compliance with Chemical attribute requirements.
 - d. Provide certification of topsoil compliance with minimum ammonium bicarbonate DPTA (chelate) extractable nutrient requirements.

125.1.5 Sequencing and Scheduling

- A. Topsoil
 1. Topsoil shall be placed directly upon completed cut and fill slopes whenever conditions and the progress of construction will permit.
- B. Wetlands Topsoil

1. CONTRACTOR shall prepare the wetland relocation site to elevations specified in the DRAWINGS or as approved by ENGINEER prior to excavating the wetlands topsoil. If ENGINEER determines that this is not possible, then CONTRACTOR shall stockpile wetlands topsoil material in an approved area, to remain undisturbed until the relocation site has been prepared.
2. Wetland topsoil shall be placed within twenty-four (24) hours in the wetland relocation site.

125.2. Products

125.2.1 Topsoil

- A. Topsoil shall consist of natural, friable, sandy loam, native upland topsoil with characteristics as defined in [Section 125.2.01 sub-section C](#). Topsoil shall be obtained from pre-approved on-site collection areas or pre-approved imported materials from off site.
- B. Topsoil shall have the following characteristics; resulting from a current agronomic and full textural class analysis of a topsoil sample collected from the actual soil proposed to be used. The results of the tests shall be submitted to the ENGINEER and must include sample date and reference the collection location.
- C. Composition shall be in general accordance with ASTM D5268 subject to the following:
 1. Gradation

Texture Class	% of Total Weight	Average %
Sand (0.05-2.0 mm dia. range)	25-75	50
Silt (0.002-0.05 mm dia. range)	15-40	27.5
Clay (<0.002 mm dia. range)	15-30	22.5

2. Chemical Attributes

Chemical Attribute	Range
pH	6.8-7.5
Organic Matter	1% - 3%
Salinity	EC < 2 mmhos/cm

3. Topsoil shall contain the following minimum ammonium bicarbonate DPTA (chelate) extractable nutrients.

Nutrient	Concentration
Nitrogen	5 ppm air dried basis
Phosphorous	5 ppm
Potassium	30 ppm
Iron (Fe)	5 ppm

125.2.2 Wetlands Topsoil

- A. Wetlands topsoil shall meet the requirements of [Section 125.2.01](#) above.
- B. Topsoil collected from wetlands sites shall be used only in wetlands areas.
- C. Wetlands Topsoil salvaged from the site shall not be used as topsoil outside of areas designated on the DRAWINGS.
- D. Source: Stockpile material onsite, in accordance with Mile High Flood District specifications for Topsoil Stripping and Stockpiling. Import topsoil if onsite material is insufficient in quantity, or quality.

125.2.3 Source Quality Control

Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

125.3. Execution

125.3.1 Topsoil Placement

- A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the WORK.
- B. Topsoil shall be placed directly upon completed cut and fill slopes whenever conditions and progress of construction permit.
- C. Approved topsoil shall be placed at locations and to the thickness as designated in the CONTRACT DOCUMENTS. Prior to final placement of topsoil, any areas compacted by construction activities shall be decompacted to at least 85 Proctor by repeated ripping in rows twelve inches (12") or less, apart, to a depth of twelve inches (12"). All subsoil areas, including any graded areas or cut slopes should be roughened with furrows four to six inches (4"-6") deep to key the topsoil into the subsoil.
- D. Water shall be applied to the topsoil in a fine spray by nozzles or spray bars so the topsoil areas will not be washed or eroded.
- E. Uniformly distribute topsoil to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.
- F. Material shall be free from objects larger than 1-1/2 inches maximum dimension including hard clods of heavy clay, shale, decomposed shale or other subsoil, noxious weed parts (roots, seeds, or shoots), grass, refuse, stumps, roots, brush, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

- G. Placed topsoil shall be stabilized immediately by:
 - 1. Preparing and seeding with the approved seed mixture and mulch,
 - 2. Installing perimeter silt fence and/or straw wattles,
 - 3. Roughening and application of 2500 pounds per acre hydromulch with 150 pounds per acre approved tackifier and later seeding and mulching, per the plans.

125.3.2 Wetlands Topsoil Placement

- A. All subsoil areas, including any graded areas or cut slopes should be roughened with furrows four to six inches (4"-6") deep to key the topsoil into the subsoil.
- B. Wetlands topsoil salvaged from the site shall be placed in locations specified on the DRAWINGS to a depth of eighteen inches (18") or as otherwise designated.
- C. Wetland topsoil in an unworkable condition due to excessive moisture, frost or other conditions shall not be placed until it is suitable for spreading.
- D. Water shall be applied to the topsoil in a fine spray by nozzles or spray bars so the topsoil areas will not be washed or eroded.
- E. After the wetland topsoil is spread all large stiff clods, rocks, roots and other foreign matter shall be cleared and disposed of by the CONTRACTOR.

END OF SECTION